MINNEAPOLIS-ST. PAUL INTERNATIONAL AIRPORT

14 CFR Part 150 Update

UPDATED
NOISE EXPOSURE MAPS
and
NOISE COMPATIBILITY PROGRAM

VOLUME I

Prepared for:

METROPOLITAN AIRPORTS COMMISSION

Prepared by:

HNTB Corporation

November 2004

CERTIFICATION

This is to certify the following:

The Noise Exposure Maps and associated documentation for Minneapolis-St. Paul International Airport submitted in this volume to the Federal Aviation Administration under 14 Code of Federal Regulations Part 150, Subpart b, Section 150.21, are true and complete under penalty of 18 U.S.C Part 1001.

All interested parties have been afforded opportunity to submit their views, data and comments concerning the correctness and adequacy of the revised existing and forecast conditions noise exposure map, and of the descriptions of forecast aircraft operations.

By: _____

Date: 11-17-04

Airport Name:	Minneapolis-St. Paul International Airport
Airport Operator:	Metropolitan Airports Commission
Address:	6040 28th Avenue South Minneapolis, MN 55450 (612) 726-8100

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Chapter One INTRODUCTION

This Study documents the revised Noise Compatibility Program (NCP) proposed by Minneapolis-St. Paul International Airport (MSP). MSP has a long and successful history of noise compatibility planning. Previous efforts have established aircraft operational procedures and land use planning policies that substantially improve the compatibility of surrounding land uses with aircraft operations at MSP.

This document was developed in accordance with Title 14 of the Code of Federal Regulations (14 CFR Part 150) *Airport Noise Compatibility Planning* and will henceforth be referred to as the "Study" or "2004 Study". The Metropolitan Airports Commission (MAC) completed its first 14 CFR Part 150 Study for MSP in 1987; the first update was approved in 1994 by the Federal Aviation Administration (FAA).

This chapter provides an introduction to the 14 CFR Part 150 regulations in Section 1.1. Section 1.2 describes the organization of the report. Section 1.3 discusses the Study's history and timeline. The language of MSP's existing NCP is in Section 1.4. A summary of the Study's goals is in Section 1.5. This chapter concludes with Section 1.6, which discusses the organizations that had major roles and responsibilities in the update process.

The FAA has developed checklists for their use in reviewing Noise Exposure Map (NEM) and NCP submittals. **Appendix A** provides copies of these checklists, which include references indicating the locations where this Study addresses the required items.

1.1 14 CFR PART 150

The FAA's 14 CFR Part 150 ("Part 150") regulation sets forth standards for airport operators to use in documenting aircraft noise exposure in the airport environs and establishing programs to minimize noise-related land use non-compatibility. Part 150 prescribes specific standards for the following:

- Measuring aircraft noise,
- Estimating cumulative aircraft noise exposure using computer models,
- Describing aircraft noise exposure (including instantaneous, single event and cumulative levels),
- Coordinating NCP development with local land use officials and other interested parties,
- Documenting the analytical process and development of the compatibility program,
- Submitting documentation to the FAA,
- the public review processes, and
- FAA approval or disapproval of the submission.

A full Part 150 submission to the FAA consists of two basic elements: a NEM and a NCP.

1.1.1 Noise Exposure Maps

The NEM describes the airport layout and operation, aircraft-related noise exposure, land uses in the airport environs, and the resulting aircraft noise and land use

compatibility status. The NEM must address two time frames: the year of submission (the "existing conditions") and the fifth calendar year following the year of submission (the "forecast conditions"). It includes graphic depictions of existing and forecast noise exposures resulting from aircraft operations, and of land uses in the airport environs. The NEM documentation must describe the data collection and analyses undertaken in its development.

For this current version of the Study, forecasts were developed with the existing condition as 2002 and the forecast condition as 2007. Due to extensive public and stakeholder involvement in the forecasting process and development of the recommended Sound Mitigation Program, the submission of the Study to FAA will not occur until 2004. Thus, the year of submission per Part 150 is 2004, with a forecast condition of 2009. According to FAA guidelines, the 2002 and 2007 forecasts may be considered representative of 2004 and 2009, respectively, if the difference between aggregate operational levels for 2002 and 2004, and 2007 and 2009, is less than 15-percent.

As shown in **Table 1.1**, there were 493,220 annual operations in 2002. The total estimated operations in 2004 at MSP are 529,659. The difference of 36,439 operations from 2002 to 2004 is equivalent to a variance of 6.9-percent. Additionally, a comparison of the Year 2002 operations with the 2004 Terminal Area Forecast shows a variance of 8.3-percent.

The Study forecast's Year 2007 includes 582,366 annual operations. By applying the TAF forecast annual growth rate during 2007-2009 by aircraft category to the Study's Year 2007 forecast, a total of 612,623 operations would be projected for 2009. The difference of 30,257 operations from 2007 to 2009 is equivalent to a variance of 4.9-percent as shown in Table 1.1. Using another measure, the FY03 TAF projects 640,661 annual operations at MSP in 2009. The difference of 58,295 operations from 2007 to 2009 is equivalent to a variance of 9.1-percent.

Therefore, the year 2002 and 2007 NEMs are considered representative of 2004 and 2009 conditions, respectively. Note that for the purposes of this Study, the existing condition will be referenced to 2002 and the forecast condition to 2007.

1.1.2 Noise Compatibility Program

The NCP is essentially a list of the actions the airport proprietor, airport users, local governments, and the FAA propose to undertake to minimize existing and forecast aircraft noise and land use non-compatibility. The NCP documentation must recount the development of the program, including a description of all measures considered, the reasons that individual measures were accepted or rejected, how measures will be implemented and funded, and the predicted effectiveness of individual measures and the overall program.

The development of an NCP begins with an evaluation of all reasonable, feasible actions that could reduce potential land use non-compatibilities identified in the NEMs. Part 150 specifies the range of alternatives that must be considered, including land acquisition, sound barriers, soundproofing of public buildings, preferential runway use, flight procedures, restrictions on the type/class of aircraft, and other actions or FAA recommendations that may provide benefit. Although Part 150 requires that these types of measures must be evaluated, it does not mandate adoption or implementation of the measures.

Table 1.1

Comparison of Baseline, Year of Submission, and Forecast Operational Levels

Category	2002 (a)	2004 (b)	Percent Difference (2002 minus 2004)	2007 (a)	2009 (c)	Percent Difference (2007 minus 2009)
Scheduled Passenger	337,479	339,093	-0.5%	366,501	387,311	-5.4%
Charter	4,940	8,993	-45.1%	5,766	6,093	-5.4%
Regional Carrier (d)	103,983	137,902	-24.6%	156,971	164,113	-4.4%
Cargo Carrier (e)	18,198	17,412	4.5%	21,158	22,359	-5.4%
GA (f)	25,496	24,635	3.5%	28,846	29,622	-2.6%
Military	3,124	1,624	92.3%	3,124	3,124	0.0%
TOTAL	**493,220**	**529,659**	-6.9%	**582,366**	**612,623**	-4.9%
FY03 TAF (g)		**538,059**	-8.3%		**640,661**	-9.1%

Notes:
(a) Study Forecast. Does not include overflights.
(b) Derived by multiplying 2003 to 2004 percent change (i.e., percent change in January to April 2004 operations versus January to April 2003 operations) in each category by the annual number of 2003 operations in each category.
(c) Derived by applying TAF 2007-2009 growth by category to 2007 Study forecast.
(d) Avro RJ85 included in Scheduled Passenger Air Carrier count.
(e) Airport statistics count many small feeder cargo flights as GA.
(f) Does not include an estimated 14,000 overflights.
(g) Based on FAA historical ATCT data which includes some overflights.

Source: HNTB analysis and as noted.

There are two categories of NCP measures, noise abatement and land use, that are described in the following paragraphs.

Noise abatement measures seek changes to operational flight procedures to reduce the size or change the shape of the noise contours so as to minimize non-compatibilities. Noise abatement alternatives consider changes to runway use, flight track use, and other operational procedures that determine where aircraft fly in the immediate vicinity of the Airport.

Land use measures address areas of land use non-compatibility that remain after the implementation of the noise abatement measures. The land use measures are intended to correct existing non-compatible land uses and prevent future non-compatibilities.

Other measures may be included that serve to enhance community and airport dialogue regarding aviation noise, improve public understanding of aviation noise, and provide

for ongoing evaluation of noise generated from aircraft flight operations.

The measures described in the revised NCP as presented in this Study reflect the airport operator's recommendations for the NCP. The proposed NCP measures are presented prior to the FAA's review for approval or disapproval and as such do not represent the opinions or decisions of the FAA.

Official FAA acceptance of the NEMs and approval of the NCP does not eliminate requirements for the submittal of environmental documentation of any proposed actions pursuant to requirements of the National Environmental Policy Act (NEPA). However, acceptance of the submission is a prerequisite to application for Federal funding of implementation actions.

1.2 REPORT ORGANIZATION

The Study is divided into three volumes. **Volume I** contains the main body of the study, plus Appendices A through L.

Chapter One, *Introduction*, primarily provides an overview of 14 CFR Part 150, a summary of this Study's goals, the project organization, and a review of the existing NCP. **Chapter Two**, *Noise and Its Effect on People*, presents an introduction to acoustics and noise terminology, and the effects of noise on human activity. **Chapter Three,** *Forecast of Flight Operations*, describes the development of the existing and forecast year fleet mixes and traffic levels for the Study**.** **Chapter Four**, *Existing Flight Operations and Procedures*, details the current operational procedures and trends at MSP as used to develop the DNL noise contours. **Chapter Five**, *Land Use and Noise Compatibility*, summarizes the land use controls near MSP, reviews the applied land use compatibility criteria, describes the development of the land use and population data, and examines existing (2002) and forecast (2007) land uses and their compatibility with MSP aircraft operations. **Chapter Six**, *Noise Exposure Maps*, presents the MSP NEMs for 2002 and 2007. **Chapter Seven**, *Noise Abatement Measures*, details the existing and potential noise abatement alternatives. **Chapter Eight**, *Land Use Compatibility Measures*, reviews the existing land use measures, identifies future non-compatible land uses, and evaluates land use alternatives**. Chapter Nine**, *Recommended Revised Noise Compatibility Program*, summarizes noise abatement and land use measures, program benefits, and NCP implementation requirements. **Chapter Ten**, *Public Involvement Summary*, presents the responsibilities of the advisory committees, descriptions of the public workshop meetings and the public hearing, and a summary of written comments and responses. Endnotes, referred to by their superscripted number, are located after each corresponding chapter.

Appendix A contains the FAA checklists for their review of the NEMs and NCP. **Appendix B** describes airspace and Air Traffic Control (ATC) procedures. **Appendix C** contains aircraft operational information specific to the modeling of noise exposure at MSP. **Appendix D** addresses Noise Abatement Departure Profiles. **Appendix E** presents the analysis of the sensitivity of noise exposure if Runway 17/35 was not constructed. Detailed noise exposure data, in terms of population, dwelling units and noise sensitive receptors, is the subject of **Appendix F**. **Appendix G** reviews Global Positioning System (GPS) initiatives. **Appendices H and I**, review the recommendations of the Low-Frequency Noise Policy Committee and impacts of low frequency noise, respectively. **Appendix J**

lists the members of the committees involved in this Study. **Appendix K** contains a Metropolitan Airport Commission (MAC) report on the development of the revised modeled arrival flight tracks. **Appendix L** provides a comparison of the 2007 Mitigated NEM in this edition of the Study with the 2005 Mitigated NEM in the November 2001 edition.

Volume II – Parts I-V, is **Appendix M**, Public Involvement, which contains the scoping comments, meeting minutes, newsletters, advertisements, meeting sign-in sheets and public comments from the Study's workshops and November 2000 public hearings.

Volume III – Parts I-V, is **Appendix N**, Forecast and Noise Exposure Map Update Public Involvement, which documents the public process related to the development of the Study aircraft operations for the existing conditions (2002) and forecast conditions (2007) and the DNL contours. Information on the September 7, 2004, public hearing is included.

The information in Appendices M and N is summarized in Chapter Ten.

1.3 STUDY HISTORY

The first Part 150 Study at MSP was submitted to FAA in October 1987. The NEMs were accepted by FAA in October 1989, while portions of the NCP were approved in April 1990.

An update to the 1987 study was begun in 1991. The update sought to determine the degree to which the approved measures in the 1987 study had been implemented, examine ways to improve measures, and incorporate new procedures and trends into the NCP. FAA accepted the revised NEMs in December 1993 and approved portions of the revised NCP in July 1994. This study is referenced as the "1993 Study."

The MAC Full Commission authorized an update to the Part 150 Study in late 1998 and the current update effort began in 1999 with development of noise contours, and noise abatement and land use measures, throughout that year and most of 2000. A draft Study was published in October 2000 with two consecutive public hearings in November 2000. In November of 2001, the MAC submitted the Study to FAA, including NEMs and a revised MAC-approved NCP (referenced in this document as the "November 2001 Study"). In May 2002, after consideration of the events of September 11, 2001, the MAC withdrew the Study from FAA to update the forecast and the associated noise contours.

The process of updating the forecast and noise contours began in February 2003. This effort specifically focused on updating the existing conditions year from 2000 to 2002 and the forecast condition year from 2005 to 2007. The purpose of the forecast update was to ensure that the events of 9/11 and ongoing changes in fleet mix were considered in the Study noise contours. In addition to updating the forecast a review of the INM input methodology and data was conducted to ensure continued consensus with the previous (i.e., November 2001) contour development process.

On November 17, 2003, the MAC Full Commission approved the revised forecast and fleet mix numbers and INM input methodology/data for use in developing the 2002 and 2007 NEMs. Subsequently, the draft 2002 and 2007 NEMs were developed and made available to the public in February 2004. In March 2004, additional revisions to the forecast were completed to incorporate Northwest Airline's announcement that it would resume service

with five RJ85 aircraft that had been taken out of service and for corrections to General Aviation operations. The draft 2002 and 2007 NEMs were revised to incorporate the forecast changes. The 2007 Mitigated NEM represents the MAC-approved 2007 forecast and INM inputs with the integration of the previously MAC-approved NCP from the November 2001 Study.

The draft 2004 Study was published for public review on August 6, 2004. A public hearing was subsequently held on September 7, 2004, as discussed in Section 10.5.2. After review of comments submitted regarding the NEMs and NCP, the MAC Planning and Environment Committee, at its November 3, 2004, meeting, recommended to the Full Commission that the Study be approved and submitted to FAA. Subsequently, at its November 15, 2004, meeting the MAC Full Commission approved the Study and authorized MAC staff to submit the Study to FAA for review, acceptance of the NEMs, and approval of the NCP. This document is the final version of the Study as submitted to FAA in November 2004.

1.4 EXISTING NCP

The existing FAA-approved NCP contains 19 elements, including 11 noise abatement measures and eight land use management measures. It should be noted that *the existing measures are stated verbatim* from the 1993 Study and, therefore, reference dated runway end designations and proposed implementation programs.

1.4.1 Existing FAA-Approved Noise Abatement Measures

The following noise abatement (NA) measures are the FAA-approved measures included in the 1993 Study.

Existing NA-1: Metropolitan Aircraft Sound Abatement Council (MASAC). The MAC has established the MASAC, which is comprised of representatives of the airline industry, municipalities surrounding the Airport, and various federal and state agencies. The MASAC should continue to be the official vehicle for addressing airport noise at MSP [according to the 1993 Study, see note below]. Its objectives are to study and evaluate noise complaints, implement effective noise abatement measures, and provide public education in current noise abatement policies and possible future programs.

Note: On October 31, 2000, ten airport user representatives on MASAC resigned from the Council. Concerns focused on the MASAC process and procedures. The catalyst for the resignations highlighted concerns that MASAC had become an unbalanced community advocacy group and did not provide a viable framework for comprehensive discussions regarding noise abatement efforts at MSP. As a result of the organizational balance required in the bylaws of MASAC, the council is no longer able to conduct business and was therefore discontinued. In June 2003, the Noise Oversight Committee, the successor to MASAC, began operation as discussed in Section 1.6.4.

Existing NA-2: Voluntary Noise Budget Program. The MAC adopted a phased-in noise budget ordinance for MSP in April 1987. The budget consisted of a proposed initial ceiling equal to the noise energy produced by air carrier aircraft in 1984. The program does not include regional/ commuter aircraft or general aviation aircraft. The Noise Budget was part of the 1989 NCP. The FAA approved the Noise Budget as a voluntary measure only. In the spring and summer of 1987, MAC negotiated a voluntary noise budget with the

following air carriers at MSP: Northwest Airlines, Delta Air Lines, Continental Airlines, American Airlines, United Air Lines, and Trans World Airlines.

These carriers account for almost all of the scheduled passenger operations at MSP. The last reduction in the total noise energy level cap (equal to 1984 noise levels) was achieved in June 1992. Continued monitoring will verify that noise levels will not exceed the 1984 levels. This program has been successful in reducing the overall noise exposure levels at MSP to pre-established goals.

Existing NA-3: Voluntary Nighttime Limits on Flights. The MAC established a second voluntary agreement with several airlines that limits the number of arriving and departing flights during nighttime hours. As with the Noise Budget, the Nighttime Limits do not include regional airlines or general aviation. The Nighttime Limits were also part of the MSP NCP. The MSP Signatory Airlines[1] all agreed to use their "best efforts" to limit nighttime activity to current levels and use Stage 3 aircraft during nighttime hours. These hours are defined as the following[2]:

11 p.m. – 6 a.m., Monday through Friday, and

11 p.m. – 8 a.m., Saturday and Sunday.

Existing NA-4: Nighttime Powerbacks. All air carriers at MSP have agreed to eliminate "powerbacks" during nighttime hours. Some aircraft move back from the gate under their power, generating noise as the engines are spooled-up and put into reverse thrust. Instead, all nighttime flights will "push back" from the gate with an aircraft tug.

Existing NA-5: Engine Run-up Field Rule. All air carriers are required to conduct maintenance run-ups at a designated run-up pad, with aircraft heading in a specific direction to minimize the noise impact to populated areas. Measure NA-5 prohibits these run-ups during the noise-sensitive nighttime hours of 11 p.m. to 6 a.m. unless pre-authorized by MAC.

Existing NA-6: Training Restriction. The major carriers at MSP have agreed not to conduct training operations at MSP. No other carriers conduct training flights at MSP at this time.

Existing NA-7: Operating Procedures. The major carriers at MSP agreed to the following:

- Continuing use of noise abatement takeoff procedures;
- Using minimum flap settings when landing;
- Limiting the use of reverse thrust on landing during nighttime hours; and
- Complying with Eagan/Mendota Heights Corridor routing in cooperation with the FAA.

Existing NA-8: Noise Surcharge Differential and Stage 3 Credit. The MAC instituted a Noise Surcharge/Differential Landing Fee at MSP, effective January 1, 1990. The fee is designed to recover from the airlines the cost of noise monitoring and mitigation. The fee is comprised of the following three parts:

The "Environmental Surcharge" is a per operation charge imposed on every Stage 2 and Stage 3 landing and takeoff by a Signatory Airline at MSP. The Surcharge is estimated by dividing off-airport aircraft noise cost incurred by MAC during the year by the total number of Stage 2 and Stage 3 operations by the Signatory Airlines at MSP.

The "Excess Stage 2 Fee" is a per operation fee imposed on every excess Stage 2 operation at MSP; it equals 30 percent of the Environmental Surcharge.

The "Stage 3 Credit" is a per operation credit against a Signatory Airline's total Environmental Surcharge and Excess Stage 2 Fees in a given year. The Stage 3 Credit equals the total of the Excess Stage 2 Fees paid by the Signatory Airlines divided by the total number of Stage 3 operations by the Signatory Airlines.

Existing NA-9: Runway Use System. The Runway Use System (RUS) was implemented in June 1990. It is intended to place aircraft arrival and departures into the Eagan/Mendota Heights Corridor to the maximum extent possible. After this, the next priority is to maximize the use of the crosswind runway (4/22) in an effort to reduce traffic from the parallel runways (11L/29R and 11R/29L) to and from the northwest during light traffic hours. The RUS replaced the Preferential Runway System (PRS), which was experiencing steadily decreasing use due to airline hubbing activity. The RUS consists of the following daytime and nighttime use priorities:

Daytime Hours (0600-2300)

- When operations require the use of the parallel runways, a configuration should be selected that will place the majority of traffic in the Eagan/Mendota Heights Corridor, when feasible.
- When feasible, maximize the use of Runway 4/22 and balance the use at both ends.
- Use Runway 4/22 in conjunction with the Eagan/ Mendota Heights corridor as much as possible.

Nighttime Hours (2300-0600)

- Maximize the use of the Eagan/ Mendota Heights corridor (head-to-head), when feasible.
- If 4/22 is required, use in a balanced manner.

Existing NA-10: Airport Noise and Operations Monitoring System (ANOMS). The ANOMS is designed to provide MAC officials with accurate runway use counts specific to aircraft type, aircraft flight path information, and 24-hour noise monitoring data at selected sites within residential communities. The FAA has agreed to provide MAC with computer processed Automated Radar Terminal Systems (ARTS IIIA) data from the Minneapolis Terminal Radar Approach Control (TRACON). In addition to providing reliable airport operations data, ANOMS archives data for future airport decisions, validates complaint information, tracks effects of RUS operations, tracks effects of air traffic routing procedures, and validates computer-generated noise models.

Existing NA-11: Noise Abatement Sensitivity Training. The MAC works with the airlines and Air Traffic Control (ATC) to encourage awareness of noise issues and to help increase compliance with current noise abatement procedures.

1.4.2 Existing FAA-Approved Land Use Measures

The 1993 Study recommended five preventive land use measures and three corrective land use measures to correct or enhance compatible development in the vicinity of MSP. Following are the recommended *preventive* land use measures:

Existing LU-1: Amend local use plans to bring them into conformance with the Metropolitan Council's (MC) Noise Compatibility Guidelines. The MAC plans to continue its coordination with the MC and the local communities to revise the noise compatibility guidelines in the Aviation Chapter of the Metropolitan Development Guide. This measure would apply regulatory actions that would inhibit non-compatible development.

Existing LU-2: Zone for Compatible Development. The MAC plans to continue coordination with the local communities to review the existing zoning policies in the Airport Noise Zones and to rezone, if necessary, to ensure consistency with the Aviation Chapter of the Metropolitan Development Guide. Local communities have conducted review/rezoning actions that should prevent the introduction of non-compatible development in the designated noise zones.

Existing LU-3: Apply Zoning Performance Standards. The MAC, in conjunction with the MC, will continue to request local jurisdictions to adopt the Model Ordinance for Aircraft Noise Attenuation developed by the MC. The areas to which this measure would apply are within the MSP Noise Zones contained in the Aviation chapter of the Metropolitan Development Guide.

Existing LU-4: Establish a Public Information Program. The MAC proposed to develop and distribute information concerning aircraft noise and NCP elements. The materials would continue to be distributed to planning agencies, housing authorities, land developers, local FHA/VA offices, lending institutions, and Realtors.

Existing LU-5: Revise Building Codes. The MAC supported the efforts of the MC to modify the State Building Code to require specified interior noise level reduction for new construction in areas affected by the aircraft noise as outlined by the MSP Development Guide. The local communities would then be required to adopt these revisions.

Following are the recommended *corrective* land use measures:

Existing LU-6: Land Acquisition Program. The MAC proposed this measure to alleviate aircraft noise effects in areas of incompatible land use within the 65 DNL contour.

Under the land acquisition program for MSP, property would be acquired only at the initiative and with the approval of the local jurisdiction, where it has established that there is a reasonable consensus among residents to vacate the area. As stated in this Part 150 Update, program eligibility will be limited to homeowners residing within the 1996 65 DNL contour in neighborhoods identified by each participating city. The neighborhood boundaries will be identified by each participating city and may include areas outside the 65 DNL contour. Acquisition priority will be based on the location within the noise contours. The homeowner must have lived in the home for two years prior to the implementation of the program, unless adequate funds are made available to allow the purchase of *all* properties within the identified area at the same time. Property will be acquired by voluntary agreement with the homeowner or through standard condemnation proceedings. The fair market value of all properties identified for acquisition will be determined by the current federal and local guidelines.

Property to be acquired will be identified by the individual cities on a block-by-block basis. Once property has been identified to be acquired, transactions will be processed

through normal appraisal and closing procedures, as with any other type of property sale. No specific timeframe for completion of the transfer of property will be defined. The payment or reimbursement of moving/relocation expenses will be determined by current federal regulations (Uniform Relocation Assistance and Real Property Acquisition Policies Act). The property will then be cleared immediately to reduce maintenance and upkeep costs. All acquired property will be held by the MAC. Prior to the issuance of any grants, the MAC will decide what property is to be converted to airport property. If the property is not to be converted for airport use, it will be released by MAC for resale as a compatible land use (non-residential) as soon as possible.

Existing LU-7: Purchase Guarantee Program. The MAC proposes to alleviate noise effects in the areas within the 65 DNL contour where neighborhood stability can be maintained and existing residential development is considered acceptable by local land use jurisdiction. As with most purchase guarantee programs, if aircraft noise levels are found to be intolerable by individual homeowners and the owner has made a "bona fide effort" to sell the property, the property would be acquired by the MAC at a fair market value and returned to residential use with appropriate sound insulation measures, releases, and restrictions. (The fair market value of all eligible properties will be determined by the current federal and local guidelines.) Homeowner participation in the program will be voluntary and based on the city-specific implementation decisions. The purchase guarantee program is not intended nor designed to acquire all, or a substantial portion, of a designated area, but rather to provide the homeowner the opportunity to sell his home at a guaranteed fair market value on a "house-by-house" basis.

Purchase Guarantee Program eligibility will be limited to homeowners residing within the 1996 65 DNL contour in neighborhoods identified by each individual city. Each participating city will be able to determine the location and number of homes eligible for participation based on their yearly Part 150 dollar allocation.

The participating home must be owner-occupied. (Owner-occupied condominium units are also eligible.) Homeowners must have resided at the property for at least two years prior to being eligible to participate in the program. Once a home has been deemed eligible for participation in the Purchase Guarantee Program, a fair market value will be established for the property through a certified appraisal process that meets federal and local guidelines. Then, a Letter-of-Intent will be signed by both the homeowner and the program administrator (MAC). The Letter will be a binding contract which describes the program elements, such as the following:

Predetermined length of time that property will be listed for sale before owner receives reimbursement of fair market value.

Sound insulation package modification details and schedules.

Granting of an avigation release to the MAC.

Existing LU-8: Part 150 Sound Insulation Program. The MAC proposes to alleviate the impact of aircraft noise by providing indoor environments where normal activities can be enjoyed without interruption. The program involves modifications to reduce the amount of noise entering such environments from the outside. Priority will be given to the sound insulation of single- and multi-family residences and schools. In addition, noise-sensitive public buildings

other than schools may be included on a case-by-case basis.

A priority system for insulating will be established on a house-by-house level and block level. Each homeowner will be responsible for submitting an application to the program administrator requesting participation in the program. Although a homeowner may apply to the program immediately after it is established, an application submitted at a later date may still be eligible for funding. Each city will determine the priority of homeowners who delay participation in the program.

The actual amount of sound insulation required to achieve 5, 10 or 15 dB additional noise level reductions for any given directly-exposed room would depend on the exterior DNL, the type of construction, and the window/wall area ratio. Other habitable rooms in each home that are not directly exposed to aircraft noise would receive additional noise level reductions equal to or less than the amounts shown above. Air-conditioning and ventilation will be provided as part of the sound insulation package.

There will be a $25,000 cap on sound insulation modification work to be done on a single residence. The individual homeowners will have the ability to reject recommended sound insulation modification plans, as long as the final insulation modification plan selected has no less than 5 dB of attenuation in any directly exposed room. Homeowners with hot water heat would be able to keep their existing heating system in the event they received an air conditioning (forced air) package through the sound insulation modifications.

Each city will be responsible for determining how long a participant in the Sound Insulation Program must wait before being eligible for another Part 150 program.

Again, note that the above listed existing measures are reprinted verbatim from the 1993 Study, and as such, reference dated runway end designations and proposed implementation programs.

1.5 STUDY REQUIREMENTS

A number of specific requirements have been identified by the 1996 MSP Noise Mitigation Committee, Airport noise related committees, and local communities to guide the development of an updated Study for MSP. This section outlines these study requirements in 1.5.1 and federal requirements in 1.5.2. Correspondence involving interested parties that assisted in the development of the study requirements is provided in Appendix M and N.

1.5.1 Locally Identified Requirements

The following items are locally-identified requirements for measures to be evaluated, although not necessarily implemented, in the Study.

1. Expand sound insulation program to residences within the 2005 60–65 DNL contour interval. *This requirement is now applied to the 2007 60 DNL contour as addressed in Section 8.2.1.*

2. Consider analyses of low frequency noise effects on residential land uses, development of a noise metric and related threshold/criterion for significant adverse interior vibration levels for potential mitigation, and evaluate the appropriate potential mitigation measures. *This requirement is addressed in Section 8.3 and Appendices H and I.*

3. Investigate a prohibition on use of Stage 2[3] [4] aircraft after December 31, 1999. *With the final implementation of the Airport Noise and Capacity Act (ANCA), no Stage 2 aircraft with a maximum takeoff weight greater than 75,000 pounds are allowed to operate in the U.S. after December 31, 1999, without a waiver granted by the FAA. A thorough investigation into Stage 2 prohibition for aircraft potentially granted a waiver by the FAA after December 31, 1999 was completed in March 1999. After the investigation, the only viable option identified by the MAC to restrict Stage 2 aircraft should FAA grant a waiver[5], and to comply with state law, was the adoption of local Ordinance #90 banning such operations. Ordinance #90 applies to U.S. and foreign air carriers, including those airlines that could obtain a waiver from the FAA to extend the deadline. Note that ANCA and Part 91 permit the continued operation of Stage 2 aircraft with a maximum takeoff weight of less than 75,000 pounds after December 31, 1999.*

4. Consider a modification to the night hours from 11:00 p.m. - 6:00 a.m. to 10:30 p.m. - 6:00 a.m. and limit activity during these hours to Stage 3 aircraft. *This requirement relates to existing NA-3 and is addressed in Section 7.3.3.*

5. Consider a departure procedure(s) to avoid densely populated residential areas potentially impacted by Runway 17 departures. *This requirement is addressed in Section 7.4.2.*

6. Evaluate departure procedures in the Eagan/Mendota Heights Corridor. *This requirement relates to existing NA-7 and is addressed in Section 7.3.4.*

7. Develop methods to encourage the aviation industry to promote further reductions in aircraft noise levels, including the accelerated phase-out of Stage 3 hushkit aircraft. *This type of phase-out would require federal mandate. The requirement is addressed in Sections 7.3.3 and 7.3.6.*

8. Increase the number of MAC noise monitors to provide more coverage of the Airport vicinity, especially areas affected by Runway 17/35. Areas affected by operations on the parallel runways may have additional microphone locations to monitor continued and growing volumes of air traffic as MSP expands. This system should be used to corroborate the accuracy of the modeled contours for noise program eligibility. *Associated with existing NA-10, five new monitors were installed in 1999 by the MAC to enhance the existing system. Additional monitors that will provide coverage for areas affected by Runway 17/35 were operational in 2002. Because the monitors have been installed prior to the beginning of operations on Runway 17/35, they allow for determination of pre- and post-development conditions.*

9. Establish procedures for monitoring the use of runways to ensure compliance with the runway use goals stipulated in the Dual Track Planning Process Final Environmental Impact Statement (FEIS) and Record of Decision (ROD). *Runway use cannot be mandated. Mandated use of runways would limit FAA's ability to safely and efficiently use the airfield. Hence, runway use cannot be tested for compliance with the goals of the FEIS. However, runway use is provided on a regular basis within monthly ANOMS reports and via interactive operations*

and noise reports on the Internet at www.macnoise.com.

10. Consider limitations on run-up operations by time and direction. *This requirement is currently considered within the MSP Field Rules (Existing NA-5).*

11. Consider noise abatement departure procedures for Runway 17/35 (follow-on to item 5). *This requirement is addressed in Sections 7.3.5 and 7.4.2.*

12. Consider including Runway 17/35 in the RUS. *This requirement is addressed in Section 7.3.7.*

1.5.2 Federally Identified Requirements

Part 150 requires that airport proprietors consider at least seven categories of noise compatibility measures for inclusion in their NCP. Following are the measures and the sections of this Study that address them:

(1) Acquisition of land and interests therein, including, but not limited to air rights, easements, and development rights, to ensure the use of property for purposes that are compatible with airport operations. *Addressed in Sections 8.1, 8.2, and 8.3.*

(2) The construction of barriers and acoustic shielding, including the soundproofing of public buildings. *Addressed in Sections 8.2 and 8.3.*

(3) The implementation of a preferential runway system. *Addressed in Section 7.3.7.*

(4) The use of flight track procedures (including modifications of flight tracks) to control the operation of aircraft to reduce exposure of individuals (or specific noise-sensitive areas) to noise in the area around the Airport. *Addressed in Sections 7.3.4, 7.4.1 and 7.4.2.*

(5) The implementation of any restriction on the use of an airport by any type or class of aircraft based on the noise characteristics of those aircraft. Such restrictions may include, but are not limited to, the following list.

(a) Denial of the Airport to aircraft types or classes that do not meet federal noise standards.

(b) Capacity limitation based on the relative noisiness of different types of aircraft.

(c) Requirement that aircraft using the Airport follow noise abatement takeoff or approach procedures previously approved as safe by the FAA.

(d) Landing fees based on FAA certificated or estimated noise emission levels or on time of arrival.

(e) Nighttime restrictions.

It is not necessary for all of these potential restrictions to be examined in each NCP, so long as a program gives consideration to at least one type of restriction. *Addressed in Sections 7.3.2, 7.3.3, 7.3.5, and 7.3.6.*

(6) Other actions or combinations of actions that would have a beneficial noise control or abatement impact on the public. *There were no measures that fall outside of the categories identified previously.*

(7) Other actions recommended for analysis by the FAA for the specific

airport. *The FAA Air Traffic Control (ATC) staff was a major contributor to the definition, analysis, and refinement of the noise abatement flight path and preferential runway use alternatives, as discussed in Sections 7.3.4, 7.3.5, 7.3.7, 7.4.1, and 7.4.2.*

1.6 PROJECT ROLES AND RESPONSIBILITIES

As highlighted in the following subsections, several groups had major roles in the Study process, including the MAC, its consultant, MASAC (prior to disbandment), the Noise Oversight Committee (NOC), Metropolitan Council (MC), and FAA.

1.6.1 Metropolitan Airports Commission

As the "airport operator," the MAC has responsibility over the entire Study, including ultimate responsibility for determining what elements will be included in the NCP submitted to the FAA for review. The MAC is also responsible for pursuing the implementation of FAA-approved measures. The MAC Aviation Noise and Satellite Programs Office also provided technical and analytical support in the development of the Study.

1.6.2 Consulting Team

The MAC retained a consultant to conduct the technical work required to fulfill the Part 150 analysis and documentation requirements.

The consulting firm of HNTB Corporation has overall project management responsibility for the Study and has responsibility for all typical Part 150 land use and noise-related technical elements.

Beyond standard noise evaluation practices, the Dual Track Planning Process Final Environmental Impact Statement (FEIS) required analysis of potential low frequency noise impacts. The Dual Track Planning Process FEIS is hereinafter referred to as the Dual Track FEIS. In an effort to study the potential effect of low frequency noise, the Low Frequency Noise Policy Committee was formed as a part of a December 18, 1998 agreement between the City of Richfield and the MAC. As part of this committee, an expert panel was developed consisting of industry leaders in noise analysis: Andrew S. Harris (Andrew S. Harris, Inc., formerly of HMMH Inc.); Sanford Fidell (BBN Technologies); and Louis C. Sutherland (independent consultant). This committee provided their final recommendations on August 10, 2000.

The consulting firm of HMMH Inc. was contracted to provide input on a potential low-frequency noise mitigation measure. Additionally HMMH Inc. was contracted to provide the recommended noise abatement measure associated with the incorporation of Global Positioning Systems (GPS) and Flight Management Systems (FMS) into arrival and departure procedures. HNTB supported this effort by performing the analysis needed to develop the recommendation.

1.6.3 Metropolitan Aircraft Sound Abatement Council

The MASAC was a private, non-profit organization made up of an equal number of citizens and airline industry representatives, dedicated to the control and alleviation of aircraft noise at and around MSP. MASAC and the MASAC Operations Committee ("MASAC OPS") served as the primary advisors to the MAC in their effort to gather input from a well-established and well-represented group. The MASAC and

MASAC OPS Committee were consulted regarding the 1993 Study and this 2004 Study and provided a wealth of history in previously developed noise mitigation policies.

Although MASAC was disbanded in November 2000, all prior work by MASAC relevant to this Study is included in the documentation.

1.6.4 Noise Oversight Committee

NOC is the successor organization to MASAC. The committee began operation in June 2003. Its purpose is to bring industry and community representatives together for dialogue about noise issues at MSP and to bring policy recommendations to the MAC Planning and Environment Committee.

The cities of Minneapolis, Richfield, Bloomington, Eagan and Mendota Heights each have a representative on NOC. The cities of Burnsville, Inver Grove Heights, St. Paul, St. Louis Park, and Sunfish Lake are represented through an at-large membership. The at-large members rotate representation duties on an annual basis. Each city is responsible for appointing its representative.

The airline industry is represented by a scheduled air carrier, a cargo carrier, a charter operator, a Chief Pilot of an airline serving MSP, the Minnesota Business Aviation Association (MBAA) and an at-large member. All but the MBAA representative are appointed by the MSP Airport and Airline Affairs Committee.

Members of the public are welcome to attend the NOC meetings and submit comments via various established channels for consideration by the NOC.

1.6.5 Metropolitan Council

The mission of the MC is to provide leadership in the effective planning of regional growth and redevelopment, and in the delivery of quality regional services. The MC coordinates regional planning and guides development in a seven county area through joint action with the public and private sectors. Created by the Minnesota legislature in 1967, the MC establishes policies for airports and provides planning and technical assistance to communities in the Twin Cities region. The MC will work with the affected cities to maintain development controls by receiving and making recommendations on development proposals, zoning change requests, and environmental impacts.

1.6.6 Federal Aviation Administration

The FAA has ultimate review authority over the NEMs and NCP submitted under Part 150. Their review encompasses the technical documentation as well as broader issues of safety, legality, and program requirements.

FAA involvement includes participation by staff from three levels within the agency: local, regional, and national.

The FAA **Air Traffic Control Tower (ATCT)** and **Terminal Radar Approach Control (TRACON)** at MSP provide significant input in several areas, including operational data from their records, input on flight procedures, judgment regarding safety and capacity effects of alternative noise abatement measures, and input on implementation requirements.

When the MAC submits the Study to the FAA for review, the FAA's **Minneapolis Airports District Office (ADO)** will conduct a local review of the NEMs and

NCP. The FAA's **Great Lakes Region** will also review the NEMs and NCP.

Additionally, **Air Traffic Division** staff will support the ATCT and TRACON role, with final review and decision authority over changes in flight procedures.

On a national level, the FAA's Washington, D.C. headquarters may conduct a final review of the NEM and NCP documentation for adequacy in satisfying technical and legal requirements.

FAA will issue a Record of Approval noting its approval or disapproval of the actions recommended in the NCP.

NOTES

[1] Airlines that have signed an operating agreement to serve MSP (21 carriers in 1992).

[2] MAC modified the nighttime hours to the current designation (10:30 p.m. to 6:00 a.m., for all days of the week) in January 1998. Previously, the nighttime hours were from 11:00 p.m. to 6:00 a.m. Monday through Friday, and 11:00 p.m. to 8:00 a.m. Saturday and Sunday.

[3] Part 36 of Title 14 CFR describes the classification of aircraft by their noise levels. Classifications are termed "stages." Currently, there are three stages of aircraft in Appendix C of Part 36 – Stages 1, 2, and 3. Stages are applied to fixed-wing Transport category jet-powered airplanes only. Stage 1 generally refers to old out-of-service aircraft such as the original Boeing 707, 727, and DC-8 aircraft. Stage 2 aircraft generally consist of second-generation Boeing 727 and 737 jet aircraft, as well as initial versions of the Boeing 747. As of 2000, Stage 2 aircraft weighing more than 75,000 lbs. are not permitted in the U.S. Stage 3 generally refers to the latest generation of aircraft such as the Boeing 757 and Airbus A320, although many Stage 2 aircraft have been modified to meet Stage 3 requirements.

[4] Refers only to Stage 2 aircraft with maximum takeoff weights greater than 75,000 pounds.

[5] No waivers to Part 91 were granted by the FAA, however, by state law, MAC was required to provide a remedy should a waiver(s) be granted by the FAA. As such, MAC adopted MAC Ordinance No. 90 that prohibits the use of Stage 2 aircraft greater than 75,000 pounds at MSP after January 1, 2000.

Chapter Two
NOISE AND ITS EFFECT ON PEOPLE

Aircraft noise exposure in this Study is primarily addressed using the Day-Night Average Sound Level (DNL) metric. This Study also involves the use of supplemental noise metrics in addition to DNL to provide comprehensive analysis for quantifying a specific situation. To assist reviewers in interpreting these complex noise metrics, this chapter presents an introduction to the relevant fundamentals of acoustics and noise terminology (Section 2.1) and the effects of noise on human activity (Section 2.2).

2.1 NOISE AND ITS METRICS

Noise, often defined as unwanted sound, is one of the most common environmental issues associated with aircraft operations. Of course, aircraft are not the only sources of noise in an urban or suburban surrounding, where interstate and local roadway traffic, rail, industrial, and neighborhood sources may also intrude on the everyday quality of life. Nevertheless, aircraft are readily identifiable to those affected by their noise and are typically singled out for criticism. Consequently, aircraft noise problems often dominate analyses of environmental impacts.

A "metric" is defined as something "of, involving, or used in measurement." As used in environmental noise analyses, a metric refers to the unit or quantity that quantitatively measures the effect of noise on the environment. Noise studies have typically involved a confusing proliferation of noise metrics used by individual researchers who have attempted to understand and represent the effects of noise. As a result, literature describing environmental noise or environmental noise abatement has included many different metrics.

However, various federal agencies involved in environmental noise mitigation have agreed on common metrics for analyses of environmental impacts. Furthermore, the FAA has specified which metrics, such as DNL, should be used for federal aviation noise assessments.

This chapter discusses the following acoustic terms and metrics:

- Decibel, dB
- A-Weighted Decibel, dBA
- Maximum Sound Level, L_{max}
- Sound Exposure Level, SEL
- Low-Frequency Sound Level, LFSL
- Equivalent Sound Level, L_{eq}
- Day-Night Average Sound Level, DNL

Maximum A-weighted level, SEL, and LFSL are used to measure the noise associated with single events. L_{eq} and DNL apply to longer-term cumulative noise exposure that includes many events.

2.1.1 The Decibel (dB)

All sounds come from a sound source: a musical instrument, a speaking voice, or an airplane passing overhead. It takes energy to produce sound. The sound energy produced by any sound source is transmitted through the air in sound waves: tiny, quick oscillations of pressure just above and just below atmospheric pressure. These

oscillations, or sound pressures, impinge on the ear, creating the sound we hear.

Our ears are sensitive to a wide range of sound pressures. The loudest sound that we hear without pain has about one trillion times more energy than the quietest sounds we hear. As this range, on a linear scale, is unwieldy, we compress the total range of sound pressures to a more meaningful range by introducing the concept of sound pressure level (SPL) and its logarithmic unit of decibel (dB).

SPL is a measure of the sound pressure of a given noise source relative to a standard reference value (typically the quietest sound that a young person with good hearing can detect). Decibels are logarithmic quantities —logarithms of the ratio of the two pressures, the numerator being the pressure of the sound source of interest, and the denominator being the reference pressure (the quietest sound we can hear).

The logarithmic conversion of sound pressure to SPL means that the quietest sound we can hear (the reference pressure) has a SPL of about zero decibels, while the loudest sounds we hear without pain have SPLs less than or equal to about 120 dB. Most sounds in our day-to-day environment have SPLs from 30 to 100 dB.

Because decibels are logarithmic quantities, they do not behave like regular numbers. For example, if two sound sources each produce 100 dB and are operated together, they produce only 103 dB; not 200 dB as might be expected. Four sources producing 100 dB simultaneously results in a total SPL of 106 dB. In fact, for every doubling of the number of equal sources, the SPL (of all of the sources combined) increases another three decibels. A ten-fold increase in the number of sources makes the SPL increase by 10 dB. A hundredfold increase makes the level increase by 20 dB, and it takes a thousand equal sources to increase the level by 30 dB.

If one source is much louder than another, the two sources together will produce the same SPL (and sound to our ears) as if the louder source were operating alone. For example, a 100 dB source plus an 80 dB source produce 100 dB when operating together. The louder source "masks" the quieter one. But if the quieter source gets louder, it will have an increasing effect on the total SPL. When the two sources are equal, as described above, they produce a level three decibels above the sound level of either one by itself.

From these basic concepts, note that one hundred 80 dB sources will produce a combined level of 100 dB; if a single 100 dB source is added, the group will produce a total SPL of 103 dB. Clearly, the loudest source has the greatest effect on the total.

There are two useful rules of thumb to remember when comparing SPLs: (1) most of us perceive a 6 to 10 dB increase in the SPL to be an approximate doubling of loudness, and (2) changes in SPL of less than about 3 dB are not readily detectable outside of a laboratory environment.

2.1.2 A-Weighted Decibel (dBA)

Another important characteristic of sound is its frequency, or "pitch." This is the rate of repetition of the sound pressure oscillations as they reach our ear. Frequency can be expressed in units of cycles per second (cps) or Hertz (Hz). Although cps and Hz are equivalent, Hz is the preferred scientific unit and terminology.

A person with very good hearing can hear sounds with frequencies from 16 Hz to 20,000 Hz. However, most people hear

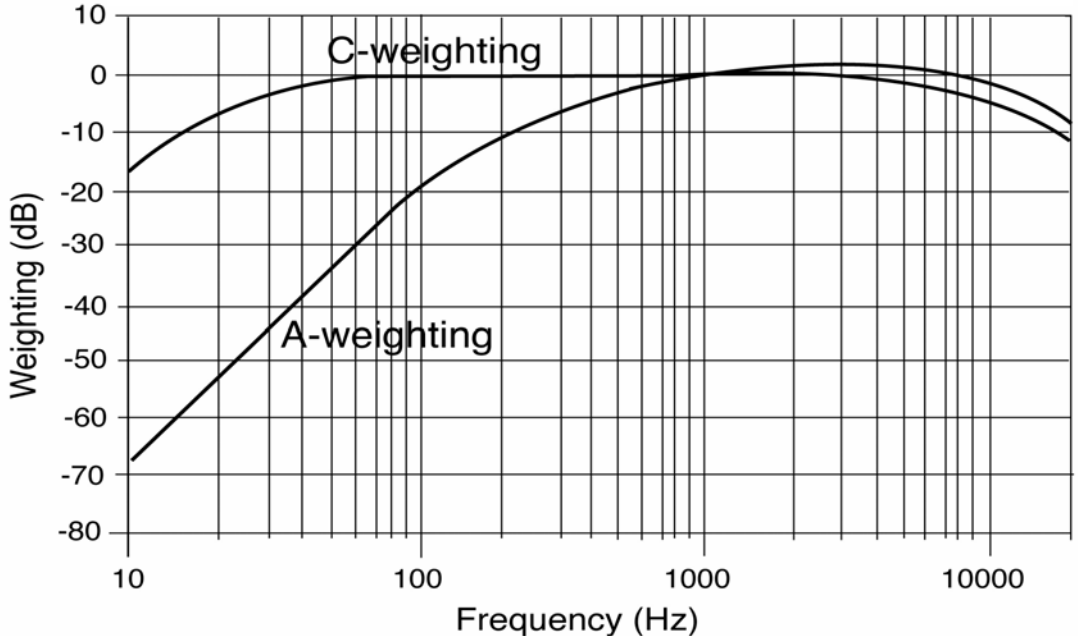
from approximately 20 Hz to approximately 10,000 - 15,000 Hz. People respond to sound most readily when the predominant frequency is in the range of normal conversation, around 1,000 to 4,000 Hz. Acousticians have developed and applied "filters" or "weightings" to SPLs to match our ears' sensitivity to the pitch of sounds and to help us judge the relative loudness of sounds made up of different frequencies. Two such filters, "A" and "C," are most applicable to environmental noises.

A-weighting significantly filters noise at low and high frequencies (below approximately 500 Hz and above approximately 10,000 Hz) where we do not hear as well. The filter has little or no effect at intervening frequencies where our hearing is most efficient. **Figure 2-1** shows a graph of the A-weighting as a function of frequency and its aforementioned characteristics. Because this filter generally matches our ears' sensitivity, sounds having higher A-weighted sound levels are usually judged to be louder than those with lower A-weighted sound levels, a relationship which does not always hold true for unweighted levels. Therefore, A-weighted sound levels are normally used to evaluate environmental noise. SPLs measured through this filter are referred to as A-weighted decibels (dBA).

As shown in Figure 2-1, C-weighting is nearly flat throughout the audible frequency range and does not filter the low frequency noise as much as A-weighting. C-weighted levels are not used as frequently as A-weighted levels, but they may be preferable in evaluating sounds whose low-frequency components are responsible for secondary effects such as the shaking of a building, window rattle, perceptible vibrations, or other factors that can cause annoyance and complaints. Uses include the evaluation of blasting noise, artillery fire, sonic boom, and, in some cases, aircraft noise inside buildings. SPLs measured through this filter are referred to as C-weighted decibels (dBC).

Figure 2-1

Frequency Response Characteristics of Various Weighting Networks



Source: ANSI S1.4-1983 "Specification of Sound Level Meters"

Other weighting networks have been developed to correspond to the sensitivity and perception of other types of sounds, such as the "B" and "D" filters. However, A-weighting has been adopted as the basic measure of community environmental noise by the U.S. Environmental Protection Agency (EPA) and nearly every other agency concerned with aircraft noise throughout the United States.

Figure 2-2 presents typical A-weighted sound levels of several common environmental sources. Sound levels measured (or computed) using A-weighting are most properly called "A-weighted sound levels" while sound levels measured without any frequency weighting are most properly called "sound levels." *However, since this Study deals only with A-weighted sound levels, the adjective "A-weighted" will be hereafter omitted, with A-weighted sound levels referred to simply as sound levels. As long as the use of A-weighting is understood, there is no difference implied by the terms "sound level" and "A-weighted sound level" or by the dB or dBA units.*

An additional dimension to environmental noise is that sound levels vary with time, as shown in **Figure 2-3.** For example, the sound level increases as an aircraft approaches, then falls and blends into the background as the aircraft recedes into the distance (although even the background varies as birds chirp, the wind blows, or a vehicle passes by).

2.1.3 Maximum Sound Level (L_{max})

The variation in sound level over time often makes it convenient to describe a particular noise "event" by its maximum sound level, abbreviated as L_{max}. For the aircraft over-flight event in Figure 2-3, the L_{max} is approximately 67 dBA.

The maximum level describes only one dimension of an event; it provides no information on the cumulative noise exposure generated by a sound source. In fact, two events with identical maxima may produce very different total exposures. One may be of short duration, while the other may continue for an extended period. The Sound Exposure Level metric, as discussed in Section 2.1.4, corrects for this deficiency.

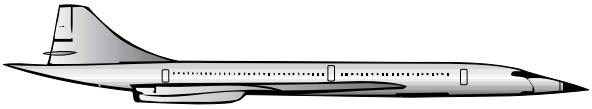
2.1.4 Sound Exposure Level (SEL)

A frequently used metric of noise exposure for a single aircraft flyover (and the metric that Part 150 specifies) is the Sound Exposure Level, or SEL. SEL may be considered an accumulation of the sound energy over the duration of an event. The shaded area in **Figure 2-4** illustrates that portion of the sound energy (or "dose") included in an SEL computation. The dose is then normalized (standardized) to a duration of one second. This "revised" dose is the SEL, shown as the shaded rectangular area in Figure 2-4. Mathematically, the SEL represents the sound level of the constant sound that would, in one second, generate the same acoustic energy as the actual time-varying noise event. For events that last more than one second, *SEL does not directly represent the sound level heard at any given time but rather provides a measure of the net impact of the entire acoustic event*.

Note that because the SEL is normalized to one second, it will always be larger in magnitude than the maximum A-weighted level for an event that lasts longer than one second. In fact, for most aircraft overflights, the SEL is on the order of 7 to 12 dBA higher than the L_{max}. The fact that it is a cumulative measure means that not only do louder flyovers have higher SELs than quieter ones (of the same duration), but *longer* flyovers also have greater SELs than shorter ones (of the same L_{max}).

Sound Levels of Typical Noise Sources (dBA)

Figure 2-2



Concorde, landing (3,280 ft from runway)

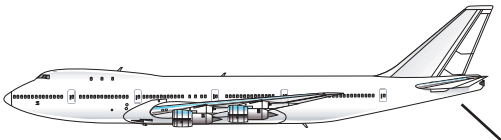
dBA

140 Threshold of Pain

130 Civil Defense Siren (100 ft)

120 Pile Driver (50 ft)

110 Motorcycle (25ft)



747-100, takeoff (21,000 ft from start of roll)



DC-9Q, takeoff (21,000 ft from start of roll)

100 Ambulance Siren (100 ft)

Power Lawn Mower (3 ft)

90 Diesel Truck, 40 Mph (50 ft)

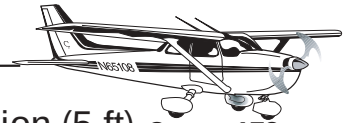


A320, takeoff (21,000 ft from start of roll)

80

Car, 65 Mph (25ft)

70 Vacuum Cleaner (3 ft)



60 Normal Conversation (5 ft)

A/C Unit (100 ft)

Cessna 172, landing (3,280 ft from runway)

50 Light Traffic (100 ft)

Bird Calls (distant)

40

30 Soft Whisper (5 ft)

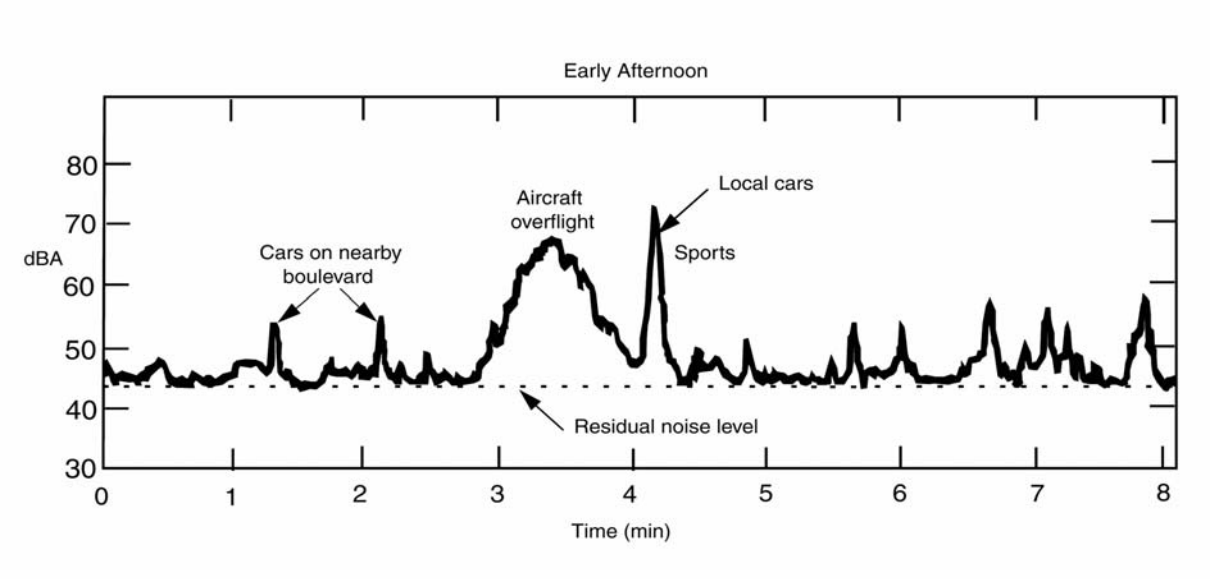
20

Just Audible 10

0 Threshold of Hearing

Figure 2-3

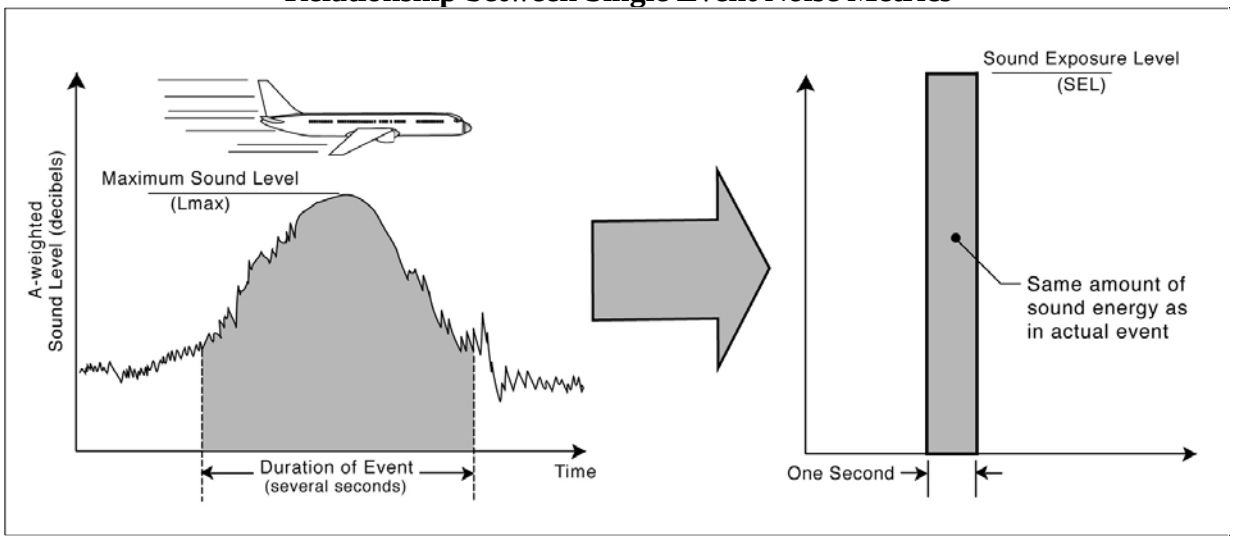
Variation of Community Noise in a Suburban Neighborhood



Source: "Community Noise," NTID 300.3 EPA, December 1971.

Figure 2-4

Relationship between Single Event Noise Metrics



It is the SEL's inclusion of both the intensity and duration of a sound source that makes SEL the metric of choice for comparing the single-event levels of varying duration and maximum sound level. This metric provides a comprehensive basis for modeling a noise event in determining overall noise exposure.

2.1.5 Low-Frequency Sound Level (LFSL)

The LFSL metric was developed by the Low-Frequency Expert Panel as a potential quantifier of low-frequency sound exposure in the vicinity of MSP. The LFSL metric is used in the evaluation of a potential low-frequency noise mitigation measure as described in Chapter Eight. As defined in Appendix H, the LFSL is the sum of the maximum (unweighted) sound pressure levels in the 25-80 Hz one-third octave bands during individual noise events. The (arithmetic) average of the greatest LFSLs in excess of 60 dB LFSL is defined as the effective low-frequency aircraft noise dose.

The frequency scale is divided into sections called bands. The bandwidth can be described in terms of octaves where the upper frequency of each octave is double that of the lower frequency. If the octave is split into thirds, then each third is referred to as a "one-third octave band" set of frequencies. Instead of denoting a specific one-third octave band by its lower and upper frequencies, the band's center frequency is traditionally listed. **Table 2.1** lists one-third octave band center frequencies from 10 Hz to 20,000 Hz. Note the center frequencies covered by the range of the LFSL metric (25-80 Hz) are band numbers 14 through 19. Sound levels associated with each one-third octave band are referred to as "one-third octave band sound levels."

Table 2.1

One-Third Octave Bands

Number	Center Frequency (Hz)	
10	10	
11	12.5	
12	16	
13	20	
14	25	LFSL metric
15	31.5	
16	40	
17	50	
18	63	
19	80	
20	100	
21	125	
22	160	
23	200	
24	250	
25	315	
26	400	
27	500	
28	630	
29	800	
30	1000	
31	1250	
32	1600	
33	2000	
34	2500	
35	3150	
36	4000	
37	5000	
38	6300	
39	8000	
40	10000	
41	12500	
42	16000	
43	20000	

Source: ANSI S 1.16, "Preferred Frequencies, Frequency Levels, and Band Numbers for Acoustical Measurements," Acoustical Society of America.

2.1.6 Equivalent Sound Level (L_{eq})

The first cumulative noise metric, the Equivalent Sound Level (abbreviated L_{eq}), is a measure of the exposure resulting from the accumulation of A-weighted sound levels over a particular period of interest (e.g., an

hour, an 8-hour school day, nighttime, or a full 24-hour day). However, because the length of the period can be different depending on the time frame of interest, the applicable period should always be identified or clearly understood when discussing the metric. Such durations are often identified through a subscript, for example $L_{eq(8)}$ or $L_{eq(24)}$.

Conceptually, L_{eq} may be thought of as a constant sound level over the period of interest that contains as much sound energy as the actual time-varying sound level with its normal "peaks" and "valleys," as illustrated in Figure 2-3. In the context of noise from typical aircraft flight events and as noted earlier for SEL, L_{eq} does not represent the sound level heard at any particular time, but rather represents the total sound exposure for the period of interest. Also, it should be noted that the "average" sound level suggested by L_{eq} is not an arithmetic value, but a logarithmic, or "energy-averaged," sound level. Thus, loud events tend to dominate the noise environment described by the L_{eq} metric.

2.1.7 Day-Night Average Sound Level (DNL)

Part 150 requires that the DNL, a slightly more complicated measure of noise exposure, be used to describe the cumulative or total noise exposure during an annual average day.

DNL is the same as L_{eq} (an energy-average noise level over a 24-hour period) except that 10 dB is added to those noise events occurring at night (between 10:00 p.m. and 7:00 a.m.). This weighting reflects the added intrusiveness of nighttime noise events attributable to the fact that community background noise levels typically decrease by about 10 dB during those nighttime hours. *DNL does not represent the sound level heard at any particular time, but rather represents the total (and partially weighted) sound exposure.*

Typical DNL values for a variety of noise environments are shown in **Figure 2-5** to indicate the range of noise exposure levels usually encountered.

As an example of the cumulative time-average nature of the DNL metric, **Table 2.2** shows the correlation between the number of flights at a given SEL that are needed to generate a specific DNL. The table shows how the DNL metric correlates the number and sound energy of events into a time-average cumulative metric. As such, DNL represents the total sound exposure on the average day and not a specific single-event heard at a particular time.

Table 2.2

Correlation between Operations Frequency, SEL, and DNL

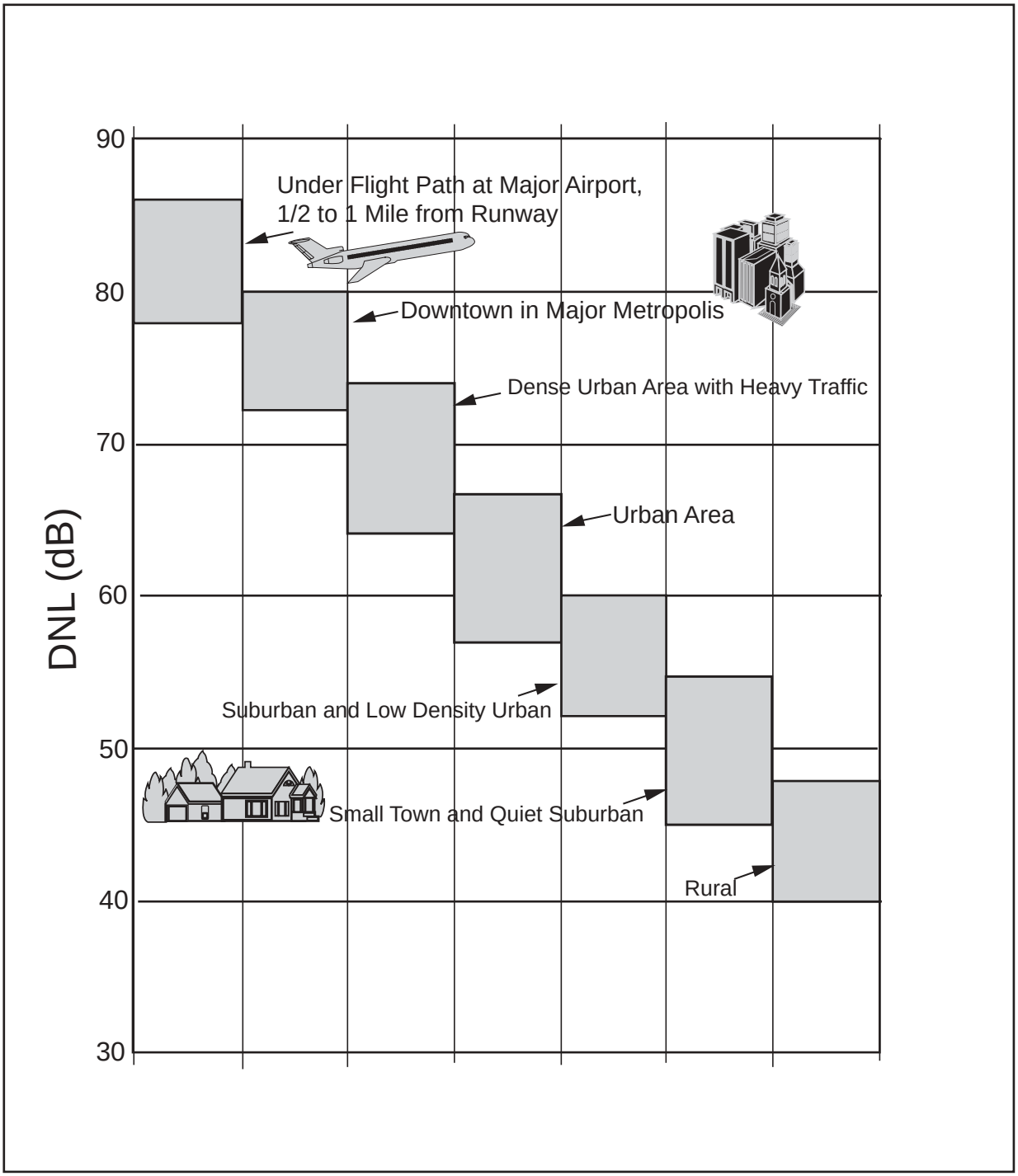
Number of Flights	SEL of Flights	Resulting DNL
500	87.4 dB	65 dB
100	94.4 dB	65 dB
50	97.4 dB	65 dB

Source: FAA Office of Environment and Energy

Due to the DNL metric's correlation with the degree of community annoyance from aircraft noise (the subject of Section 2.2), DNL has been formally adopted by most federal agencies dealing with noise exposure. These agencies include the EPA, FAA, Department of Defense, Department of Housing and Urban Development (HUD), and Veterans Administration. Furthermore, Part 150 *requires* that DNL be used in describing cumulative noise exposure and in identifying aircraft noise and land use compatibility issues.

Typical Range of Outdoor Community Day-Night Average Sound Levels

Figure 2-5



Source: U.S. Department of Defense. Departments of the Air Force, the Army, and the Navy, 1978. *Planning in the Noise Environment.* AFM 19-10. TM 5-803-2, and NAVFAC P-970. Washington, D.C.: U.S. DoD.

Part 150 also requires that the annual average 65, 70, and 75 DNL contour lines (or contours) be depicted on the NEMs. DNL contours are lines of equal noise exposure. This is analogous to topographic contours that are lines of equal elevation.

In order to create DNL contours, the DNL must be assessed for many points on the ground. Measurements of DNL using noise monitoring equipment are practical only for obtaining values for a relatively limited number of points. As a result, airport noise studies, including this Study, are based on estimates of DNL using a FAA-approved computer-based noise model. The model used for this Study is discussed in greater detail in Chapter Four.

2.2 EFFECTS OF AIRCRAFT NOISE ON PEOPLE

To residents around airports, aircraft noise can be an annoyance and a nuisance. It can interfere with conversation and listening to television, disrupt classroom activities in schools, and disrupt sleep. Relating these effects to specific noise metrics aids in the understanding of how and why people react to their environment. This section addresses three ways we are potentially affected by aircraft noise: annoyance, interference of speech, and disturbance of sleep.

2.2.1 Community Annoyance

The primary potential effect of aircraft noise on exposed communities is one of annoyance. EPA defines noise annoyance as any negative subjective re-action on the part of an individual or group.[1]

Scientific studies [1] [2] [3] [4] [5] and a large number of social/attitudinal surveys[6] [7] have been conducted to appraise U.S. and international community annoyance due to all types of environmental noise, especially aircraft events. These studies and surveys have found the DNL to be the best measure of that annoyance.

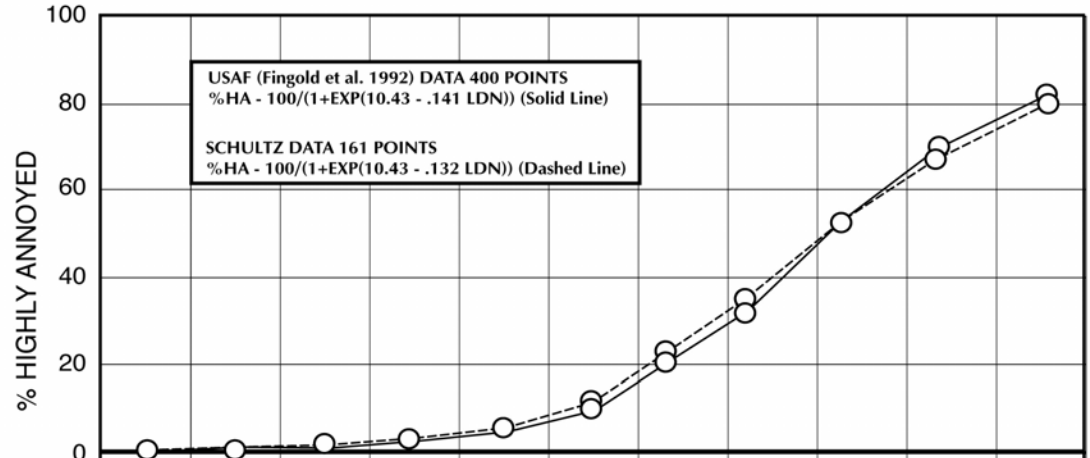
This relation between community annoyance and time-average sound level has been confirmed, even for infrequent aircraft noise events.[8] For example, with helicopter overflight occurrences from 1 to 52 per day, the stated reactions of community individuals correlated with the daily time-average sound levels of the helicopter overflights.

The relationship between annoyance and DNL that has been determined by the scientific community and endorsed by many federal agencies, including the FAA, is shown in **Figure 2-6**. The two lines in Figure 2-6 represent two large sets of social/attitudinal surveys: one for a curve fit of 161 data points compiled by an individual researcher, Ted Schultz, in 1978 and one for a curve fit of 400 data points (which include Schultz's 161 points) compiled in 1992 by the U.S. Air Force. The agreement of these two curves simply means that when one combines the more recent studies with the early landmark surveys in 1978, the results of the early surveys (i.e., the quantified effect of noise on annoyance) are confirmed.

Figure 2-6 shows the percentage of people "highly annoyed" by a given DNL. For example, the two curves in the figure yield a value of about 13 percent for the percentage of the people that would be highly annoyed by a DNL exposure of 65 dB. The figure also shows that at very low values of DNL, such as 45 dB or less, one percent or less of the exposed population would be highly annoyed. Furthermore, at very high values of DNL, such as 90 dB, more than 80-percent of the exposed population would be highly annoyed.

Figure 2-6

Relationship Between Annoyance and Day-Night Average Sound Level



Day - Night Average Sound Level in dB		40	45	50	55	60	65	70	75	80	85	100
Calculated %HA Points	USAF	0.41	0.831	1.66	3.31	6.48	12.29	22.1	36.47	53.74	70.16	82.64
	SCHULTZ	0.576	1.11	2.12	4.03	7.52	13.59	23.32	37.05	53.25	68.78	81

Source: Federal Interagency Committee on Noise (FICON), "Federal Agency Review of Selected Airport Noise Analysis Issues", August 1992, p.3-6, Figure 3-1.

The DNL metric has been criticized as not accurately representing community annoyance and land-use compatibility with aircraft noise.

One frequent criticism is based on the inherent feeling that people react more to single noise events and not as much to "meaningless" time-average sound levels. In fact, a time-average noise metric, such as DNL, takes into account both the noise levels of all individual events which occur during a 24-hour period and the number of times those events occur. As described briefly above, the logarithmic nature of the decibel unit causes the noise levels of the loudest events to control the 24-hour average.

As a simple example of this characteristic, consider a case in which only one aircraft overflight occurs in daytime hours during a 24-hour period, creating a sound level of 100 dB for 30 seconds. During the remaining 23 hours 59 minutes and 30 seconds of the day, the ambient sound level is 50 dB. The DNL for this 24-hour period is 65.5 dB. As a second example, assume that 10 such 30-second overflights occur in daytime hours during the next 24-hour period, with the same ambient sound level of 50 dB during the remaining 23 hours and 55 minutes of the day. The DNL for this 24-hour period is 75.4 dB. Clearly, the averaging of noise over a 24-hour period does not ignore the louder single events and tends to emphasize both the sound levels and number of those events. This is the basic concept of a time-average sound metric, and, specifically, the DNL.

It is often suggested that a lower DNL, such as 60 or 55 dB, be adopted as the threshold of community noise annoyance for airport and land use compatibility studies. A DNL of 65 dB is used in the Part 150 regulations

as the FAA definition of non-compatible noise sensitive land use as it:[9]

- Provides a valid basis for comparing and assessing community noise effects,
- Represents a noise exposure level that is normally dominated by aircraft noise,
- Reflects the FAA's threshold for grant-in-aid funding of airport noise mitigation projects, and
- HUD also established a DNL standard of 65 dB for eligibility for federally guaranteed home loans.

For this Study, DNLs equal to and greater than 60 dB are used for assessing community noise impact. The Study considers a standard of 60 DNL to define non-compatible land uses and for eligibility for a Sound Mitigation Program for the following reasons:

- The 1996 MSP Noise Mitigation Committee recommended that sound insulation should be provided to residents within the 60 DNL contour.
- Minnesota legislation dealing with the Dual Track Planning Process Environmental Impact Statement (EIS) required MAC to make a recommendation to the State Advisory Council on Metropolitan Airport Planning. The legislation stated that "the recommendation shall examine mitigation measures to the 60 Ldn level."[10] Therefore, the State of Minnesota Advisory Council on Metropolitan Airport Planning, pursuant to the Legislature's direction to review the recommendation and comment to the Legislature, reviewed the recommendation and concurred with the Commission's recommendation.[11]
- Metropolitan Council Land Use Policy guidance indicates that new development, major re-development, and infill development of residential land use within the 60-64 DNL contour interval is "conditional" upon land use review factors, including noise level reduction construction and methods to inform future residents of potential aircraft noise impacts. Presently the Metropolitan Council is updating the policy via the Transportation Policy Plan including language designating residential use within the 60 DNL contour as incompatible. See Section 5.3 for more discussion of the Metropolitan Council guidelines and the definition used for infill development.

2.2.2 Speech Interference

A primary effect of aircraft noise is its tendency to drown out or "mask" speech, making it difficult to carry on a normal conversation.

Speech interference associated with aircraft noise is a primary cause of annoyance to individuals on the ground. The disruption of routine activities, such as radio or television listening, telephone use, or family conversation, causes frustration and aggravation. Research has shown that "whenever intrusive noise exceeds approximately 60 dB indoors, there will be interference with speech communication."[12]

Indoor speech interference[13] can be expressed as a percentage of sentence intelligibility among two people speaking in relaxed conversation approximately one meter apart in a typical[14] living room or bedroom. The percentage of sentence intelligibility is a non-linear function of the (steady) indoor background sound level, as shown in **Figure 2-7**. This curve was digitized and curve-fitted for the purposes of

this Study. Such a curve-fit yields 100-percent sentence intelligibility for background levels below 57 dB and yields less than 10 percent intelligibility for background levels above 73 dB. Note that the function is especially sensitive to changes in sound level between 65 dB and 75 dB. As an example of this sensitivity, a 1 dB increase in background sound level from 70 dB to 71 dB yields a 14 percent decrease in sentence intelligibility.

In the same document from which Figure 2-7 was taken, the EPA established an indoor criterion of 45 DNL as requisite to protect against speech interference indoors.

For the reasons cited in Section 2.2.1, this Study utilizes an outdoor DNL of 60 dB to assess community noise impact.

2.2.3 Sleep Disturbance

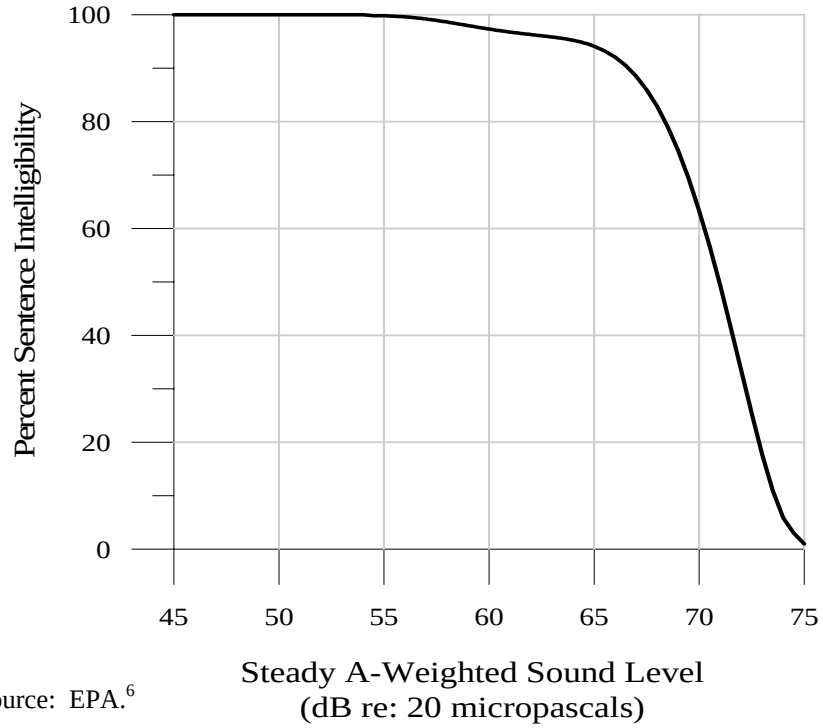
Sleep disturbance is another source of annoyance associated with aircraft noise. This is especially true because of the intermittent nature and content of aircraft noise, which is more disturbing than continuous noise of equal energy and neutral meaning.

Sleep disturbance can be measured in one of two ways. "Arousal" represents awakening from sleep, while a change in "sleep stage" represents a shift from one of four sleep stages to another stage of lighter sleep without awakening. In general, arousal requires a higher noise level than does a change in sleep stage.

In terms of average daily noise levels, some guidance is available to judge sleep disturbance. The EPA identified an indoor

Figure 2-7

Percent Sentence Intelligibility



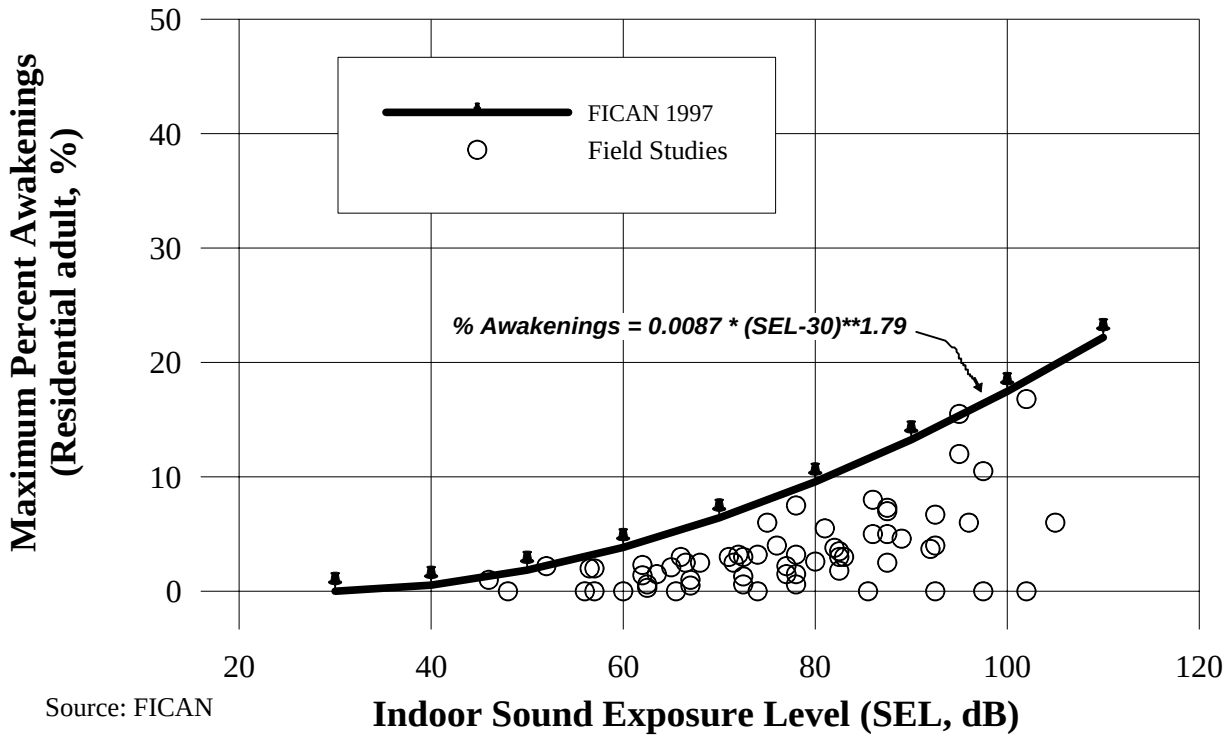
Source: EPA.[6]

DNL of 45 dB as necessary to protect against sleep interference.[1]

In June 1997, the Federal Interagency Committee on Aviation Noise (FICAN) reviewed the sleep disturbance issue and presented a sleep disturbance dose-response prediction curve.[15] FICAN based their curve on data from field studies [16] [17] [18] [19] and recommends the curve as the tool for analysis of potential sleep disturbance for residential areas. **Figure 2-8** shows this curve which, for an indoor SEL of 60 dB, predicts that a maximum of approximately 5 percent of the residential population exposed are expected to be behaviorally awakened. FICAN cautions that this curve should only be applied to long-term adult residents.

Figure 2-8

Sleep Disturbance Dose-Response Relationship



Source: FICAN

NOTES

[1] "Information on Levels of Environmental Noise Requisite to Protect the Public Health and Welfare with an Adequate Margin of Safety," U.S. Environmental Protection Agency, Report 550/9-74-004, March 1974.

[2] "Sound Level Descriptors for Determination of Compatible Land Use," American National Standards Institute Standard ANSI S3.23-1980."

[3] "Federal Agency Review of Selected Airport Noise Analysis Issues," Federal Interagency Committee on Noise, August 1992.

[4] "Quantities and Procedures for Description and Measurement of Environmental Sound, Part I," American National Standards Institute Standard ANSI S21.9-1988.

[5] "Guidelines for Considering Noise in Land Use Planning and Control," Federal Interagency Committee on Urban Noise, June 1980.

[6] Schultz, T.J., "Synthesis of Social Surveys on Noise Annoyance," J. Acoust. Soc. Am., 64, 377-405, August 1978.

[7] Fidell, S., & Barger, D.S., & Schultz, T.J., "Updating a Dosage-Effect Relationship for the Prevalence of Annoyance Due to General Transportation Noise." J. Acoust. Soc. Am., 89, 221-233, January 1991.

[8] "Community Reactions to Helicopter Noise: Results from an Experimental Study," J. Acoust. Soc. Am., 479-492, August 1987.

[9] See 14 CFR 150.7 and 14 CFR Part 150 Table 1.

[10] Dual Track Airport Planning Process, Chapter 464, House 3012, Article 3, Metropolitan Airport Provisions.

[11] Minnesota Advisory Council on Metropolitan Airport Planning, February 10, 1997.

[12] "Sound Level Descriptors for Determination of Compatible Land Use," American National Standards Institute Standard ANSI S3.23-1980."

[13] See note 1.

[14] "Typical' is defined as a room with about 300 sabins of sound absorption, which is representative of living rooms and bedrooms. See note 6.

[15] "Effects of Aviation Noise on Awakenings from Sleep," Federal Interagency Committee on Aviation Noise, June 1997.

[16] Pearson, K.S., Barber, D.S. Tabachnick, B.G., "Analyses of the Predictability of Noise-Induced Sleep Disturbance," USAF Report HSD-TR-89-029, October 1989.

[17] Ollerhead, J.B., Jones, C.J., Cadous, R.E., Woodley, A., Atkinson, B.J., Horne, J.A., Pankhurst, F., Reyner, L, Hume, K.I., Van, F., Watson, A., Diamond, I.D., Egger, P., Holmes, D., McKean, J., "Report of a Field Study of Aircraft Noise and Sleep Disturbance," London Department of Safety, Environment, and Engineering, 1992.

[18] Fidell, S., Pearsons, K., Howe, R., Tabachnick, B., Silvati, L., Barber, D.S., "Noise-Induced Sleep Disturbance in Residential Settings," AL/OE-TR-1994-0131, Wright Patterson AFB, OH, Armstrong Laboratory, Occupational Environmental Health Division, 1994.

[19] Fidell, S., Howe, R., Tabachnick, B., Pearsons, K., Sneddon, M., "Noise-Induced Sleep Disturbance in Residences Near Two Civil Airports," Langley Research Center, 1995.

Chapter Three
FORECAST OF FLIGHT OPERATIONS

The MSP airport activity forecasts have been updated for use in the Study and, in accordance with Part 150 regulations, to include annual average daily airport activity distributions for a five year forecast period (2002-2007).

The Study forecast includes the following components:

- Scheduled passenger operations
- Charter operations
- All-cargo operations
- General aviation and military operations

Each forecast year includes the number of arrivals and departures by aircraft, by day/night split and by stage length (departures only). These forecasts were updated to reflect the current state of the aviation industry, including the impact of the September 11, 2001, terrorist attacks and the recent economic downturn.

This chapter first describes the process used to incorporate public input into the forecast. This is followed by a description of historical activity and the assumptions and methodologies that were used to develop each of the forecast components along with a summary of the forecast results.

It should be noted that forecasting is not an exact science and variances from forecast levels in the airline business environment may significantly affect the projections presented herein.

3.1 SUMMARY OF FORECAST PROCESS

There were several milestones associated with the Study forecast process involving the full MAC, the Planning and Environment (P&E) Committee of the MAC, the NOC and the general public.

The first step was a "kick-off" presentation before the P&E Committee on February 4, 2003. At this presentation, the purpose of the study was described, the performance of previous forecasts was discussed, the general approach and major tasks were outlined, and the schedule was presented.

There was a second presentation before the P&E Committee on May 7, 2003. The estimate of 2002 MSP aircraft operations was presented, and specific issues such as the inclusion of overflights in the MSP tower counts were raised. In addition, proposed forecast assumptions including passenger forecasts, fleet mix, load factor, cargo growth rates, and general aviation growth rates were presented.

The May 7th presentation was repeated on May 22 before a group that was to comprise the membership of the NOC (which later conducted its first meeting in June 2003). Later that evening, a public workshop was held. Presentation boards describing forecast data and assumptions were displayed, and MAC and consultant staff answered questions from the members of the public that attended.

There was a follow-up presentation before the P&E Committee on June 4, 2003. The

purpose was to present additional detail on the forecast assumptions and to report on the public workshop presentation. At the meeting, there was concern that formal input from the NOC should be obtained before rendering a decision on the assumptions. At the following full MAC meeting the decision on acceptance of the forecast assumptions was postponed pending input from the NOC.

The forecast assumptions were formally presented to the NOC on July 17, 2003. At that meeting, the NOC voted to recommend that the MAC approve the assumptions. The full MAC approved the forecast assumptions on August 18, 2003.

Once the assumptions were formally approved, draft forecasts were prepared and presented before the P&E Committee on October 8, 2003. The drafts included annual operations and annual average daily operations by aircraft type and day/night split (for the purposes of generating DNL contours, daytime is defined as 7:00 a.m. to 9:59 p.m. and nighttime is defined as 10:00 p.m. to 6:59 a.m.) This was followed by a presentation before the NOC on October 23rd, and a public workshop later the same day. On October 23, 2003, the NOC recommended that MAC approve the forecast and fleet mix, recognizing that the forecast and fleet mix needed to be updated based on recent announcements regarding grounding of five Avro RJ85 aircraft from Northwest Airlines.

On October 7, 2003, Northwest Airlines had announced that they would be grounding five RJ85 aircraft, which are operated by Mesaba Airlines, in favor of the more economical Canadair Regional Jet. Based on discussions regarding the most likely replacement for these aircraft, the fleet mix was revised resulting in a slightly smaller average aircraft size. Since the passenger forecast remained unchanged, an increase in aircraft operations was required to accommodate the projected activity without the five RJ85s in the fleet. The draft forecasts were revised slightly to incorporate Northwest Airlines' decision to retire five of their Avro RJ-85 aircraft.

The revised forecasts were then presented before the P&E Committee on November 5, 2003. During that meeting, the P&E Committee recommended that the full MAC approve the forecasts. The MAC formally approved the forecasts later that month. On November 20, 2003, the NOC was briefed on the revised forecast and fleet mix with the RJ85s removed.

However, in late January 2004, Northwest Airlines announced that the airline would be bringing all five RJ85 aircraft back into service by June 2004. Per an operating agreement between Northwest Airlines and Mesaba Airlines, the fleet of RJ85 aircraft is anticipated to operate at least through 2007. Subsequently, on March 3, 2004, the MAC Planning and Environment Committee directed staff to integrate the five RJ85 aircraft back into the forecast 2007 fleet mix.

Additionally, during this period HNTB discovered that a small number of General Aviation (GA) operations (approximately one daily operation) were inadvertently excluded from the initial 2002 annual operations number of 492,809 operations. HNTB then incorporated these operations into the year 2002 operations level, resulting in a total annual operations number of 493,220 for the year 2002. The draft revised forecast, to include the five Avro RJ85 aircraft and the corrected GA operations, was published in March 2004.

3.2 HISTORICAL ACTIVITY

Table 3.1 displays historical enplanements and originations at MSP. Originating passengers are those passengers that begin

Table 3.1

Historic Passenger Originations and Enplanements

Year	Originations (a)	Domestic Air Carrier Enplanements	International Air Carrier Enplanements (b)	Regional Enplanements	Non-Scheduled Enplanements	TOTAL Enplanements (c)
1980	2,870,890	4,285,217	28,731	159,727	113,793	4,587,468
1981	2,641,700	4,391,802	57,871	129,497	85,869	4,665,039
1982	2,887,110	5,071,395	50,574	178,590	82,278	5,382,837
1983	3,046,490	5,702,094	49,638	256,615	149,486	6,157,833
1984	3,609,460	5,986,288	73,014	287,762	187,076	6,534,140
1985	3,888,260	7,114,367	83,533	349,281	312,186	7,859,367
1986	4,099,980	7,845,494	81,700	481,188	238,972	8,647,354
1987	4,091,830	8,171,206	85,023	509,246	205,700	8,971,175
1988	4,265,650	8,023,121	65,265	516,083	266,344	8,870,813
1989	4,525,060	8,349,920	78,910	415,910	343,418	9,188,158
1990	4,736,990	8,609,638	102,673	495,439	387,320	9,595,070
1991	4,732,130	8,683,232	124,125	492,075	353,590	9,653,022
1992	4,878,820	9,550,986	144,255	566,186	419,060	10,680,487
1993	5,049,690	9,851,910	170,544	649,104	350,918	11,022,476
1994	5,136,470	10,261,328	166,114	646,788	457,715	11,531,945
1995	5,661,660	11,288,317	256,669	617,477	501,792	12,664,255
1996	6,148,870	12,142,783	276,575	720,749	481,532	13,621,639
1997	6,670,780	12,578,587	419,048	872,377	465,628	14,335,640
1998	6,617,890	12,645,248	519,395	820,709	635,290	14,620,642
1999	7,342,100	14,020,304	575,079	1,211,306	650,350	16,457,039
2000	8,312,480	15,278,927	644,096	1,204,681	399,683	17,527,387
2001	7,602,960	14,379,588	558,276	809,019	280,609	16,027,492
2002	7,189,160	13,794,354	551,203	1,054,192	365,023	15,764,772
2003 (d)	7,302,056	13,710,534	530,300	1,250,064	611,296	16,102,194
Average Annual Growth						
1980-2003	4.1%	5.2%	13.5%	9.4%	7.6%	5.6%

(a) 1990-2003 Database Products. Domestic scheduled originations. Includes air carrier and regional carrier plus those passengers traveling on the domestic portion of an international journey (DPIJ). 1980-1989 MSP Long Term Comprehansive Plan.
(b) Does not include passengers traveling to Canada.
(c) Revenue enplanements.
(d) 2003 originations extrapolated based on monthly enplanement distribution.

Sources: US DOT Origin-Destination Survey, LTCP Volume 6 Revised Activity Forecasts: Technical Appendix, MAC activity statistics and HNTB analysis.

the air portion of their trip at MSP. Enplanements include all passengers that board an aircraft at MSP regardless of whether they are beginning their air trip at MSP or connecting between flights in MSP. Although passenger levels remain below their 2000 peak due to the September 11th terrorist attacks, the recent economic downturn, and the current financial state of the airline industry, they have grown steadily over the last twenty-three years. Originations have grown more slowly than enplanements and, as a result, make up a smaller percentage of total passengers than they did in the 1980s. On average, international enplanements have shot up nearly 14-percent per year since 1980 and growth in regional enplanements (9.4-percent per year) has outpaced growth in domestic air carrier enplanements (5.2-percent per year).

As shown in **Table 3.2**, aircraft operations have followed a similar trend with growth in regional operations far outpacing domestic air carrier operations, and international passenger operations climbing nearly 14-percent per year. All-cargo operations at MSP have grown about 12-percent per year, on average, while both GA and military operations have decreased about 5-percent per year, on average. On average, operations have increased almost 3-percent per year over the last twenty-three years.

The types of aircraft used to serve MSP have changed dramatically since 1990, as shown in **Table 3.3**. For example, Stage 2[1]/Hushkitted aircraft operations declined steadily through the 1990s and accounted for a much smaller portion of total operations in 2002 than they did in 1990. Similarly, the percentage of widebody operations has dropped significantly over the last decade. On the other hand, the next generation Boeing 737 aircraft and Airbus A319s and A320s made up a larger portion of the fleet in 2002 than they did in the early 1990's. Table 3.3 includes only air carrier operations and thus does not reflect either the recent influx of regional jets (with the exception of RJ85s due to their classification by Northwest Airlines) or the recent decline in turboprops in the fleet at MSP.[2]

3.3 BASE YEAR DATA—2002

Table 3.4 summarizes MSP 2002 operations data from the following sources: (1) Airport operations statistics as published by the MAC, (2) FAA's Air Traffic Activity Data System (ATADS), and (3) MSP operations data gathered by the Airport Noise and Operations Monitoring System (ANOMS). Table 3.4 also presents the recommended activity data which was derived primarily from ANOMS data and Airport statistics, with scheduled passenger operations being corroborated with Official Airline Guide (OAG) data.

The figures displayed in Table 3.4 differ significantly from one another for a number of reasons, including:

1. The FAA data and Airport statistics reflect higher total operations figures than do the other sources because, after analysis of 2002 ANOMS data and discussions with the fixed base operator (FBO) and air traffic controllers, it was determined that the FAA and Airport 2002 count of total aircraft operations includes over 14,000 GA overflights and, thus, they over estimate the actual number of take-offs and landings at MSP in 2002. When these overflights are removed from the FAA and Airport counts, the number of aircraft operations in 2002 drops to 493,220 (the total reflected in the 2002 recommended activity data).

2. The ANOMS total is lower than the other sets of data because it does not always

Table 3.2

Historic Aircraft Operations

Year	Domestic Air Carrier	Regional	International Air Carrier (a)	Non-Scheduled	All-Cargo	General Aviation	Military	Total
1980	146,524	12,128	350	1,976	1,214	114,260	6,604	283,056
1981	146,338	9,904	472	2,568	1,446	97,278	5,606	263,612
1982	150,450	22,838	390	2,478	2,556	82,303	5,359	266,374
1983	170,108	33,924	388	3,752	3,192	83,548	5,100	300,012
1984	189,830	35,938	506	2,234	5,966	93,367	7,721	335,562
1985	220,190	31,460	628	3,346	5,338	106,715	14,020	381,697
1986	231,760	50,520	680	2,426	12,360	71,406	6,869	376,021
1987	213,540	56,410	644	3,002	15,434	70,050	8,676	367,756
1988	211,562	58,896	544	2,836	17,958	68,634	6,698	367,128
1989	218,168	59,338	718	3,310	17,194	71,669	4,347	374,744
1990	223,884	74,446	860	4,538	18,526	58,864	2,804	383,922
1991	225,390	75,856	1,078	5,046	20,280	55,702	2,534	385,886
1992	242,670	85,926	1,222	5,824	18,900	60,929	3,003	418,474
1993	258,374	108,237	1,285	4,855	15,198	49,216	2,825	439,990
1994	264,519	115,164	1,478	6,103	14,110	50,898	2,451	454,723
1995	281,334	106,763	1,832	6,832	15,909	49,769	2,915	465,354
1996	295,776	105,926	2,256	8,750	20,362	49,786	2,624	485,480
1997	294,220	102,038	3,821	8,350	15,011	64,209	3,624	491,273
1998	278,828	90,421	5,109	11,531	15,323	79,757	2,044	483,013
1999	314,883	109,017	6,036	10,600	17,271	49,256	3,358	510,421
2000	341,980	89,105	7,224	5,959	18,395	58,076	2,473	523,212
2001	342,122	81,661	7,449	4,090	17,077	45,943	3,180	501,522
2002	338,744	95,248	7,048	4,833	14,974	44,279	2,543	507,669
2003	332,251	104,931	6,515	10,656	16,579	37,594	1,856	510,382
Average Annual Growth								
1980-2003	3.6%	9.8%	13.6%	7.6%	12.0%	-4.7%	-5.4%	2.6%

(a) Does not include Canadian traffic. Canadian traffic included in domestic numbers.

Source: MAC

Table 3.3

Historic Air Carrier Departures by Aircraft Type

Aircraft	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
							Stage2/Huskit Aircraft						
727-100	3,526	2,844	243	72							3	2	
727-200	25,419	21,359	24,749	23,048	22,722	21,320	18,088	15,992	14,249	19,879	18,877	14,118	3,577
737-1/200	2,435	3,087	3,335	3,748	3,618	5,718	8,835	9,234	8,745	5,617	5,314	2,494	319
737-200C	683	483	286	551	484	446	870	97	656	6	10	9	6
DC-8-7	7	2											
DC-9-10	6,054	7,455	8,014	5,874	7,418	7,647	7,304	5,424	4,189	3,186	3,496	2,412	2,286
DC-9-15/15	643	135											
DC-9-30	26,630	26,548	27,454	30,307	29,881	33,884	38,814	41,432	37,649	38,213	39,759	37,608	36,721
DC-9-40	386	290	2,741	2,976	3,197	3,628	2,624	2,801	3,316	3,311	3,749	2,438	2,670
DC-9-50	9,758	10,407	8,587	11,173	10,685	11,171	10,575	9,031	7,448	8,372	8,339	8,762	8,736
747-100	1,157	884	909	880	619	372	277						
Stage 2/Hushkit Subtotal	**76,698**	**73,494**	**76,318**	**78,629**	**78,624**	**84,186**	**87,387**	**84,011**	**76,252**	**78,584**	**79,547**	**67,843**	**54,315**
							Widebody Stage 3 Aircraft						
747-2/300					1			31	90	243	227	191	172
747-400	312	377	302	329	117	15	5	4	20	6	5	6	5
767-200	1	3	3	2		1		3		5	3	2	
767-300	1		2		1		2	2	1	3	7	3	2
A300 B4			1		1								
B-777								1	1	3	4	4	2
DC-10-10	8	6	6	5	2	2	4	5	20	214	600	214	242
DC-10-30	2	327	678	528	650	680	580	980	890	967	291	590	523
DC-10-40	5,379	4,844	4,935	4,672	4,257	3,733	3,771	4,037	2,828	3,625	5,070	4,720	1,773
L-1011	4	8	6		1								
Widebody Stage 3 Subtotal	**5,707**	**5,565**	**5,933**	**5,536**	**5,030**	**4,431**	**4,362**	**5,063**	**3,850**	**5,066**	**6,207**	**5,730**	**2,719**
							Narrowbody Stage 3 Aircraft						
717-200											1,266	2,519	1,875
737-3/700	4,759	5,054	4,180	4,084	3,527	3,465	3,133	3,400					
737-300									3,824	5,612	4,438	3,601	6,939
737-400	31	17	304	62	560	303	54	11	28	168	373	311	75
737-500	2	83	890	1,279	1,891	2,056	1,394	1,573	1,700	2,010	2,559	3,074	3,848
737-700LR												44	77
737-800										3	72	1,666	2,994
757-200	10,703	10,796	10,628	10,056	10,201	11,580	14,354	15,286	15,755	16,297	16,745	16,366	18,772
757-300													597
A319									15	1,092	4,534	11,808	17,064
A320	2,264	4,146	8,637	13,427	14,887	14,091	13,735	14,042	15,332	23,452	27,884	24,714	25,468
A321												3	3
Avro RJ-85								231	1,147	7,706	11,183	13,304	11,665
BAe 146		1	4			34	184	2,002	4,454				
F-100	32	213	470	2,356	4,840	6,486	6,828	7,374	6,376	4,532	4,650	4,623	5,850
MD-80/DC-9	8,717	10,146	11,536	9,919	8,767	7,933	7,667	7,477	7,814	9,838	5,254	4,407	4,743
MD-87													4
Narrowbody Stage 3 Subtotal	**26,508**	**30,456**	**36,649**	**41,183**	**44,673**	**45,948**	**47,349**	**51,396**	**56,445**	**70,710**	**78,958**	**86,440**	**99,974**
Grand Total	**108,913**	**109,515**	**118,900**	**125,348**	**128,327**	**134,565**	**139,098**	**140,470**	**136,547**	**154,360**	**164,712**	**160,013**	**157,008**

Source: T-100 data as published by Database Products.

Table 3.4

2002 Operations Data

Component	Airport Statistics	FAA ATADS Data	ANOMS Data	Recommended Activity Data (a)
Scheduled Passenger (b)	441,040	443,416	425,871	441,462
Charter (c)	4,939	-	3,929	4,940
All-Cargo (c)	14,974	-	16,179	18,198
General Aviation (d)	44,279	60,874	23,954	25,496
Military (e)	2,543	3,032	2,798	3,124
Other	-	-	3,984	-
TOTAL	507,775	507,322	476,715	493,220

(a) ANOMS data adjusted to reflect actual activity, with corroboration of scheduled passenger operations per OAG. See text for adjustment details.

(b) FAA data includes air carrier and air taxi operations from ATADS data. Recommended data reflects a slightly higher operation level than Airport statistics because scheduled passenger flights operated by Bemidji Airlines (as reflected in OAG) are included in this category.

(c) FAA statistics do not provide a breakout of all-cargo and charter operations. Recommended data for cargo activity is significantly higher than Airport statistics because small "feeder" cargo flights are included in this category whereas Airport and FAA counted a significant portion of these flights as GA operations.

(d) Recommended data significantly lower than Airport and FAA data because recommended data does not include overflights, small cargo "feeder" flights, etc.

(e) The recommended operations level for military flights was reached by equalizing the military data in the ANOMS data file--military arrivals significantly outweighed military departures and departures were adjusted upwards to reflect arrival levels. This adjustment generated an estimated military operations level of 3,124.

Sources: Airport statistics by airline, FAA ATADS data, 2002 ANOMS data for MSP, OAG, and HNTB analysis.

capture every single operation at an airport.

3. The FAA data, as organized in Table 3.4, underestimates activity in some categories and overestimates activity in other categories because the FAA divides operations into only four categories: Air Carrier (AC), Air Taxi (AT), General Aviation (GA) and Military. The AC category includes scheduled passenger flights, all-cargo flights, and charter flights and the AT category usually includes true air taxi operations as well as most regional operations and some smaller all-cargo operations. Many small cargo-operations also get miscounted as GA operations.[3]

4. The Airport statistics underestimate the number of true all-cargo operations because many of the smaller "feeder" cargo operations are mistakenly identified as GA operations.

In general, the data sets presented in Table 3.4 each have variances from one another due to the differing structures with which operational data is collected and categorized. The data sets were, therefore, used in conjunction to develop the recommended activity data file—the baseline 2002 activity file used to develop the Study forecast. For example, the MAC publishes summary activity data on an airline by airline basis and this airline information was used to adjust the raw ANOMS data upwards to reflect actual operations at MSP in 2002, with additional corroboration for scheduled passenger operations per OAG data.[4] The Airport statistics on their own do not provide enough detail for a Part 150 forecast—they do not include a breakout of aircraft types and day/night splits—and thus had to be used in conjunction with other sources of Airport activity data, namely the ANOMS data.

3.4 RESULTS OF AIRLINE SURVEYS

Airline input was critical to the development of the Study forecast. To garner this input, each airline was sent a Study Forecast Questionnaire, including scheduled air carriers and regional carriers, charter carriers, and cargo carriers. Those airlines that had not returned a survey by the established deadline were contacted by phone and encouraged to return their questionnaire. Since Northwest Airlines operates a hub at MSP and, thus, accounts for a significant portion of activity at MSP, interviews were arranged with representatives from Northwest Airlines.

The Study Questionnaire requested the following information of the carriers:

- Number of daily aircraft operations by aircraft type and day/night split for 2002 (actual) and 2007 (projected),
- Average annual load factor for 2002 (actual) and 2007 (projected),
- Anticipated changes in stage length, and
- Comments on future activity at MSP.

The response from the airlines was generally good with a majority of airlines returning surveys. Most of the carriers responded to all the survey questions, however, some simply indicated "unknown" in response to requests for 2007 forecast data.

Participating carriers included (in no particular order):

- Northwest (interview in lieu of questionnaire, Northwest also provided information about Mesaba activity.)
- America West
- Skyway/Midwest Connect
- Air Canada

- Sun Country
- Delta
- Great Lakes
- Icelandair
- United
- Frontier
- American
- UPS
- Airborne Express (ABX)
- Continental
- Champion
- KLM
- FedEx
- DHL

In general, the surveys revealed that the airlines anticipate little change in the percentage of nighttime (10 p.m. to 7 a.m.) operations and in the stage length distribution of flights through 2007. The airlines that provided load factor estimates for 2007 anticipate that load factors will either remain steady or increase slightly over the forecast period. Many of the airlines expect minor fleet changes and these are summarized in the following sections.

Because some survey responses were incomplete and because some airlines did not participate, the survey results were used only to guide the analyses described in the following sections. Additionally, there is the possibility that, over the forecast period, airlines that either do not yet exist or that do not currently operate at MSP will begin service at the Airport and airlines currently serving MSP will discontinue service at the Airport. The airline survey was unable to account for this future activity and, thus, the survey data had to be supplemented with industry information as referenced and detailed in the following sections.

3.5 GENERAL FORECAST ASSUMPTIONS

The general forecast assumptions that were applied in this forecast are based on industry sources and professional judgment. The more critical assumptions were reviewed by the MAC. Detailed assumptions, specific to each activity component, are described later in this section.

The general assumptions are described below:

1. Anticipated air service trends: It is assumed that factors such as government regulation and labor union resistance will prevent any major consolidation. Although some minor airline consolidation could continue to occur, no attempt is made to predict the individual airlines that would be affected. It is assumed that any diversion to corporate aviation will be insufficient to materially affect commercial passenger traffic.
2. Regulatory assumptions: No return to airline regulation, as occurred prior to 1979, is assumed. Airlines are assumed to be free to increase service and charge fares as market conditions dictate.
3. Fuel assumptions: The real cost of fuel is assumed to increase gradually, in accordance with FAA forecasts. No major price shocks or disruptions, as occurred in the mid- and late 1970s, are assumed. Also, no major increases in fuel taxes are assumed.
4. Future security environment: Security issues related to air travel have changed and will continue to change as new security procedures and technology are incorporated to improve airport security.

Events that may affect traveler confidence in airport security or air travel security cannot be predicted. It is assumed that there will be no terrorist attacks during the forecast period that will affect confidence in the aviation system to the same extent as 9/11. It is also assumed that the Transportation Security Administration (TSA) requirements and associated security costs will continue through the forecast period.

5. Economic assumptions: It is assumed that no major economic recession will take place over the forecast period.
6. International political environment: No major international conflicts that would disrupt aviation at MSP are assumed. Likewise, no major trade wars or embargoes that would restrict the international flow of commerce and travel are assumed.
7. Evolution of logistics industry: It is assumed that the logistics industry will continue to evolve and that requirements will become more sophisticated, favoring the integrated all-cargo carriers, such as FedEx and UPS, as opposed to the more traditional all-cargo carriers that focus primarily on air transport.
8. Dependence of cargo industry on passenger carriers: In accordance with current trends and increasing security requirements, it is assumed that the share of both domestic and international air cargo carried by passenger carriers will continue to decrease.

3.6 SCHEDULED PASSENGER ACTIVITY FORECAST

This section discusses forecast development for scheduled passenger aircraft operations.

3.6.1 Assumptions & Methodology

The Part 150 process requires only a forecast of aircraft operations; however, in order to forecast passenger aircraft operations at MSP it was necessary to make some assumptions about future passenger levels and passenger load factors at MSP.

An existing passenger forecast was used for the Study, rather than preparation of a new passenger forecast. This was done for two reasons. First, a streamlined approach that relies on an existing forecast would help prevent further delays to a Study process that had already been interrupted several times in the past. Secondly, recent passenger trends at MSP have been more sensitive to security and financial factors affecting the national aviation industry than to local economic trends. These factors have been incorporated into the FAA-based forecast recommended for use in this study (discussed later in this section) but have not been addressed in any recent local studies.

To project passenger levels at MSP in 2007, the following three forecast options were considered:

- FAA's Terminal Area Forecast (TAF) for MSP
- Bond Feasibility Study Forecast for MSP
- FAA's most recent forecast for the U.S. (*FAA Aerospace Forecast, Fiscal Years 2003-2014*, Published March 2003)

Table 3.5 presents projected scheduled passenger levels for each of the three forecast options. Both the TAF and the Bond Feasibility Forecast are MSP specific; however, they each have their drawbacks. The TAF does not incorporate the effects of either the Iraq War or the SARS outbreak and does not fully incorporate recent changes

Table 3.5

Scheduled Passenger Forecast Options

	Terminal Area Forecast (b)	FAA Rate for the U.S.	Bond Feasibility Study Forecast
2002 (a)	30,798,968	30,798,968	30,798,968
2003	32,300,000	31,600,000	31,500,000
2004	33,900,000	33,100,000	32,200,000
2005	35,600,000	34,500,000	32,900,000
2006	37,300,000	34,400,000	33,700,000
2007	39,100,000	35,700,000	34,500,000
Average Annual Growth Rate	4.90%	3.68%	2.30%

Notes:
(a) Growth rate from each forecast applied to actual 2002 scheduled passengers.
(b) Adjusted to reflect calendar year.

Sources: As noted in text and HNTB analysis

in the airline industry, including the United Airlines bankruptcy and the continued layoffs, labor negotiations, and schedule reductions that are taking place across the industry. The Bond Feasibility Study Forecast is intended to be conservative, since in determining the feasibility of a bond issue the negative consequences of overestimating activity are much greater than in underestimating activity.

Although the FAA national growth rate for the U.S. is not specific to MSP it provides the best match to both historical and actual year-to-date 2003 growth at MSP, as well as current airline trends. It was thus chosen to forecast passengers at MSP for use in this Study forecast. Using this annual growth rate of approximately 3.68-percent, total annual scheduled passengers at MSP are expected to grow from 30.8 million in 2002 to 36.9 million in 2007.[5]

As shown in **Table 3.6**, this passenger forecast was reached by applying the FAA national growth rate to each corresponding group of passengers at MSP and, collectively, the total number of passengers is expected to increase 3.68-percent. As indicated in Table 3.6, the number of regional carrier passengers is expected to grow more quickly than the number of domestic and international air carrier passengers.

The average passenger load factor at MSP is projected to increase 2.2-percent over the forecast period, from 65.0-percent in 2002 to 66.4-percent in 2007. The 2002 load factor estimate reflects both air carrier and regional carrier operations and was calculated by dividing total seat departures (based on OAG schedule of flights by aircraft type) by total enplanements as reported in the Airport statistics published by the MAC for calendar year 2002. The 2007 load factor estimate was based on airline surveys.

Table 3.6

FAA U.S. Forecast Growth Rates Applied to MSP 2002 Base Year Passenger Levels

	2002	2003	2004	2007	2002-2007 Average Annual Growth Rate Growth Rate
MSP Domestic Air Carrier (a)	27,556,585	28,100,000	29,400,000	32,500,000	3.36%
MSP International Air Carrier (a)	1,106,130	1,200,000	1,200,000	1,400,000	4.82%
MSP Regional Carrier (a)	2,136,253	2,300,000	2,500,000	3,000,000	7.03%
Total Scheduled	30,798,968	31,600,000	33,100,000	36,900,000	3.68%
MSP Charter (a)	728,792	757,000	785,000	870,000	3.61%
Total	31,527,760	32,357,000	33,885,000	37,770,000	3.68%

Note:
(a) FAA national forecast growth rates applied to MSP 2002 base for each category.

Sources: As noted in text and HNTB analysis.

Using these assumptions about passenger growth and load factors, the following steps were taken to forecast passenger aircraft operations at MSP in 2007 (See **Table 3.7**):

1. Total scheduled passenger enplanements in 2007 are calculated by dividing total scheduled passengers by two, yielding approximately 18.5 million enplanements.

2. Total seat departures in 2007 are calculated by dividing total scheduled passenger enplanements by the 2007 estimated load factor, yielding 27.8 million seat departures.

3. Airline surveys, data on aircraft orders, and anticipated air service trends are used to estimate the most probable manner in which airlines will supply (i.e., fleet mix) the projected number of seat departures in 2007. This step translates projected seat departures into projected aircraft operations by airline and by aircraft.

4. Determine the day/night splits of arrivals and departures (by aircraft type) based on airline surveys and 2002 ANOMS data and supplemented with airline schedule information where necessary.

5. Existing schedules and air service trends by airline are used to determine the stage length split for departures on an aircraft by aircraft basis.

3.6.2 Forecast of Scheduled Passenger Operations

Table 3.8 displays the forecast of passenger operations (annual average day) by aircraft type and day/night split, while **Table 3.9** provides the stage length distribution for the passenger fleet mix. As shown, passenger aircraft activity is projected to total about 1,434.2 daily operations, on average, in 2007

Table 3.7

Passenger Forecast Assumptions

	2002	2007	Average Annual Growth
Total Scheduled Revenue Passengers	30,798,968	36,900,000	3.68%
Total Scheduled Revenue Enplanements (a)	15,399,749	18,450,000	3.68%
Average Passenger Load Factor (b)	65.0%	66.4%	0.44%
Total Seat Departures (c)	23,689,870	27,800,000	3.25%
Scheduled Aircraft Operations (d)	441,462	523,472	3.47%
Average Seats per Aircraft (e)	107.3	106.2	-0.21%

Notes:
(a) Total Passengers divided by two. Enplanements for 2002 are actual. All figures are rounded.

(b) 2002 load factor reflects scheduled air carrier and regional carrier operations. Calculated by dividing total seat departures (OAG) by enplanements (Airport statistics). 2007 load factor estimated based on airlines surveys.

(c) Enplanements divided by load factor. All figures are rounded.
(d) 2002 operations reflect actual 2002 ANOMS data and Airport statistics as corroborated by OAG data. 2007 operations based on projected fleet mix, see text for details.
(e) Calculated by multiplying seat departures by two, then dividing by aircraft operations.

Sources: As noted in text and HNTB analysis.

Table 3.8

Forecast Passenger Aircraft Operations by Day/Night Split, 2007 Annual Average Day

Aircraft Type	Arrivals			Departures		
	Day	Night	Total	Day	Night	Total
A318	2.58	0.52	3.10	3.10	-	3.10
A319	74.73	1.77	76.50	74.37	2.13	76.50
A320	84.61	9.47	94.08	87.53	6.54	94.08
A330	3.10	-	3.10	3.10	-	3.10
A340	1.03	-	1.03	1.03	-	1.03
B190	4.13	0.00	4.14	4.13	0.01	4.14
B712	3.37	0.76	4.14	3.94	0.20	4.14
B733	23.23	2.61	25.84	24.95	0.89	25.84
B735	2.85	0.25	3.10	2.81	0.29	3.10
B737	3.88	0.26	4.14	3.93	0.20	4.14
B738	30.55	8.36	38.92	34.73	4.18	38.92
B739	2.58	0.52	3.10	3.10	-	3.10
B744	0.89	0.15	1.03	1.01	0.03	1.03
B752	42.55	5.00	47.55	44.62	2.93	47.55
B753	16.76	0.82	17.57	17.32	0.25	17.57
BA46	37.79	0.46	38.25	36.54	1.71	38.25
BE20	0.74	0.29	1.03	0.79	0.25	1.03
CARJ	127.10	6.26	133.36	125.28	8.08	133.36
CRJ7	1.03	-	1.03	1.03	-	1.03
DC10	1.89	0.18	2.07	2.04	0.03	2.07
DC9Q	125.37	3.86	129.22	119.66	9.57	129.22
E140	5.17	-	5.17	5.17	-	5.17
E145	9.17	0.13	9.30	9.28	0.02	9.30
E170	8.27	-	8.27	8.27	-	8.27
J328	3.09	0.01	3.10	3.09	0.01	3.10
MD80	8.94	0.36	9.30	8.02	1.28	9.30
SF34	46.88	2.74	49.62	46.44	3.18	49.62
TOTAL	**672.31**	**44.78**	**717.09**	**675.29**	**41.80**	**717.09**

Notes:

Differences may exist due to rounding as actual INM input is to four decimal places; only two decimal places are shown in the table in the interest of conciseness.

Due to rounding, a notation of "0.00" indicates a value of less than 0.005, while a notation of "-" indicates a value of zero.

Sources: As noted in text and HNTB analysis.

Table 3.9

Forecast Passenger Aircraft Stage Length Distributions, 2007 Annual Average Day

Aircraft Type	Departures													
	0-500 nm (SL1)		500-1000 nm (SL2)		1000-1500 nm (SL3)		1500-2500 nm (SL4)		2500-3500 nm (SL5)		3500-4500 nm (SL6)		4500+ nm (SL7)	
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
A318	-	-	33.3%	-	66.7%	-	-	-	-	-	-	-	-	-
A319	12.3%	11.7%	70.8%	72.2%	17.0%	16.1%	-	-	-	-	-	-	-	-
A320	20.4%	20.6%	42.7%	42.1%	36.2%	36.7%	0.6%	0.6%	-	-	-	-	-	-
A330	-	-	-	-	-	-	-	-	33.3%	-	66.7%	-	-	-
A340	-	-	-	-	-	-	-	-	-	-	100.0%	-	-	-
B190	100.0%	100.0%	-	-	-	-	-	-	-	-	-	-	-	-
B712	-	-	100.0%	100.0%	-	-	-	-	-	-	-	-	-	-
B733	25.3%	25.3%	62.7%	62.7%	12.0%	12.0%	-	-	-	-	-	-	-	-
B735	-	-	100.0%	100.0%	-	-	-	-	-	-	-	-	-	-
B737	-	-	45.0%	45.0%	30.0%	30.0%	25.0%	25.0%	-	-	-	-	-	-
B738	44.5%	44.5%	43.4%	43.4%	11.2%	11.2%	0.9%	0.9%	-	-	-	-	-	-
B739	-	-	-	-	100.0%	-	-	-	-	-	-	-	-	-
B744	-	-	-	-	-	-	-	-	-	-	-	-	100.0%	100.0%
B752	19.0%	20.3%	16.7%	17.9%	52.9%	53.1%	9.1%	8.0%	2.3%	0.7%	-	-	-	-
B753	10.0%	10.0%	20.0%	20.0%	62.5%	62.5%	7.5%	7.5%	-	-	-	-	-	-
BA46	62.0%	62.0%	38.0%	38.0%	-	-	-	-	-	-	-	-	-	-
BE20	100.0%	100.0%	-	-	-	-	-	-	-	-	-	-	-	-
CR70	-	-	100.0%	-	-	-	-	-	-	-	-	-	-	-
CARJ	49.7%	50.9%	48.4%	47.2%	1.9%	1.9%	-	-	-	-	-	-	-	-
DC10	-	-	-	-	-	-	-	-	100.0%	100.0%	-	-	-	-
DC9Q	56.7%	56.7%	43.3%	43.3%	-	-	-	-	-	-	-	-	-	-
E140	100.0%	-	-	-	-	-	-	-	-	-	-	-	-	-
E145	22.2%	22.4%	77.8%	77.6%	-	-	-	-	-	-	-	-	-	-
E170	-	-	100.0%	-	-	-	-	-	-	-	-	-	-	-
J328	100.0%	100.0%	-	-	-	-	-	-	-	-	-	-	-	-
MD80	-	-	88.9%	88.9%	11.1%	11.1%	-	-	-	-	-	-	-	-
SF34	100.0%	100.0%	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	**40.5%**	**43.9%**	**43.1%**	**42.1%**	**14.1%**	**12.9%**	**1.1%**	**0.9%**	**0.6%**	**0.1%**	**0.5%**	**-**	**0.1%**	**0.1%**

Note: Differences may exist due to rounding as actual INM input is to four decimal places; the percentages are shown to one decimal place in the interest of conciseness.

Sources: As noted in text and HNTB analysis.

(approximately 717.1 arrivals and 717.1 departures). This translates into about 523,472 annual scheduled passenger operations, which reflects an annual average increase of about 3.5-percent. This growth rate is almost the same as the expected growth in passengers (3.68-percent per year) because, although load factors are expected to increase, they are off-set by a projected decrease in average aircraft size in the forecast.

As shown in **Table 3.10**, the average aircraft size is expected to decrease slightly as regional operations make up an anticipated larger share of total passenger operations.[6] The 2007 fleet mix also reflects a number of other changes from the 2002 fleet mix, namely:

- The number of A318s, A319s and A320s as well as the number of next generation 737s (-700s, -800s, and -900s) are expected to grow in number.
- The number of turboprops is expected to drop while the number of regional jets is projected to increase sharply.
- Larger 70-seat regional jets are expected to make up an increasing, albeit still small, share of regional jets operations.
- The number of hushkitted and widebody aircraft is expected to decrease.

3.7 CHARTER ACTIVITY FORECASTS

This section reviews the methodology and assumptions that were used to develop the charter forecast for MSP and discusses the results of the forecast.

3.7.1 Assumptions and Methodology

The methods and assumptions used to develop the 2007 charter activity forecast for MSP are similar to those used to project scheduled passenger activity. Charter passengers are expected to increase at about 3.6-percent per year and charter load factors are expected to increase 2.2-percent over the forecast period, from about 68.7-percent in 2002 to an estimated 70.2-percent in 2007. Because load factors are projected to increase, the number of charter seat departures is expected to increase more slowly than the number of charter passengers. **Table 3.11** summarizes the steps taken and the assumptions used to develop the charter forecast. A more detailed account of these steps and assumptions is provided in the scheduled passenger operations section of this report.

3.7.2 Forecast of Charter Operations

Table 3.12 displays the results of the charter activity forecast by aircraft type and day/night split. **Table 3.13** provides the stage length distribution for the charter aircraft forecast. As shown, charter activity is expected to total about 15.8 operations per day, on average (about 7.9 arrivals and 7.9 departures). This translates into nearly 5,766 annual charter operations in 2007, which reflects an average annual increase of about 3.1-percent.

In contrast to scheduled passenger aircraft, the average size of charter aircraft is expected to increase slightly, from about 213 seats per aircraft, on average, to about 215 seats per aircraft. This increase in average aircraft size in combination with the expected increase in load factors renders a slower growth rate for charter operations than for charter passengers.

3.8 AIR CARGO ACTIVITY FORECAST

This section begins with a summary of the principal cargo forecast assumptions and then reviews the methods used to forecast cargo tonnage and translate it into cargo operations.

Table 3.10

Comparison of 2002 versus 2007 Passenger Fleet Mix as Share of Operations

Operation Type	Aircraft	2002	2007
Hushkitted Air Carrier	B72Q	1.7%	-
	B73Q	0.2%	-
	DC9Q	25.1%	18.0%
	SUBTOTAL	**27.0%**	**18.0%**
Manufactured Stage 3 Air Carrier	A318	-	0.4%
	A319	8.7%	10.7%
	A320	12.3%	13.1%
	A330	-	0.4%
	A340	-	0.1%
	B712	0.9%	0.6%
	B733	3.1%	3.6%
	B734	0.0%	-
	B735	1.7%	0.4%
	B737	0.0%	0.6%
	B738	1.5%	5.4%
	B739	-	0.4%
	B744	0.5%	0.1%
	B752	8.8%	6.6%
	B753	0.3%	2.5%
	B763	0.0%	-
	DC10	1.4%	0.3%
	F100	2.7%	-
	J328	0.4%	0.4%
	MD80	2.2%	1.3%
	SUBTOTAL	**44.4%**	**47.1%**
Regional Carrier	B190	1.0%	0.6%
	BA46	5.5%	5.3%
	BE20	-	0.1%
	BE58	0.1%	-
	CARJ	7.4%	18.6%
	CRJ7	-	0.1%
	E135	0.0%	-
	E140	-	0.7%
	E145	0.8%	1.3%
	E170	-	1.2%
	SF34	13.8%	6.9%
	SUBTOTAL	**28.7%**	**34.9%**
	GRAND TOTAL	**100.0%**	**100.0%**

Notes:
Differences may exist due to rounding as actual INM input is to four decimal places; the percentages are shown to one decimal place in the interest of conciseness.
Due to rounding, a notation of "0.0" indicates a value of less than 0.05%, while a notation of "-" indicates a value of zero percent

Sources: As noted in text and HNTB analysis.

Table 3.11

Charter Forecast Assumptions

	2002	2007	Average Annual Growth
Charter Passengers (a)	728,792	869,766	3.60%
Charter Enplanements (b)	365,023	435,631	3.60%
Estimated Load Factor (c)	68.7%	70.2%	0.44%
Total Seat Departures (d)	531,427	620,571	3.15%
Charter Operations (e)	4,940	5,766	3.14%

Notes:

(a) Actual 2002 passengers as reflected in Airport statistics. Year 2007 passengers based on assumption of 3.6% average annual growth.

(b) Actual 2002 enplanements. Year 2002 ratio of enplanements to total passengers multiplied by total 2007 passengers.

(c) Actual 2002 Enplanements divided by estimated 2002 seat departures (departures by aircraft type multiplied by seats per aircraft). 2007 load factor estimated from airline surveys.

(d) Enplanements divided by load factor.

(e) 2002 operations reflect actual 2002 ANOMS data and Airport statistics as corroborated by OAG data. Year 2007 operations based on projected fleet mix; see text for details.

Sources: As noted in text and HNTB analysis.

Table 3.12

Forecast Charter Aircraft Operations by Day/Night Split, 2007 Annual Average Day

Aircraft Type	Arrivals			Departures		
	Day	Night	Total	Day	Night	Total
A320	0.53	0.33	0.86	0.74	0.12	0.86
B72Q	2.09	1.65	3.73	2.91	0.82	3.73
B73Q	0.11	0.04	0.15	0.13	0.03	0.15
B733	0.01	0.00	0.01	0.01	0.01	0.01
B734	0.05	0.03	0.07	0.06	0.01	0.07
B738	0.10	0.02	0.12	0.10	0.01	0.12
B752	0.52	0.26	0.78	0.58	0.19	0.78
DC10	1.06	0.31	1.37	1.07	0.29	1.37
DC9Q	0.12	0.01	0.13	0.11	0.02	0.13
L101	0.28	0.11	0.39	0.33	0.06	0.39
MD11	0.00	-	0.00	0.00	0.00	0.00
MD80	0.27	0.02	0.28	0.26	0.03	0.28
TOTAL	**5.12**	**2.78**	**7.90**	**6.30**	**1.60**	**7.90**

Notes:

Differences may exist due to rounding as actual INM input is to four decimal places; only two decimal places are shown in the table in the interest of conciseness.

Due to rounding, a notation of "0.00" indicates a value of less than 0.005, while a notation of "-" indicates a value of zero.

Sources: As noted in text and HNTB analysis.

Table 3.13

Forecast Charter Aircraft Stage Length Distributions, 2007 Annual Average Day

Aircraft Type	Departures													
	0-500 nm (SL1)		500-1000 nm (SL2)		1000-1500 nm (SL3)		1500-2500 nm (SL4)		2500-3500 nm (SL5)		3500-4500 nm (SL6)		4500+ nm (SL7)	
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
A320	-	-	17.5%	17.5%	40.0%	40.0%	42.5%	42.5%	-	-	-	-	-	-
B72Q	-	-	4.3%	5.3%	92.0%	89.9%	3.7%	4.8%	-	-	-	-	-	-
B73Q	-	-	30.4%	34.9%	69.6%	65.1%	-	-	-	-	-	-	-	-
B733	-	-	-	-	36.0%	35.6%	64.0%	64.4%	-	-	-	-	-	-
B734	-	-	50.3%	33.1%	44.1%	41.2%	5.6%	25.7%	-	-	-	-	-	-
B738	-	-	33.2%	32.1%	54.1%	53.3%	12.6%	14.6%	-	-	-	-	-	-
B752	-	-	3.7%	3.5%	56.1%	52.4%	40.1%	44.0%	0.1%	-	-	-	-	-
DC10	-	-	-	-	43.4%	43.3%	26.5%	26.6%	30.0%	30.1%	-	-	-	-
DC9Q	5.9%	9.9%	94.1%	90.1%	-	-	-	-	-	-	-	-	-	-
L101	-	-	10.0%	10.0%	60.0%	60.0%	30.0%	30.1%	-	-	-	-	-	-
MD11	-	-	-	-	-	-	50.0%	50.0%	50.0%	50.0%	-	-	-	-
MD80	-	-	76.6%	79.9%	23.4%	20.1%	-	-	-	-	-	-	-	-
TOTAL	**0.1%**	**0.1%**	**11.3%**	**8.6%**	**66.7%**	**68.1%**	**16.8%**	**17.6%**	**5.1%**	**5.6%**	**-**	**-**	**-**	**-**

Note: Differences may exist due to rounding as actual INM input is to four decimal places; the percentages are shown to one decimal place in the interest of conciseness.

Sources: As noted in text and HNTB analysis.

Finally, the results of the cargo forecast, including all-cargo operations by aircraft type and then by day/night split and stage length, are discussed.

3.8.1 Assumptions & Methodology

In many ways, development of the cargo operations forecast was quite similar to that of the passenger operations forecast, but instead of beginning with a passenger forecast, the cargo operations forecast is built on a cargo tonnage forecast.

As with the passenger forecast, a number of different growth rates were considered in order to project MSP 2007 cargo tonnage:

- 4.7-percent— FAA forecast for U.S. large air carriers[7]
- 3.7-percent— Airbus forecast[8]
- 4.3-percent—Boeing forecast[9]
- 1.8-percent—MergeGlobal forecast[10]

Each of these forecasts was published by reputable organizations and, therefore, the average of the four rates, 3.6-percent per year, was used to forecast cargo tonnage at MSP in 2007.

In 2002, nearly 368,000 tons of cargo (enplaned, deplaned, and thru) passed through MSP. Assuming an average annual increase of 3.6-percent per year, this figure is projected to climb to 439,000 tons by 2007 (See **Table 3.14**). The next step was to allocate the tonnage projection to passenger carriers (belly cargo) and integrated all-cargo carriers, like FedEx and UPS.

Historically, the portion of freight carried by passenger carriers has declined as the integrated carriers have gained market share and the passenger carriers have increasingly emphasized quick turnaround times and high passenger load factors, which reduce their ability to load air freight. Additionally, belly cargo has been negatively impacted by the more stringent "belly" cargo restrictions that were put in place by the FAA after the September 11th terrorist attacks.

The FAA's most recent *Aerospace Forecast* was used to estimate the proportion of air freight that would be carried on passenger aircraft at MSP in 2007.[11] According to the FAA, the percentage of cargo that is carried by passenger carriers is expected to decline by about 1.6-percent per year over the forecast period. In other words, belly cargo is expected to grow more slowly than total cargo and will, thus, represent a smaller share of total cargo in 2007.

In 2002, approximately 30-percent of air freight was carried by passenger carriers at MSP. Assuming that this share decreases at the FAA rate, only about 27.3-percent of cargo at MSP will be carried by passenger carriers in 2007. The 2007 forecast for belly cargo at MSP is thus 27.3-percent of 439,000 tons, or almost 120,000 tons. The projected amount of cargo carried by all-cargo carriers is then simply the difference between total cargo (439,000 tons) and belly cargo (120,000 tons), or about 319,000 tons.

Because the percentage of passenger carrier belly cargo is projected to decrease over the forecast period, all-cargo carrier tonnage is expected to grow more quickly (4.2-percent per year) than total cargo tonnage at MSP (3.6-percent per year). Assuming that the cargo load factor remains constant over the forecast period, the total capacity of all-cargo aircraft (the number of operations by aircraft multiplied by the estimated capacity of each aircraft) at MSP is expected to increase at approximately the same rate as the tonnage carried by all-cargo carriers (4.3-percent per year).[12] In 2002 and 2007, all-cargo capacity

Table 3.14

Cargo Forecast Assumptions, Short Tons

	2002	2007	Average Annual Growth
Total Cargo Tonnage (a)	367,974	439,000	3.6%
Percent Carried by Passenger Carriers (b)	29.6%	27.3%	-1.6%
Cargo Carried by Passenger Carriers (c)	108,900	120,000	2.0%
Cargo Carried by All-cargo Carriers (d)	259,074	319,000	4.2%
All-cargo Aircraft Capacity (e)	483,957	597,000	4.3%
All-cargo Load Factor (f)	53.5%	53.5%	0.0%
All-cargo Operations (g)	18,198	21,158	3.1%

Notes:

(a) 2002 tonnage reflects Airport statistics and 2007 tonnage reflects 2002 tonnage grown by 3.6% per year. Short tons (equal to 2000 U.S. pounds).

(b) 2002 percentage estimated based on Airport cargo statistics by airline. 2007 percentage estimated based on FAA projections for belly cargo.

(c)Total cargo tonnage multiplied by percent carried by passenger carriers.

(d) Total cargo tonnage minus tonnage carried by passenger carriers.

(e) Estimated by multiplying the number of operations (arrivals + departures) by type of aircraft by the estimated cargo capacity of each aircraft.

(f) Cargo carried by all-cargo carriers divided by all-cargo aircraft capacity.

(g) 2002 operations reflect actual 2002 ANOMS data and Airport statistics as corroborated by OAG data. 2007 operations based on projected fleet mix, see text for details.

Sources: FAA, *Economic Values for Evalutaion of FAA Investment & Regulatory Decisions* , June 1998 and HNTB analysis.

at MSP was estimated to be nearly 484,000 and 597,000 tons, respectively.

Using information on all-cargo aircraft orders and FAA and industry projections, a 2007 fleet mix was developed. This fleet mix attempts to estimate the way in which the all-cargo airlines will provide the projected all-cargo capacity in 2007.

Once the fleet mix was developed, the day/night splits of arrivals and departures (by aircraft type) were determined based on existing schedules, airline surveys and 2002 ANOMS data. Lastly, existing schedules and airline surveys were used to determine the stage length split for departures on an aircraft by aircraft basis.

All-cargo operations are projected to grow more slowly than tonnage and capacity because the average capacity of all-cargo aircraft is projected to increase about 1.2-percent per year over the forecast period, from about 26.6 tons in 2002 to approximately 28.2 tons in 2007.[13]

3.8.2 Forecast of All-Cargo Aircraft Operations

Table 3.15 presents the forecast of all-cargo aircraft operations (annual average day) by aircraft type and day/night split. **Table 3.16** provides the stage length distribution for all-cargo operations. As shown, cargo aircraft activity is projected to reach about 58.0 daily operations, on average, in 2007 (almost 29.0 arrivals and 29.0 departures). This translates into about 21,158 annual all-cargo operations, which reflects an average annual increase of about 3.1-percent.

3.9 GENERAL AVIATION AND MILITARY FORECASTS

This section discusses the general aviation (GA) and military forecasts for MSP.

3.9.1 General Aviation—Assumptions & Methodology

The GA forecast is based upon the following assumptions:

- No dramatic changes in the GA regulatory environment, though some segments will continue to be affected by "no fly zones."
- Increased growth in the fractional ownership market, which brings new owners and operators into business aviation.

Similar to the cargo and scheduled passenger forecasts, three different growth rates were considered for use in the GA forecast and they included:

- 2.5-percent—FBO estimate
- 6.1-percent—FAA's business jet forecast for hours flown[14]
- 1.5-percent—FAA's forecast for hours flown for all GA aircraft[15]

Over the past five years, GA activity at MSP has grown more quickly than it has for the U.S. as a whole. The faster rate of growth at MSP is due, in part, to the fact that GA jets make up a disproportionate share (when compared to their share of GA activity nationwide) of total GA activity at MSP, and that GA jets are the fastest growing segment of GA activity. As a result, it is reasonable to believe that GA activity at MSP will grow more quickly over the forecast period than it will grow nationwide. The FBO growth estimate (2.5-percent) is specific to MSP and is the most consistent with this growth trend described previously. Thus, 2.5-percent was chosen to forecast GA activity at MSP in 2007.

The following steps were then taken to determine the GA fleet mix at MSP:

Table 3.15

Forecast All-Cargo Aircraft Operations by Day/Night Split, 2007 Annual Average Day

Aircraft Type	Arrivals			Departures		
	Day	Night	Total	Day	Night	Total
A300	2.29	2.25	4.53	2.55	1.98	4.53
A310	0.77	0.59	1.36	0.64	0.72	1.36
B190	1.37	0.06	1.42	0.66	0.77	1.42
B722	1.09	2.24	3.33	1.67	1.66	3.33
B742	0.01	0.01	0.02	0.01	0.01	0.02
B752	0.07	0.14	0.21	0.08	0.12	0.21
B762	0.41	0.44	0.85	0.82	0.03	0.85
BE58	0.00	0.01	0.01	0.01	-	0.01
BE80	6.15	0.26	6.41	3.33	3.08	6.41
BE99	2.74	0.11	2.85	1.31	1.54	2.85
C208	0.67	0.12	0.79	0.64	0.16	0.79
C212	0.02	0.00	0.02	0.01	0.00	0.02
C310	0.01	0.03	0.03	0.02	0.01	0.03
C402	0.01	0.01	0.03	0.01	0.01	0.03
DC10	1.83	1.43	3.26	1.67	1.59	3.26
DC8Q	-	0.71	0.71	-	0.71	0.71
DC9Q	0.03	0.89	0.92	0.01	0.91	0.92
E110	0.01	0.01	0.01	0.01	0.00	0.01
F27	0.03	-	0.03	0.03	-	0.03
FA20	0.45	0.36	0.81	0.54	0.27	0.81
LJ25	0.24	0.13	0.36	0.27	0.09	0.36
LJ35	0.10	0.07	0.16	0.13	0.04	0.16
MD11	0.18	0.15	0.32	0.08	0.24	0.32
SW4	0.14	0.38	0.52	0.14	0.38	0.52
TOTAL	**18.59**	**10.39**	**28.98**	**14.64**	**14.34**	**28.98**

Notes:

Differences may exist due to rounding as actual INM input is to four decimal places; only two decimal places are shown in the table in the interest of conciseness.

Due to rounding, a notation of "0.00" indicates a value of less than 0.005, while a notation of "-" indicates a value of zero.

Sources: As noted in text and HNTB analysis.

Table 3.16

Forecast All-Cargo Aircraft Stage Length Distributions, 2007 Annual Average Day

Aircraft Type	Departures													
	0-500 nm (SL1)		500-1000 nm (SL2)		1000-1500 nm (SL3)		1500-2500 nm (SL4)		2500-3500 nm (SL5)		3500-4500 nm (SL6)		4500+ nm (SL7)	
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
A300	31.0%	25.2%	68.2%	73.2%	0.7%	1.5%	-	-	-	-	-	-	-	-
A310	19.3%	19.4%	75.7%	75.6%	5.0%	5.0%	-	-	-	-	-	-	-	-
B190	100.0%	100.0%	-	-	-	-	-	-	-	-	-	-	-	-
B722	70.1%	51.9%	27.1%	43.6%	2.8%	4.6%	-	-	-	-	-	-	-	-
B742	-	-	50.0%	50.0%	50.0%	50.0%	-	-	-	-	-	-	-	-
B752	20.0%	20.0%	80.0%	80.0%	-	-	-	-	-	-	-	-	-	-
B762	-	-	100.0%	100.0%	-	-	-	-	-	-	-	-	-	-
BE58	100.0%	-	-	-	-	-	-	-	-	-	-	-	-	-
BE80	100.0%	100.0%	-	-	-	-	-	-	-	-	-	-	-	-
BE99	100.0%	100.0%	-	-	-	-	-	-	-	-	-	-	-	-
C208	100.0%	100.0%	-	-	-	-	-	-	-	-	-	-	-	-
C212	100.0%	100.0%	-	-	-	-	-	-	-	-	-	-	-	-
C310	100.0%	100.0%	-	-	-	-	-	-	-	-	-	-	-	-
C402	100.0%	100.0%	-	-	-	-	-	-	-	-	-	-	-	-
DC10	4.9%	4.9%	85.2%	85.2%	9.9%	9.9%	-	-	-	-	-	-	-	-
DC8Q	-	79.0%	-	21.0%	-	-	-	-	-	-	-	-	-	-
DC9Q	50.4%	26.5%	49.6%	73.5%	-	-	-	-	-	-	-	-	-	-
E110	100.0%	100.0%	-	-	-	-	-	-	-	-	-	-	-	-
F27	100.0%	-	-	-	-	-	-	-	-	-	-	-	-	-
FA20	100.0%	100.0%	-	-	-	-	-	-	-	-	-	-	-	-
LJ25	78.3%	100.0%	21.7%	-	-	-	-	-	-	-	-	-	-	-
LJ35	100.0%	100.0%	-	-	-	-	-	-	-	-	-	-	-	-
MD11	5.2%	9.6%	83.9%	75.8%	10.9%	14.6%	-	-	-	-	-	-	-	-
SW4	100.0%	100.0%	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	**63.1%**	**61.3%**	**35.0%**	**36.4%**	**1.9%**	**2.4%**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Note: Differences may exist due to rounding as actual INM input is to four decimal places; the percentages are shown to one decimal place in the interest of conciseness.

Sources: As noted in text and HNTB analysis.

1. Year 2002 operations (based on ANOMS data and discussions with the FBO) for each aircraft type (i.e., GA jet, single engine piston, multi-engine piston, and turboprop) were increased at the annual average rate specific to each aircraft type in the FAA *Aerospace Forecast.*[16]
2. The results (for each aircraft type) from Step 1 were then summed and each aircraft's share of the total was calculated (i.e., GA jets, once grown at the FAA rate for GA jets, represented about 78-percent of the total).
3. Each aircraft's share of the total was then multiplied by the projected number of GA operations at MSP in 2007 (as calculated using the 2.5-percent average annual growth rate).

3.9.2 Forecast of General Aviation Aircraft Operations

Table 3.17 summarizes the results of the GA forecast by aircraft type. Consistent with the FAA forecast, it is anticipated that with the retirement of the older piston-powered aircraft and the purchase of new, more sophisticated jet aircraft, most of the growth in GA activity at MSP is expected to come in the form of jet activity. The number of turboprop operations is projected to drop slightly while the number of single engine and multi-engine piston operations is expected to drop about two-percent per year.

Table 3.18 presents 2007 forecasts of GA operations by aircraft type, by day/night split and stage length for MSP. Average daily GA activity is projected to account for approximately 79.0 operations by 2007 (about 39.5 arrivals and 39.5 departures). This translates into almost 28,846 annual GA operations by 2007, an average annual increase of 2.5-percent.

As shown in Table 3.17, jets are expected to account for nearly 79-percent of the GA fleet in 2007, up from about 74-percent in 2002. Turboprops accounted for about 9.8-percent of the GA fleet in 2002 but are expected to account for only about 8.4-percent of the fleet in 2007. Similarly, the share held by single-engine pistons is expected to decrease from about 6.6-percent in 2002 to about 5.4-percent in 2007. The share held by multi-engine piston aircraft is expected to decrease from 9.6-percent in 2002 to 7.6-percent in 2007.

3.9.3 Military—Assumptions & Methodology

Military operations are related to national and international political and institutional factors rather than local economic conditions. Over the forecast period, the FAA projects that military activity will remain constant both at the national level and at MSP.[17] Due to the uncertainties surrounding military operations and consistent with the FAA's projections, military operations at MSP are assumed to remain constant at their 2002 levels throughout the forecast period.

3.9.4 Forecast of Military Aircraft Operations

Table 3.18 also shows the 2007 forecast of military operations at MSP by aircraft type, by day/night split and stage length. The overall military fleet at MSP is expected to remain the same over the forecast period and military activity at MSP is expected to remain at about 8.6 operations per day, on average (about 4.3 arrivals and 4.3 departures). In annual terms, this translates into about 3,124 military operations at MSP in 2007.

3.10 SUMMARY: TOTAL OPERATIONS FORECAST

The following two sections summarize the year 2002 and 2007 aircraft operations and fleet mix.

Table 3.17

General Aviation Annual Operations Forecast Summary

Aircraft	2002 (a)	2007 (b)	Average Annual Growth
Jet	18,862	22,667	3.7%
Turboprop	2,492	2,430	-0.5%
Single Engine Piston (SEP)	1,688	1,564	-1.5%
Multi-Engine Piston (MEP)	2,454	2,185	-2.3%
TOTAL	25,496	28,846	2.5%

Notes:
(a) Estimated based on 2002 ANOMS data and discussions with Signature FBO.
(b) Based on FAA growth rates by type of GA aircraft.

Sources: As noted in text and HNTB analysis.

Table 3.18

Forecast General Aviation and Military Aircraft Operations by Day/Night Split and Stage Length, 2007 Annual Average Day

Aircraft Type	Arrivals			Departures		
	Day	Night	Total	Day	Night	Total
General Aviation Activity						
Jets						
C500	0.68	0.04	0.71	0.68	0.03	0.71
C650	2.55	0.19	2.75	2.36	0.39	2.75
C750	2.30	0.14	2.44	2.26	0.18	2.44
CL60	1.61	0.12	1.73	1.62	0.11	1.73
CL61	0.08	0.11	0.20	0.18	0.01	0.20
FA20	0.01	0.02	0.03	0.02	0.01	0.03
GLF2	0.99	0.14	1.14	1.07	0.07	1.14
GLF4	1.29	0.10	1.39	1.33	0.06	1.39
GLF5	0.40	0.04	0.44	0.40	0.04	0.44
LJ25	0.82	0.06	0.88	0.79	0.09	0.88
LJ35	12.97	1.05	14.02	12.85	1.17	14.02
MU30	3.60	0.28	3.88	3.60	0.28	3.88
SBR2	0.19	0.02	0.21	0.20	0.01	0.21
WW24	1.13	0.11	1.24	1.16	0.08	1.24
Turboprop						
DHC6	3.01	0.32	3.33	3.10	0.23	3.33
Piston						
Single-engine	1.78	0.36	2.14	1.97	0.18	2.14
Multi-engine	1.97	1.02	2.99	2.73	0.26	2.99
TOTAL	**35.39**	**4.12**	**39.52**	**36.30**	**3.21**	**39.52**
Military Activity						
BE20	0.08	0.01	0.09	0.09	0.00	0.09
C130	3.80	0.18	3.98	3.95	0.04	3.98
C17	0.02	0.01	0.03	0.03	-	0.03
C5	0.03	-	0.03	0.03	-	0.03
F16	0.05	-	0.05	0.05	-	0.05
F18	0.02	-	0.02	0.01	0.01	0.02
SW4	0.02	-	0.02	0.02	-	0.02
T37	0.03	-	0.03	0.03	-	0.03
T38	0.03	-	0.03	0.03	-	0.03
TOTAL	**4.09**	**0.19**	**4.28**	**4.23**	**0.05**	**4.28**

Notes:

All operations are assumed to be stage length one per INM profiles.

Differences may exist due to rounding as actual INM input is to four decimal places; only two decimal places are shown in the table in the interest of conciseness.

Due to rounding, a notation of "0.00" indicates a value of less than 0.005, while a notation of "-" indicates a value of zero.

Sources: As noted in text and HNTB analysis.

3.10.1 Aircraft Operations

Total annual operations at MSP are projected to increase from about 493,220 in 2002 to about 582,366 in 2007, an average annual increase of about 3.4-percent (see **Table 3.19**). The 2002 operations level is slightly lower than the numbers in the FAA's 2002 TAF; however, this may be in part because the FAA's count of operations at MSP includes overflights which are not included in the Study forecast (see **Table 3.20**). The Study forecast is slightly lower than the forecast prepared in 1994 as part of the Long Term Comprehensive Plan (LTCP); however, actual 2002 operations were considerably lower than the LTCP.

Each component (scheduled passenger, charter, cargo, GA, and military) was forecasted separately, based on component-specific assumptions (detailed in the previous sections), and then all of the forecasts were aggregated to create the total operations forecast for MSP in 2007. The individual operations categories are projected to grow at the following annual growth rates:

- Scheduled passenger aircraft operations: 3.5-percent per year
- Charter aircraft operations: 3.1-percent per year
- All-cargo aircraft operations: 3.1-percent per year
- GA aircraft operations: 2.5-percent per year
- Military aircraft operations: expected to remain constant

The all-cargo operations growth rate of 3.1-percent per year is based on the assumption that cargo tonnage will grow 3.6-percent per year over the forecast period. The cargo rates differ from one another due to an expected increase in the capacity of all-cargo aircraft over the forecast period (fewer aircraft are required to carry the same amount of cargo even if load factors remain constant).

Whereas scheduled passenger operations are forecast to grow at nearly the same rate (3.5 - percent per year) as scheduled passengers (3.68-percent per year) because it is anticipated that increased load factors will be nearly offset by a decrease in the average passenger aircraft size over the forecast period.

Conversely, charter operations are projected to increase more slowly (3.1-percent per year) than charter passengers (3.6-percent per year) due to an expected increase in the average size of charter aircraft coupled with an anticipated increase in load factors (2.2-percent) over the forecast period.

3.10.2 Fleet Mix

Tables 4.3 and 4.5 in Chapter Four present the annual average daily fleet mixes for 2002 and 2007, respectively, as developed with the analysis outlined in this chapter. In brief, the 2007 forecast reflects a number of changes over actual 2002 operations:

- The number of A318s, A319s and A320s, as well as the number of next generation Boeing 737s (-700s, -800s, and -900s), are expected to grow in number.
- The number of passenger turboprops is expected to drop while the number of regional jets is projected to increase sharply.
- Larger 70-seat regional jets are expected to remain a small but increasing share of regional jets operations.
- The number of passenger hushkitted and widebody aircraft is expected to decrease.

Table 3.19

Annual Forecast Summary, Total Operations

Component	2002	2007	Average Annual Growth
Scheduled Passenger Air Carrier (a)	441,462	523,472	3.5%
Cargo	18,198	21,158	3.1%
Charter	4,940	5,766	3.1%
GA	25,496	28,846	2.5%
Military (b)	3,124	3,124	0.0%
TOTAL	493,220	582,366	3.4%

Notes:
(a) Includes both air carrier and regional carrier operations.
(b) Average annual day in Table 3.18 multiplied by 365.

Sources: Tables 3.7, 3.11, 3.14, 3.17 and 3.18.

Table 3.20

Forecast Comparison

	2004 Study	LTCP(a)	TAF (b)
		Total Passengers (c)	
2002 Estimate	N/A	35,104,800	31,106,846
2002 Actual	31,527,760		
2007 Estimate	37,769,766	39,234,400	39,892,682
		Operations	
2002 Estimate	N/A	560,120	497,934
2002 Actual (d)	493,220		
2007 Estimate	582,366	586,520	591,854

Notes:
(a) *Long-Term Comprehensive Plan (LTCP) Revised Activity Forecasts Technical Appendix* , March 1994, Interpolated from Table -27 - Combination 2 Forecast.
(b) FAA 2002 Terminal Area Forecast (TAF).
(c) Includes scheduled and non-scheduled revenue passengers.
(d) Lower than FAA count because this figure does not include overflights.

Sources: As noted in text and HNTB analysis.

- GA jets are expected to account for a larger percentage of the GA fleet, while GA turboprops, single-engine pistons and multi-engine pistons are expected to account for a smaller share of the GA fleet.
- The cargo fleet is expected to include more A310s and A300s and fewer DC8s and 727s.

NOTES

[1] Stage 2 aircraft with a maximum takeoff weight greater than 75,000 pounds.

[2] RJ85 aircraft are not considered regional jets due to their classification by Northwest Airlines.

[3] The FAA ATADS Glossary defines air taxi (AT) as aircraft designed to have a maximum seating capacity of 60 seats or less or a maximum payload capacity of 18,000 pounds or less carrying passengers or cargo for hire or compensation. As a result, most regional/commuter operations are included in the FAA's Air Taxi (AT) count.

[4] For example, if the Airport statistics reflected 3,000 operations for an Airline "X" but the ANOMS data only reflected 2,980 operations for the Airline "X", then the ANOMS data was adjusted upwards by 20 for this airline. This upward adjustment required careful attention to the types of aircraft flown by Airline "X" (based on the ANOMS data) and the times at which these aircraft are flown (based on the ANOMS data) because the adjustment was weighted based on these factors. As discussed, OAG was also used to corroborate the ANOMS data.

[5] This figure does not include the approximately 365,000 non-scheduled passengers at MSP in 2002.

[6] The average size of regional aircraft and the average size of air carrier aircraft are both expected to increase over the forecast period; however, collectively the average aircraft size is expected to decrease as regional operations account for a larger share of total passenger operations.

[7] *FAA Aerospace Forecast, Fiscal Years 2003-2014*, March 2003.

[8] Airbus, *Global Market Forecast: 2001-2020*, September 2002.

[9] Boeing, *Current Market Outlook 2003*, June 2003.

[10] MergeGlobal Inc., presentation before 2002 FAA Forecasting Conference.

[11] *FAA Aerospace Forecast, Fiscal Years 2003-2014*, Table 19.

[12] Cargo aircraft capacity figures reflect those in the FAA publication *Economic Values for Evaluation of FAA Investment & Regulatory Decisions*, June 1998.

[13] The estimated increase in average capacity of all-cargo aircraft is a product of the estimated fleet mix. The forecasted fleet mix includes the estimated number of operations for each type of aircraft. The average capacity of all-cargo aircraft was derived by multiplying the capacity of an aircraft by the number of operations projected by that aircraft and summing the results for all aircraft types.

[14] The FAA growth rates are from the *FAA Aerospace Forecast, Fiscal Years 2003-2014*, March 2003, Table 30.

[15] Ibid.

[16] The FBO (Signature Flight) at MSP estimates that less than two percent of GA operations are VFR—MSP sees only some occasional VFR activity on the weekend.

[17] MSP-specific projections for military activity are from the FAA's 2002 Terminal Area Forecast (TAF).

Chapter Four
EXISTING FLIGHT OPERATIONS AND PROCEDURES

This chapter describes the existing and forecast aircraft flight operations at MSP with current flight procedures, and the development of the noise modeling used to generate the DNL contours. The operations data presented in this chapter are used to generate the DNL noise contours shown on the Noise Exposure Maps (NEM). Two cases are discussed in this chapter:

- 2002 Existing Conditions NEM, which represents existing flight procedures and resulting noise exposure.
- 2007 Unmitigated NEM, which represents future conditions with the existing NCP and Dual Track FEIS assumptions.

Section 4.1 describes the computer-based noise model used for this study. Section 4.2 provides general information about MSP. Section 4.3 describes the modeled aircraft operations as derived from the forecasts shown in Chapter Three. Section 4.4 describes the existing condition noise exposure levels and correlation with the noise monitors at MSP. Section 4.5 presents the forecast noise exposure.

4.1 NOISE MODEL

Part 150 directs that modeling and analyses of subsonic aircraft noise exposure around airports be accomplished using a computer program called the Integrated Noise Model (INM), which is distributed by the FAA. Version 6.1 was used for this Study as it is the latest version as of June 2004.

INM uses annual average daily operations to compute existing and forecast noise exposure. Annual average daily operations are representative of all aircraft operations that occur over the course of a year. The total annual operations are divided by 365 days to determine the number of operations on the hypothetical annual average day. Runway use, flight track location and use, and aircraft profiles define the paths that aircraft use as they fly to and from the Airport. Runway and flight track use is also averaged over one year.

Annual average daily operations consist of the number of aircraft operations, including departures and arrivals, by daytime and nighttime. For the purposes of the DNL metric, daytime is defined as 7:00 a.m. to 9:59 p.m. and nighttime is defined as 10:00 p.m. to 6:59 a.m. It is important to note the distinction between DNL nighttime hours and MSP's nighttime hours. MSP defines nighttime as 10:30 p.m. to 6 a.m. to encourage voluntary nighttime flight operation reductions. However, the MSP definition is not applicable to the DNL metric. Throughout this document, *all references to daytime or nighttime refer to DNL definitions, unless otherwise noted.*

INM and the data input for fleet mix, runway use, flight tracks, and aircraft profiles form the "noise model" that calculates the DNL contours. The term "model" is used in this document to indicate data input and assumptions that are representative of actual operations, for the purpose of generating DNL contours.

INM computes the overall annual average daily noise exposure (i.e., DNL) at points on the ground around the Airport. From the grid of points, contours of equal daily sound level are drawn by INM for overlay onto land-use maps. INM also has the capability to calculate daily sound levels at specified points, so that noise exposure at sensitive locations around an airport can be obtained.

As a computer-based noise model, the use of INM allows for the projection of forecast noise exposure. Noise monitoring data is not used in the calculation of existing and future noise exposure for several reasons. First, the noise monitors do not provide sufficient geographic coverage to draw DNL contours as there are only 39 total noise monitors installed around MSP. INM calculates noise at several thousand points. Second, noise monitor data is not available for future conditions. Finally, in Part 150 the FAA directs that DNL contours are to be calculated by INM, and not via noise monitoring. However, noise monitor data is used in this study to correlate INM data inputs and contours with actual conditions, as described in Section 4.4.

INM results provide a relative measure of noise levels around airfield facilities. When the calculations are made in a consistent manner, INM is the most accurate for comparing "before-and-after" noise effects resulting from forecast changes or potential noise abatement alternatives. INM allows noise predictions for such proposed actions without the actual implementation and noise monitoring of those actions. This includes the analyses of noise abatement flight procedure alternative measures discussed in Chapter Seven.

Whenever possible, data from MSP's ANOMS were used to develop information on actual aircraft operations (consistent with the provision of the 1996 Noise Mitigation Program). ANOMS is a sophisticated system that records information on arrivals and departures that are tracked with the FAA's Automated Radar Terminal System (ARTS). The date, time, arrival/departure designation, aircraft type, airline, flight number, origin/ destination, and specific flight track (including location and altitude) are recorded by the system. As described in Section 4.3, twelve months of ANOMS data were compiled and analyzed for this study. As a result of using actual flight data, all existing noise abatement measures are incorporated into the modeled operations. The comprehensiveness of the data allows for a substantial increase in the accuracy and precision of the inputs to the INM as compared to the previous Part 150 study.

4.2 AIRPORT AND GENERAL INFORMATION

This section is divided into the following four subsections: Airport Location and Layout, Weather and Climate, Flight Rules and Weather Conditions, and Airspace and Air Traffic Control.

4.2.1 Airport Location and Layout

Figure 4-1 shows the existing airport layout and landmarks in the immediate vicinity of the Airport, including the locations of Runway 17/35 and the new Cargo Area. MSP is located approximately six miles southeast of downtown Minneapolis, Minnesota. The Airport is bounded by Trunk Highway (TH) 77 and Cedar Avenue on the west, TH62/55 on the north, I-494 on the south, and Highway 5 and the Minnesota River on the east.

Two parallel runways and a third crosswind runway serve the Airport. A fourth runway with a north-south orientation is under construction. Following are descriptions of the runways at MSP:

Existing and Future Airport Facilities

Figure 4-1



Access Improvements
Airfield
Terminal/Parking
Aircraft Maintenance
Air Cargo
Support
Existing Airport Boundary
Properties Acquired/To Be Acquired
Runway Protection Zones
N
Scale in Feet 0 2000

- Runway 12L/30R is an 8,200-foot-long northwest/southeast runway.

- Runway 12R/30L is a 10,000-foot-long northwest/southeast runway.

- Runway 4/22 is an 11,000-foot-long northeast/southwest runway. It is the longest runway at the Airport and is used primarily by heavy aircraft, such as the B747 or DC10 for long range flights.

- Runway 17/35 will be a new 8,000-foot-long north-south runway that is forecast to increase airport capacity by 25 percent; it is scheduled to open in late 2005.

The elevation of MSP is 841 feet above Mean Sea Level (MSL). The current magnetic declination (the difference between magnetic north and true geographic north) is 1.5-degrees east as of May 2004.[1] ATC and pilots use magnetic headings to direct and fly aircraft.

The terrain in the vicinity of MSP is generally flat, and does not affect aircraft operations. INM can account for the affect of terrain on the distance between aircraft in flight and people on the ground. Areas of moderately higher terrain exist around MSP; therefore, terrain was modeled using 10-foot elevation intervals.

4.2.2 Weather and Climate

The operational performance of aircraft is heavily influenced by weather. Weather is an important factor in runway use. As a result, weather has a significant impact on noise exposure and propagation. The following subsections detail modeled weather conditions and their impact on aircraft operations.

Temperature

Temperature is an important factor in aircraft performance, and is further discussed in Section 4.3.4. Essentially, high temperatures increase takeoff distance and reduce climb performance, generally resulting in increased noise exposure. In 2002 the average daily temperature at MSP in January was 25°F, while the average daily temperature in July was 76°F.[2]

The weather observations[3] for 2002 were weighted for the hourly distribution of aircraft observations. The resultant weighted annual average daily temperature used for the 2002 DNL contours was 51.5°F. For the 2007 DNL contours, hourly weather data from 1945-2002 was used to established a weighted average daily temperature of 47.7°F. Since the majority of aircraft operations occur during the day when temperatures are higher, the average temperature is weighted in proportion to the number of operations and temperature during a given hour of the day.

Humidity

Humidity does not have a substantial impact on aircraft performance. In conjunction with temperature, however, it does impact the propagation of noise through the air. In general, sound travels farther in more humid conditions. Humidity is highest at night, and gradually drops during the day. It is generally at its lowest point in the afternoon. For 2002, the weighted annual average daily humidity at MSP was 65.0-percent. For 2007, the weighted annual average daily humidity is estimated to be 64.0-percent, as derived from 1945-2002 weather observations at MSP. The humidity values were developed using the same methodology used to develop the weighted annual average daily temperature.

Wind

Wind speed and direction primarily determine runway selection and operational flow.

Aircraft generally takeoff and land into the wind (known as a headwind) whenever possible. Headwinds reduce an aircraft's takeoff and landing distance, and increase climb rate. Aircraft can operate with considerable crosswinds (a wind blowing at the side of the aircraft), up to about 20 knots for a typical air carrier aircraft. Aircraft can operate with limited tailwinds (a wind blowing on the rear of the aircraft), up to 10 knots for a typical air carrier aircraft. Tailwinds increase takeoff and landing distance. Winds in excess of crosswind and tailwind limits force aircraft to use a different runway.

The winds at MSP are generally out of the northwest or southeast, and usually favor operations on the parallel runways (12L/30R and 12R/30L), that are aligned accordingly. Use of Runway 4/22 for crosswinds is minimal. During winter months, the winds are predominantly out of the northwest. During summer months, the winds are usually from the southeast. Wind data used in this Study were derived from 10 years of weather observations between January 1990 and December 1999.[4] For the purpose of establishing a typical headwind for use in calculating aircraft departure profiles, year 2002 ANOMS operations data and hourly weather data was used to establish an average headwind component of 5.3 knots.

4.2.3 Flight Rules and Weather Conditions

Weather is a significant factor in aircraft operations. Weather conditions determine the flight rules under which aircraft operate, and have a direct impact on required aircraft separation (physical distance between aircraft) and airport capacity. Aircraft are separated from each other to ensure safety of flight. The required separation varies depending on aircraft type, weather, and flight rules. Aircraft separation requirements increase during poor weather conditions, as it is more difficult for a pilot to see other aircraft. Increased separation requirements reduce airport capacity, as less aircraft can use an airport during a given time interval. Reduced separation requirements will increase airport capacity, as more aircraft can use an airport during a given time interval.

Aircraft operate under two distinct categories of operational flight rules: visual flight rules (VFR) and instrument flight rules (IFR). These flight rules are linked to the two categories of weather conditions: visual meteorological conditions (VMC) and instrument meteorological conditions (IMC). VMC exist during generally fair to good weather, and IMC exist during times of rain, low clouds, or reduced visibility. IMC exist whenever visibility falls below 3 statute miles (SM) or the ceiling drops below 1,000 feet above ground level (AGL). The ceiling is the distance from the ground to the bottom of a cloud layer that covers more than 50 percent of the sky.

During VMC, aircraft may operate under VFR, and the pilot is primarily responsible for seeing other aircraft and maintaining safe separation. Aircraft operating under VFR typically navigate by orientation to geographic and other visual references. Aircraft separation is reduced, and airspace and airfield capacities are greater than in IMC.

During IMC, aircraft operate under IFR. ATC exercises positive control (i.e., separation of all air traffic within designated airspace) over aircraft, and is primarily

responsible for aircraft separation. Aircraft operating under IFR must meet minimum equipment requirements. Pilots must also be specially certified and meet proficiency requirements. IFR aircraft fly assigned routes and altitudes, and use a combination of radio navigation aids and vectors from ATC to navigate. Additionally, aircraft separation is increased, and airspace and airfield capacities are less than in VMC.

The majority of commercial air traffic (including air carrier aircraft), regardless of weather, operates under IFR as required by Federal Aviation Regulations. In an effort to increase airport and airspace capacity, ATC can allow IFR aircraft to maintain visual separation when weather permits. At MSP, VMC occur approximately 92 percent of the time, and IMC occur approximately 8 percent of the time.[5]

4.2.4 Airspace and Air Traffic Control

The airspace and ATC procedures in use at MSP direct the flow of aircraft in and out of the Airport. As a result, they are an essential component in understanding and determining noise exposure. Appendix B contains an overview of general ATC procedures and the National Airspace System. Operational procedures unique to MSP are discussed in Section 4.3.

4.3 AIRCRAFT OPERATIONS

Section 4.3 describes the INM operational inputs, including flight operations and fleet mix, runway use, flight track layout and use, aircraft flight profiles, and run-up operations. INM uses these inputs to compute noise exposure on the ground. Additional information is provided in Appendix C.

4.3.1 Flight Operations and Fleet Mix

This section details the annual operations for 2002 and the forecast annual operations for 2007.

In 2003, MSP was the 7th busiest airport in the world. In terms of passenger traffic, MSP was the 15th busiest airport in the world, with nearly 33.4 million passengers using the Airport.[6] MSP is served by 32 scheduled passenger, charter, and cargo airlines. Northwest Airlines (NWA) conducts the majority of flights at MSP.

Aircraft are grouped into operational categories for the purpose of modeling discrete runway and flight track use, as explained in Sections 4.3.2 and 4.3.3. Operational categories allow the unique trends of certain airlines and aircraft types to be included in the noise model. **Table 4.1** shows the operational categories used in this Study. **Table 4.2** shows the International Civil Aviation Organization (ICAO) aircraft identifiers used throughout this document.

Year 2002 average daily operations and distribution of departure stage lengths are shown in **Tables 4.3 and 4.4**. Similarly, **Tables 4.5 and 4.6** show year 2007 average daily operations and distribution of departure stage lengths. The development of the 2002 and 2007 operational levels and fleet mixes are documented in Chapter Three. See Section 4.3.4 for an explanation of stage lengths. For the purpose of the forecast, fleet mix, and noise modeling discussion, aircraft operational levels are shown to two decimal places in the interest of conciseness. The actual input data for the noise model is to four decimal places, as shown in Appendix C.

For the purposes of this discussion, flight operations refer to the forecast level of annual average daily aircraft operations, and

the fleet mix distribution. The term fleet mix refers specifically to the distribution of flight operations by aircraft type, arrival/departure, stage length, and daytime/nighttime.

Table 4.1

Noise Model Operational Categories

Operational Category	Description
CH	Cargo Heavy Jet
CJ	Cargo Large Jet
CP	Cargo Propeller
GJ	General Aviation Jet
GP	General Aviation Propeller
MJ	Military Jet
MP	Military Propeller
NH	Northwest Heavy
NW	Northwest Jet
PH	Passenger Heavy Jet
PJ	Passenger Large Jet
RJ	Regional Jet
RP	Regional Turboprop

Source: HNTB analysis

INM Aircraft Database

INM contains reference noise and performance data on the aircraft types that operate at MSP, including hushkitted aircraft. Aircraft manufacturers, such as Boeing and Airbus, provide the data to the FAA. The data is used to model an aircraft's departure and arrival flight profiles and resultant noise exposure. Aircraft that are not specifically included in the database are modeled using appropriate substitution aircraft, per the FAA's pre-approved substitution list for INM version 6.1.

More specifically, the fleet mixes shown in Tables 4.3 and 4.5 represent the modeled fleet mix after application of the FAA's substitution list to the fleet mixes presented in Chapter Three. This is necessary to model the aircraft types that are not specifically included in the INM database. For example, the Beech 1900 turboprop is modeled as a DHC6 turboprop. Note that the total number of operations remains the same with the substitution of certain aircraft types.

4.3.2 Runway Use

Runway use is the proportion of aircraft that use a runway for departure or arrival, expressed as a percent. From an operational perspective, runway use is determined by several factors, including safety, weather, traffic demand, runway capacity, direction of flight, runway length requirements, and prescribed runway use procedures. ATC assigns runway use with consideration to all of these factors.

Capacity needs require ATC to use the parallel runways during much of the day. The use of the parallel runways, in an east or west flow (also known as a configuration), yields the highest runway capacity available at MSP. Flows are used to direct arriving and departing aircraft in the same direction to maximize runway capacity. **Figure 4-2** shows east and west runway flows. During west flow, aircraft depart and arrive on Runways 30L and 30R. During east flow, aircraft depart and arrive on Runways 12L and 12R. The crosswind runway, Runway 4/22, is the longest runway at MSP. During east and west flows, heavy aircraft such as the B747 may operate from the crosswind runway. On rare occasions, Runway 4/22 is also used when high winds from the north or south restrict the use of the parallel runways.

Each morning at MSP, ATC sets the airport's flow for the day, based on the prevailing winds. Due to the complexities of re-routing aircraft to alternative runway ends, the flow is not changed unless wind conditions require it.

Table 4.2

IACO Aircraft Identifiers

ID	Aircraft	ID	Aircraft
A300	Airbus A300	CV58	Convair 580
A306	Airbus A300-600	CVLT	Convair 580
A310	Airbus A310	D93Q	DC9-30 Hushkit
A318	Airbus A318	D95Q	DC9-50 Hushkit
A319	Airbus A319	DC10	McDonnell-Douglas DC10
A320	Airbus A320	DC3	DC3 Piston
A330	Airbus A330	DC87	Douglas DC8-70 (re-engined)
A340	Airbus A340	DC8Q	Douglas DC8-60 (Hushkit)
A748	Hawker-Siddley 748 Turboprop	DC9Q	DC9-30/50 Hushkit
ASTR	Astra Jet 1125	DHC6	Dash-6 Twin Otter Turboprop
B190	Beech 1900	E110	Embraer 100 Turboprop
B712	Boeing 717-200	E135	Emrbaer 135 Regional Jet
B722	Boeing 727-200 (Stage 2)	E140	Emrbaer 140 Regional Jet
B72Q	Boeing 727-200 Hushkit	E145	Emrbaer 145 Regional Jet
B732	Boeing 737-200 (Stage 2)	E170	Emrbaer 170 Regional Jet
B73Q	Boeing 737-200 Hushkit	F100	Fokker 100
B733	Boeing 737-300	F16	F16 Falcon
B734	Beoing 737-400	F18	F18 Hornet
B735	Boeing 737-500	F27	Fairchild F-27
B737	Boeing 737-700	F2TH	Falcon 2000 Bizjet
B738	Boeing 737-800	F900	Falcon 900 Bizjet
B739	Boeing 737-900	FA10	Falcon 10/100 Bizjet
B742	Boeing 747-200	FA20	Falcon 20/100 Bizjet
B744	Boeing 747-400	FA50	Falcon 50 Bizjet
B752	Boeing 757-200	FK27	Fokker 27 Jet
B753	Boeing 757-300	GALX	IAI Gulfstream 200 Bizjet
B762	Boeing 767-200	GLEX	Canadair Global Express
B763	Boeing 767-300	GLF2	Gulfstream II Bizjet
BA46	RJ85 Avro/Bae-146	GLF3	Gulfstream III Bizjet
BE18	Beech Twin	GLF4	Gulfstream IV Bizjet
BE20	Beech Super King Air	GLF5	Gulfstream V Bizjet
BE40	Beechjet 400	H25A	BAe HS 125 Series 1/2/3/400/600 Bizjet
BE58	Beech 58	H25B	BAe-125-700/800 Bizjet
BE65	Beech Queen Air	H25C	BAe-125-1000 Bizjet
BE80	Beech Queen Air	J328	Dornier 328 Jet
BE99	Beech Airliner	L101	Lockheed L1011
C130	C130 Hercules	LJ25	Learjet 25
C17A	C17A Globemaster	LJ35	Learjet 35
C206	Cessna 206 Piston	MD11	MD11
C208	Cessna 208 Caravan	MD80	McDonnell-Douglas MD80
C212	Casa Aviocar	MD81	McDonnell-Douglas MD81
C25A	Cessna 525A Citation CJ2	MD83	McDonnell-Douglas MD83
C310	Cessna Twin Prop	MEP	GA Multi-Engine Piston
C402	Cessna Twin Prop	MU30	Mitsubishi 3001
C441	Cessna 441 Turboprop	RJ85	RJ85 Avro/Bae-146
C5	C5 Galaxy	SBR1	NA-265 Sabre 40/60/65
C500	Cessna 500 Bizjet	SBR2	NA-265 Sabre 75/80
C550	Cessna 550 Bizjet	SEP	GA Single-Engine Piston
C55B	Cessna 550 Bizjet	SEPF	GA Single-Engine Piston - Fixed Pitch Prop
C560	Cessna 560 Ultra Bizjet	SEPV	GA Single-Engine Piston - Variable Pitch Prop
C650	Cessa Citation 3/6 Series Bizjet	SF34	Saab 340 Turboprop
C750	Cessna 750 Bizjet	SW3	Fairchild Merlin 3 Turboprop
CARJ	Canadair Regional Jet	SW4	Fairchild Metro Turboprop
CL60	Canadair CL600	T37	Cessna T37 Jet Trainer
CL61	Canadair CL601	T38	T38 Talon Jet
CRJ7	Canadair Regional Jet	WW24	IAI Westwind 1124 Bizjet

Source: FAA Order 7110.65P, Appendix A; as amended.

Table 4.3

Modeled 2002 Average Daily Flight Operations

Operational Category	Aircraft Type	Departures			Arrivals			Total		
		Day	Night	Total	Day	Night	Total	Day	Night	Total
NW/PJ	A319	50.81	1.74	52.55	50.93	1.62	52.55	101.73	3.36	105.09
	A320	69.67	5.32	74.99	69.31	5.68	74.99	138.98	11.00	149.98
	B712	4.96	0.25	5.21	4.24	0.96	5.21	9.20	1.21	10.41
	B72Q	12.75	1.21	13.95	11.70	2.25	13.95	24.45	3.46	27.91
	B733	18.05	0.64	18.70	16.81	1.89	18.70	34.86	2.53	37.39
	B734	0.21	0.01	0.22	0.21	0.02	0.22	0.41	0.03	0.44
	B735	9.48	0.98	10.46	9.62	0.84	10.46	19.10	1.81	20.92
	B738	8.08	0.99	9.07	7.16	1.91	9.07	15.24	2.90	18.14
	B73Q	1.04	0.10	1.14	0.99	0.15	1.14	2.03	0.25	2.28
	B752	49.86	3.43	53.29	48.40	4.89	53.29	98.25	8.32	106.57
	B753	1.68	0.02	1.70	1.63	0.08	1.70	3.30	0.10	3.41
	D93Q	101.89	5.85	107.74	104.65	3.09	107.74	206.54	8.94	215.48
	D95Q	41.00	3.28	44.28	42.96	1.31	44.28	83.96	4.59	88.55
	F100	14.35	1.71	16.07	14.39	1.68	16.07	28.74	3.39	32.14
	MD81	0.20	0.01	0.21	0.19	0.01	0.21	0.39	0.02	0.41
	MD83	11.41	1.59	13.00	12.26	0.74	13.00	23.67	2.34	26.01
NW/PJ Total		395.42	27.14	422.56	395.45	27.11	422.56	790.86	54.26	845.12
NH/PH	B744	2.89	0.08	2.97	2.54	0.42	2.97	5.43	0.50	5.93
	B763	0.02	0.00	0.02	0.02	0.00	0.02	0.04	0.01	0.04
	DC10	9.17	0.40	9.57	8.57	0.99	9.57	17.74	1.40	19.14
	L101	0.27	0.05	0.32	0.22	0.09	0.32	0.49	0.14	0.63
NH/PH Total		12.35	0.53	12.87	11.36	1.52	12.87	23.71	2.04	25.75
RJ	BA46/RJ85	31.93	1.50	33.43	33.03	0.41	33.43	64.96	1.90	66.87
	CARJ	44.31	3.17	47.48	44.83	2.66	47.48	89.14	5.82	94.96
	E135	0.12	-	0.12	0.12	-	0.12	0.24	-	0.24
	E145	4.96	0.01	4.97	4.90	0.07	4.97	9.86	0.08	9.95
RJ Total		81.33	4.68	86.01	82.87	3.13	86.01	164.20	7.81	172.01
RP	BE58	0.34	0.11	0.45	0.32	0.13	0.45	0.66	0.23	0.89
	DHC6	5.84	0.01	5.85	5.84	0.01	5.85	11.68	0.02	11.70
	SF34	78.21	5.36	83.57	78.95	4.62	83.57	157.16	9.98	167.13
RP Total		84.38	5.48	89.86	85.11	4.75	89.86	169.50	10.23	179.73
CH	A306	1.38	1.21	2.59	1.65	0.93	2.59	3.04	2.14	5.18
	A310	0.02	0.12	0.14	0.12	0.02	0.14	0.14	0.14	0.28
	B742	0.01	0.01	0.03	0.02	0.01	0.03	0.04	0.02	0.05
	B763	0.01	0.03	0.04	0.02	0.02	0.04	0.03	0.05	0.08
	DC10	1.78	1.43	3.21	1.75	1.46	3.21	3.53	2.89	6.42
	DC8Q	0.82	1.05	1.87	0.10	1.77	1.87	0.92	2.82	3.74
	MD11	0.07	0.02	0.09	0.04	0.05	0.09	0.11	0.07	0.18
CH Total		4.10	3.87	7.96	3.71	4.25	7.96	7.80	8.12	15.93
CJ	B72Q	2.01	1.79	3.80	1.44	2.36	3.80	3.45	4.16	7.61
	B752	0.05	0.24	0.28	0.14	0.15	0.28	0.18	0.38	0.57
	D93Q	0.24	0.81	1.05	0.43	0.62	1.05	0.66	1.43	2.10
	FA20	0.53	0.26	0.79	0.44	0.35	0.79	0.97	0.61	1.59
	LJ25	0.15	0.02	0.18	0.14	0.03	0.18	0.30	0.05	0.35
	LJ35	0.06	0.02	0.07	0.04	0.03	0.07	0.10	0.05	0.15
CJ Total		3.04	3.14	6.18	2.63	3.55	6.18	5.67	6.69	12.35
CP	BE58	3.91	3.93	7.83	7.31	0.53	7.83	11.21	4.45	15.67
	C441	0.04	0.00	0.04	0.02	0.02	0.04	0.07	0.02	0.09
	CV58	0.02	0.01	0.02	0.02	0.01	0.02	0.04	0.01	0.05
	DC3	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.03
	DHC6	1.24	1.50	2.74	2.30	0.44	2.74	3.55	1.93	5.48
	SEPF	0.11	0.03	0.14	0.12	0.02	0.14	0.23	0.05	0.27
CP Total		5.32	5.47	10.79	9.78	1.02	10.79	15.10	6.48	21.58
GJ	ASTR	1.16	0.07	1.23	1.13	0.10	1.23	2.29	0.18	2.47
	C500	0.54	0.03	0.57	0.54	0.03	0.57	1.09	0.06	1.14
	C55B	0.75	0.08	0.82	0.73	0.09	0.82	1.48	0.17	1.65
	C650	1.98	0.33	2.31	2.14	0.16	2.31	4.12	0.49	4.61
	C750	1.89	0.15	2.05	1.93	0.12	2.05	3.82	0.27	4.10
	CL60	1.51	0.11	1.62	1.50	0.12	1.62	3.01	0.23	3.24
	FA20	1.42	0.21	1.63	1.47	0.15	1.63	2.90	0.36	3.26
	GLF2	0.88	0.06	0.93	0.82	0.12	0.93	1.69	0.18	1.87
	GLF4	0.92	0.05	0.97	0.90	0.07	0.97	1.82	0.11	1.93
	GLF5	0.32	0.03	0.35	0.32	0.03	0.35	0.64	0.06	0.70
	LJ25	0.63	0.06	0.69	0.64	0.05	0.69	1.26	0.11	1.38
	LJ35	9.42	0.79	10.21	9.47	0.74	10.21	18.88	1.53	20.41
	MU30	2.30	0.16	2.46	2.32	0.14	2.46	4.62	0.30	4.92
GJ Total		23.71	2.13	25.84	23.91	1.93	25.84	47.62	4.06	51.68
GP	BE58	3.08	0.29	3.36	2.23	1.13	3.36	5.31	1.42	6.72
	DHC6	3.18	0.24	3.41	3.08	0.33	3.41	6.26	0.57	6.83
	SEPV	2.12	0.19	2.31	1.92	0.39	2.31	4.04	0.58	4.62
GP Total		8.38	0.71	9.09	7.23	1.86	9.09	15.61	2.57	18.18
MJ	C17A	0.02	-	0.02	0.02	0.00	0.02	0.05	0.00	0.05
	C5	0.02	-	0.02	0.02	-	0.02	0.04	-	0.04
	F16	0.05	-	0.05	0.05	-	0.05	0.09	-	0.09
	F18	0.01	0.01	0.02	0.02	-	0.02	0.04	0.01	0.04
	T37	0.03	-	0.03	0.03	-	0.03	0.05	-	0.05
	T38	0.03	-	0.03	0.03	-	0.03	0.07	-	0.07
MJ Total		0.17	0.01	0.18	0.17	0.00	0.18	0.34	0.01	0.35
MP	C130	3.95	0.04	3.98	3.80	0.18	3.98	7.75	0.22	7.97
	DHC6	0.11	0.00	0.11	0.10	0.01	0.11	0.21	0.01	0.22
MP Total		4.05	0.04	4.09	3.91	0.19	4.09	7.96	0.22	8.19
Total Operations		622.24	53.19	675.43	626.12	49.31	675.43	1,248.36	102.50	1,350.86

Notes:

Differences may exist due to rounding as actual INM input is to four decimal places; only two decimal places are shown in the table in the interest of conciseness.

Due to rounding, a notation of "0.00" indicates a value of less than 0.005, while a notation of "-" indicates a value of zero.

Source: Chapter Three

Table 4.4

Modeled 2002 Departure Stage Length Distribution

Operational Category	Aircraft Type	Departures							
		SL1	SL2	SL3	SL4	SL5	SL6	SL7	Total
NW/PJ	A319	11.7%	71.5%	16.8%	-	-	-	-	100%
	A320	18.6%	42.1%	38.2%	1.1%	-	-	-	100%
	B712	24.7%	75.3%	-	-	-	-	-	100%
	B72Q	22.2%	38.3%	38.0%	1.5%	-	-	-	100%
	B733	28.2%	61.5%	10.3%	-	-	-	-	100%
	B734	-	89.2%	10.8%	-	-	-	-	100%
	B735	43.3%	56.7%	-	-	-	-	-	100%
	B738	45.4%	29.6%	24.9%	0.2%	-	-	-	100%
	B73Q	-	-	-	100.0%	-	-	-	100%
	B752	21.3%	19.2%	52.3%	5.9%	1.4%	-	-	100%
	B753	21.5%	16.3%	62.2%	-	-	-	-	100%
	D93Q	-	-	100.0%	-	-	-	-	100%
	D95Q	-	-	100.0%	-	-	-	-	100%
	F100	57.9%	42.1%	-	-	-	-	-	100%
	MD81	24.8%	75.2%	-	-	-	-	-	100%
	MD83	44.6%	55.4%	-	-	-	-	-	100%
NW/PJ Total		15.4%	29.2%	54.0%	1.3%	0.2%	-	-	100%
NH/PH	B744	-	-	-	-	20.5%	62.1%	17.4%	100%
	B763	-	100.0%	-	-	-	-	-	100%
	DC10	4.4%	10.9%	49.2%	2.5%	23.0%	10.0%	-	100%
	L101	-	25.0%	25.0%	25.7%	24.3%	-	-	100%
NH/PH Total		3.2%	8.9%	37.2%	2.5%	22.5%	21.8%	4.0%	100%
RJ	BA46/RJ85	63.5%	36.5%	-	-	-	-	-	100%
	CARJ	100.0%	-	-	-	-	-	-	100%
	E135	100.0%	-	-	-	-	-	-	100%
	E145	-	100.0%	-	-	-	-	-	100%
RJ Total		80.0%	20.0%	-	-	-	-	-	100%
RP	BE58	100.0%	-	-	-	-	-	-	100%
	DHC6	100.0%	-	-	-	-	-	-	100%
	SF34	100.0%	-	-	-	-	-	-	100%
RP Total		100.0%	-	-	-	-	-	-	100%
CH	A306	44.7%	55.3%	-	-	-	-	-	100%
	A310	-	-	100.0%	-	-	-	-	100%
	B742	-	50.0%	50.0%	-	-	-	-	100%
	B763	-	100.0%	-	-	-	-	-	100%
	DC10	-	100.0%	-	-	-	-	-	100%
	DC8Q	26.3%	73.7%	-	-	-	-	-	100%
	MD11	-	100.0%	-	-	-	-	-	100%
CH Total		20.7%	77.4%	1.9%	-	-	-	-	100%
CJ	B72Q	54.2%	41.4%	4.4%	-	-	-	-	100%
	B752	51.5%	48.5%	-	-	-	-	-	100%
	D93Q	-	-	100.0%	-	-	-	-	100%
	FA20	100.0%	-	-	-	-	-	-	100%
	LJ25	100.0%	-	-	-	-	-	-	100%
	LJ35	100.0%	-	-	-	-	-	-	100%
CJ Total		52.6%	27.7%	19.6%	-	-	-	-	100%
CP	BE58	100.0%	-	-	-	-	-	-	100%
	C441	100.0%	-	-	-	-	-	-	100%
	CV58	100.0%	-	-	-	-	-	-	100%
	DC3	100.0%	-	-	-	-	-	-	100%
	DHC6	100.0%	-	-	-	-	-	-	100%
	SEPF	100.0%	-	-	-	-	-	-	100%
CP Total		100.0%	-	-	-	-	-	-	100%
GJ	ASTR	100.0%	-	-	-	-	-	-	100%
	C500	100.0%	-	-	-	-	-	-	100%
	C55B	100.0%	-	-	-	-	-	-	100%
	C650	100.0%	-	-	-	-	-	-	100%
	C750	100.0%	-	-	-	-	-	-	100%
	CL60	100.0%	-	-	-	-	-	-	100%
	FA20	100.0%	-	-	-	-	-	-	100%
	GLF2	100.0%	-	-	-	-	-	-	100%
	GLF4	100.0%	-	-	-	-	-	-	100%
	GLF5	100.0%	-	-	-	-	-	-	100%
	LJ25	100.0%	-	-	-	-	-	-	100%
	LJ35	100.0%	-	-	-	-	-	-	100%
	MU30	100.0%	-	-	-	-	-	-	100%
GJ Total		100.0%	-	-	-	-	-	-	100%
GP	BE58	100.0%	-	-	-	-	-	-	100%
	DHC6	100.0%	-	-	-	-	-	-	100%
	SEPV	100.0%	-	-	-	-	-	-	100%
GP Total		100.0%	-	-	-	-	-	-	100%
MJ	C17A	100.0%	-	-	-	-	-	-	100%
	C5	100.0%	-	-	-	-	-	-	100%
	F16	100.0%	-	-	-	-	-	-	100%
	F18	100.0%	-	-	-	-	-	-	100%
	T37	100.0%	-	-	-	-	-	-	100%
	T38	100.0%	-	-	-	-	-	-	100%
MJ Total		100.0%	-	-	-	-	-	-	100%
MP	C130	100.0%	-	-	-	-	-	-	100%
	DHC6	100.0%	-	-	-	-	-	-	100%
MP Total		100.0%	-	-	-	-	-	-	100%
Total SL Distribution		41.3%	22.1%	34.7%	0.8%	0.5%	0.4%	0.1%	100%

Notes:
SL = Stage length per Table 4.11
Differences may exist due to rounding

Source: Chapter Three , with adjustments for derate profiles and takeoff distances

Table 4.5

Modeled 2007 Average Daily Flight Operations

Operational Category	Aircraft Type	Departures			Arrivals			Total		
		Day	Night	Total	Day	Night	Total	Day	Night	Total
NW/PJ	A318	3.10	-	3.10	2.58	0.52	3.10	5.69	0.52	6.20
	A319	74.37	2.13	76.50	74.73	1.77	76.50	149.10	3.90	153.00
	A320	88.27	6.67	94.94	85.14	9.80	94.94	173.41	16.46	189.88
	B712	3.94	0.20	4.14	3.37	0.76	4.14	7.31	0.96	8.27
	B72Q	2.91	0.82	3.73	2.09	1.65	3.73	5.00	2.47	7.47
	B733	24.96	0.90	25.86	23.24	2.62	25.86	48.20	3.51	51.71
	B734	0.06	0.01	0.07	0.05	0.03	0.07	0.10	0.04	0.15
	B735	2.81	0.29	3.10	2.85	0.25	3.10	5.66	0.54	6.20
	B737	3.93	0.20	4.14	3.88	0.26	4.14	7.81	0.46	8.27
	B738	34.83	4.20	39.03	30.65	8.38	39.03	65.48	12.58	78.06
	B739	3.10	-	3.10	2.58	0.52	3.10	5.69	0.52	6.20
	B73Q	0.13	0.03	0.15	0.11	0.04	0.15	0.24	0.07	0.31
	B752	45.20	3.13	48.33	43.07	5.26	48.33	88.27	8.39	96.66
	B753	17.32	0.25	17.57	16.76	0.82	17.57	34.08	1.07	35.15
	D93Q	97.75	7.83	105.58	102.42	3.16	105.58	200.16	10.99	211.15
	D95Q	22.02	1.76	23.78	23.07	0.71	23.78	45.08	2.47	47.55
	MD81	0.26	0.03	0.28	0.27	0.02	0.28	0.52	0.05	0.57
	MD83	8.02	1.28	9.30	8.94	0.36	9.30	16.97	1.64	18.61
NW/PJ Total		432.99	29.72	462.71	425.80	36.91	462.71	858.79	66.63	925.42
NH/PH	A330	3.10	-	3.10	3.10	-	3.10	6.20	-	6.20
	A340	1.03	-	1.03	1.03	-	1.03	2.07	-	2.07
	B744	1.01	0.03	1.03	0.89	0.15	1.03	1.89	0.17	2.07
	DC10	3.11	0.33	3.43	2.95	0.48	3.43	6.06	0.81	6.87
	L101	0.33	0.06	0.39	0.28	0.11	0.39	0.61	0.17	0.78
	MD11	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.01
NH/PH Total		8.58	0.41	9.00	8.25	0.75	9.00	16.83	1.16	17.99
RJ	BA46/RJ85	36.54	1.71	38.25	37.79	0.46	38.25	74.32	2.18	76.50
	CARJ	129.41	8.09	137.49	131.23	6.27	137.49	260.63	14.36	274.99
	E145	22.72	0.02	22.74	22.61	0.13	22.74	45.33	0.15	45.49
RJ Total		188.67	9.82	198.49	191.62	6.86	198.49	380.29	16.69	396.98
RP	DHC6	4.91	0.26	5.17	4.87	0.30	5.17	9.79	0.55	10.34
	SF34	46.44	3.18	49.62	46.88	2.74	49.62	93.32	5.93	99.24
RP Total		51.35	3.44	54.79	51.75	3.04	54.79	103.10	6.48	109.58
CH	A306	2.55	1.98	4.53	2.29	2.25	4.53	4.84	4.23	9.07
	A310	0.64	0.72	1.36	0.77	0.59	1.36	1.41	1.31	2.72
	B742	0.01	0.01	0.02	0.01	0.01	0.02	0.02	0.02	0.04
	B762	0.82	0.03	0.85	0.41	0.44	0.85	1.23	0.48	1.71
	DC10	1.67	1.59	3.26	1.83	1.43	3.26	3.50	3.02	6.52
	DC87	-	0.71	0.71	-	0.71	0.71	-	1.42	1.42
	MD11	0.08	0.24	0.32	0.18	0.15	0.32	0.26	0.39	0.65
CH Total		5.77	5.30	11.06	5.49	5.57	11.06	11.26	10.87	22.13
CJ	B72Q	1.67	1.66	3.33	1.09	2.24	3.33	2.76	3.90	6.66
	B752	0.08	0.12	0.21	0.07	0.14	0.21	0.15	0.26	0.41
	D93Q	0.01	0.91	0.92	0.03	0.89	0.92	0.04	1.80	1.84
	FA20	0.54	0.27	0.81	0.45	0.36	0.81	0.99	0.62	1.62
	LJ25	0.27	0.09	0.36	0.24	0.13	0.36	0.50	0.22	0.72
	LJ35	0.13	0.04	0.16	0.10	0.07	0.16	0.22	0.11	0.33
CJ Total		2.70	3.09	5.79	1.97	3.83	5.79	4.67	6.91	11.58
CP	BE58	3.38	3.10	6.48	6.18	0.31	6.48	9.55	3.41	12.96
	C206	0.01	0.00	0.02	0.02	0.00	0.02	0.03	0.01	0.04
	DHC6	2.12	2.69	4.81	4.25	0.56	4.81	6.36	3.25	9.61
	FK27	0.03	-	0.03	0.03	-	0.03	0.05	-	0.05
	SEPF	0.64	0.16	0.79	0.67	0.12	0.79	1.31	0.28	1.59
CP Total		6.17	5.96	12.13	11.14	0.99	12.13	17.31	6.95	24.26
GJ	ASTR	1.16	0.08	1.24	1.13	0.11	1.24	2.29	0.18	2.48
	C500	0.68	0.03	0.71	0.68	0.04	0.71	1.36	0.07	1.43
	C650	2.36	0.39	2.75	2.55	0.19	2.75	4.91	0.58	5.50
	C750	2.26	0.18	2.44	2.30	0.14	2.44	4.55	0.33	4.88
	CL60	1.62	0.11	1.73	1.61	0.12	1.73	3.23	0.23	3.46
	CL61	0.18	0.01	0.20	0.08	0.11	0.20	0.27	0.13	0.40
	FA20	0.02	0.01	0.03	0.01	0.02	0.03	0.03	0.03	0.06
	GLF2	1.07	0.07	1.14	0.99	0.14	1.14	2.06	0.22	2.27
	GLF4	1.33	0.06	1.39	1.29	0.10	1.39	2.62	0.16	2.77
	GLF5	0.40	0.04	0.44	0.40	0.04	0.44	0.80	0.07	0.88
	LJ25	0.79	0.09	0.88	0.82	0.06	0.88	1.61	0.15	1.76
	LJ35	12.85	1.17	14.02	12.97	1.05	14.02	25.82	2.21	28.03
	MU30	3.60	0.28	3.88	3.60	0.28	3.88	7.20	0.56	7.76
	SBR2	0.20	0.01	0.21	0.19	0.02	0.21	0.39	0.03	0.42
GJ Total		28.51	2.54	31.05	28.63	2.42	31.05	57.14	4.96	62.10
GP	BE58	2.73	0.26	2.99	1.97	1.02	2.99	4.70	1.29	5.99
	DHC6	3.10	0.23	3.33	3.01	0.32	3.33	6.11	0.55	6.66
	SEPV	1.97	0.18	2.14	1.78	0.36	2.14	3.75	0.54	4.28
GP Total		7.80	0.67	8.47	6.76	1.71	8.47	14.56	2.37	16.93
MJ	C17A	0.03	-	0.03	0.02	0.01	0.03	0.05	0.01	0.05
	C5	0.03	-	0.03	0.03	-	0.03	0.05	-	0.05
	F16	0.05	-	0.05	0.05	-	0.05	0.09	-	0.09
	F18	0.01	0.01	0.02	0.02	-	0.02	0.04	0.01	0.04
	T37	0.03	-	0.03	0.03	-	0.03	0.06	-	0.06
	T38	0.03	-	0.03	0.03	-	0.03	0.07	-	0.07
MJ Total		0.18	0.01	0.19	0.18	0.01	0.19	0.36	0.01	0.37
MP	C130	3.95	0.04	3.98	3.80	0.18	3.98	7.75	0.22	7.97
	DHC6	0.11	0.00	0.11	0.10	0.01	0.11	0.21	0.01	0.22
MP Total		4.05	0.04	4.09	3.91	0.19	4.09	7.96	0.22	8.19
Total Operations		736.77	60.99	797.76	735.50	62.26	797.76	1,472.27	123.26	1,595.52

Notes:

Differences may exist due to rounding as actual INM input is to four decimal places; only two decimal places are shown in the table in the interest of conciseness.

Due to rounding, a notation of "0.00" indicates a value of less than 0.005, while a notation of "-" indicates a value of zero.

Source: Chapter Three

Table 4.6

Modeled 2007 Departure Stage Length Distribution

Operational Category	Aircraft Type	Departures							
		SL1	SL2	SL3	SL4	SL5	SL6	SL7	Total
NW/PJ	A318	50.0%	16.7%	33.3%	-	-	-	-	100%
	A319	56.1%	35.4%	8.5%	-	-	-	-	100%
	A320	60.1%	21.2%	18.1%	0.5%	-	-	-	100%
	B712	50.0%	50.0%	-	-	-	-	-	100%
	B72Q	50.0%	2.2%	47.1%	0.7%	-	-	-	100%
	B733	62.7%	31.3%	6.0%	0.0%	-	-	-	100%
	B734	51.6%	23.2%	21.8%	3.4%	-	-	-	100%
	B735	50.0%	50.0%	-	-	-	-	-	100%
	B737	50.0%	22.5%	15.0%	12.5%	-	-	-	100%
	B738	72.2%	21.7%	5.6%	0.5%	-	-	-	100%
	B739	50.0%	-	50.0%	-	-	-	-	100%
	B73Q	50.1%	-	-	49.9%	-	-	-	100%
	B752	59.4%	8.3%	26.5%	4.8%	1.1%	-	-	100%
	B753	55.0%	10.0%	31.2%	3.7%	-	-	-	100%
	D93Q	50.0%	-	50.0%	-	-	-	-	100%
	D95Q	50.0%	-	50.0%	-	-	-	-	100%
	MD81	50.1%	38.6%	11.3%	-	-	-	-	100%
	MD83	50.0%	44.4%	5.6%	-	-	-	-	100%
NW/PJ Total		56.8%	17.1%	25.1%	0.9%	0.1%	-	-	100%
NH/PH	A330	50.0%	-	-	-	16.7%	33.3%	-	100%
	A340	50.0%	-	-	-	-	50.0%	-	100%
	B744	50.0%	-	-	-	19.1%	13.9%	17.0%	100%
	DC10	50.0%	-	8.6%	5.3%	36.1%	-	-	100%
	L101	50.0%	4.9%	30.1%	15.0%	-	-	-	100%
	MD11	79.3%	-	-	10.3%	10.3%	-	-	100%
NH/PH Total		50.0%	0.2%	4.6%	2.7%	21.7%	18.8%	1.9%	100%
RJ	BA46/RJ85	81.0%	19.0%	-	-	-	-	-	100%
	CARJ	100.0%	-	-	-	-	-	-	100%
	E145	65.9%	34.1%	-	-	-	-	-	100%
RJ Total		92.4%	7.6%	-	-	-	-	-	100%
RP	DHC6	100.0%	-	-	-	-	-	-	100%
	SF34	100.0%	-	-	-	-	-	-	100%
RP Total		100%	-	-	-	-	-	-	100%
CH	A306	64.3%	35.2%	0.5%	-	-	-	-	100%
	A310	59.7%	37.8%	2.5%	-	-	-	-	100%
	B742	51.8%	24.1%	24.1%	-	-	-	-	100%
	B762	50.0%	50.0%	-	-	-	-	-	100%
	DC10	52.4%	42.6%	5.0%	-	-	-	-	100%
	DC87	89.5%	10.5%	-	-	-	-	-	100%
	MD11	54.2%	39.1%	6.7%	-	-	-	-	100%
CH Total		60.4%	37.4%	2.2%	-	-	-	-	100%
CJ	B72Q	80.5%	17.7%	1.8%	-	-	-	-	100%
	B752	59.8%	40.2%	-	-	-	-	-	100%
	D93Q	50.1%	-	49.9%	-	-	-	-	100%
	FA20	100.0%	-	-	-	-	-	-	100%
	LJ25	100.0%	-	-	-	-	-	-	100%
	LJ35	100.0%	-	-	-	-	-	-	100%
CJ Total		79.4%	11.6%	9.0%	-	-	-	-	100%
CP	BE58	100.0%	-	-	-	-	-	-	100%
	C206	100.0%	-	-	-	-	-	-	100%
	DHC6	100.0%	-	-	-	-	-	-	100%
	FK27	100.0%	-	-	-	-	-	-	100%
	SEPF	100.0%	-	-	-	-	-	-	100%
CP Total		100%	-	-	-	-	-	-	100%
GJ	ASTR	100.0%	-	-	-	-	-	-	100%
	C500	100.0%	-	-	-	-	-	-	100%
	C650	100.0%	-	-	-	-	-	-	100%
	C750	100.0%	-	-	-	-	-	-	100%
	CL60	100.0%	-	-	-	-	-	-	100%
	CL61	100.0%	-	-	-	-	-	-	100%
	FA20	100.0%	-	-	-	-	-	-	100%
	GLF2	100.0%	-	-	-	-	-	-	100%
	GLF4	100.0%	-	-	-	-	-	-	100%
	GLF5	100.0%	-	-	-	-	-	-	100%
	LJ25	100.0%	-	-	-	-	-	-	100%
	LJ35	100.0%	-	-	-	-	-	-	100%
	MU30	100.0%	-	-	-	-	-	-	100%
	SBR2	100.0%	-	-	-	-	-	-	100%
GJ Total		100%	-	-	-	-	-	-	100%
GP	BE58	100.0%	-	-	-	-	-	-	100%
	DHC6	100.0%	-	-	-	-	-	-	100%
	SEPV	100.0%	-	-	-	-	-	-	100%
GP Total		100%	-	-	-	-	-	-	100%
MJ	C17A	100.0%	-	-	-	-	-	-	100%
	C5	100.0%	-	-	-	-	-	-	100%
	F16	100.0%	-	-	-	-	-	-	100%
	F18	100.0%	-	-	-	-	-	-	100%
	T37	100.0%	-	-	-	-	-	-	100%
	T38	100.0%	-	-	-	-	-	-	100%
MJ Total		100%	-	-	-	-	-	-	100%
MP	C130	100.0%	-	-	-	-	-	-	100%
	DHC6	100.0%	-	-	-	-	-	-	100%
MP Total		100%	-	-	-	-	-	-	100%
Total SL Distribution		71.8%	12.4%	14.7%	0.6%	0.3%	0.2%	0.0%	100%

Notes:

SL = Stage length per Table 4.11

Differences may exist due to rounding

Source: Chapter Three , with adjustments for derate profiles and takeoff distances

East and West Runway Flows

Figure 4-2



EAST FLOW



WEST FLOW

When wind and capacity conditions allow for flexibility in runway selection, ATC uses the RUS to direct aircraft away from the most populated areas. The RUS was established by existing NA-9, as described in Chapter One. The current RUS operates in the following manner:

- When possible, jet aircraft are directed to overfly the Eagan/Mendota Heights Corridor (i.e., the "Corridor"). The Corridor is an area of land immediately east of MSP, as shown in **Figure 4-3**. This land is zoned primarily for industrial and commercial use and, as a result, it has the lowest residential population of any community near MSP. Aircraft departing from Runway 12L or 12R, or arriving on Runway 30L or 30R, overfly the Corridor.

- When use of the Corridor Procedure for departures is not possible and operations and conditions permit the use of Runway 4/22, ATC will use Runway 4/22 to the extent possible. The consideration for use of either Runway 4 or Runway 22 will be made in a balanced manner. It is important to note that "balanced" use does not mean that an equal number of aircraft will use Runway 4 and Runway 22; it means that the aircraft will be directed to use either runway end with equal priority for noise abatement purposes. Operational factors, such as wind, weather, and aircraft destination will determine final selection of use of Runway 4 or 22.

- When use of Runway 4/22 is not possible, aircraft are directed to depart on Runway 30L or 30R, or arrive on Runway 12R or 12L. In these configurations, aircraft overfly some of the most densely populated communities near MSP.

The Corridor Procedure is used to direct jet aircraft departing from Runways 12L and 12R. Jet departures are assigned headings inclusive of 090-degrees to 120-degrees. As a result, a heading of 090-degrees serves as the north boundary of the Corridor, while the Runway 30L localizer,[7] which approximates a true heading of 118-degrees, serves as the south boundary of the Corridor. Jet aircraft departing from Runway 12L or 12R maintain their initial assigned departure heading of 090- to 120-degrees, inclusive, until reaching a distance of at least three statute miles from the departure ends of the runways. Through repeated ANOMS analyses, the MAC has demonstrated that over 90-percent of jet departures comply with Corridor procedures.[8] Turboprop aircraft, because of their quieter noise characteristics, are not required to use Corridor procedures.

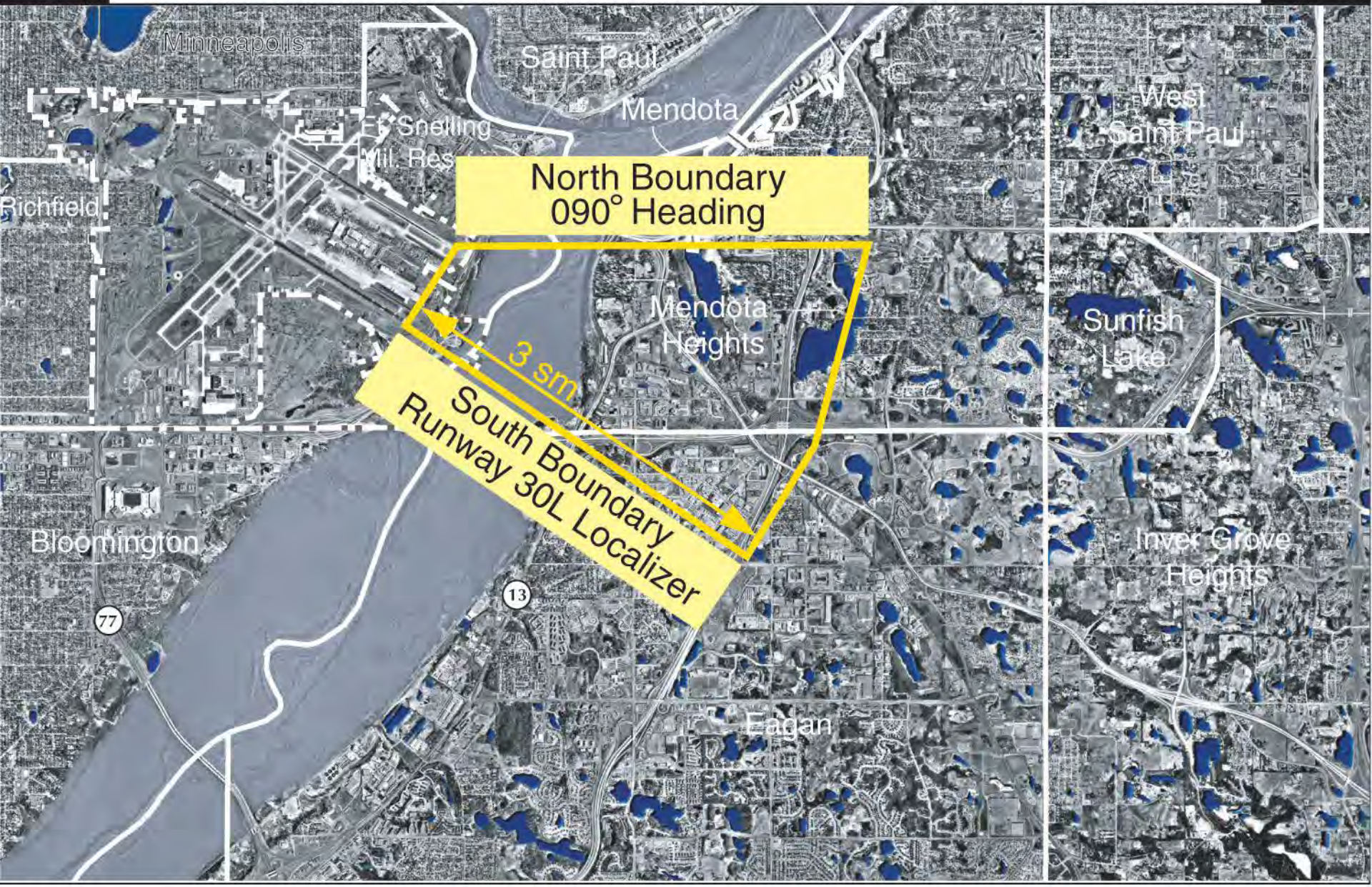
In practice, the RUS gives ATC guidance on noise-sensitive runway selection. When MSP is operating in an east flow, departing aircraft will takeoff on Runways 12L and 12R and overfly primarily commercial/ industrial areas. Arriving aircraft, landing on Runways 12L and 12R, overfly densely populated areas in Minneapolis. At MSP, many departing aircraft are substantially noisier than arriving aircraft due to the substantial portion of older, hushkitted aircraft that are at a higher thrust setting in order to takeoff and gain altitude.[9] Consequently, the RUS provides noise relief by directing the loudest operations over less populated areas.

When winds are from the west, MSP usually operates in a west flow to meet safety and capacity requirements. Departing aircraft overfly densely populated areas in Minneapolis and Richfield. Between traffic peaks, the RUS allows ATC to assign aircraft to Runway 4/22 and direct aircraft over other areas. Historically, MSP operates

Eagan/Mendota Heights Corridor

0 1 2 miles N

Figure 4-3



in a west flow as often as in an east flow (i.e., both west and east flows occur approximately 50 percent of the time each).

On a typical day, traffic at MSP decreases substantially after 11:30 p.m. Winds are usually calmer at night, affording ATC greater flexibility in runway selection and employing the RUS.

The head-to-head procedure at MSP is a unique noise abatement measure that directs aircraft to use opposite direction operations (as opposed to same direction operations in an east or west flow). Using this procedure, aircraft depart from Runway 12L or 12R and arrive on Runway 30L or 30R. This allows both arrivals and departures to overfly the Corridor. The procedure can only be used at night when there is very little traffic demand at MSP, and then only under specific conditions, including favorable winds and ATC workload. When head-to-head operations are not possible, ATC will attempt to use cross-runway operations, utilizing the Corridor and Runway 4/22. Because of the complexity of the head-to-head procedure, its use is infrequent and difficult to quantify.[10]

As with aircraft flight operations, the INM runway use input is on an annual average daily basis. For the purpose of noise modeling, runway use is determined by counting the number of operations that used (or are projected to use) a runway for departure or arrival during daytime and nighttime periods. Operations are grouped into operational categories by airline and aircraft type. For example, cargo airlines tend to use the south parallel runway (Runway 12R/30L) more often than the north parallel runway (Runway 12L/30R) because it is closer to the cargo apron area. Passenger airlines with gates at the Lindbergh Terminal use both parallel runways. Runway use at nighttime changes considerably from daytime use due to fewer operations and the RUS. Operational categories allow these unique trends to be incorporated into INM. The derivation of modeled runway use is explained in the following subsections.

Existing Runway Use

Average runway use for the 2002 Existing Conditions NEM was determined using ANOMS data from all twelve months of 2002. As a result, the runway use includes seasonal variations during the summer and winter months. ANOMS provided detailed runway use information on over 475,000 flights.

Table 4.7 shows modeled annual average runway use for the 2002 NEM. The table shows overall average runway use, by arrival and departure, for daytime and nighttime periods. The effect of the RUS can be seen as the total use of Runways 12L and 12R increases during the nighttime for departures, while the use of Runways 30L and 30R increases during the nighttime for arrivals. Runway use by operational category is shown in Appendix C.

Table 4.7

Existing 2002 Annual Average Runway Use

Runway	Arrival			Departure			Total		
	Day	Night	Overall	Day	Night	Overall	Day	Night	Overall
4	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
22	0.1%	0.7%	0.2%	0.9%	0.5%	0.8%	0.5%	0.6%	0.5%
12L	22.7%	15.9%	22.2%	20.2%	17.1%	20.0%	21.5%	16.5%	21.1%
12R	22.7%	22.8%	22.7%	19.1%	24.6%	19.6%	20.9%	23.7%	21.1%
30L	27.8%	35.3%	28.4%	28.7%	36.1%	29.2%	28.2%	35.7%	28.8%
30R	26.5%	25.2%	26.4%	31.1%	21.6%	30.3%	28.8%	23.3%	28.4%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%

Note: Totals may not equal 100% due to rounding.

Source: 2002 ANOMS

Forecast Runway Use

The forecast 2007 annual average runway use utilized in this Study was determined in the Dual Track FEIS. Weather and wind data, runway use configurations, and computer simulations of airport operations were analyzed to establish average runway use, with the goal of maximizing airport capacity.

As indicated in the Dual Track FEIS, the opening of the north-south runway, Runway 17/35, will substantially change the average runway use at MSP. **Figure 4-4** shows primary runway use configurations.[11] **Figure 4-5** shows future non-standard runway use configurations, which may occur during non-typical weather conditions. Non-typical weather conditions may include strong direct winds from the north or south or very low visibility or cloud ceilings.

Runway 17/35 will be a unidirectional runway (i.e., it is intended for use in only one direction). Departing aircraft will take-off to the south on Runway 17, and arriving aircraft will land from the south on Runway 35. Except during rare circumstances, aircraft cannot depart to the north on Runway 35 or land from the north on Runway 17. Operations to and from the north on Runway 17/35 would often interfere with operations on the parallel runways in some runway use configurations. This would reduce airport capacity. Additionally, agreements between MAC and the City of Minneapolis restrict the use of Runway 17/35 to and from the north.

The parallel runways will continue to be used in east and west flows, and Runway 4/22 will continue to be used for crosswind conditions and heavy aircraft operations. In both the east and west flows, Runway 17/35 will be used for single mode operations to meet traffic demands. Single-mode means that the runway can be used for arrivals only or departures only, but that it cannot support concurrent arrival and departure operations. During arrival peaks it can be used for arrivals, and during departure peaks it can be used for departures. High winds from the east and west will occasionally limit the use of Runway 17/35; this is expected to happen less than four-percent of the time annually.

Future Primary Runway Use Configurations

Figure 4-4

N



- ARRIVE AND DEPART RUNWAYS 12L AND 12R
- DEPART RUNWAY 17



- ARRIVE AND DEPART RUNWAYS 12L AND 12R
- ARRIVE RUNWAY 35



- ARRIVE AND DEPART RUNWAYS 30L AND 30R
- DEPART RUNWAY 17



- ARRIVE AND DEPART RUNWAYS 30L AND 30R
- ARRIVE RUNWAY 35

NOTE: TOTALS DO NOT EQUAL 100% DUE TO ROUNDING
SOURCE: DUAL TRACK FEIS

Future Non-Standard Runway Use Configurations

Figure 4-5



- ARRIVE AND DEPART RUNWAYS 30L AND 30R ONLY



- ARRIVE AND DEPART RUNWAYS 12L AND 12R ONLY



- ARRIVE AND DEPART RUNWAY 35
- DEPART RUNWAY 4



- ARRIVE AND DEPART RUNWAY 17
- ARRIVE RUNWAY 22

NOTE- TOTALS DO NOT EQUAL 100% DUE TO ROUNDING

SOURCE: DUAL TRACK FEIS

Whereas the parallel runways must support mixed arrival and departure operations, Runway 17/35 can only be used for single-mode operations (i.e., all departures or all arrivals for a given time period). As a result, Runway 17 is forecast to handle approximately 37-percent of the total departures at MSP. This is the highest departure percentage of any runway at MSP. The future runway use configurations, as shown in Figures 4-4 and 4-5, and the resultant runway use are necessary for safety and to meet airport capacity requirements. Overall, Runway 17/35 will increase airport capacity by 25-percent.

Table 4.8 shows forecast annual average runway use for 2007, by arrival and departure, for daytime and nighttime periods. Operational trends derived from the 2002 ANOMS data is used to establish operational categories within the overall runway use as determined by the Dual Track FEIS. Runway use by operational category is shown in Appendix C.

Table 4.8

Forecast 2007 Annual Average Runway Use

Runway	Arrival			Departure			Total		
	Day	Night	Overall	Day	Night	Overall	Day	Night	Overall
4	0.1%	0.1%	0.1%	0.2%	0.2%	0.2%	0.2%	0.1%	0.2%
22	0.5%	0.5%	0.5%	0.2%	0.0%	0.2%	0.3%	0.3%	0.3%
12L	21.8%	16.3%	21.1%	8.2%	10.3%	8.5%	15.0%	13.3%	14.8%
12R	14.8%	13.7%	14.6%	15.9%	20.6%	16.6%	15.3%	17.1%	15.6%
30L	21.0%	32.1%	22.4%	15.1%	14.5%	15.0%	18.1%	23.3%	18.7%
30R	24.5%	24.3%	24.5%	23.1%	20.5%	22.7%	23.8%	22.4%	23.6%
17	0.1%	0.1%	0.1%	37.2%	33.9%	36.8%	18.7%	17.0%	18.4%
35	17.4%	13.1%	16.9%	0.1%	0.1%	0.1%	8.8%	6.6%	8.5%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%

Note: Totals may not equal 100% due to rounding.

Source: Dual Track FEIS.

4.3.3 Flight Track Layout and Use

Modeled flight tracks depict the approximate paths, or ground tracks, that aircraft use for departure or arrival at MSP. Flight track layout and use was determined by analyzing ARTS and ANOMS data.

Modeled flight track locations were determined by analyzing six days of ARTS data, including nearly 6,500 flights, from spring 1999. MAC staff revalidated the flight track layout in spring 2003 using additional ARTS data. Flight track use for the existing runways was determined using the same methodology used to determine average runway use, including 12 months of ANOMS data for 2002.

INM uses core and sub flight tracks to accurately model actual flight tracks. Since aircraft fly through a moving air mass, a given heading will result in different paths over the ground under different wind conditions. Weather, traffic levels, pilot technique, and differing aircraft performance capabilities make an infinite number of ground tracks possible. ATC does not currently have the ability, for example, to direct aircraft along a highway corridor or other specific points on the ground. The core flight track is the mean, or

average, track for a specific heading; the sub flight track models the dispersion that occurs to either side of the mean flight track due to the above factors. Dispersion rates for all flight tracks were determined using ANOMS data.

Due to the complex and increased dispersion of aircraft flight tracks beyond the immediate vicinity of MSP, modeled arrival and departure flight tracks are only intended to be representative of actual operations extending up to the 60 DNL contour. Deviation from typical flight tracks will occur due to safety requirements, emergencies, weather, traffic demands, capacity needs, and aircraft performance.

Departure Flight Tracks

Figures 4-6 through 4-13 show modeled departure flight tracks, including core and sub flight tracks, by runway. Actual radar flight tracks (ARTS data) are shown for comparison to the INM modeled flight tracks.[12]

As with flight operations and runway use, modeled flight track use is on an annual average basis. Flight track use is expressed as a percentage of total operations from a specific runway. Flight track use, as a percentage of total operations using a specific flight track from a specific runway, is expected to remain constant for 2002 and 2007. **Table 4.9** shows average departure flight track use by daytime and nighttime.

The annual average daily number of aircraft modeled on any given flight track can be derived by multiplying the average daily flight operations by the runway use percentages, and then by the flight track use percentages. Note that this is representative of annual average daily operations only; in reality the actual number of operations that use a specific flight track on a given day can vary significantly due to wind, runway configuration, and other operational factors. If, for example, MSP were in a west flow configuration for an entire day, this method would not be representative of the absolute number of aircraft on a flight track. It is only with the combination of all flows over a year that this method becomes representative of the annual average day.

Several trends are evident in departure flight track layout and use at MSP. Most aircraft are traveling eastbound, destined for places like Chicago and other cities on the East Coast. As a result, most of the departure traffic from Runways 12L and 12R maintain an eastbound heading, as modeled by Tracks F and G in Figure 4-6 and Tracks B and C in Figure 4-7.

Similarly, most of the traffic departing from Runways 30L and 30R makes a 180-degree turn after takeoff and heads east, as modeled by Tracks B, F, and G in Figure 4-8 and Tracks A, E, and F in Figure 4-9. The complete 180-degree turn is not depicted in the figures due to the scale of the illustration. Heavy, international traffic usually heads to the north via great circle routes to Europe and Asia.

Flight track noise abatement measures, currently used at MSP when traffic conditions allow, include the following:

- Runway 30L and Runway 30R departures are assigned headings slightly to the left and right of the straight-out heading, when possible. This routes departure traffic away from areas overflown by straight-in arrival traffic on Runways 12L and 12R. The intent of this procedure is to reduce the number of departure overflights of homes receiving direct arrival overflights.

Runway 12L Departure Flight Tracks

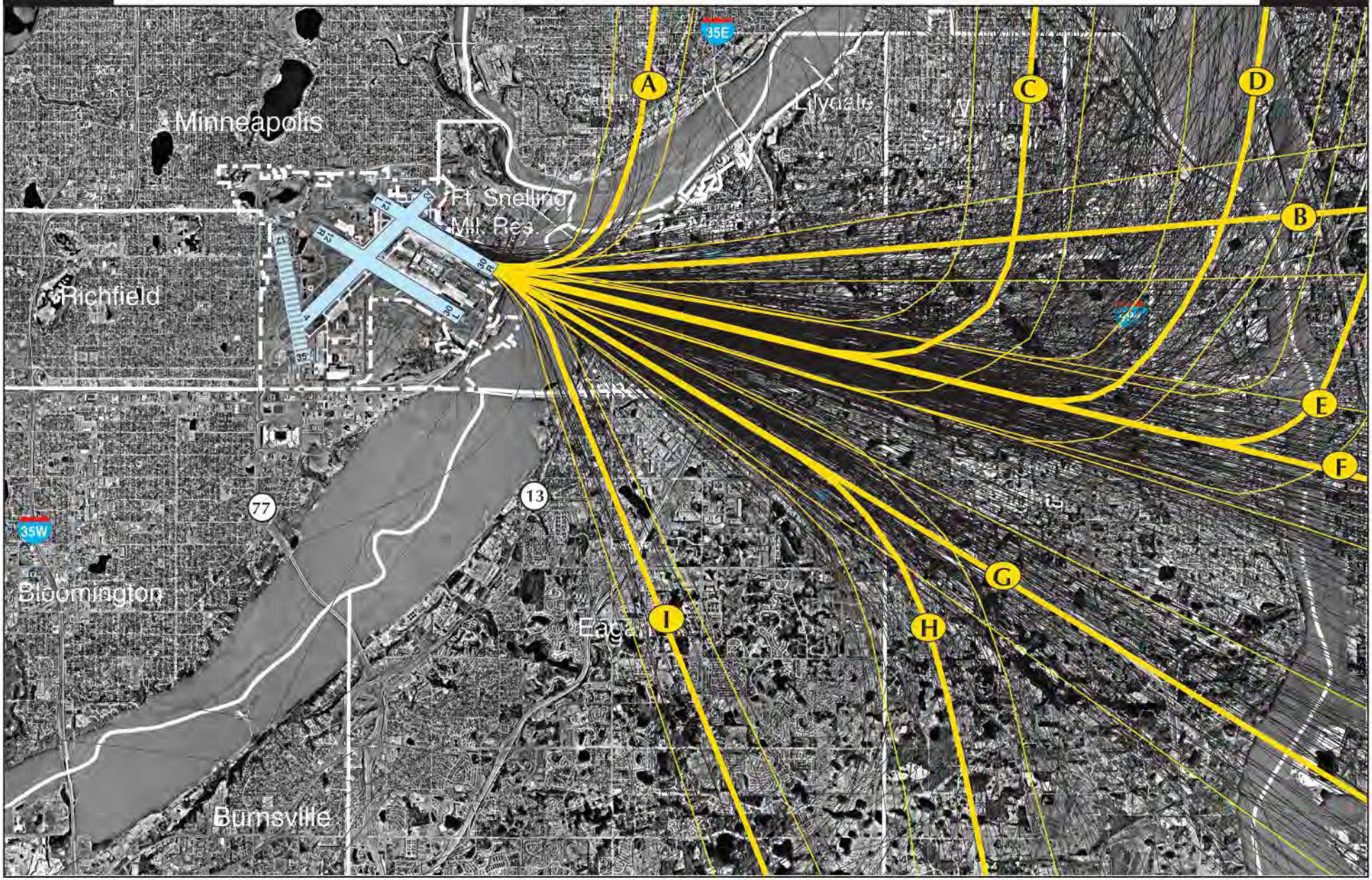
Modeled Core and Sub Tracks

ARTS Tracks

0 1 2 miles

N

Figure 4-6



Runway 12R Departure Flight Tracks

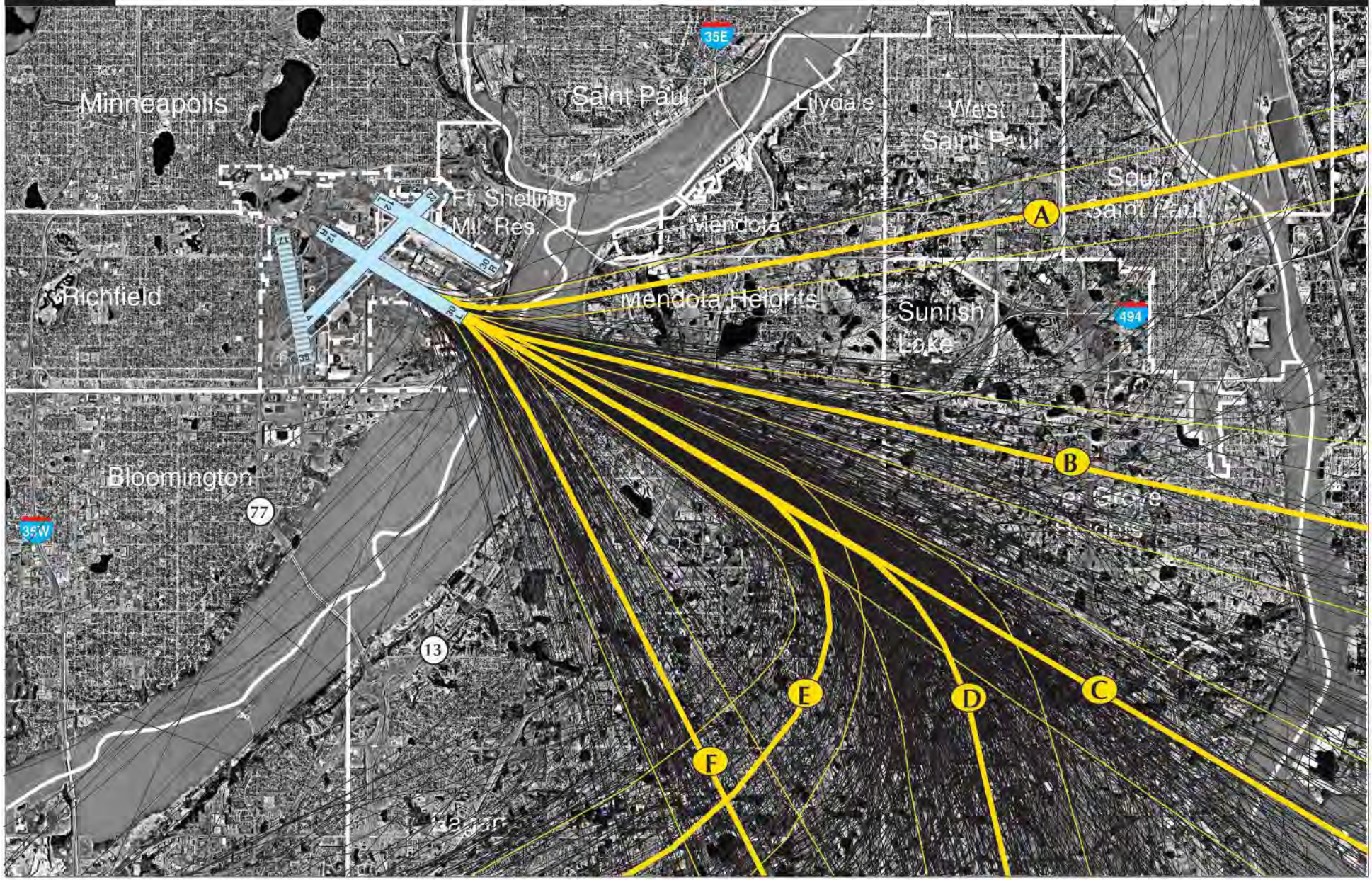
Modeled Core and Sub Tracks

ARTS Tracks

0 1 2 miles

N

Figure 4-7



Runway 30L Departure Flight Tracks

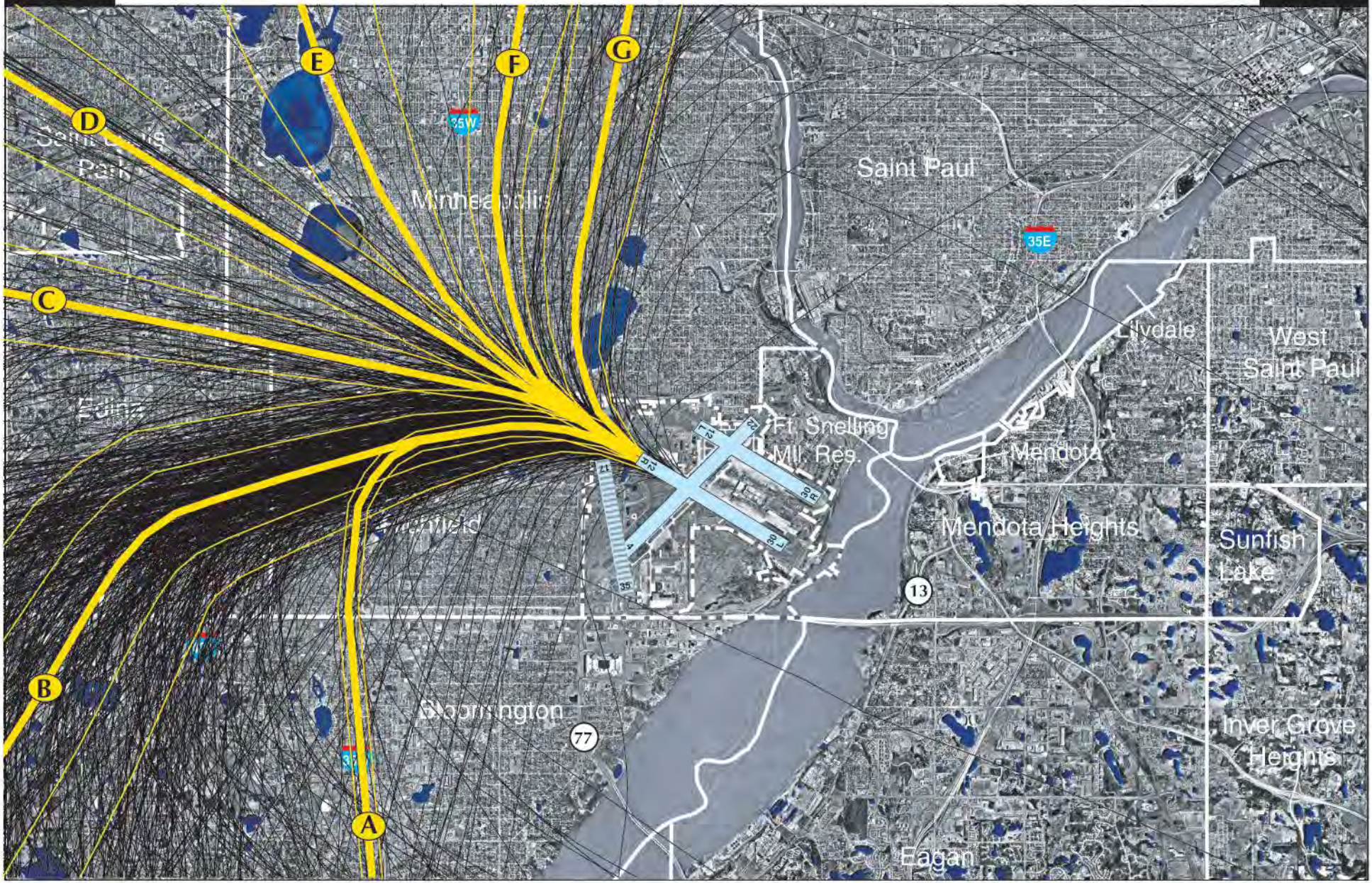
Modeled Core and Sub Tracks

ARTS Tracks

0 1 2 miles

N

Figure 4-8



Runway 30R Departure Flight Tracks

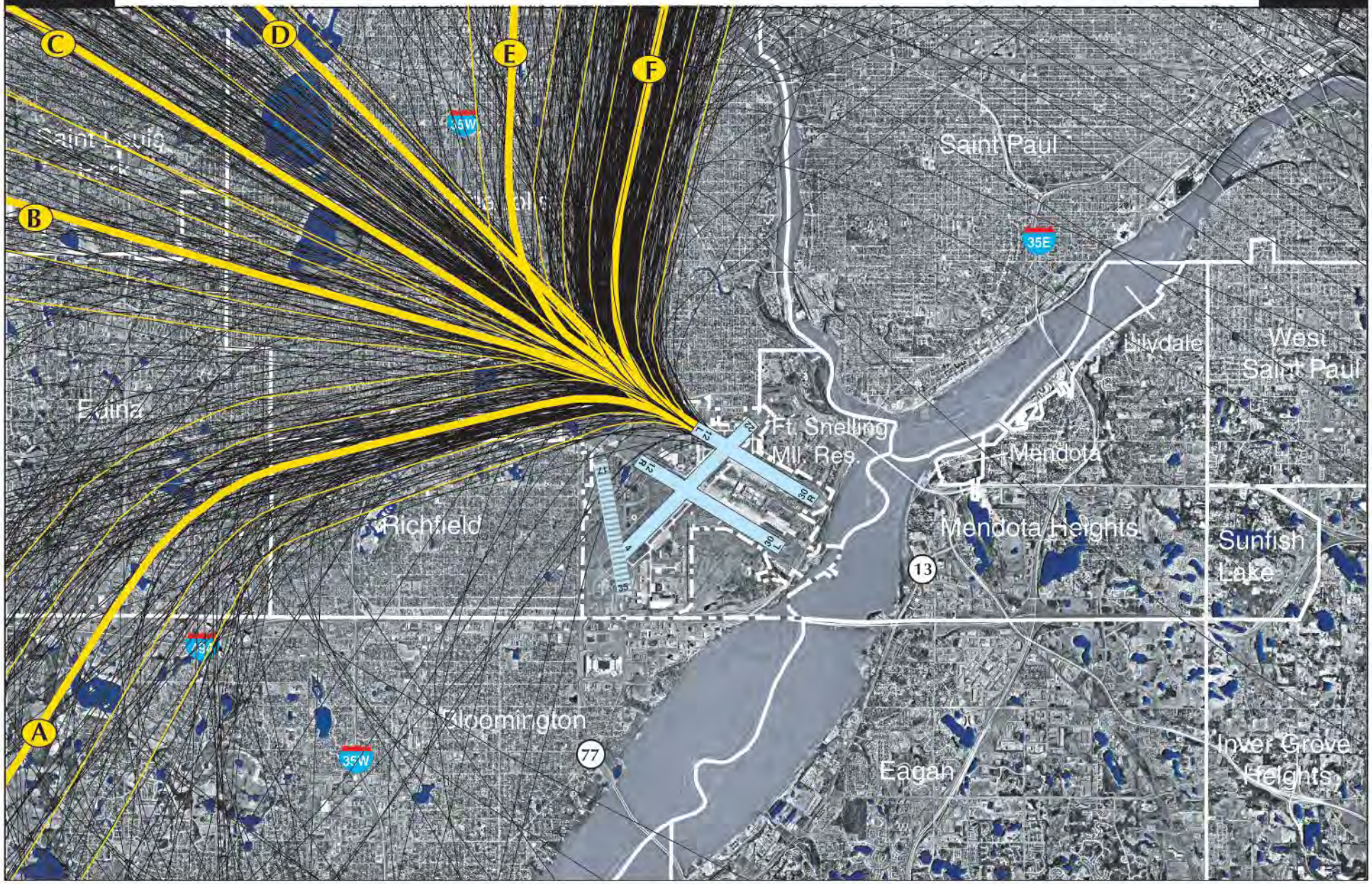
Modeled Core and Sub Tracks

ARTS Tracks

0 1 2 miles

N

Figure 4-9



Runway 04
Departure Flight Tracks

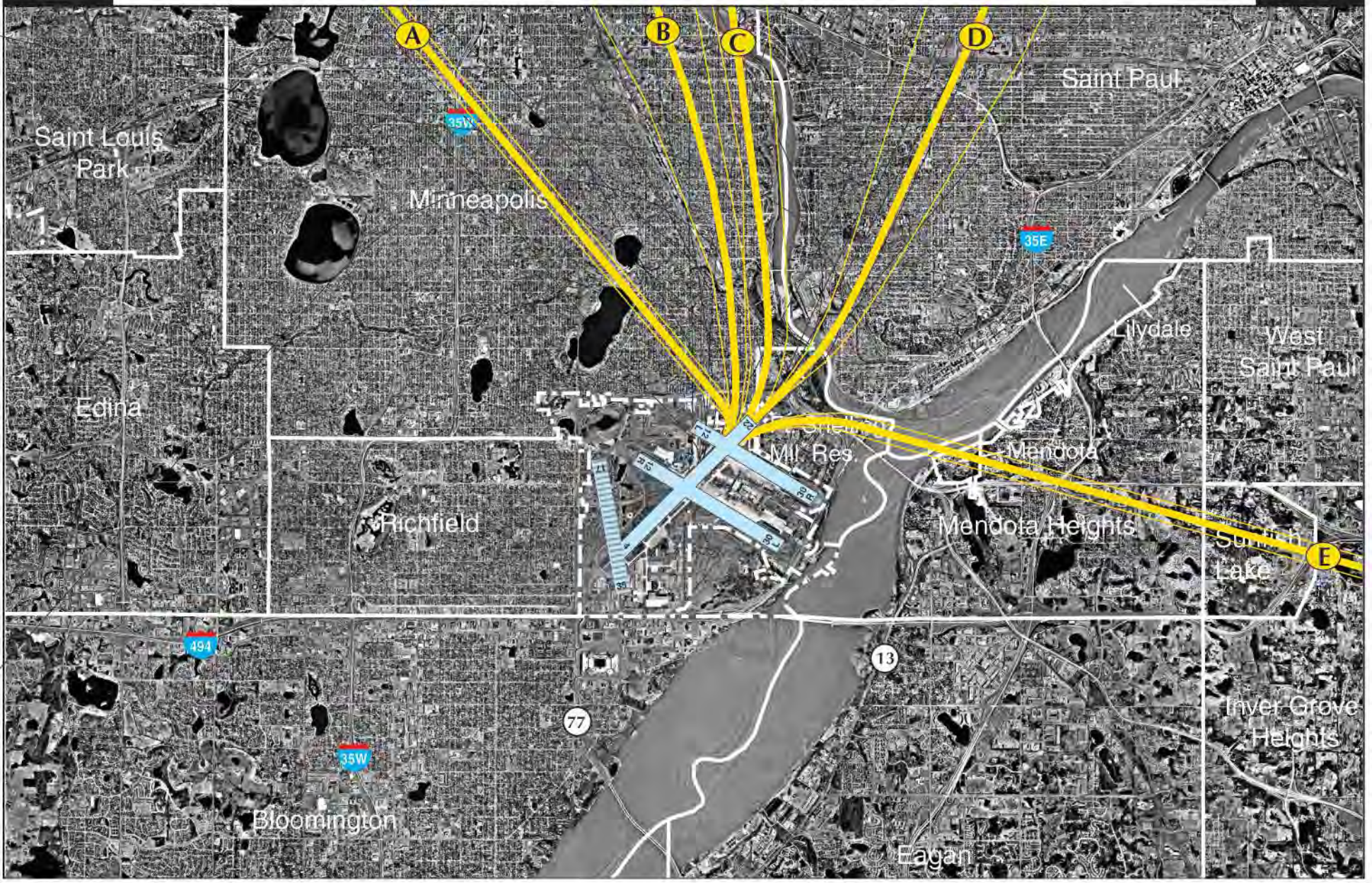
Modeled Core and Sub Tracks

ARTS Tracks

0 1 2 miles

N

Figure 4-10



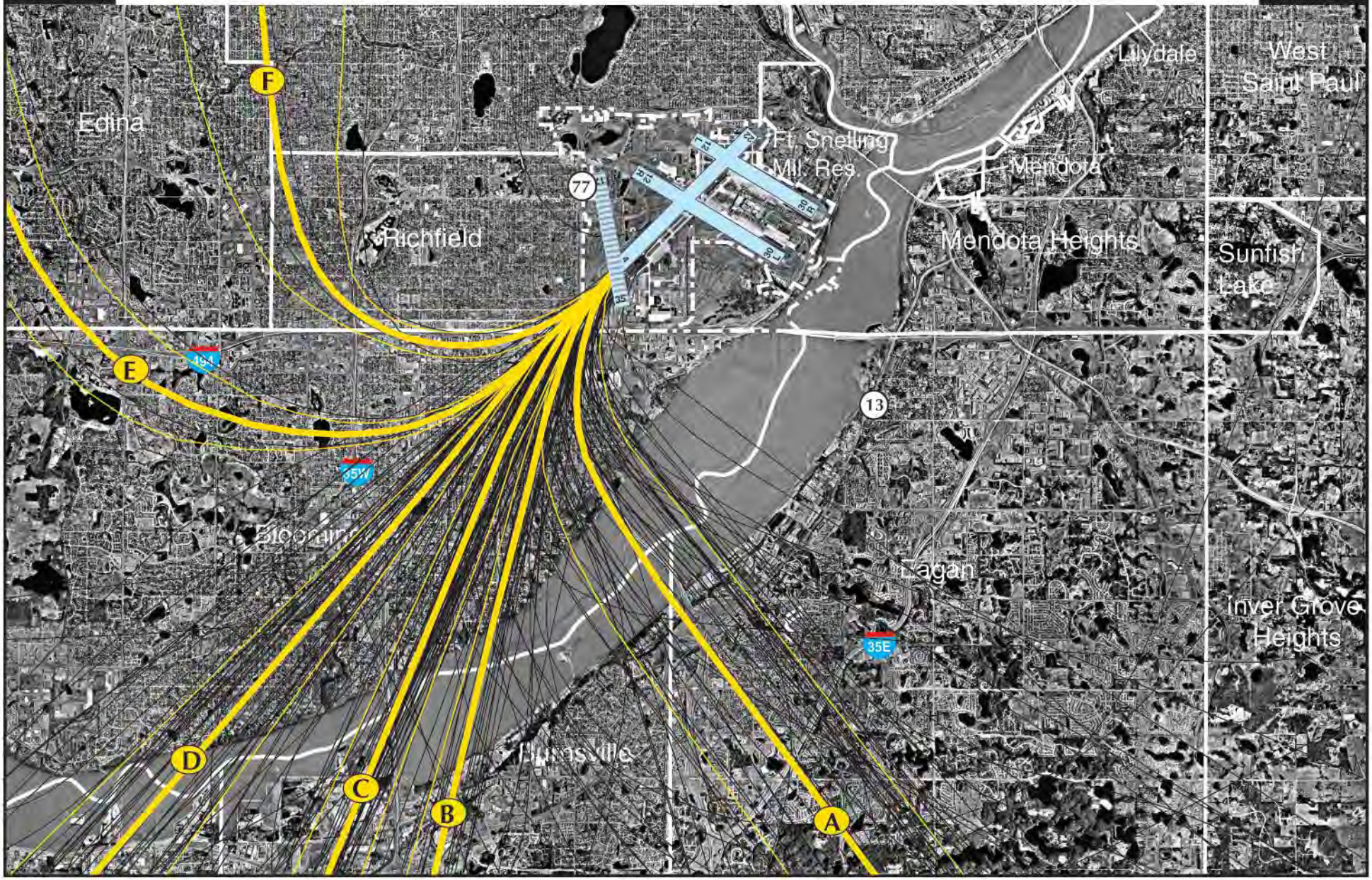
Runway 22
Departure Flight Tracks

Modeled Core and Sub Flight Tracks
ARTS Flight Tracks

0 1 2 miles

N

Figure 4-11



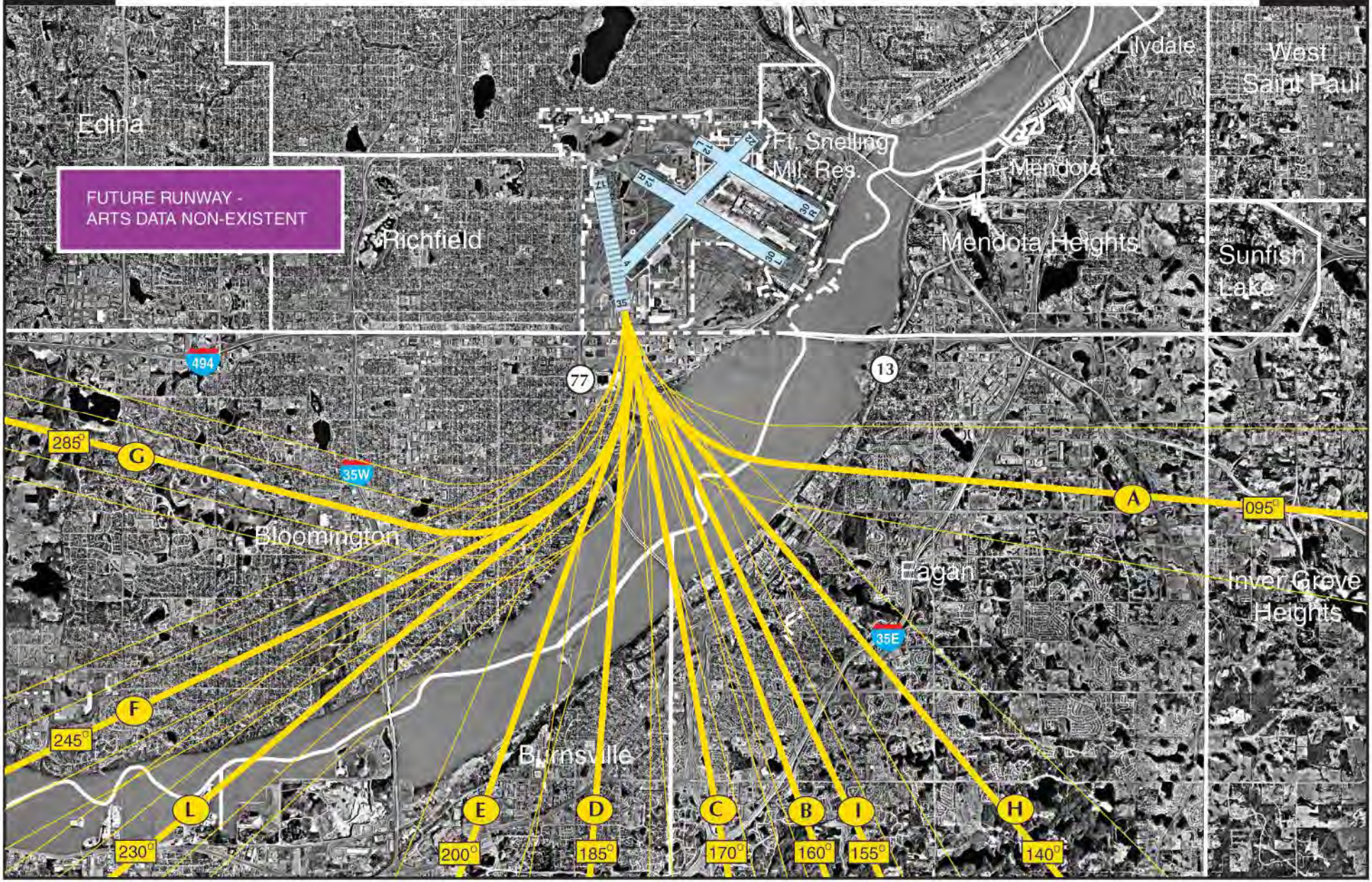
Runway 17 Departure Flight Tracks

Modeled Core and Sub Flight Tracks

0 1 2 miles

N

Figure 4-12



Runway 35 Departure Flight Track

Modeled Core Track

0 1 2 miles

N

Figure 4-13

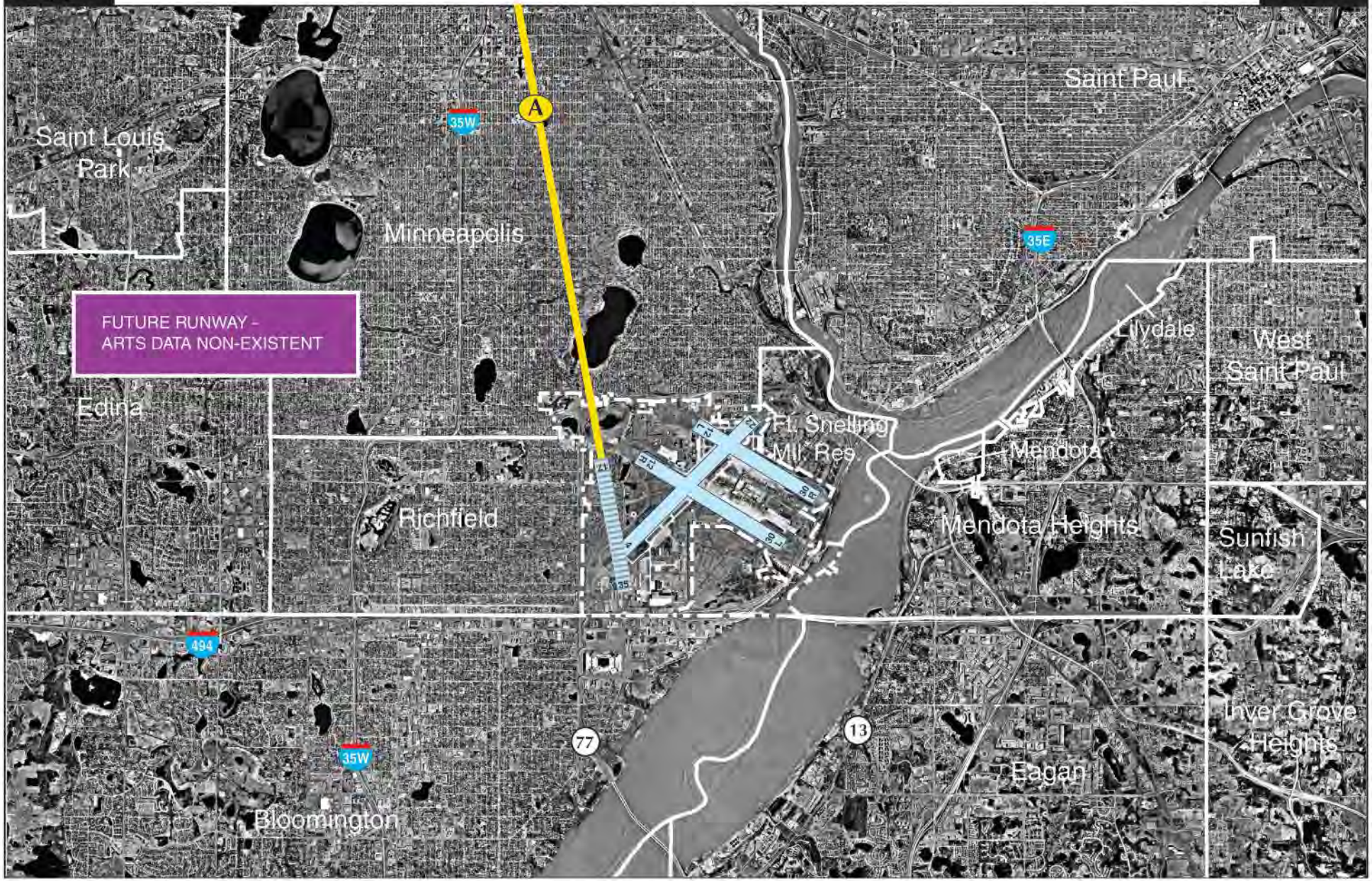


Table 4.9

Annual Average Departure Flight Track Use

Runway	Track	2002			2007		
		Daytime	Nighttime	Overall	Daytime	Nighttime	Overall
4	A	3.5%	3.2%	3.4%	3.8%	2.1%	3.6%
	B	5.3%	12.8%	6.2%	7.0%	8.5%	7.1%
	C	21.8%	23.0%	22.0%	24.8%	21.8%	24.6%
	D	53.3%	58.5%	54.0%	43.5%	62.7%	45.0%
	E	16.1%	2.5%	14.4%	20.9%	5.0%	19.7%
	Total	100%	100%	100%	100%	100%	100%
22	A	8.7%	14.8%	9.0%	8.9%	15.3%	9.4%
	B	8.3%	6.8%	8.2%	8.0%	4.9%	7.8%
	C	14.5%	10.9%	14.3%	14.5%	7.3%	14.0%
	D	52.1%	45.0%	51.7%	52.2%	48.1%	51.9%
	E	5.2%	3.6%	5.1%	4.0%	3.5%	4.0%
	F	11.3%	19.0%	11.7%	12.3%	20.9%	12.9%
	Total	100%	100%	100%	100%	100%	100%
12L	A	1.9%	5.6%	2.1%	1.2%	4.9%	1.5%
	B	18.0%	12.5%	17.6%	13.1%	10.3%	12.8%
	C	11.3%	12.5%	11.4%	11.5%	12.2%	11.6%
	D	14.9%	13.6%	14.8%	16.0%	13.8%	15.8%
	E	7.6%	4.8%	7.4%	8.2%	4.8%	7.8%
	F	31.4%	16.5%	30.4%	33.8%	16.8%	32.2%
	G	8.8%	17.4%	9.4%	10.3%	19.4%	11.2%
	H	3.8%	11.5%	4.3%	4.7%	13.8%	5.5%
	I	2.4%	5.7%	2.6%	1.4%	4.0%	1.6%
	Total	100%	100%	100%	100%	100%	100%
12R	A	0.8%	8.5%	1.5%	0.6%	7.6%	1.3%
	B	7.2%	18.9%	8.4%	6.6%	19.1%	7.8%
	C	30.2%	33.9%	30.6%	32.5%	35.8%	32.8%
	D	41.8%	27.0%	40.3%	44.4%	27.3%	42.7%
	E	8.2%	5.9%	8.0%	8.5%	5.9%	8.3%
	F	11.8%	5.9%	11.2%	7.4%	4.4%	7.1%
	Total	100%	100%	100%	100%	100%	100%
30L	A	1.9%	4.1%	2.1%	1.8%	4.3%	2.0%
	B	69.3%	50.6%	67.5%	70.7%	52.6%	69.4%
	C	11.0%	5.0%	10.4%	11.1%	4.9%	10.6%
	D	5.8%	4.4%	5.6%	5.2%	3.5%	5.0%
	E	2.7%	4.3%	2.9%	2.3%	3.9%	2.4%
	F	2.6%	9.9%	3.3%	2.3%	9.8%	2.9%
	G	6.8%	21.7%	8.2%	6.6%	21.0%	7.7%
	Total	100%	100%	100%	100%	100%	100%
30R	A	15.0%	32.6%	16.0%	16.8%	36.1%	18.1%
	B	8.2%	10.4%	8.3%	8.4%	11.5%	8.6%
	C	14.6%	13.4%	14.5%	12.3%	12.0%	12.2%
	D	1.4%	1.1%	1.4%	1.1%	1.0%	1.1%
	E	7.4%	4.8%	7.2%	7.0%	4.4%	6.9%
	F	53.5%	37.7%	52.6%	54.4%	35.1%	53.0%
	Total	100%	100%	100%	100%	100%	100%
17	A	-	-	-	10.1%	10.1%	10.1%
	B	-	-	-	8.0%	8.0%	8.0%
	C	-	-	-	17.3%	17.3%	17.3%
	D	-	-	-	8.5%	8.5%	8.5%
	E	-	-	-	22.3%	22.3%	22.3%
	F	-	-	-	7.9%	7.9%	7.9%
	G	-	-	-	8.9%	8.9%	8.9%
	H	-	-	-	5.1%	5.1%	5.1%
	I	-	-	-	4.0%	4.0%	4.0%
	L	-	-	-	7.9%	7.9%	7.9%
	Total	-	-	-	100%	100%	100%
35	A	-	-	-	100.0%	100.0%	100.0%
	Total	-	-	-	100%	100%	100%

Note: Differences may exist due to rounding

Sources: ANOMS, Dual Track FEIS, and HNTB analysis

- Also, northbound aircraft departing from Runways 30L and 30R are required to climb to 1,500 feet MSL before turning to their assigned headings. This is not a noise abatement measure, but is necessary so that aircraft avoid a tall tower to the north of MSP.

- Aircraft departing from Runways 12L and 12R use the "Crossing in the Corridor" procedure. ATC will assign a heading that approximates a 118-degree track (Track G in Figure 4-6) along the ground to aircraft departing from Runway 12L and a 105-degree track (Track B on Figure 4-7) to aircraft departing from Runway 12R. The tracks cross in the middle of the Eagan/Mendota Heights Corridor, and route departing aircraft away from residential areas near the Corridor borders. Since this procedure affects runway capacity, it can only be used when traffic conditions allow for non-simultaneous departures. Additionally, it can only be used when there is a single air traffic controller issuing departure instructions. Consequently, the procedure is used primarily at night.

- The effect of the Eagan/Mendota Heights Corridor procedure can also be seen in modeled flight track layout and use. Note that the aircraft routed via the 090-, 105-, and 120-degree headings from Runway 12L are modeled by tracks B, C-F, and G-H, respectively, as shown in Figure 4-6. Aircraft routed via the 090-, 105-, and 120-degree headings from Runway 12R are modeled by tracks A, B, and C-E, respectively, as shown in Figure 4-7. As shown in Figures 4-6 and 4-7, and Table 4.9, jets maintain their initial assigned departure heading of 090- to 120-degrees, inclusive, until at least three statute miles from the departure runway end. The turn beyond the corridor boundary can be seen in modeled tracks C, D, E, and H from Runway 12L, and modeled tracks D and E from Runway 12R.

Note that modeled track B from Runway 12L and modeled track A from Runway 12R (these tracks represent an approximate 090-degree heading from Runways 12L and 12R) lie slightly northward of the (north) Corridor boundary. Approximately 73-percent of the aircraft assigned to the 090-degree heading from Runways 12L and 12R are turboprop aircraft, which are not required to fly within the Corridor boundaries. Thus, the majority of aircraft assigned to the 090-degree heading have a ground track north of the Corridor boundary. The locations of the core modeled tracks for track B from Runway 12L and track A from Runway 12R are established at the median of both turboprop and jet aircraft assigned to an approximate 090-degree heading, as shown by analysis of ARTS data. Therefore, the location of the core modeled flight track is north of the Corridor boundary. Note also that the layout of these modeled flight tracks was established to model the 090-degree heading; the actual track of an aircraft modeled by these flight tracks can vary depending on when the aircraft begins the turn to a heading of 090-degrees (i.e., the aircraft's turn point). The location of the core modeled flight track to the north of the corridor boundary is necessary to appropriately and conservatively model both turboprop and jet aircraft noise exposure; however, the modeled flight track location is not to be construed as the de facto north Corridor boundary.

Runway 17/35 Departure Flight Tracks

The original flight track layout for Runway 17/35 was developed in the Dual Track FEIS. As discussed in Appendix B, ATC

uses airspace "gates" to transition aircraft from the terminal area to the en route environment. Headings from Runway 17 to the departure gates were used to project flight track location. The modeled flight tracks are estimates of future operations, as the runway is not yet operational. Because of the low proportion of operations to and from the north, Runway 35 departures and Runway 17 arrivals are modeled using only straight flight tracks.

The modeled departure flight tracks for Runway 17 were modified from those presented in the Dual Track FEIS for this Study. **Figure 4-14** compares the original FEIS modeled flight tracks with the modified Study modeled flight tracks, which were previously shown in Figure 4-12. Although the true headings[13] of the flight tracks were not changed, the following factors lead to a revision of the forecast modeled flight tracks:

- Digital methods of analyzing ARTS and ANOMS data, using AutoCAD and Geographic Information Systems (GIS), allow improved, comprehensive analysis of comparable flight tracks from existing runways and improved projections of operations from Runway 17.

- The use of high performance aircraft, such as regional jets, A320s, and B757s, continues to increase. These aircraft have shorter takeoff distances and can climb quicker and turn sooner than older aircraft.

- Improved ability to model the dispersion, using sub tracks, that occurs as aircraft turn to assigned headings.

The analyses indicate that aircraft would be able to turn sooner than originally projected in the FEIS. In order to more accurately predict noise exposure from forecast aircraft operations, the forecast-modeled flight tracks were modified and supplemented by analyzing actual operations and flight tracks from existing runways. The revision is in agreement with the ROD of the FEIS, which allows for turns immediately off the runway end to headings between 095-degrees and 285-degrees.[14]

For the purposes of modeling and contour generation, specified departure tracks must be developed and modeled. For this study and the Dual Track FEIS, departure tracks that would allow aircraft a direct routing on course were provided by ATC. Flight tracks are determined by ATC issuing headings to be flown by a pilot. These headings are assigned by ATC in 5-degree increments. Although INM only allows the primary headings to be evaluated, ATC may assign any heading within the specified departure fan of 095-degrees to 285-degrees, inclusive, to departures from Runway 17.

Forecast flight track use for the Runway 17 departure flight tracks was determined in the Dual Track FEIS. Most of the aircraft using Runway 17 are expected to depart for southern and western destinations. A destination analysis was used to forecast flight track use. However, several factors lead to a revision of forecast flight track use for this Study, as described in the following paragraphs. **Table 4.10** shows forecast flight track use for departures from Runway 17, for both the Dual Track FEIS and this Study, as modified.

When aircraft are arriving on Runways 30L and 30R, the airspace inclusive of the 095-degree to 160-degree tracks (from Runway 17) would typically be used for arrivals on Runways 30L and 30R instead of departures from Runway 17. This means that departing aircraft from Runway 17 would not normally be assigned to a heading east of

Revised Runway 17 Departure Flight Tracks

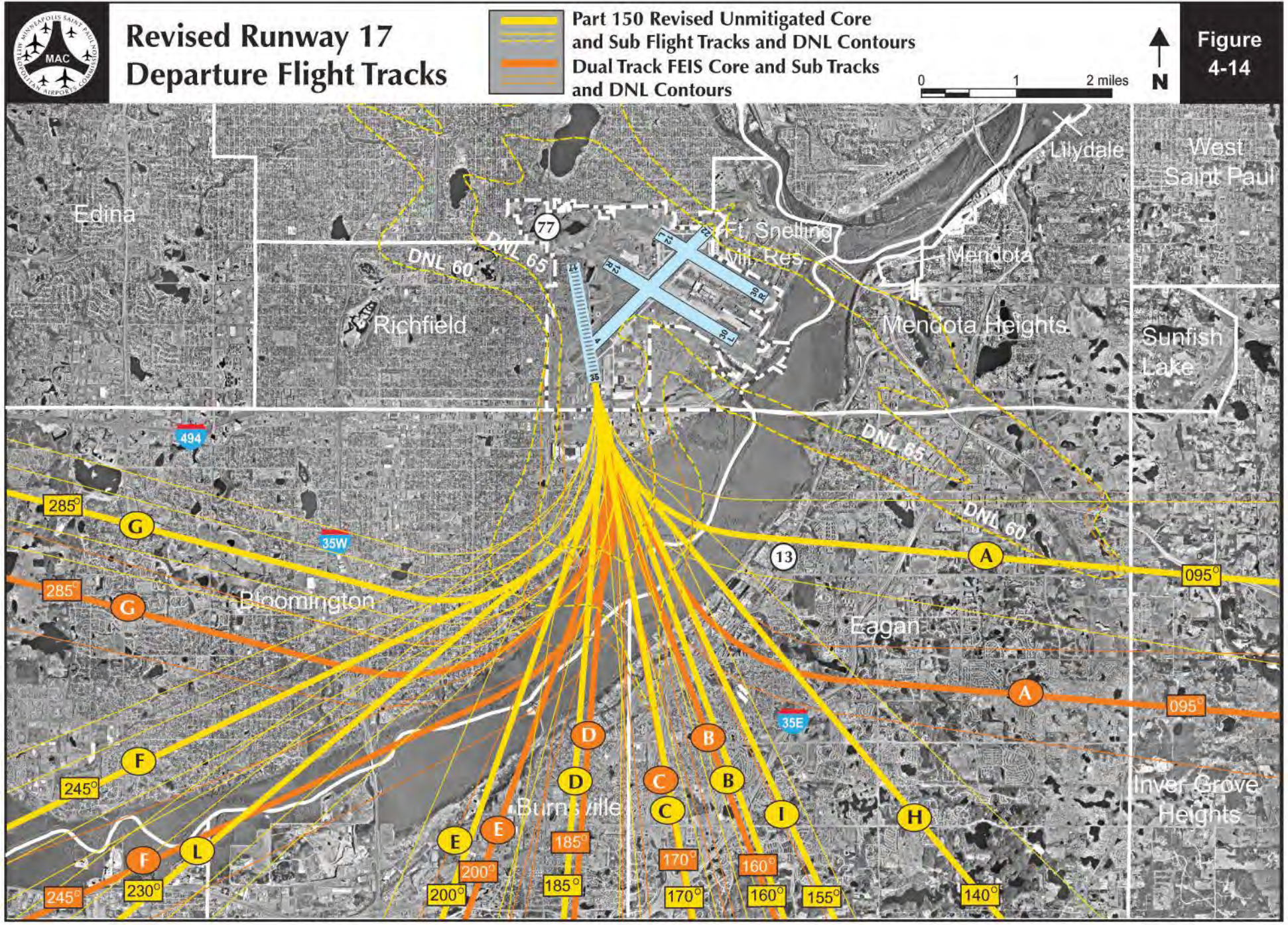


Table 4.10

Forecast Runway 17 Departure Flight Track Use

Track (a)	Heading (degrees)	Dual Track FEIS Day/Night	Modified Day/Night
A	95	15.2%	10.1%
H	140	-	5.1%
I	155	-	4.0%
B	160	12.0%	8.0%
C	170	17.3%	17.3%
D	185	8.5%	8.5%
E	200	22.3%	22.3%
L	230	-	7.9%
F	245	11.6%	7.9%
G	285	13.1%	8.9%
Total		100%	100%

(a) Track designators J and K were not used

Source: Dual Track FEIS, ATC, and HNTB analysis.

160-degrees when there are arrivals on Runways 30L or 30R. This procedure ensures adequate separation between arriving and departing aircraft. Similarly, when aircraft are arriving on Runways 12L and 12R, the airspace inclusive of the 230-degree to 285-degree tracks (from Runway 17) would normally be used for arrivals on Runways 12L and 12R instead of departures from Runway 17. This means that departing aircraft from Runway 17 would not normally be assigned to a heading west of 230-degrees when there are arrivals on Runways 12L or 12R.

The procedures governing arrivals on Runways 12L and 12R while departures are using Runway 17 were incorporated into the FEIS flight track use. However, the procedure governing arrivals on Runways 30L and 30R while departures are using Runway 17 was not incorporated into the FEIS flight track use. As a result, flight track use for Runway 17 departures was revised for this Study with consideration of arrivals on Runway 30L and 30R as well.

Additionally, one-third of the traffic on Tracks A and B was shifted to Tracks H and I, respectively, to better represent the divergence that is expected to occur with departures from Runway 17. This shift does not have any substantial effect on the 60 DNL contour.

Operations on Runway 17/35 will affect departures from Runway 4 because the runways intersect. Most departures on Runway 4 will start their takeoff roll at the intersection of Runway 4 and Taxiway S, a displacement of 1,550 feet. Distinct flight tracks were created to model intersection departures. Heavy aircraft will not use intersection departure procedures because they require the full runway length.

Arrival Flight Tracks

Figure 4-15 shows modeled arrival flight tracks. Actual radar flight tracks (ARTS data) are shown for comparison to the INM modeled flight tracks. Average arrival flight

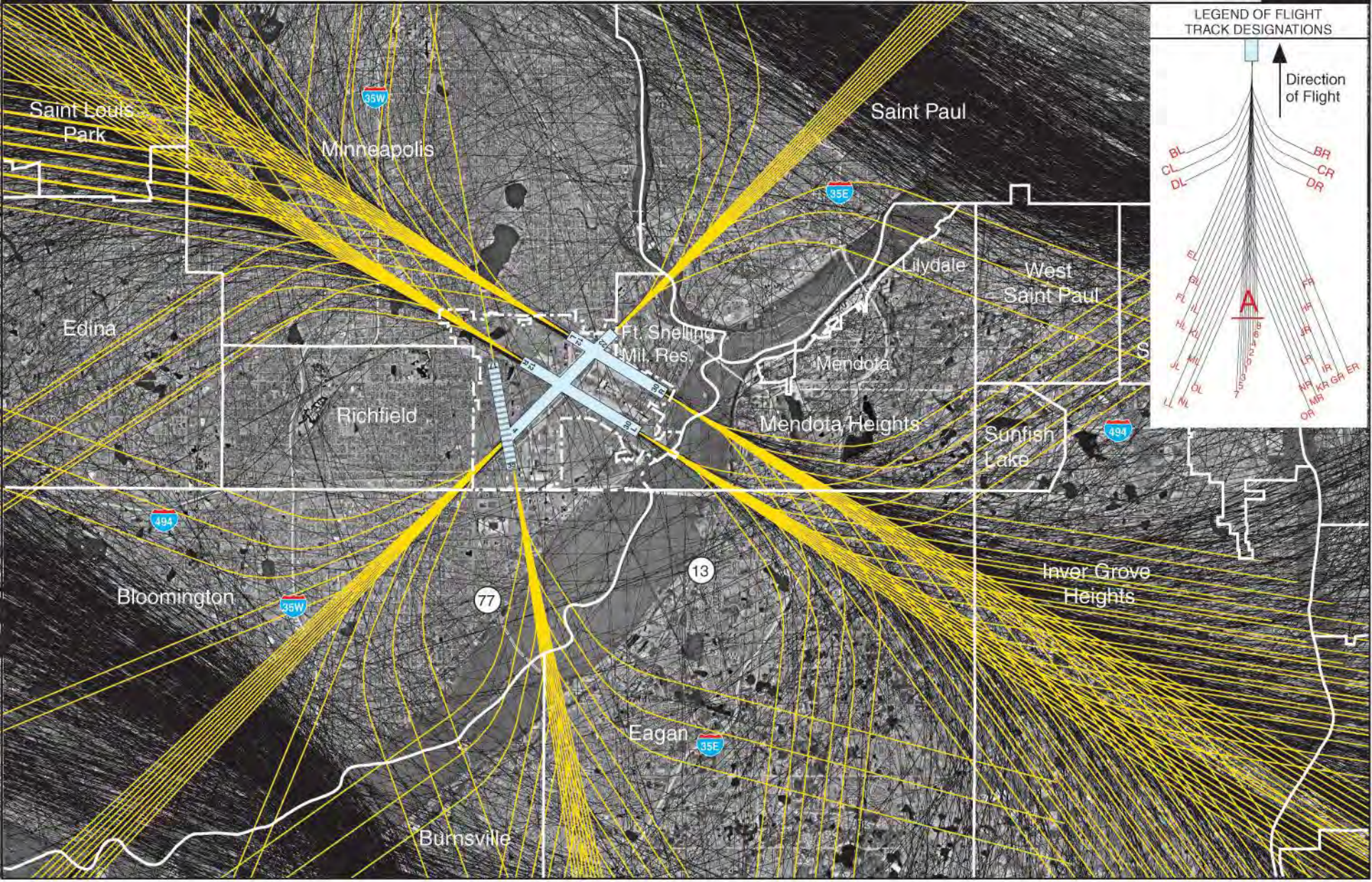
Modeled Arrival Flight Tracks

FUTURE RUNWAY 17/35
ARTS DATA NON-EXISTENT

0 1 2 miles

N

Figure 4-15



track use by daytime and nighttime is shown in Appendix C.

Arriving aircraft use a straight-in approach path, known as a final approach course, when landing at MSP. The straight-in approach path permits use of an ILS, allows ATC to efficienctly separate aircraft, and permits the pilot to establish a safe, stablized descent to the runway. The point at which aircraft turn onto the final approach course varies; some aircraft turn relatively close to the Airport, while other aircraft are established on the final approach course when they are still many miles from the Airport.

As part of the November 2001 Study, the modeled arrival flight tracks were revised in September 2001 in response to community concerns regarding the comprehensiveness of previous modeled arrival flight tracks as discussed in Appendix K. A grid of modeled arrival flight tracks was developed to capture two predominant effects related to the arrival routes into MSP, as described below:

- **Dispersion about Final Approach Course.** Arriving aircraft fly to the left, right, and directly on the final approach course, or extended runway centerline, for landing at MSP. The flight of aircraft to the left or right of the median track is known as dispersion, and is the result of wind, pilot technique, and/or the performance of radio navigational aids systems (e.g., ILS). A narrow fan of modeled flight tracks, that is wider than (and therefore encompassing of) the predominant straight-in arrival route, is used to model the dispersed straight-in arrival flight tracks. Each flight track in the fan has a unique flight track use percent; thus, the modeled arrival flight tracks capture the unique dispersion trends off each runway end. Note that dispersion is not a violation of ATC directions or Federal Aviation Regulations.

- **Intercept of Final Approach Course.** Some aircraft intercept the final approach course at a point outside the 60 DNL contour, and are modeled using the dispersed straight-in tracks, as described above. Other aircraft, however, intercept the final approach course relatively close to MSP, and within the 60 DNL contour. The close-in intercepts of the final approach course can occur due to ATC directives (which result from requirements for aircraft separation and/or airspace capacity and traffic demand considerations), weather, and the use of visual approaches. Regardless of the reason, close-in intercepts are a safe and established procedure, and do not violate Federal Aviation Regulations. The flight tracks that model this occurrence are collectively known as dispersed intercept arrival flight tracks. Some dispersed intercept arrival flight tracks model aircraft that intercept the final approach course at a relatively narrow intercept angle (relative to the final approach course); these routes are typically used by aircraft intercepting the final approach course as part of an ILS Instrument Approach Procedure. Other dispersed intercept arrival flight tracks model the relatively broad intercept angle (relative to the final approach course) used by aircraft on initial approach close to the runway threshold; the broad angle is necessitated by the aircraft's proximity to the runway threshold, and is reflective of typical close-in visual approach procedures.

For the purposes of this Study, and as with modeled departure flights tracks, modeled arrival flight tracks are only intended to be representative of actual flight operations up

to the 60 DNL contour. Regardless, the revised modeled arrival flight tracks improve the modeling of arrival operations at MSP, especially in areas between the 60-64 DNL contour, where significant arrival dispersion can and does occur. The net effect of the revised modeled arrival flight tracks is to improve the INM data inputs and thereby improve the estimation of aircraft noise exposure as depicted in the DNL contours.

4.3.4 Aircraft Flight Profiles

Flight profiles specify the altitude, speed, and engine thrust of an aircraft at any point along a departure or arrival flight track. INM uses this information to calculate noise exposure on the ground. Profiles are unique to each aircraft type, and are based on airline operating procedures, temperature, and aircraft operating weight. Detailed information on aircraft flight profiles, under varying conditions, is stored in the INM aircraft database.

Arrival Flight Profiles

Most arriving aircraft at MSP use ILS approaches. ILS provides accurate horizontal and vertical guidance to aircraft so they can land during poor weather conditions. The system guides aircraft on a straight-in horizontal path and a standard 3-degree descending vertical path, known as a glideslope, to the runway. During good weather conditions, the use of ILS approaches ensures that aircraft are at optimum altitudes for landing. A standard 3-degree approach was used to model arriving aircraft. INM has a database of standard arrival flight profiles for each INM aircraft type.

Departure Flight Profiles

The climb rate, and flight profile, of departing aircraft varies considerably. New, modern aircraft have higher thrust engines and improved wing designs over older aircraft, which results in a superior climb rate. Modern jet engines are also much quieter than their predecessors, even though they have more thrust. Temperature, takeoff weight, and airline operating procedures are also important factors that affect climb rate.

As temperature increases, air density decreases. This reduces engine thrust, which results in increased takeoff distance and a lower climb rate. Because departing aircraft are at a lower altitude, noise exposure generally increases. Conversely, noise exposure is less on cold days when aircraft have improved takeoff and climb performance capabilities.

The INM aircraft database contains departure flight profiles for each aircraft type, grouped by stage length. Stage length refers to the length of the trip (to be made) by the aircraft type. INM assumes aircraft weight increases with stage, or trip length, due to the need for more fuel. Thus, stage length is an approximation of the aircraft's takeoff weight. Each aircraft type's takeoff distance and climb performance is different for each stage length. Heavy (long trip, high stage length) aircraft have increased takeoff distances and lower climb rates than lighter (short trip) aircraft, for a given aircraft type.

Stage lengths are indexed according to the range of trip length, as shown in **Table 4.11**. For example, if an aircraft is departing for a trip of length less than 500 nautical miles (NM), it is assigned a stage length of one; if the trip length is between 500 and 1,000 NM, it is assigned a stage length of two, and so on. Note that arriving aircraft do not use stage lengths, as these aircraft have

consumed most of their fuel during the flight to MSP and are landing at typical landing weights.

Pilots use airline operating procedures to maneuver an aircraft during takeoff. The procedures are unique to each aircraft type. Although airlines develop their own procedures, with aircraft manufacturer and FAA approval, operating procedures among most airlines are similar. The INM departure flight profiles represent typical takeoff procedures for each aircraft type.

Table 4.11

Stage Length Definition

Stage Length	Trip Distance
1	0 to 500 NM
2	500 to 1000 NM
3	1000 to 1500 NM
4	1500 to 2500 NM
5	2500 to 3500 NM
6	3500 NM to 4500 NM
7	Over 4500 NM

Source: INM 6.0 User's Guide

Communities and airports have long sought operating procedures that reduce takeoff noise. FAA Advisory Circular (AC) 91-53A, published in 1993, establishes guidelines for Noise Abatement Departure Profiles (NADP). The AC is general, and defines guidelines and minimum operating parameters for airlines to use in developing operating procedures. Due to their complexity, the AC does not detail exact, aircraft type-specific procedures.

The AC establishes the two distinct NADPs:

- Close-In NADP reduces noise for communities within the immediate vicinity of the airport.
- Distant NADP reduces noise for other communities that are not within the immediate vicinity of the airport.

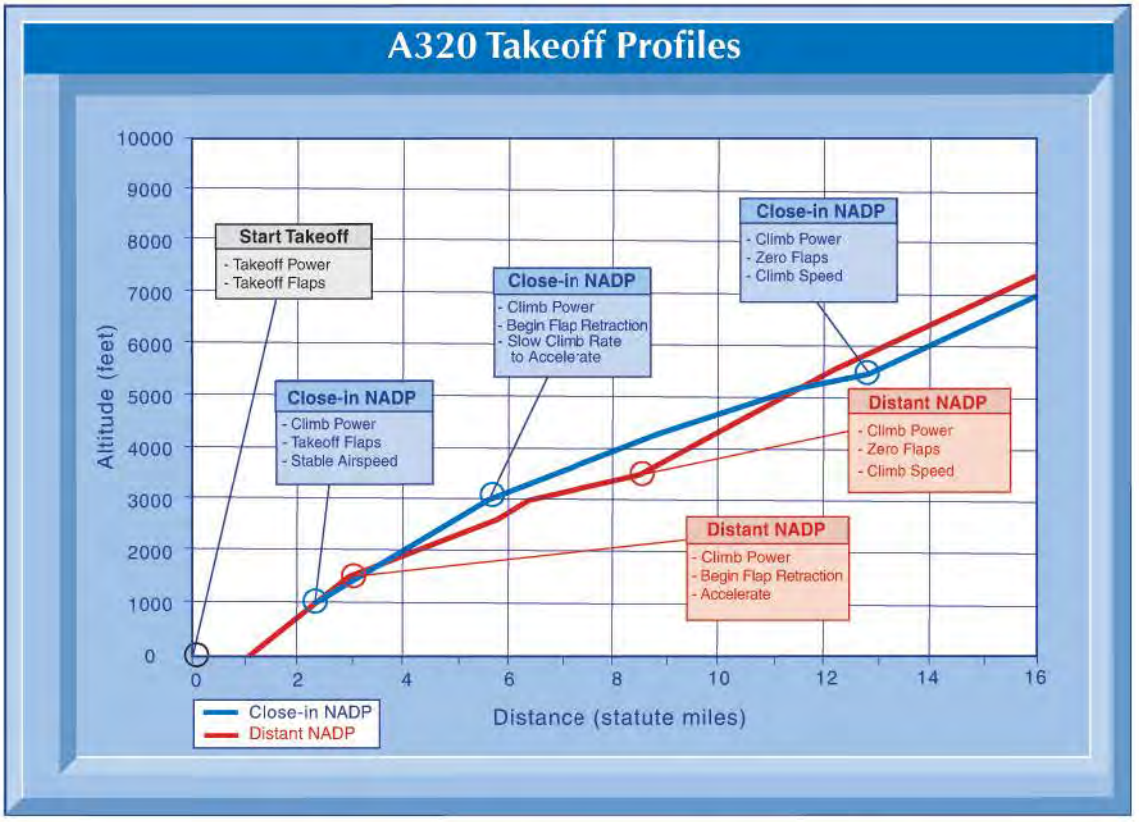
The AC does not allow airports to develop their own unique procedures due to safety issues. The AC establishes a standardized system so that an aircraft type will use the same generalized operating procedures throughout the nation. Each airline develops their specific NADPs, which are approved by the FAA. Airports are permitted to select the appropriate NADP to use on each runway end. Unless otherwise instructed, airlines typically use the Distant NADP.

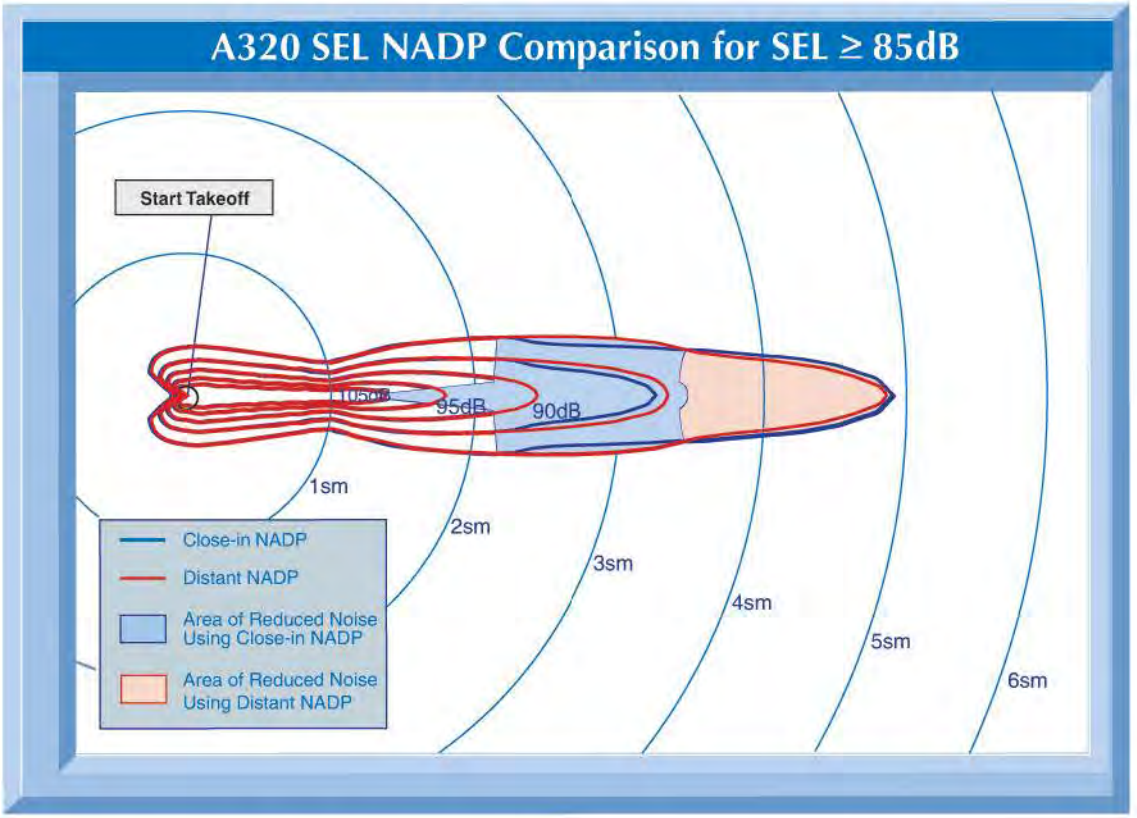
Figures 4-16 and 4-17 show typical NADPs for A320 and DC9Q type aircraft, respectively, and their resultant single-event Sound Exposure Level (SEL) footprint. It is evident from these figures that the Close-In NADP provides a slight reduction in noise to areas within approximately 3.5 statute miles from the start of takeoff roll (not from the end of the runway). The Distant NADP provides a slight reduction to areas beyond approximately 3.5 statute miles from the start of takeoff roll. Although aircraft using the Close-In NADP are higher than aircraft using the Distant NADP, they are also slower and at a higher engine thrust during certain segments of the procedure. Beyond 3.5 statute miles from the start of takeoff roll, the Close-In NADP results in higher noise exposure. For modern, high-performance jet aircraft (such as the A320, B757, and B717) the difference in noise between a Close-In and Distant NADP is minimal. However, as shown in Figure 4-17, the difference in noise exposure for older aircraft such as the DC9Q is more pronounced. Additional information on NADPs is provided in Appendix D.

At MSP, the Close-In NADP was used during 2002 for takeoffs on Runways 30L and 30R. However, in July 2003, MAC

A320 Noise Abatement Departure Profiles

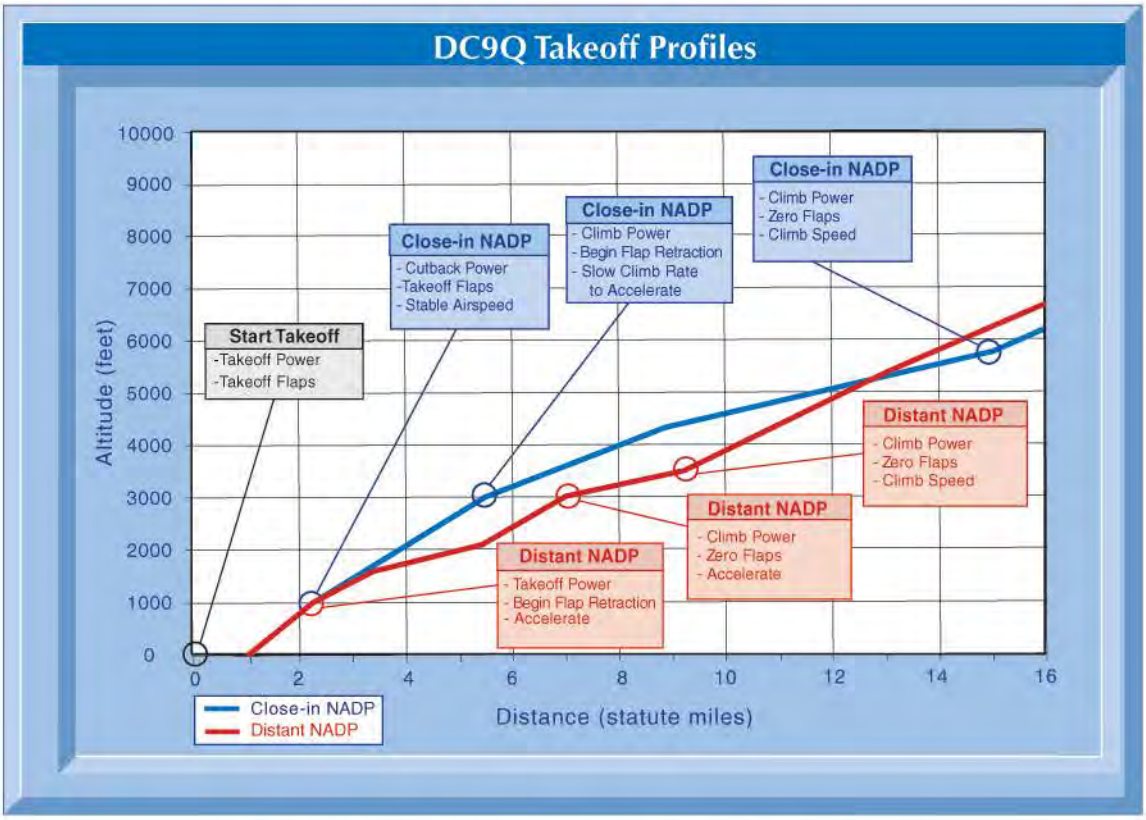
Figure 4-16

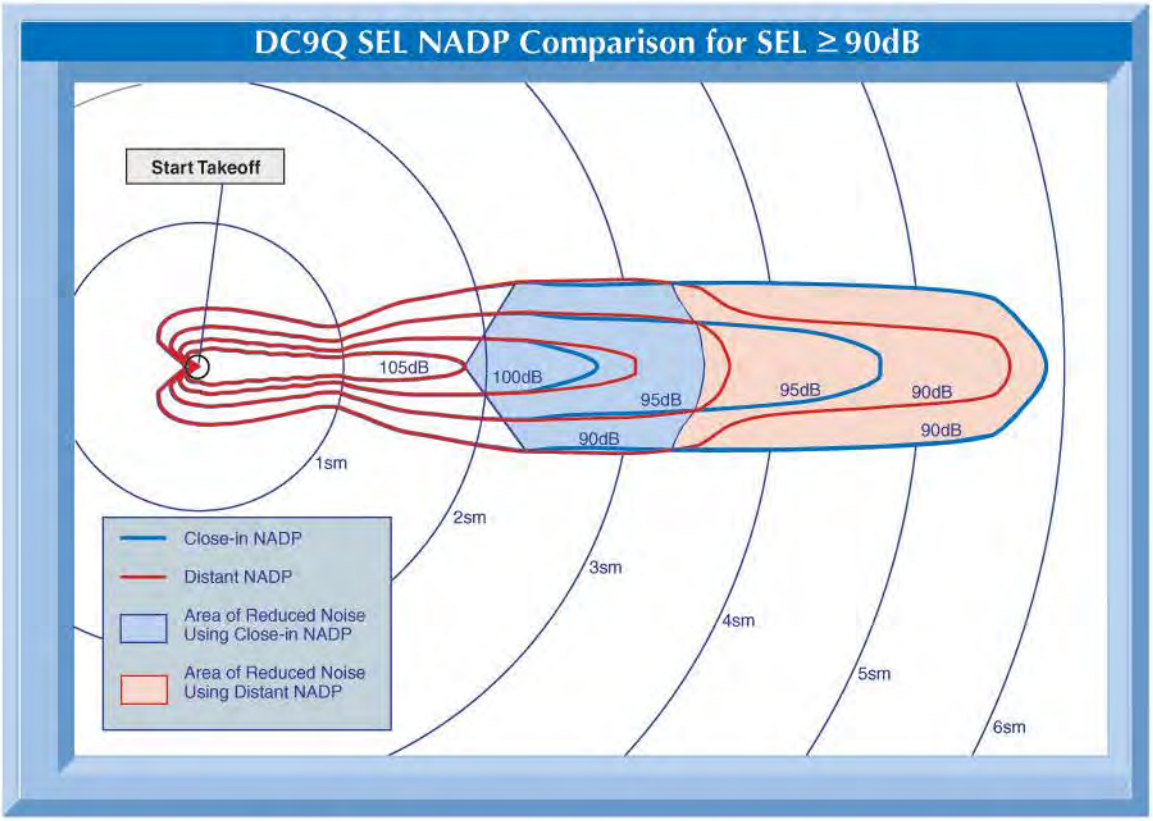




DC9Q Noise Abatement Departure Profiles

Figure 4-17





directed that aircraft instead use the Distant NADP on Runways 30L and 30R. The change in procedure was due to the recommendations of the November 2001 Study that favor the Distant NADP, as discussed in Chapter Seven. The MSP ATCT also requested the change for operational reasons.[15] The change was endorsed by the NOC on June 26, 2003. The Distant NADP is used for takeoffs from Runways 4, 22, 12L, and 12R. The Dual Track FEIS and this Study assume use of the Distant NADP for Runway 17.

Modeled Departure Profiles

A detailed analysis of departure flight profiles at MSP was completed to ensure that INM is correctly modeling departure aircraft flight profiles. The analysis focused primarily on NWA operations because NWA is the largest airline operator at MSP.

Average takeoff weights, by aircraft type and stage length, were provided by NWA for input into INM. NWA also provided detailed information on their operating procedures, by aircraft type, for both the Close-In and Distant NADPs. When necessary, other airlines also provided detailed information on operating procedures. Operating procedures describe the actions of pilots during takeoff, including actions such as thrust settings, landing gear retraction, and flap position. The INM's procedure step methodology was used to model NWA and certain non-NWA operating procedures. INM departure flight profiles were developed using this data in conjunction with aircraft manufacturer flight data. Per FAA requirements, the INM departure profiles developed for this Study were submitted to the FAA for approval; copies of the FAA approval letters are contained in Appendix A.[16]

INM-generated departure flight profiles of NWA operations were compared to actual radar data by aircraft type, stage length, and temperature. Modeled flight profiles achieved good correlation with actual aircraft flight profiles. Figures showing the comparison are contained in Appendix D.

Derate, or reduced thrust takeoff procedures were also incorporated into the noise model. When using derate thrust takeoff procedures, thrust is reduced to the amount necessary for an aircraft that is at less than maximum takeoff weight to takeoff on the available runway length, including safety margins. Nearly all airlines use derate thrust takeoffs to reduce engine wear and fuel consumption. Aircraft using this procedure essentially perform like aircraft using full power at maximum takeoff weight, with similar noise exposure. Derate thrust takeoffs have little quantifiable impact on the climb performance of new, modern aircraft; the effect is more pronounced for DC9Q and B73Q operations. All DC9Q and B73Q operations (including NWA and other carriers) are modeled at maximum stage length and using full takeoff power, to represent the use of derate thrust takeoff procedures.[17]

Other aircraft operations at MSP, such as cargo and other passenger carriers are assumed to use standard takeoff weights and Close-In and Distant NADPs.

4.3.5 Run-Up Operations

NWA and Mesaba Airlines operate maintenance facilities at MSP. Other airlines also perform maintenance at MSP, as needed. After maintenance is complete, the engine is powered up to test engine performance to ensure successful repair. Run-ups typically last for 15 minutes; most of that time is spent at idle power, with approximately 30 seconds at full power.

MAC procedures require that run-ups be scheduled in advance, in accordance with the following rules:

- Run-ups may be performed daily between 6:00 a.m. and 10:30 p.m. only.
- Run-ups are not permitted between 10:30 p.m. and 6:00 a.m. except in the following case:
    - A run-up will be permitted between 10:30 p.m. and midnight, and 5 a.m. and 6 a.m., if a scheduled departure time will not be met without the run-up.

MAC logs all run-up operations.[18] An average of 5.7 daily run-ups were performed in 2002. Based upon the forecasted growth rates discussed in Chapter Three, the number of run-ups is forecast to increase to an average of 6.7 operations per day in 2007.

Figure 4-18 shows the three locations currently available for run-ups at MSP. During 2002, the Ground Run-up Pad (GRP) was used by nearly 98-percent of all aircraft performing run-ups. A 32-foot-tall blast fence on the east and south sides and a 14-foot blast fence on the west side bound the GRP. The blast fence protects nearby aircraft, cars, people, and buildings from jet blast, and also helps to reduce noise.

Aircraft are generally run-up into the wind. The GRP cannot be used when there are strong winds from the south. As an alternate location in 2002, about one-percent of jet aircraft run-ups were performed on the approach end of Runway 4. However, this location will not be available upon the completion of Runway 17/35. Turboprop aircraft can be run-up on the approach end of Runway 22. In 2002 approximately two percent of the turboprop aircraft run-ups were conducted on the approach end of Runway 22. However, the number of total turboprop aircraft operations at MSP continues to decline as shown in the forecast of 2002 and 2007 operations. According to 2003 MAC logs of run-up operations, there were zero run-up operations conducted on the approach end of Runway 22. Thus, future run-ups on the approach end of Runway 22 would be expected to be negligible.

4.4 EXISTING NOISE EXPOSURE

The 2002 DNL noise contours, representing existing noise exposure, are shown in **Figures 4-19, 5-2, and 6-1.** The DNL contours include all existing noise abatement measures. Some trends are discernable in the contours. The narrow, pointed lobes that are on the extended centerline of each runway are primarily from arriving aircraft on approach to MSP. The other, more rounded lobes are primarily from departing aircraft. The lobes extending west from Runway 30L and north from Runway 30R are primarily due to departures.

4.4.1 Correlation with Noise Monitoring Data

Modeled noise exposure (i.e., INM-generated predictions of noise exposure) for the 2002 DNL contours was compared to the measured noise exposure recorded at monitoring locations around MSP during the year 2002. The purpose of the comparison is to assess the correlation between the noise model and verify that the noise model and operational data inputs are accurately estimating overall noise exposure around MSP.

ANOMS includes 39 permanent Remote Monitoring Towers (RMT) located around

Run-Up Locations

Figure 4-18



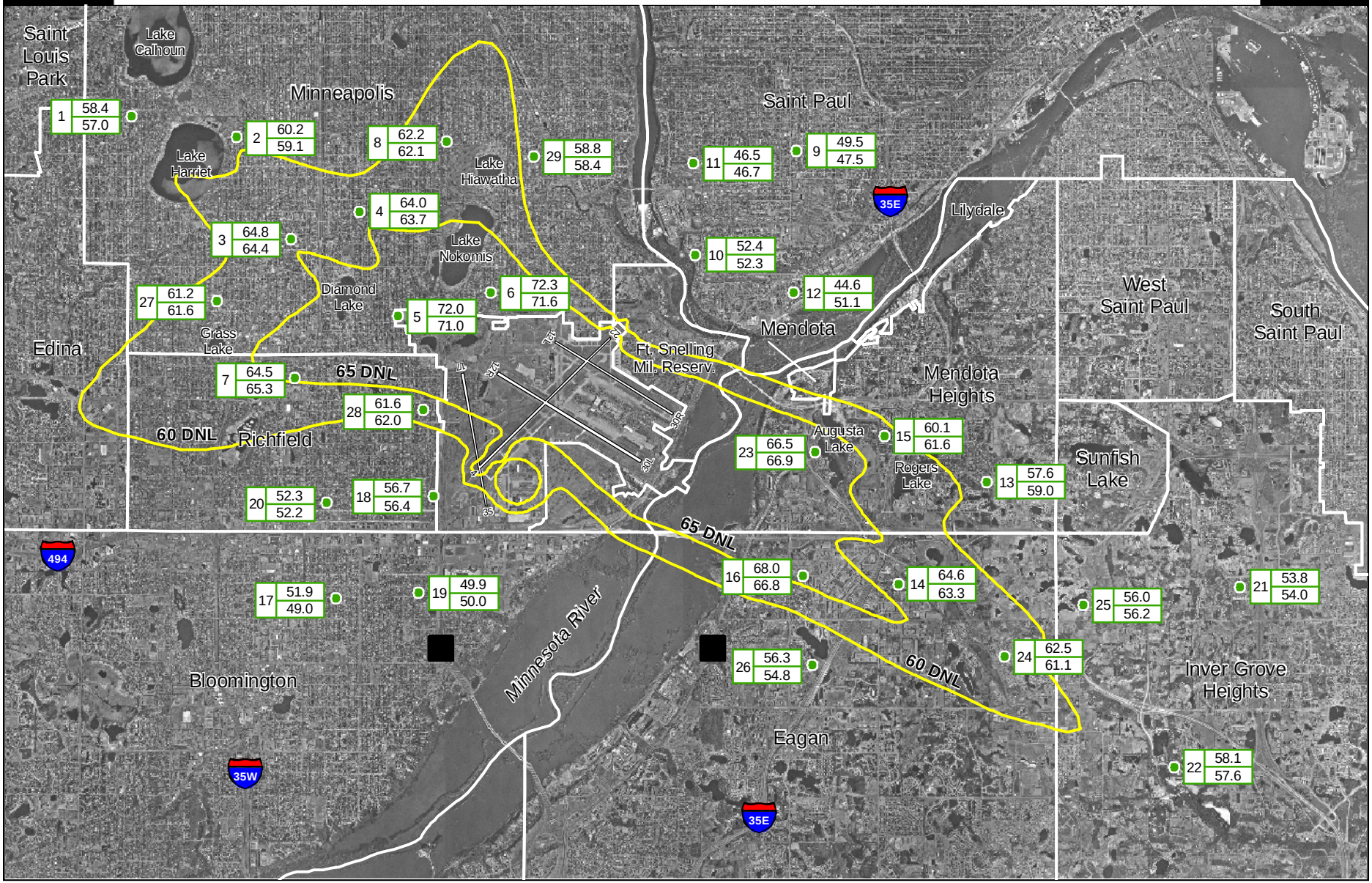
2002 DNL Contours and Model Correlation

RMT SITE ● | 7 | Measured DNL / Modeled DNL

0 1 2 Miles

N

Figure 4-19



MSP. The RMTs record sound levels from aircraft operations, which are used to determine measured DNL at those locations. The measured data gathered via ANOMS complies with Part 150 guidelines for noise monitoring.[19] Monitoring data for 29 of the RMT sites is used in this correlation analysis; the other 10 sites were newly established for operations from Runway 17/35 and the data is not applicable to the correlation analysis as that runway is not yet operational. Note that the noise monitor data is only used for comparison to modeled DNL data as part of the model correlation process; measured data is not used to develop noise contours.

Figure 4-19 shows the measured and modeled 2002 DNL at the RMT locations. **Table 4.12** also provides a comparison of the measured and modeled 2002 DNL at the RMT locations. The average absolute difference between measured and modeled DNL at the RMT sites was 1.2 DNL, while the median absolute difference was 0.5 DNL. By basing the average and median differences on absolute values, the correlation analysis seeks to estimate the total differences between measured and modeled DNL, rather than the net differences calculated from positive and negative values. Also, for this analysis, the median measure of central tendency is considered to be a more reliable indicator of correlation than an average calculation, due to the variances in both the measured and modeled data.

The largest difference at a single RMT site was +6.5 DNL, which occurred at RMT #12. The measured DNL at the RMT site was 44.6 dB, while the modeled DNL was 51.1 dB. The difference likely occurred because of the relatively few eastbound departures from Runway 4 and the resulting variance in the precise location of typical flight tracks. INM's ability to accurately compute noise exposure degrades rapidly beyond the 60 DNL contour line, due to complex aircraft interactions and routings that occur at this distance from the airport. These complex interactions are not normally included in the noise model, as they do not affect the generation of the noise contours at levels at and above 60 DNL. As such, the difference at RMT #12 is not considered to be significant in terms of correlating the noise model with measured data. The largest difference at any other RMT site was -2.9 DNL.

The 2002 Existing Conditions DNL contours achieves close correlation between modeled and measured noise exposure at RMT sites, and demonstrates that the noise model is accurately estimating overall noise exposure around MSP. Enhanced agreement between modeled and measured noise exposure, beyond a median correlation of 0.5 DNL, is not probable.

4.5 FORECAST NOISE EXPOSURE

The 2007 Unmitigated DNL noise contours, representing forecast noise exposure, are shown in **Figures 4-20, 5-3, and 6-2.** This contour includes all existing noise abatement measures and the Dual Track FEIS planning assumptions. It does not include any new mitigation measures to reduce noise exposure. Population and dwelling counts within the contours are discussed in Chapter Six. Noise abatement measures are discussed in Chapter Seven and compared to the 2007 Unmitigated DNL contours to assess potential benefits.

The contours show the effect of future operations on Runway 17/35. As discussed in Appendix E, a sensitivity analysis was completed to assess the impact of Runway 17/35 on contour size and shape. A 2007 "no-build" unmitigated scenario was

Table 4.12

Comparison of Modeled and Measured DNL values at RMT Sites

RMT Site	Annual Measured DNL (a)	2002 Modeled DNL	Difference (Modeled minus Measured)	
			Sign	Absolute
1	58.4	57.0	-1.4	1.4
2	60.2	59.1	-1.1	1.1
3	64.8	64.4	-0.4	0.4
4	64.0	63.7	-0.3	0.3
5	72.0	71.0	-1.0	1.0
6	72.3	71.6	-0.7	0.7
7	64.5	65.3	0.8	0.8
8	62.2	62.1	-0.1	0.1
9	49.5	47.5	-2.0	2.0
10	52.4	52.3	-0.1	0.1
11	46.5	46.7	0.2	0.2
12	44.6	51.1	6.5	6.5
13	57.6	59.0	1.4	1.4
14	64.6	63.3	-1.3	1.3
15	60.1	61.6	1.5	1.5
16	68.0	66.8	-1.2	1.2
17	51.9	49.0	-2.9	2.9
18	56.7	56.4	-0.3	0.3
19	49.9	50.0	0.1	0.1
20	52.3	52.2	-0.1	0.1
21	53.8	54.0	0.2	0.2
22	58.1	57.6	-0.5	0.5
23	66.5	66.9	0.4	0.4
24	62.5	61.1	-1.4	1.4
25	56.0	56.2	0.2	0.2
26	56.3	54.8	-1.5	1.5
27	61.2	61.6	0.4	0.4
28	61.6	62.0	0.4	0.4
29	58.8	58.4	-0.4	0.4
Logarithmic Difference			**Average**	**1.2**
			Median	**0.5**

Notes:
All units in dB DNL
(a) computed from daily DNLs

Source: MAC RMT data and HTNB analysis.

Comparison of 2005 FEIS and Part 150 Update 2007 DNL Contours

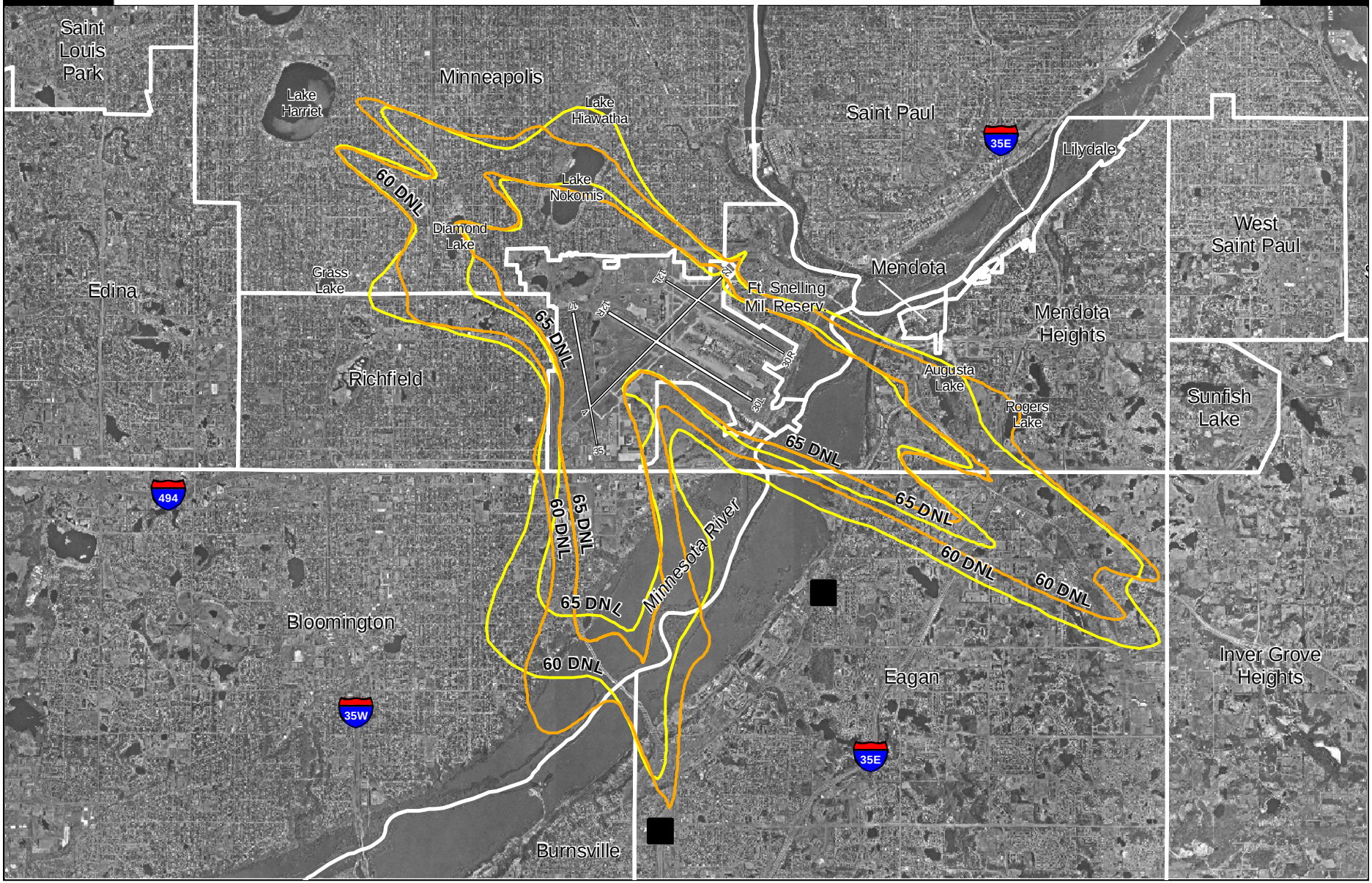
Dual Track FEIS High Forecast 2005 DNL Contours

Part 150 Update 2007 Unmitigated DNL Contours

0 1 2 Miles

N

Figure 4-20



developed to assess contour size and shape if Runway 17/35 were not constructed. The 2007 no-build contour is shown in Figure E-1. Because operations from Runway 17/35 will predominantly overfly the Minnesota River Valley area, use of the Runway will reduce the total noise-impacted population and dwellings. Without Runway 17/35, 25,455 additional people and 10,355 additional dwellings would be in the 60 DNL contour, relative to the 2007 Unmitigated DNL noise contour.

4.5.1 Changes from Dual Track FEIS

As shown in Figure 4-20, the 2007 Unmitigated DNL contours are slightly larger and have a somewhat different shape than the 2005 Dual Track FEIS High Forecast DNL contours.[20] Relative to the latter, an additional 5,508 people and 2,336 dwellings are contained within the 2007 Unmitigated 60 DNL contour.[21] The primary reasons for the change are detailed below. Changes to the fleet mix and INM software increase the size of the contour, while enhanced use of ANOMS data and flight track refinements improve the fidelity of INM and/or change the contour location.

Flight Operations and Fleet Mix

The number of average daily operations in both the FEIS 2005 forecast and the Study 2007 forecasts are similar, at 1577.6 and 1595.5, respectively. The 2007 forecast has 17.9 more daily operations than the FEIS. More importantly, however, there are significantly more jet operations in this Study's forecast. **Table 4.13** shows that this Study contains 427.2 more daily jet operations than the FEIS. Much of the growth in jet operations is due to the use of regional jets instead of turboprop aircraft.

INM Software

The FEIS contour was created using INM version 4.11, while this Study's contour was created using INM version 6.1. There are several significant changes in the new version, including changes to the noise propagation algorithms, which now account for humidity. An analysis showed that the algorithm change from 4.11 to 6.1 increases the area within the 65 DNL contour by 13.1-percent and within the 60 DNL contour by 17.6-percent.

Additionally, many aircraft have been added to the INM aircraft database since version 4.11, including hushkit aircraft such as the DC9Q. The new database improves the accuracy of the modeled aircraft noise exposure. INM version 6.1 also contains new lateral attenuation algorithms that enhance calculation of noise exposure from wing-mounted jet engines.

ANOMS/ARTS

This Study employs ANOMS data to determine runway and track use, daytime/ nighttime split, and other operational trends. Twelve composite months of ANOMS data were compiled and used for this study. Thirteen operational categories were developed using ANOMS data; this allows the unique trends of cargo, passenger, GA, regional carriers, and the varying performance capabilities of aircraft, to be incorporated into INM.

ARTS data were used to calibrate INM aircraft takeoff profiles, by stage length and temperature, for both the Distant and Close-In NADPs as discussed in Section 4.3.4. ARTS data were also used to develop the flight tracks, as detailed below.

This level of detail was not possible with INM Version 4.11 and supporting software.

Table 4.13

Comparison of Dual Track FEIS 2005 High Forecast and Study 2007 Flight Operations

Group	Aircraft Type	Average Daily Operations						Difference between FEIS and this Study
		Day		Night		Total		
		2005 FEIS	2007 Study	2005 FEIS	2007 Study	2005 FEIS	2007 Study	
Manufactured / Re-engined Stage 3 Jet	A306	1.0	4.8	1.4	4.2	2.4	9.1	6.7
	A310	10.5	1.4	1.3	1.3	11.8	2.7	-9.1
	A318	-	5.7	-	0.5	-	6.2	6.2
	A319	-	149.1	-	3.9	-	153.0	153.0
	A320	132.9	173.4	18.5	16.5	151.4	189.9	38.5
	A330	-	6.2	-	-	-	6.2	6.2
	A340	-	2.1	-	-	-	2.1	2.1
	ASTR	-	2.3	-	0.2	-	2.5	2.5
	B712	-	7.3	-	1.0	-	8.3	8.3
	B733	44.6	48.2	5.0	3.5	49.6	51.7	2.1
	B734	18.0	0.1	2.0	0.0	20.0	0.1	-19.9
	B735	10.7	5.7	1.3	0.5	12.0	6.2	-5.8
	B737	-	7.8	-	0.5	-	8.3	8.3
	B738	-	65.5	-	12.6	-	78.1	78.1
	B739	-	5.7	-	0.5	-	6.2	6.2
	B742	5.9	0.0	1.5	0.0	7.4	0.0	-7.4
	B744	9.9	1.9	0.7	0.2	10.6	2.1	-8.5
	B752	178.8	88.4	25.0	8.6	203.8	97.1	-106.7
	B753	-	34.1	-	1.1	-	35.1	35.1
	B762	8.1	1.2	0.9	0.5	9.0	1.7	-7.3
	B763	1.8	-	0.2	-	2.0	-	-2.0
	BA46	-	74.3	-	2.2	-	76.5	76.5
	C500	10.2	1.4	1.6	0.1	11.8	1.4	-10.4
	C650	-	4.9	-	0.6	-	5.5	5.5
	C750	-	4.6	-	0.3	-	4.9	4.9
	CARJ/CL60	25.2	264.1	3.0	14.7	28.2	278.8	250.6
	DC10	22.6	9.6	3.8	3.8	26.4	13.4	-13.0
	DC87	2.9	-	3.7	1.4	6.6	1.4	-5.2
	E145	-	45.3	-	0.2	-	45.5	45.5
	F100	20.7	-	2.3	-	23.0	-	-23.0
	GLF4	1.7	2.6	0.2	0.2	1.9	2.8	0.9
	GLF5	-	0.8	-	0.1	-	0.9	0.9
	L101	1.3	0.6	0.9	0.2	2.2	0.8	-1.4
	LJ35	41.1	26.0	6.4	2.3	47.5	28.4	-19.1
	MD11	7.6	0.3	1.6	0.4	9.2	0.7	-8.5
	MD81	-	0.5	-	0.0	-	0.6	0.6
	MD82	68.7	-	8.5	-	77.2	-	-77.2
	MD83	12.5	17.0	1.5	1.6	14.0	18.6	4.6
	MU30	-	7.2	-	0.6	-	7.8	7.8
	SBR2	-	0.4	-	0.0	-	0.4	0.4
	Total	636.7	1,070.5	91.3	84.3	728.0	1,154.8	426.8
Hushkit Stage 3 Jet	B72Q	26.0	8.0	7.2	6.4	33.2	14.4	-18.8
	B73Q	0.4	-	0.2	-	0.6	-	-0.6
	DC9Q	218.3	245.3	28.9	15.3	247.2	260.5	13.3
	Total	244.7	253.3	36.3	21.7	281.0	275.0	-6.0
Stage 2 less than 75,000 lb. MTOW	FA20	-	1.0	-	0.7	-	1.7	1.7
	GLF2	-	2.1	-	0.2	-	2.3	2.3
	LJ25	-	2.1	-	0.4	-	2.5	2.5
	Total	-	5.2	-	1.2	-	6.4	6.4
Propeller	A748	46.0	-	12.4	-	58.4	-	-58.4
	BE58	20.4	14.3	3.2	4.7	23.6	19.0	-4.6
	C130	7.8	7.8	0.4	0.2	8.2	8.0	-0.2
	C206	-	0.0	-	0.0	-	0.0	0.0
	C441	33.2	-	11.2	-	44.4	-	-44.4
	DHC6	86.2	22.5	20.0	4.4	106.2	26.8	-79.4
	DHC8	84.2	-	10.0	-	94.2	-	-94.2
	FK27	-	0.1	-	-	-	0.1	0.1
	SEPF	-	1.3	-	0.3	-	1.6	1.6
	SEPV	16.8	3.7	2.6	0.5	19.4	4.3	-15.1
	SF34	192.1	93.3	22.1	5.9	214.2	99.2	-115.0
	Total	486.7	142.9	81.9	16.0	568.6	159.0	-409.6
Military Jet (FEIS used civil substitutes per INM 4.11 requirements)	C17A	-	0.0	-	0.0	-	0.1	0.1
	C5	-	0.1	-	-	-	0.1	0.1
	F16	-	0.1	-	-	-	0.1	0.1
	F18	-	0.0	-	0.0	-	0.0	0.0
	T37	-	0.1	-	-	-	0.1	0.1
	T38	-	0.1	-	-	-	0.1	0.1
	Total	-	0.4	-	0.0	-	0.4	0.4
Total Operations		1,368.1	1,472.3	209.5	123.3	1,577.6	1,595.5	17.9

Summary of Forecast Flight Operations Change

Category	Day	Night	Total	Total w/night (x10)
Manufactured/Re-engined Stage 3 Jet	433.8	-7.0	426.8	363.6
Hushkit Stage 3 Jet	8.6	-14.6	-6.0	-137.4
Stage 2 Jetless than 75,000 lb. MTOW	5.2	1.2	6.4	17.6
Propeller	-343.8	-65.9	-409.6	-1002.5
Military Jet	0.4	0.0	0.4	0.5

Differences may exist due to rounding as actual INM input for 2007 is to four decimal places; only one decimal place is shown in the table for comparison to the FEIS fleet mix.

Due to rounding, a notation of "0.00" indicates a value of less than 0.005, while a notation of "-" indicates a value of zero.

Source: HNTB analysis.

The improvement in data vastly increases the accuracy and precision of inputs to INM.

Flight Tracks

The flight tracks in this Study differ slightly from those in the FEIS. Although ARTS data were used to develop the flight tracks for both analyses, advances in software allow for improved data analyses and flight track layout.

This Study uses AutoCAD and GIS software to analyze digital ARTS/ANOMS data and develop appropriate model flight tracks, which are imported directly into INM. Dispersed flight tracks, with sub track(s) to the left and right of the primary flight track, are used. Dispersed tracks model the fanning that occurs as aircraft of different performance capabilities turn to assigned headings. A gate analysis was completed using a full year of ANOMS data to determine track use and dispersion, allowing track use trends to be incorporated into the model by operational category and daytime/nighttime split. The FEIS used multiple core tracks to model dispersion, and used overall average track use. This Study contains 169 modeled flight tracks; the FEIS has 61. These methods were not available during the FEIS process. The refinements to the flight tracks in this Study increase the fidelity of the modeled noise contours.

The flight track layout estimated for Runway 17 departures was also revised during the Study analyses. The changes, along with supporting figures, are detailed in Section 4.3.3. The FEIS flight tracks are appropriate given the data and modeling technology available at the time. Because Runway 17 is not yet operational, the flight tracks in both the FEIS and this Study are estimates of flight track locations based on typical destinations and ATC routing procedures. Although use of the runway is not expected to change from the FEIS, advancements in software, data analyses, and the increasing use of higher-performance aircraft have changed the projected layout of the Runway 17 departure flight tracks.

Analyses showed that aircraft would sometimes turn to assigned headings quicker than projected in the FEIS. The Study must ensure that the impact of these operations is modeled accurately. ARTS data from the existing runways were used to analyze typical jet departure turn points and turn rates, which was used to develop the layout and ground track of the projected Runway 17 flight tracks. As a result of this change, the 2007 Unmitigated DNL contours shift to the north and west over populated areas of Bloomington.

NOTES

[1] National Oceanic and Atmospheric Administration (NOAA).

[2] National Climatic Data Center and HNTB analysis.

[3] Ibid.

[4] Ibid.

[5] Ibid.

[6] Airports Council International.

[7] A localizer provides horizontal guidance to aircraft on an Instrument Landing System (ILS) approach. Aircraft on approach to Runway 30L normally use the Runway 30L localizer. However, the localizer can also provide horizontal guidance to departing aircraft going in the opposite direction. As a result, the 30L localizer is used to define the south boundary of the Corridor, as it provides positive guidance to aircraft on the location of the Corridor boundary and increases compliance with Corridor procedures. The localizer signal fans out approximately 2° from the runway centerline.

[8] MAC ANOMS analyses.

[9] Hushkitted Stage 3 aircraft are generally louder on takeoff than on arrival. However, many manufactured Stage 3 aircraft are quieter on takeoff than on arrival. Given the large number of hushkit aircraft that operate at MSP, departures have priority over arrivals for the purposes of RUS runway selection criteria. However, for NA-9, the continued modernization of the aircraft fleet at MSP may, at some point, require a re-examination of the RUS departure/arrival runway selection criteria.

[10] MSP ATCT letter to MASAC Operations Committee, dated May 29, 1998.

[11] The percentage values shown in Figures 4-4 and 4-5 are percentage of time. However, because an equivalent number of operations will use each runway use configuration, the values are also representative of percentage of operations.

[12] ARTS data shown for February 1 and 2, March 6 and 29, and April 14, 1999.

[13] The headings used in this study for the Runway 17 departure flight tracks have shifted five-degrees to the east (counterclockwise) from those in the Dual Track FEIS in order to define the true heading of the flight track. The change in track layout does not affect the true heading of the flight track.

[14] ROD for Dual Track FEIS in response to comments by the City of Bloomington, dated June 15, 1998.

[15] Letter from MSP ATCT to MAC, May 21, 2003.

[16] Due to INM software upgrades, some of the previously-approved profile data (from the November 2001 document) was re-formatted as a result of technical revisions with INM version 6.1. This re-formatting only affects how the profile data are incorporated into INM; the actual procedures in use by the airlines and the effective modeling of the profiles have not changed. The re-formatted profile data were approved by FAA in January 2004.

[17] Northwest Airlines Performance Engineering, March 18, 1996.

[18] MSP Ground Run-up Pad Feasibility Report, April 2000, contains additional detailed information on run-up operations at MSP.

[19] 14 CFR A150.5

[20] As shown in Figure 2-8 of the MSP Noise Mitigation Program, November 1996.

[21] FEIS contours overlaid on land use database and using this Study's population and dwelling unit count methodology.

Chapter Five
LAND USE AND NOISE COMPATIBILITY

This chapter provides details on the existing and forecast land uses relative to the MSP noise environment. Specifically, Section 5.1 summarizes the controls on land use near MSP in terms of relevant statutes. Section 5.2 reviews FAA land use guidelines for aircraft noise and land use compatibility. Section 5.3 reviews the applied land use compatibility criteria used by this Study. Section 5.4 describes the development of the land use and population data. Section 5.5 examines existing land use and its compatibility with current MSP aircraft operations, while Section 5.6 concludes the chapter with a discussion of forecast land use and compatibility with noise exposure levels due to forecast MSP aircraft operations.

5.1 EXISTING LAND USE CONTROLS

In the State of Minnesota, counties and municipalities have the power to perform comprehensive planning and prepare zoning ordinances to guide development. In the Twin Cites area of Minneapolis-St. Paul, a regional body called the Metropolitan Council (MC) also has a significant role in aviation and land use planning. The following two paragraphs cite two state regulations.

Municipalities §462.351 *et seq*. A municipality, city, or town may prepare, adopt, and amend a comprehensive plan and implement it by ordinance. A comprehensive plan includes policy statements, goals, standards, and maps for guiding physical, social, and economic development. The municipality may establish a planning agency, planning department, or planning commission. The municipality shall study and propose means of implementing the comprehensive plan, including, but not limited to, zoning regulations, regulations for the subdivision of land, an official map, programs for coordination of normal public improvement and service of the municipality, urban renewal, and a capital improvement program. A municipality may request that the county carry on planning and zoning activities for the municipality. Towns may not enact controls that are less restrictive or that are inconsistent with county controls.

The Minnesota Metropolitan Council §473.123 *et seq*. This planning body for the Minneapolis-St. Paul (Twin Cities) region is an appointed body with the terms of the members running concurrently with the Governor's. It is required to prepare the Metropolitan Development Guide (MDG), also known as the "Blueprint." The MDG must "consist of a compilation of policy statements, goals, standards, programs, and maps prescribing guides for the orderly and economical development, public and private, of the metropolitan area." The guide should also include elements covering public facilities, housing, and open spaces. The MC shall determine the necessity and location of airports, highways, transit facilities, public hospitals, libraries and schools. The MC may also assist local governments with their comprehensive plans. Local area governments must prepare and submit a comprehensive plan to the Council for review. If the comprehensive plan conflicts with a zoning ordinance, the zoning ordinance supersedes the plan. The comprehensive plan shall contain objectives,

policies, standards, and programs to guide public and private land use, development, redevelopment, and preservation for all land and waters within the jurisdiction of the local government.

The State Land Planning Act, which is the underlying law that requires local units of government to prepare a comprehensive plan and submit it for MC review, was enacted in 1976. By 1980, all community plans were approved. The 1973 Aviation Chapter of the MDG was updated in 1977. In 1978, the MSP Master Plan was reviewed. As a result of those planning actions, an agency/community group was formed to undertake a noise evaluation [NOISEMAP] of MSP (1979-81). In 1983, the MC amended the Aviation Policy Plan to include "Land Use Compatibility Guidelines for Aircraft Noise." These guidelines were applied within a noise policy contour that combined existing/future noise conditions and were based on the state's [L_{eq}] noise standard. Local city plans and project amendments affecting MSP were reviewed using this system from mid-1983 until 1996.

In 1994, the Land Planning Act of 1976 had been amended to require that communities update their comprehensive plans at least every ten years. Therefore, all MDG chapters were updated by December 1996, and revised local plans were due for MC review by December 1998.

Under the 1976 legislation, communities designated land uses and defined the zoning applicable to the particular land use parcel; the zoning took precedence. The land use measure was a request that local jurisdictions review existing zoning in Airport Noise Zones to determine their consistency with the regional compatibility guidelines, and rezone the property for compatible development if consistent with other development factors. This policy changed in 1994.

Under the amended Land Planning Act, communities determine the land use designation, and the zoning has to be consistent with that designation. Thus, the communities had to re-evaluate designated use, permitted uses within the designation, zoning classifications, and adequacy.

As of June 2004, the status of the individual community comprehensive plans relative to the MC requirements for comprehensive plan update is as follows:

- Minneapolis: Complete - Aviation element is complete and in conformance; City is not recommending large-scale land use changes concerning aircraft noise. Undeveloped land is essentially not available. Corrective measures in the form of home and school noise attenuation have been underway for many years.

- Mendota: Complete - Plan is in conformance.

- Mendota Heights: Complete - Plan is in conformance.

- Sun Fish Lake: Complete - Plan is in conformance.

- Inver Grove Heights: Complete - Plan is in conformance.

- Eagan: Complete - Plan is in conformance.

- Burnsville: Complete - Plan is in conformance.

- Bloomington: Complete - Plan is in conformance.

- Richfield: Complete - Plan is in conformance.

The contours shown in the MDG Aviation Policy Plan are a combination of the 1996 60 DNL and 2005 60 DNL, as developed in the Dual Track FEIS. With acceptance of the revised NEMs developed during this Study, the MDG Aviation Policy Plan will necessarily be updated to reflect the FAA-accepted 2007 NEM as the projected noise environment.

The 1996 Aviation Policy Plan is being incorporated into the Transportation Policy Plan (TPP) of the MDG. The TPP update is expected to be adopted by December 2004. Land use compatibility guidelines for all metropolitan system airports are included in the TPP.

5.2 FAA GUIDELINES

The degree of annoyance that people experience from aircraft noise varies depending on their activities at any given time. People are usually less disturbed by aircraft noise when they are shopping, working, or driving than when they are at home. Transient hotel and motel residents seldom express as much concern with aircraft noise as do permanent residents of an area. The concept of "land use compatibility" has arisen from this systematic variation in community reaction to noise.

Following are the two principal uses that DNL estimates have in a Part 150 study:

- Provide a basis for comparing existing noise conditions to the effects of noise abatement procedures and/or forecast changes in airport activity.

- Provide a quantitative basis for identifying potential noise impacts.

Both of these functions require the application of objective criteria for evaluating noise impacts. Part 150 provides the FAA's recommended guidelines for aircraft noise/land use compatibility evaluation, as shown in **Table 5.1.**

The FAA's guidelines represent a compilation of the results of scientific research into noise-related activity interference and attitudinal response. However, reviewers of DNL contours should recognize the highly subjective nature of response to noise, and that special circumstance can affect individuals' tolerances. For example, a high non-aircraft background noise level can reduce the significance of aircraft noise, such as in areas constantly exposed to relatively high levels of vehicular traffic noise. Alternatively, residents of areas with unusually low background levels may find relatively low levels of aircraft noise annoying.

Response may also be affected by expectation and experience. People may become accustomed to a level of exposure that guidelines typically indicate may be unacceptable; conversely, minor changes in exposure may generate a response that is far greater than that which the guidelines suggest.

The cumulative nature of DNL means that the same level of noise exposure can be achieved in an essentially infinite number of ways. For example, a reduction in a small number of relatively noisy operations may be counterbalanced by a much greater increase in relatively quiet flights, with no net change in DNL. Residents of the area may be highly annoyed by the increased frequency of operations, despite the apparent maintenance of the noise status quo.

Table 5.1

FAA Aircraft Noise and Land Use Compatibility Guidelines

Land Use	DNL Contour Interval (dB)					
	Less than 65	**65-69**	**70-74**	**75-79**	**80-84**	**Greater than 85**
Residential						
Residential, other than mobile homes and transient lodgings	Y	N(1)	N(1)	N	N	N
Mobile home park,	Y	N	N	N	N	N
Transient Lodgings	Y	N(1)	N(1)	N(1)	N	N
Public Use						
Schools	Y	N(1)	N(1)	N	N	N
Hospitals and nursing homes	Y	25	30	N	N	N
Churches, auditoriums, and concert halls	Y	25	30	N	N	N
Governmental services	Y	Y	25	30	N	N
Transportation	Y	Y	Y(2)	Y(3)	Y(4)	Y(4)
Parking	Y	Y	Y(2)	Y(3)	Y(4)	Y
Commercial Use						
Offices, business and professional	Y	Y	25	30	N	N
Wholesale and retail–building materials, Hardware and farm equipment	Y	Y	Y(2)	Y(3)	Y(4)	N
Retail trade–general	Y	Y	25	30	N	N
Utilities	Y	Y	Y(2)	Y(3)	Y(4)	N
Communication	Y	Y	25	30	N	N
Manufacturing and Production						
Manufacturing, general	Y	Y	Y(2)	Y(3)	Y(4)	N
Photographic and optical	Y	Y	25	30	N	N
Agriculture (except livestock) and forestry	Y	Y(6)	Y(7)	Y(8)	Y(8)	Y(8)
Livestock farming and breeding	Y	Y(6)	Y(7)	N	N	N
Mining and fishing, resource Production and extraction	Y	Y	Y	Y	Y	Y
Recreational						
Outdoor sports arenas and spectator sports	Y	Y(5)	Y(5)	N	N	N
Outdoor music shells, amphitheaters	Y	N	N	N	N	N
Nature exhibits and zoos	Y	Y	N	N	N	N
Amusements, parks, resorts and camps	Y	Y	Y	N	N	N
Golf courses, riding stables, and water recreation	Y	Y	25	30	N	N

See following page for Table Key and Notes.

Key to Table 5.1

SLUCM	Standard Land Use Coding Manual.
Y(Yes)	Land use and related structures compatible without restrictions.
N(No)	Land use and related structures are not compatible and should be prohibited.
NLR	Noise Level Reduction (outdoor to indoor) to be achieved through incorporation of noise attenuation into the design and construction of the structure.
25, 30, or 35	Land use and related structures generally compatible; measures to achieve NLR of 25, 30, or 35 dB must be incorporated into design and construction of structure.

Notes for Table 5.1

The designations contained in this table do not constitute a federal determination that any use of land covered by the program is acceptable or unacceptable under federal, state, or local law. The responsibility for determining the acceptable and permissible land uses and the relationship between specific properties and specific noise contours rests with the local authorities. FAA determinations under Part 150 are not intended to substitute locally determined land uses for those determined to be appropriate by local authorities in response to locally determined needs and values in achieving noise compatible land uses.

(1) Where the community determines that residential or school uses must be allowed, measures to achieve outdoor to indoor Noise Level Reduction (NLR) of at least 25 dB and 30 dB should be incorporated into building codes and be considered in individual approvals. Normal residential construction can be expected to provide a NLR of 20 dB, thus, the reduction requirements are often stated as 5, 10, or 15 dB over standard construction and normally assume mechanical ventilation and closed windows year round. However, the use of NLR criteria will not eliminate outdoor noise problems.

(2) Measures to achieve NLR of 25 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas or where the normal noise level is low.

(3) Measures to achieve NLR of 30 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas or where the normal noise level is low.

(4) Measures to achieve NLR of 35 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas or where the normal noise level is low.

(5) Land use compatible provided special sound reinforcement systems are installed.

(6) Residential buildings require an NLR of 25.

(7) Residential buildings require an NLR of 30.

(8) Residential buildings not permitted.

Source: 14 CFR Part 150

As listed in Table 5.1, Part 150 guidelines indicate that all uses are normally compatible with aircraft noise at exposure levels below 65 DNL. This limit is supported in a formal way by standards adopted by the Department of Housing and Urban Development (HUD). The HUD standards address whether sites are eligible for federal funding support. These standards, set forth in 24 CFR Part 51, define areas with DNL exposure not exceeding 65 dB as acceptable for funding. Areas exposed to noise levels between 65 and 75 DNL are "normally unacceptable," and require special abatement measures and review. Those areas at 75 DNL and above are "unacceptable" except under limited circumstances.

5.2.1 FAA Land Use Approval and Funding Policies

FAA policy limits approval of Part 150 remedial mitigation measures (e.g., soundproofing, property acquisitions, and relocation) to non-compatible land uses that were in place prior to October 1, 1998, within an FAA-accepted NEM. Non-compatible development that occurs on or after October 1, 1998, may only be addressed in Part 150 programs via preventive noise mitigation measures, such as zoning amendments, subdivision regulation, and/or building codes. For the MSP environs, most new non-compatible development within the previously accepted NEMs would typically be infill development of established residential neighborhoods.

Approval of remedial noise mitigation measures for (1) bypassed lots (i.e., infilling) or additions to existing structures within noise-impacted neighborhoods, (2) additions to existing noise-impacted schools or other community facilities required by demographic changes within their service areas, (3) formerly noise compatible uses that have been rendered non-compatible as a result of airport expansion or changes in airport operations, and (4) other reasonable exceptions to this policy on similar grounds must be justified by airport operators in submittals to the FAA and will be considered by the FAA on a case-by-case basis.

This policy effectively limits FAA funding for implementation of noise compatibility measures when Part 150 approval is a prerequisite for funding. The objective is to strongly encourage preventive actions where there are currently no non-compatible land uses and to limit remedial actions and dollars to those uses that are already noise-impacted. This policy will also affect the use of Airport Improvement Program (AIP) funds to the extent that such funding is dependent on approval under Part 150. This policy does not affect AIP funding for noise mitigation projects that do not require Part 150 approval, that can be funded with Passenger Facility Charges revenue, or that are included in FAA-approved environmental documents for airport development.

5.3 LAND USE COMPATIBILITY CRITERIA

Table 5.2 shows the recommended land use compatibility guidelines for the MSP environs. For simplicity, Table 5.2 shows the 24 land use categories of Table 5.1 compiled into 18 *generalized* land use categories. Note that the criteria in Table 5.2 are based on the Part 150 guidelines described in Table 5.1, with some modifications to account for local conditions, such as land use compatibility below 65 DNL. This section discusses differences between FAA guidelines and MSP guidelines. Differences are separated into areas that exceed 65 DNL and areas below 65 DNL.

Table 5.2

MSP Aircraft Noise and Land Use Compatibility Guidelines

Land Use	DNL Contour Interval (dB)					
	Less than 60	**60-64**	**65-69**	**70-74**	**75-79**	**Greater Than or Equal to 80**
Single-Family Residential	Y	N (a)	N (a)	N (a)	N	N
Multi-Family Residential	Y	N (a)	N (a)	N (a)	N	N
Mobile Home Residential*	Y	N	N (a)	N (a)	N	N
Hotel, Motel, Transient Lodging	Y	Y	Y (b)	Y (b)	Y (b)	Y (b)
Nursing Home	Y	N (a)	N (a)	N (a)	N	N
Hospital	Y	Y	30	35	N	N
Place of Worship	Y	Y	25	30	N	N
School	Y	25	30	N	N	N
Child Care/Pre-school	Y	Y	25	30	N	N
Historical Site	Y	Y	Y	Y	N	N
Recreation/Open Space	Y	Y	Y	25	30	N
Government/Public	Y	Y	Y	25	30	N
Commercial/Office (c)	Y	Y	Y	25	30	N
Industrial	Y	Y	Y	25	30	N
Agriculture	Y	Y	Y (d)	Y (e)	Y (f)	Y (f)
Vacant	Y	Y	Y	Y	Y	Y
Unclassified	N/A	N/A	N/A	N/A	N/A	N/A
Airport Property	Y	Y	Y	Y	Y	Y

Y (Yes) Land use and related structures compatible without restrictions.

N (No) Land use and related structures are not compatible and should be prohibited.

25, 30, or 35 Land use and related structures generally compatible; measures to achieve NLR of 25, 30, or 35 dB must be incorporated into design and construction of structure.

N/A Not applicable.

(a) New development allowed only where infilling of existing residential areas is the only reasonable use; such infill development is permitted on a conditional basis with provisions for an interior sound level of 45 dB and disclosure of noise exposure to future residents.

(b) Must achieve an indoor DNL of 45 dB.

(c) Includes secondary place of worship complex structures and "storefront" places of worship.

(d) Residential buildings require an NLR of 25.

(e) Residential buildings require an NLR of 30.

(f) Residential buildings not permitted.

* Aircraft noise exposure in mobile homes, using traditional aircraft sound insulation techniques, is difficult to mitigate due to the design of most mobile homes. Traditional aircraft sound insulation techniques seeking a minimum of 5 dB NLR require upgrades to the entire structure—door and window replacements, upgrades to the exterior walls, and upgrades to the roof structure. In most cases, it is not feasible to apply these techniques to mobile home design/construction because of structural weight limitations, building codes, or homeowner inconvenience.

Sources: As noted in text per Table 5.1; the Metropolitan Development Guide, Aviation Policy Plan, December 1996, and updates to the policy in the Transportation Policy Plan; and input from MAC and the study consultation process.

It should be noted that the guidelines in this Study for land uses within 65 DNL are identical to those recommended in the 1993 Study.

5.3.1 Consideration of Aircraft Noise Exposure Levels Greater Than or Equal to 65 DNL

Regarding the Residential (other than hotels) generalized categories, the only differences between FAA and MSP-specific guidelines are the footnotes for the 65-69 and 70-74 DNL intervals. In both intervals, new single-family residential construction is permitted only where infilling of existing residential neighborhoods is the only reasonable land use. Also, in both intervals, home sellers are required to notify the prospective homebuyer of the noise environment. FAA policy on infilling is described in Section 5.2.1. However, the FAA leaves the ultimate decision on defining remedial measures to MAC as the airport sponsor. MAC defines infilling in its strictest form: development of limited parcels within an area zoned for residential use prior to October 1, 1998, and within an established community. New expansions of residential development are not considered infilling by the MAC.

For the Hotels, Motels, and Transient Lodging generalized category, the differences between FAA and MSP-specific guidelines are evident in the DNL intervals at or above 65 dB. For MSP, it is recommended that hotel-like structures be permitted in all noise zones provided an interior noise level of 45 DNL is achieved. The 45 DNL criterion is readily achieved as construction of hotels and motels generally results in NLRs higher (i.e., better) than that of single-family homes. In Table 5.1, FAA lists these uses as non-compatible and suggests their prohibition.

The Nursing Home generalized category for MSP is separate from Hospital whereas the FAA guidelines combine them. Nursing homes are essentially residential in character and are addressed consistent with requirements for multi-family dwellings.

Regarding the Hospital (excluding nursing homes) generalized category, MSP guidelines are 5 dB more restrictive than FAA guidelines for the 65-70 dB and 70-75 DNL intervals. For MSP, NLRs of 30 dB and 35 dB are recommended for these respective intervals.

The School generalized category includes private and public schools. For the School category, the MSP-specific guidelines are more restrictive than the FAA guidelines for the 65-70 DNL and 70-75 DNL intervals. It is recommended that schools incorporate a NLR of 30 dB in the 65-69 DNL band in contrast to a NLR of 25 dB in Table 5.1. For the 70-74 DNL interval, school use is non-compatible without exception, whereas the FAA guidelines allow exceptions.

The Child Care generalized category for MSP is separate from the School, Hospital, or Nursing Home categories. Since formal classroom instruction is not as typical a function of a child care center as it is a function of a school, it is recommended that criteria for child care centers be less stringent than those for schools. As with the 1993 Study, it is recommended that these facilities be considered compatible in the 65-69 and 70-74 DNL contour intervals with NLRs of at least 25 dB and 30 dB, respectively. Furthermore, child care facilities are non-compatible within the 75 DNL contour.

For schools, child care centers, or other types of facilities that are part of a place of worship, the criteria for these secondary types of facilities would be applied as

indicated by note (c) in Table 5.2. In addition to structures specifically dedicated to use by places of worship, numerous small places of worship are often established in portions of commercial buildings. These "storefront" places of worship are frequently located in commercial areas that are otherwise compatible with aircraft noise levels. Due to their location and sometimes transient nature, it is recommended that storefront places of worship be treated as commercial land use.

Guidelines for the Historical Site, Vacant, and Airport Property generalized categories do not differ from FAA guidelines but are identified distinctly in Table 5.2 for this Study.

5.3.2 Consideration of Aircraft Noise Exposure Levels Less Than 65 DNL

According to FAA guidelines, all land uses are considered to be compatible with noise levels below 65 DNL.[1] A 1980 review of noise compatibility criteria conducted by the Federal Interagency Committee on Urban Noise (FICUN) concluded that 65 DNL should be retained as the standard for "significant" noise impact.[2] FICUN also recognized that community noise concerns do not stop abruptly at the 65 DNL contour line. Rather, as Figure 2-6 illustrates, the percentage of people highly annoyed by noise gradually declines as noise levels decrease below 65 DNL.

In 1995, the FAA sponsored a Study Group on Compatible Land Use to "address the need for an effective policy and programs to achieve compatible land use controls within the noise-impacted areas around the nation's airports." This study group consisted of representatives from the FAA, the aviation industry, and airport community interests. In their final report, the group recommended "that the FAA continue to support locally-initiated compatible land use planning beyond the DNL 65 dB contour, when appropriate."[3] The conclusion was based on the recognition that individual sensitivities to noise vary, community noise concerns exist beyond the 65 DNL contour, and both airports and communities would benefit from decreased residential development in noise-impacted areas beyond the 65 DNL contour.

As first expressed in the 1996 Dual Track Legislation, the MAC, advisory bodies, and the local communities have sought to utilize the 60 DNL contour as the boundary within which to apply NCP measures. Because of recent changes in the noise environment, non-compatible development currently exists within the 60-64 and 65-69 DNL contour intervals. In this light, three criteria must be met for the FAA to consider noise compatibility below 65 DNL.[4] These criteria were provided by the FAA and are as follows:

- The Airport Operator must adopt a NCP designation of non-compatibility that is different than Table 5.1.

- The NEM contours and NCP narrative should identify the areas exposed to levels less than 65 DNL as non-compatible and should propose mitigation measures.

- The mitigation proposal must meet the Part 150 standard to reduce or prevent non-compatible land uses.

The MSP aircraft noise and land use compatibility guidelines shown in Table 5.2 are intended to satisfy these requirements. The 1996 MDG Aviation Policy Plan permits infill residential development within the 60 DNL contour on a "conditional" basis if the development meets certain

requirements, including a 45 dBA interior sound level, similar adjacent land uses, and methods for potential new residents to be made aware of the noise environment prior to moving into impacted areas. Although the Aviation Policy Plan currently permits new development and major development of residential use within the 60 DNL contour (i.e., non infill) on a conditional basis, the TPP expected to be adopted by the end of 2004 (see Section 5.1) is anticipated to define new development and major re-development within the 60 DNL contour as "incompatible," meaning that "land uses are not acceptable even if acoustical treatment were incorporated in the structure." Given the extensive development of the MSP environs, most new residential development within the NEMs would be expected to be infill of established residential neighborhoods and thus subject to the conditional provisions of the Aviation Policy Plan and TPP. As such, the land use compatibility guidelines in Table 5.2 define residential development within the 60 DNL contour as non-compatible, with the conditional exception for infill development as described in note (a) of the table.

The conditional exception for infill development is appropriate given that such development in existing residential neighborhoods would be a reasonable land use. Also, the conditional provision is consistent with the land use guidelines for the 65 DNL contour as discussed in Section 5.3.1. As policy, MAC will typically discourage any new development or major re-development within the 60 DNL contour.

Due to the sensitivity of classroom teaching to periodic aircraft noise events, the MSP aircraft noise and land use compatibility guidelines state that schools should only be permitted within the 60 DNL contour when the attenuation performance specified in Table 5.2 can be achieved.

The MSP aircraft noise and land use compatibility guidelines recognize that community concerns extend beyond the 65 DNL contour and that changes in aircraft activity levels could change (increase the extent of) the 65 DNL contour in the future.

5.4 DEVELOPMENT OF LAND USE AND POPULATION DATA

Noise impact analysis for the Study was conducted using a Geographic Information System (GIS). GIS facilitated a detailed, comprehensive analysis of the geographical relationships and patterns emerging from the region surrounding MSP.

In July 1999, a letter was sent to city officials in each of the affected cities, requesting the most current digital data sets depicting existing land use, future land use, zoning, demography, and lot/parcel information. The affected cities/regions include the MSP Airport and Fort Snelling area, the City of Minneapolis to the northwest, the Cities of Mendota and Mendota Heights to the east, the Cities of Eagan and Inver Grove Heights to the southeast, the City of Bloomington to the southwest and the Cities of Richfield and Edina to the west.

If a city did not have access to digital data, the MAC GIS staff compiled 1998 land use and parcel data from Dakota, Hennepin, or Ramsey Counties and used that information as the basis for the city's land use validation. In addition, the MAC had existing land use information field-verified within an extended contour area.

After obtaining the land use information from each city and performing field verification, a meeting was scheduled with the assigned city contact to establish a line of communication and request that they examine the existing land use map for

quality assurance purposes. If changes were necessary, MAC GIS staff updated the map and resubmitted it to the city contact for subsequent review. This process continued until each city representative had fully validated the existing land use data for the purposes of the Study. This procedure was originally completed for the 2001 Study. For this Study, updated land use from the cities and counties was again solicited in order to update the land use and population database. The resulting land use maps were again field verified as needed and then submitted to the jurisdictions for their review and comment.

Figure 5-1 illustrates the validated existing land use for the MSP region. Determination of land use was based on professional planning criteria and procedures utilizing one or more of the following, as appropriate: comprehensive land use planning, zoning, building design and codes, and site planning. For the purpose of defining single-family and multi-family residential development, a residential parcel with one dwelling unit is considered to be single-family, where as a parcel with two or more dwelling units is considered to be multi-family. This definition is in line with the MC's definition of single- and multi-family uses. If more than one existing land use is permissible, land use is based on the use most adversely impacted by noise. In general, the urban area surrounding MSP is fully developed, and has limited potential for new development in the next five years. However, some municipalities have designed large-scale *re-development* programs that should be considered in terms of potential noise impacts.

Each of the cities had a unique land classification system, which made it difficult to uniformly compare noise impacts across jurisdictional boundaries. As a result, MAC GIS staff normalized each city's land use classification system into a set of 18 generalized land use types, which facilitated accurate data for future analysis and also provided better clarity of non-compatible land uses in map compositions.

After obtaining the land use information from each city, population and dwelling unit counts were conducted. Staff demographers at the MC were contacted to obtain current demographic statistics and to employ their technical expertise in establishing an analytical methodology for the population estimation. Based on powers established under Chapter 4A of the Minnesota Statutes, the MC prepares an annual estimate of population and the number of households for each governmental subdivision. The latest estimate includes demographic data from the 2000 U.S. Census. These data provide the basis for estimating city population for the purposes of the Part 150 by maintaining an average number of persons per household, based on several housing categories including single-family, duplex/townhome, multi-family and mobile home. Also known as the "population multiplier," these demographic estimates were attached to the appropriate residential class for each city in the GIS.

Dwelling unit estimates for all non-compatible land uses were based on the generalized land use classifications identified previously. For example, single-family land uses were "tagged" with one dwelling unit on that particular parcel in the database. In cases where there was more than one dwelling unit on residential property, additional information was needed so that both an accurate population and dwelling unit estimate could be derived for the areas under the noise contours at MSP. The preferred format for that information was from existing city databases; if cities did not have digital data or maintained dwelling unit counts, County Assessment

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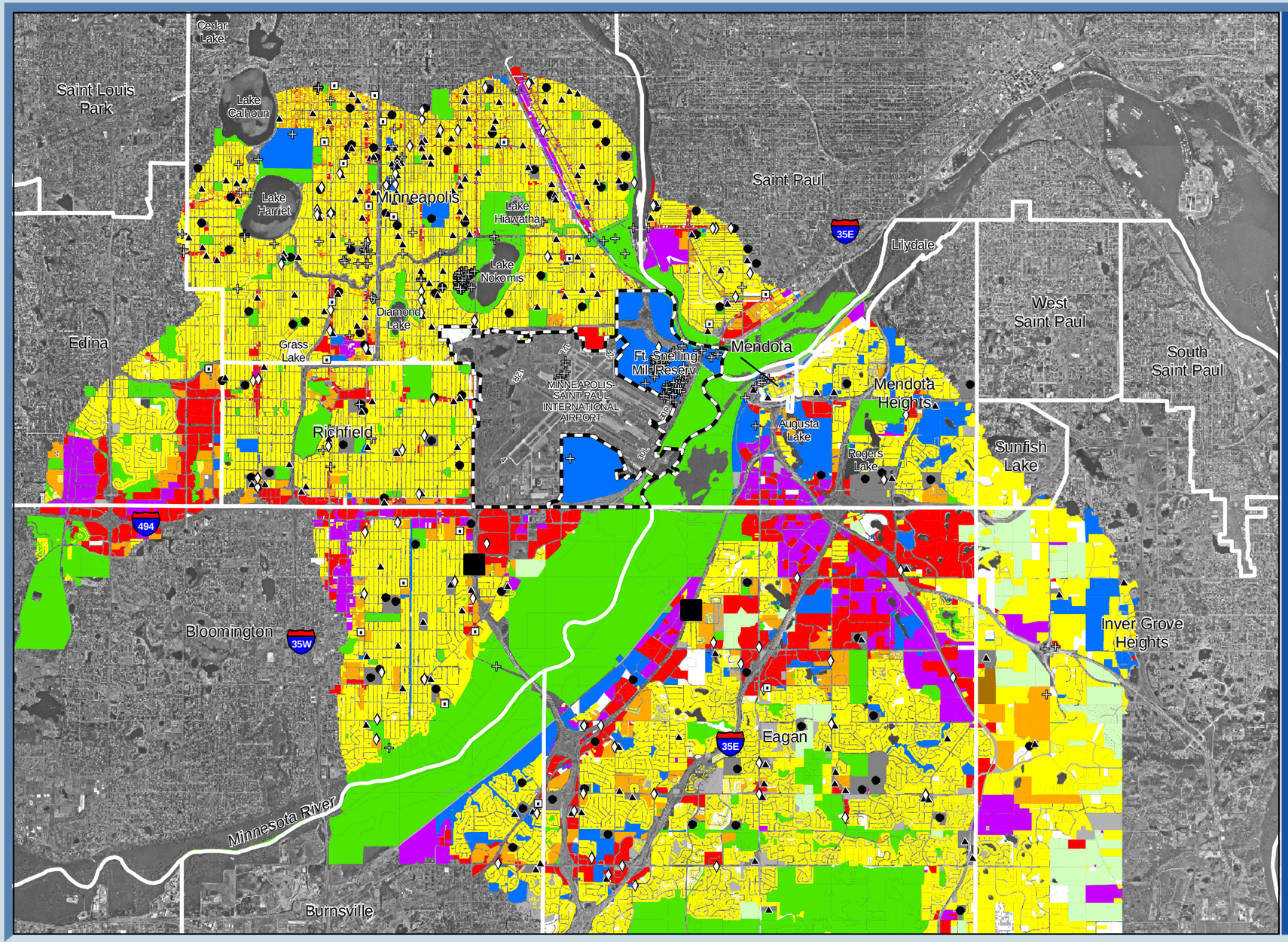

Legend of Land Uses

- Single Family Residential
- Multi-Family Residential
- Mobile Home Residential
- Recreation/Open Space
- Government/Public
- Commercial/Office
- Industrial
- Agriculture
- Vacant
- Unclassified
- Non-Residential Noise Sensitive

- Historic Site
- Nursing Home
- Preschool
- Place of Worship
- School
- Airport Boundary
- Jurisdiction Boundary

N

0 0.5 1 1.5 2 Statute Miles

SOURCE OF AERIAL PHOTOGRAPHY: The Metropolitan Council, Minneapolis, MN, April, 1997.
ORIGINAL LAND USE DATA: from the counties of Ramsey, Dakota, and Hennepin, and the municipalities of Bloomington, Burnsville, Eagan, Edina, Inver Grove Heights, Lilydale, Mendota, Mendota Heights, Minneapolis, Richfield, Saint Louis Park, Saint Paul, South Saint Paul, Sunfish Lake, and West Saint Paul, augmented with field data.

Existing Land Use

Figure 5-1

dwelling unit figures were used as a proxy and related by parcel identification number in the GIS. Parcels having missing and/or incomplete dwelling unit data were field-verified by MAC staff.

The total population living on each parcel was estimated by multiplying the number of dwelling units by the Population Multiplier for the respective city and type of residential development. For instance, according to MC data, a single-family residential unit in the City of Richfield has 2.48 people. Multiplying 2.48 people by one dwelling unit yields an estimated 2.48 people that live on that parcel of land. This procedure was completed for all impacted communities and provided the final information needed to perform the population estimate for noise impacts.

After geographically registering noise contours on the base land use map, the dwellings and population were calculated for each DNL interval listed in Table 5.2.

5.5 EXISTING LAND USE AND COMPATIBILITY

Section 5.5.1 discusses existing land use located within and intersecting the 2002 Existing Condition 60 DNL contour. Section 5.5.2 reviews the degree of noise compatibility achieved by the existing land use in reference to the 2002 Existing Condition DNL contours.

5.5.1 Existing Land Use

Figure 5-2 shows the existing land uses within the general vicinity of the 2002 Existing Condition DNL noise contours. The following subsections discuss Figure 5-2 by city.

City of Bloomington

Bloomington is located south and southwest of MSP in Hennepin County. There is no area of Bloomington within the 2002 60 DNL contours. Land use near MSP is mostly commercial, with some residential uses.

City of Eagan

Eagan is located in Dakota County, southeast of the Airport. The predominant land use types within the 60 DNL contour are industrial and commercial, with areas of residential use. There is an expanse of parkland within the Minnesota River floodplain. A vast residential area in Eagan is situated to the south of the 2002 60 DNL contours.

City of Edina

Edina is located in Hennepin County and lies west of Richfield and MSP. Only a small section in the southeastern part of the City is impacted by the 2002 DNL noise contours. The land use within the 60 DNL contour is made up of a commercial corridor flanked to the north by single- and multi-family residential units.

City of Inver Grove Heights

Inver Grove Heights is located in Dakota County to the southeast of MSP. Portions of the City are impacted by the 2002 60 DNL contour; the primary land uses in this area are noise-sensitive (residential and a place of worship).

City of Mendota

Mendota is located in Dakota County, east of MSP, and northwest of Mendota Heights. Mendota is a relatively small community that is mostly residential in nature; a small

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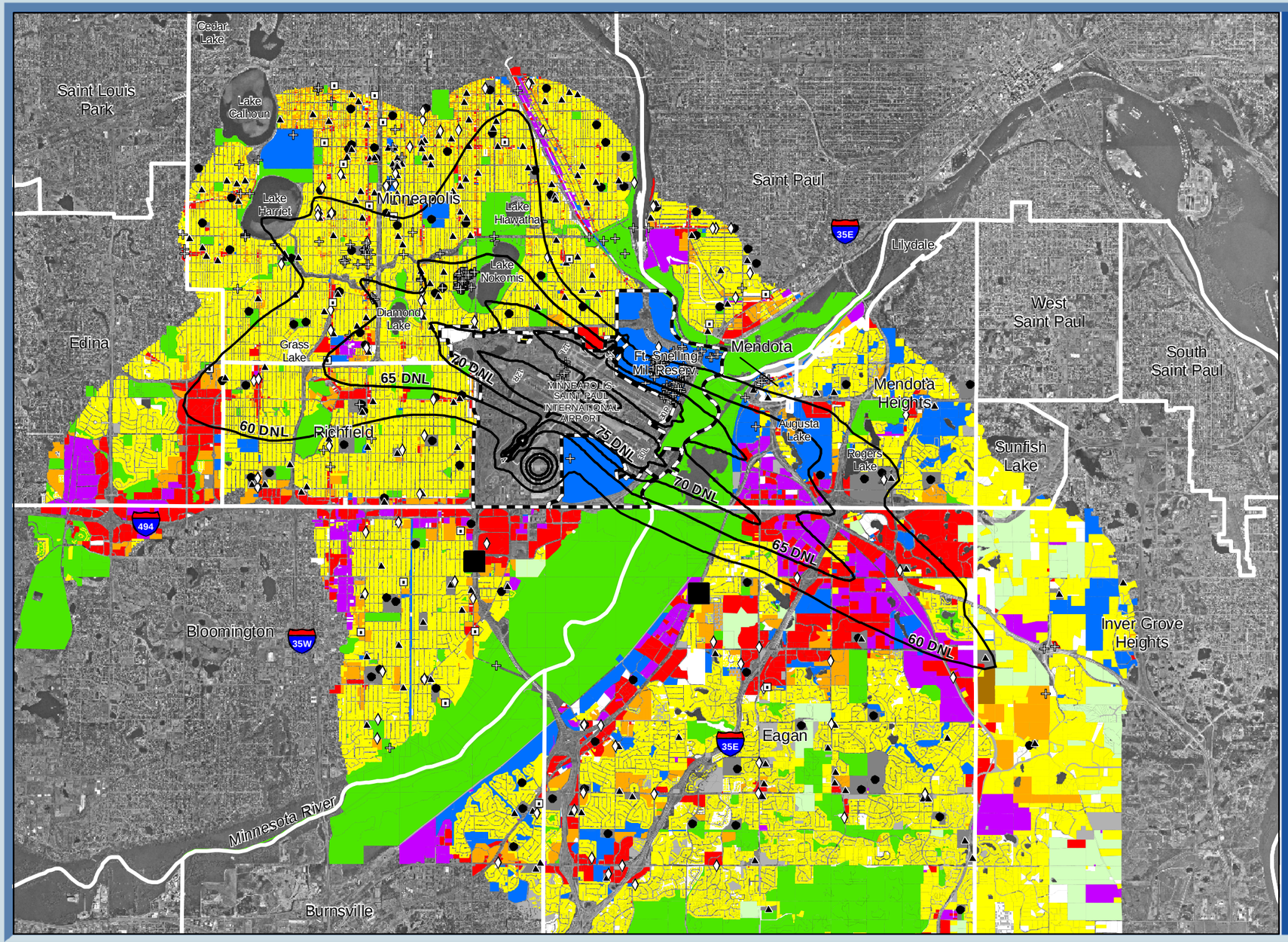


Legend of Land Uses

- Single Family Residential
- Multi-Family Residential
- Mobile Home Residential
- Recreation/Open Space
- Government/Public
- Commercial/Office
- Industrial
- Agriculture
- Vacant
- Unclassified
- Non-Residential Noise Sensitive

- Historic Site
- Nursing Home
- Preschool
- Place of Worship
- School
- Airport Boundary
- Jurisdiction Boundary

N

0 0.5 1 1.5 2 Statute Miles

SOURCE OF AERIAL PHOTOGRAPHY: The Metropolitan Council, Minneapolis, MN, April, 1997.
ORIGINAL LAND USE DATA: from the counties of Ramsey, Dakota, and Hennepin, and the municipalities of Bloomington, Burnsville, Eagan, Edina, Inver Grove Heights, Lilydale, Mendota, Mendota Heights, Minneapolis, Richfield, Saint Louis Park, Saint Paul, South Saint Paul, Sunfish Lake, and West Saint Paul, augmented with field data.

Year 2002 DNL Contours with Existing Land Use

Figure 5-2

area of single-family use is contained within the 2002 60 DNL contour.

City of Mendota Heights

Mendota Heights is located in Dakota County to the east of MSP. The predominant land uses within the 2002 60 DNL contour are commercial and industrial; other land is used for cemeteries and governmental purposes. However, there are significant residential areas within the 2002 60 DNL contour. Rogers and Augusta Lakes also exist within the 2002 60 DNL contour. While the majority of land uses correspond with the designated zoning, much of the currently vacant land is zoned to allow residential development.

City of Minneapolis

Minneapolis is located in Hennepin County to the north and northwest of MSP. The predominant land use within the 2002 60 DNL contour is single-family and multi-family residential. Small parcels of commercial development are scattered throughout the area. Lake Nokomis, Diamond Lake, Lake Hiawatha, and part of Lake Harriet, are also included in the 2002 60 DNL contour.

City of Richfield

Richfield is located directly west of the Airport in Hennepin County. The predominant land use within the 2002 60 DNL contour is residential, with neighborhood commercial/office areas scattered throughout the impacted region. In addition, Richfield Lake and Wood Lake recreation areas are included within the 2002 60 DNL contour. The Richfield Ice Arena and Swimming Pool are designated as noise-sensitive.

5.5.2 Existing Land Use Compatibility

The following discussion addresses both non-compatible and noise-sensitive land uses. In this Study, the term "non-compatible" refers to residential uses located within the 60 DNL contour. The term "noise-sensitive" refers to educational, religious, health care, parks, and historical sites located within the 60 DNL contour. It should be noted that, just as the 65 DNL contour does not define the limits of potential noise concern, the 60 DNL contour does not include all persons concerned about aircraft noise.

The analysis of noise impact, and non-compatible and noise-sensitive land uses, is based on the development of the noise contours described in Chapter Four.

The 2002 Existing Condition DNL contours were evaluated for their impact on land use compatibility. **Table 5.3** presents the distribution of off-airport noise-exposed land areas by land use for the 2002 DNL contours. Nearly 11,400 acres are within the 60 DNL contour, 37-percent of which is single-family residential use. Nearly 69-percent of the acreage is in the 60-64 DNL interval. About 62 acres of land are exposed to a DNL of 75 dB or greater. From Table 5.3, non-compatible acreage consists of 45-percent of the total acreage within the 60 DNL contour, with the majority of non-compatible land being of single-family residential use within the 60-64 DNL contour interval.

Appendix F details the information presented in Table 5.3 for each of the impacted cities/regions except the MSP/Fort Snelling area. The Cities of Minneapolis and Eagan have the most impacted land area of the eight cities.

Table 5.3

Estimated Off-Airport Acreage within 2002 Existing Condition DNL Contours

Generalized Land Use	Acreage Within DNL Contour Interval				
	60-64 dB	65-69 dB	70-74 dB	75+ dB	Total
Single-Family Residential	3,248	895	110	-	4,253
Multi-Family Residential	306	101	17	-	424
Mobile Home Residential	76	-	-	-	76
Nursing Home	8	2	-	-	10
Place of Worship	122	12	1	-	135
School	253	11	4	-	268
Recreation/Open Space	1,511	477	147	-	2,135
Government/Public	317	389	34	-	740
Commercial/Office	1,141	348	52	62	1,603
Industrial	567	422	3	-	992
Agriculture	18	-	-	-	18
Vacant	143	48	399	-	590
Unclassified	92	31	2	-	125
Total	**7,802**	**2,736**	**769**	**62**	**11,369**
Compatible	**3,789**	**1,715**	**637**	**62**	**6,203**
Non-compatible	**4,013**	**1,021**	**132**	**-**	**5,166**

Source: HNTB analysis.

Minneapolis and Eagan have about 4,000 acres and 3,100 acres within the 2002 60 DNL contour, respectively. Minneapolis also has the largest amount of residential acreage with almost 3,000 acres. The City of Mendota has the least acreage within the 2002 60 DNL contour with about 48 acres.

Table 5.4 contains the number of noise-sensitive structures within the 2002 Existing Condition DNL contours. Table 5.4 lists five types of noise-sensitive structures, including schools, places of worship, nursing homes, historic structures, and pre-school/child care facilities. For the 2002 DNL contours, there are 226 noise-sensitive structures within the 60 DNL contour. Approximately 48-percent of these are within the 60-64 DNL interval, with most of the remainder in the 65-70 DNL interval. One school is within the 70-74 DNL interval. No noise-sensitive structures exist within the 75 DNL contour.

Appendix F details the noise-sensitive structure information presented in Table 5.4 by city. Similar to the land use impacts, the City of Minneapolis contains the most noise-sensitive structures for each category.

Table 5.5 contains the estimated number of people and dwellings by city within the 2002 DNL contours. Within the 60 DNL contour, there are approximately 79,476 people and 33,466 dwellings, 76-percent of which is within the 60-64 DNL interval. There are zero people and dwellings impacted by DNLs of 75 dB or greater. Most of the people within the 60 DNL contour are in the City of Minneapolis. Richfield and Edina also have substantial populations within the 60 DNL contour. Mendota has the least number of impacted people and dwellings.

Table 5.4

Estimated Noise-Sensitive Structures within 2002 Existing Condition DNL Contours

Structure	Number Within DNL Interval				
	60-64 DNL	65-69 DNL	70-74 DNL	75+ DNL	Total
Schools	23	4	1	-	28
Places of Worship	42	13	-	-	55
Nursing Homes	3	1	-	-	4
Child Care/Pre-schools	14	5	-	-	19
Historic	27	93	-	-	120
Total	**109**	**116**	**1**	**-**	**226**

Excludes MSP Airport and Fort Snelling area

Source: HNTB analysis.

Table 5.5

Estimated Residential Land Use within 2002 Existing Condition DNL Contours

City	60-64 DNL		65-69 DNL		70-74 DNL		75+ DNL		Total	
	Dwelling Units	Population	Dwelling Units	Population	Dwelling Units	Population	Dwelling Units	Population	Dwelling Units	Population
Single Family										
Bloomington	-	-	-	-	-	-	-	-	-	-
Burnsville	-	-	-	-	-	-	-	-	-	-
Eagan	643	2,011	68	221	-	-	-	-	711	2,232
Edina	28	78	-	-	-	-	-	-	28	78
Inver Grove Heights	9	28	-	-	-	-	-	-	9	28
Mendota	10	23	-	-	-	-	-	-	10	23
Mendota Heights	147	453	45	138	-	-	-	-	192	591
Minneapolis	14,247	37,270	4,222	11,040	792	2,073	-	-	19,261	50,383
Richfield	3,548	8,804	870	2,157	21	52	-	-	4,439	11,013
Total Single-Family	*18,632*	*48,667*	*5,205*	*13,556*	*813*	*2,125*	-	-	*24,650*	*64,348*
Multi-Family										
Bloomington	-	-	-	-	-	-	-	-	-	-
Burnsville	-	-	-	-	-	-	-	-	-	-
Eagan	320	595	-	-	-	-	-	-	320	595
Edina	1,350	2,077	-	-	-	-	-	-	1,350	2,077
Inver Grove Heights	365	846	-	-	-	-	-	-	365	846
Mendota	-	-	-	-	-	-	-	-	-	-
Mendota Heights	247 (a)	386	26 (a)	43	-	-	-	-	273	429
Minneapolis	2,842	4,844	1,263	2,154	370	633	-	-	4,475	7,631
Richfield	1,650	2,884	383	666	-	-	-	-	2,033	3,550
Total Multi-Family	*6,774*	*11,632*	*1,672*	*2,863*	*370*	*633*	-	-	*8,816*	*15,128*
Grand Total	**25,406**	**60,299**	**6,877**	**16,419**	**1,183**	**2,758**	**-**	**-**	**33,466**	**79,476**

Notes: Includes existing NCP. Values do not include block intersect methodology. All values rounded to the nearest whole number, except for values that would round to zero, which are rounded up.

(a) Includes 22 units in the 60-64 DNL and 24 units in the 65-69 DNL in Mendota Heights built since 2000 that are ineligible for the Sound Mitigation Program.

Source: HNTB analysis.

5.6 FORECAST LAND USE AND COMPATIBILITY

Section 5.6.1 discusses forecast land use and Section 5.6.2 reviews the degree of noise compatibility achieved by the forecast land use with consideration of the 2007 Unmitigated 60 DNL contour as the area of noise impact. All discussions of land use in this section apply to the area within the 2007 Unmitigated 60 DNL contour.

5.6.1 Forecast Land Use

Since the future land use within the study area is not likely to significantly change over the next five years, the forecast land use for this Study is assumed to be the same as the existing land use presented in Figure 5-1. Because of certain areas undergoing transition from residential to commercial uses and the development controls in place to discourage new non-compatible uses, the residential population could slightly decline in the noise-impacted areas. Nonetheless, only minor changes to existing land use are anticipated. The changes, if any, are discussed in the following subsections by city.

City of Bloomington

The City of Bloomington has set policy to encourage MSP to remain at its present location. West of Cedar Avenue, Bloomington is almost entirely developed as recognized in the City's Comprehensive Plan 2000 (last amended in March 2004) thus limiting the potential for future non-compatible development. There would be six vacant acres within the noise-impacted areas in Bloomington.

East of Cedar Avenue there is significant opportunity for growth in Bloomington, particularly in an area known as the "Airport South District" and in the area east of the Mall of America that is undergoing change as a result of the construction of Runway 17/35.

The Bloomington Central Station is a new mixed-used development that is planned in the Airport South District. The development will be centered on the Bloomington Central Light Rail Train station and will include 1,000 condominium housing units, a hotel, and substantial office and commercial space. The development will include a number of provisions for noise attenuation, including (1) NLR construction and testing based on peak noise levels to achieve undetectable exterior to interior levels; (2) no operable windows or outdoor living areas (e.g., balconies), (3) exterior light deflection capabilities, (4) no unnecessary structural penetrations, and (5) notification of outside noise impacts and proximity of the Airport to residents. Consistent with this Study, any residential development on this property would be ineligible for the corrective Sound Mitigation Program (LU-8). The development is proceeding with the understanding that it would be ineligible for future corrective measures.

In 1984, the MSP Joint Airport Zoning Board (JAZB) adopted the MSP Airport Zoning Ordinance.[5] The Ordinance established (1) height restrictions proximate to the Airport as required by federal and state law to protect aircraft operations; (2) land use safety zoning for the runway approach zones as dictated by federal and state law; (3) land use safety zoning for other zones related to the runways; and (4) administration and enforcement mechanisms to implement height and land use zoning controls.

Runway 17/35 is a major impetus for updating the Ordinance. Accordingly, the

JAZB was reconvened in September 2001 as height and land use controls need to be enacted for Runway 17/35 consistent with the provisions of the Ordinance.

The City of Bloomington has adopted Airport Runway Overlay Districts for the purpose of enacting the MSP Zoning Ordinance for land adjacent to the south side of MSP. The overlay district includes restrictions on structure height and prohibits the development of certain land uses in the interest of protecting safety, promoting appropriate land uses, and preventing the establishment of airport hazards. Thus, the overlay districts provide for cooperative land use compatibility planning and yield opportunities for developing compatible land uses adjacent to the Airport and within areas prescribed as runway safety zones.

Cities of Burnsville, Eagan, and Inver Grove Heights

There would be zero vacant acreage within the noise-impacted areas of Burnsville. Inver Grove Heights is not impacted by the 2007 Unmitigated DNL contours. The City of Eagan estimates that about 500 new housing units will be constructed within the next five years in the corridor along Cedar Avenue and between the Minnesota River and I-35E. However, this development would not occur within the 2007 60 DNL Unmitigated contours. There would be 66 acres of vacant land within the noise-impacted areas in the City of Eagan.

Each of these cities has comprehensive planning considerations relative to MSP. The City of Burnsville's 2000 Comprehensive Plan recognizes that while noise issues have not been a concern in the past, the addition of Runway 17/35 may create concerns to address in the future. The City of Eagan considers development in accordance with MDG Aviation Policy Plan guidelines. Inver Grove Heights considers airspace planning and the MDG Aviation Policy Plan as guidance for comprehensive planning; recognizing that a one-mile buffer zone beyond the 60 DNL contour allows flexibility for addressing local concerns. The City of Inver Grove Heights will, however, monitor new development and work towards land use compatibility guidelines to ensure standards and policies are adequately addressed.

City of Mendota Heights

Although most of the existing vacant land is zoned to allow residential development, Mendota Heights is expected to remain fairly stable in terms of development. A few scattered areas of commercial and industrial development are anticipated in currently vacant areas. Two small existing residential areas northeast of the I-494/TH 149 interchange are planned to expand eastward into a currently vacant area. In Mendota Heights there would be approximately 17 acres of vacant land within 2007 60 DNL Unmitigated contours. The City has adopted the MDG Aviation Policy Plan.

A residential development called Augusta Shores was developed in 2000 within the 2007 Unmitigated 60 DNL contour. The MC approved a comprehensive plan amendment for 46 townhomes. MAC has been given assurances that the townhome construction would provide sufficient acoustical protection to prevent sleep disturbance and speech interference. This development will not be eligible for FAA or MSP remedial mitigation programs.

The City of Mendota Heights has designated medium- and high-density residential development for another property that is located within the 65 DNL of the 1996 NEM and the 60 DNL contour of the 2007 NEMs (Unmitigated and Mitigated). The property,

also known as the "Garron/Acacia" property, is located immediately south of Highway 55, adjacent to Pilot Knob Road, and north of Acacia Cemetery. The current zoning of the property is "B-1A Business Park" for the parcel to the west of Pilot Knob Road and "R-3 Multiple Family Residential" for the parcel to the east of Pilot Knob Road.

In June 2001, the Mendota Heights City Council unanimously declined a proposal to construct an office building on a portion of the property. More recently residential development proposals have been brought before the City for the construction of about 157 homes on the 25-acre site; however, the development proposals have encountered environmental issues including concerns about noise and historic status.

This Study advocates specific land use compatibility guidelines (as discussed in Section 5.3) that have been endorsed by MAC and the communities via MASAC, and that are reflected in the MC's draft MDG Transportation Policy Plan. The area between the 60-64 DNL contour interval is non-compatible for new development of single- or multi-family residential use as shown in Table 5.2. Consistent with this Study, any residential development on the property would be ineligible for the corrective Sound Mitigation Program (LU-8).

City of Minneapolis

Since Minneapolis is almost entirely developed, no major change in the land use is anticipated over the next five years. There would be approximately 29 acres of vacant land in the noise-impacted areas of Minneapolis (i.e., 2007 Unmitigated 60 DNL Contour).

The City of Minneapolis has comprehensive planning that considers land use compatibility for major and intermediate airports. The comprehensive plan follows the 1996 MDG Aviation Policy Plan in that single/multiplex residential use with individual entrances is inconsistent within the 65 DNL contour and conditional (identified as conditionally acceptable in local comprehensive plans) within one mile beyond the 60 DNL contour. Multiplex/Apartment residential use with shared entrances is provisional (land uses must comply with certain structural performance standards to be acceptable according to the [MS 473.192] Metropolitan Area Aircraft Noise Attenuation Act) for areas exposed to DNL less than 75 dB. Additionally, the City of Minneapolis has guidance on airport area height restrictions.

City of Richfield

Richfield is largely developed within the vicinity of MSP. Anticipated development over the next five years will be primarily infill development, which would be consistent with the existing land use designations. The latest comprehensive plan for Richfield was updated and adopted in August 1997 and revised in May 1999. This comprehensive plan included areas of planning/proposed redevelopment areas; one such area is the Cedar Avenue Corridor that may be impacted by operations from the new Runway 17/35. Areas where the land use is expected to change include the areas between 63rd and 69th Streets just west of TH 77. These areas will change from residential to commercial uses. Other anticipated development includes the reconstruction and widening of I-35W, TH 62, and 77th Street, which are expected to affect the residential and commercial properties along the respective corridors. There would be 20 acres of vacant land

within the noise-impacted areas of Richfield (i.e., 2007 Unmitigated 60 DNL contour).

5.6.2 Forecast Land Use Compatibility

Although the forecast land use is not expected to significantly change for any of the cities directly impacted by aviation noise, aircraft operations are expected to change, as discussed in Chapter Three and Four. Additionally, Runway 17/35 will be in operation in 2007. The resultant change in noise exposure causes a corresponding change in the compatibility of land uses. For example, while Edina and Inver Grove Heights are impacted by the 2002 60 DNL contour, the cities are not impacted by the 2007 60 DNL contours (Unmitigated and Mitigated). Conversely, Bloomington is not impacted by the 2002 DNL contours, but is impacted by the 2007 DNL contours (Unmitigated and Mitigated). This section analyzes land use compatibility, in terms of non-compatible and noise-sensitive land uses, for the 2007 Unmitigated DNL contours developed using the current NCP and Dual Track FEIS planning assumptions for Runway 17/35 as described in Chapter Four. See Section 5.5.2 for definitions of non-compatible and noise-sensitive land uses.

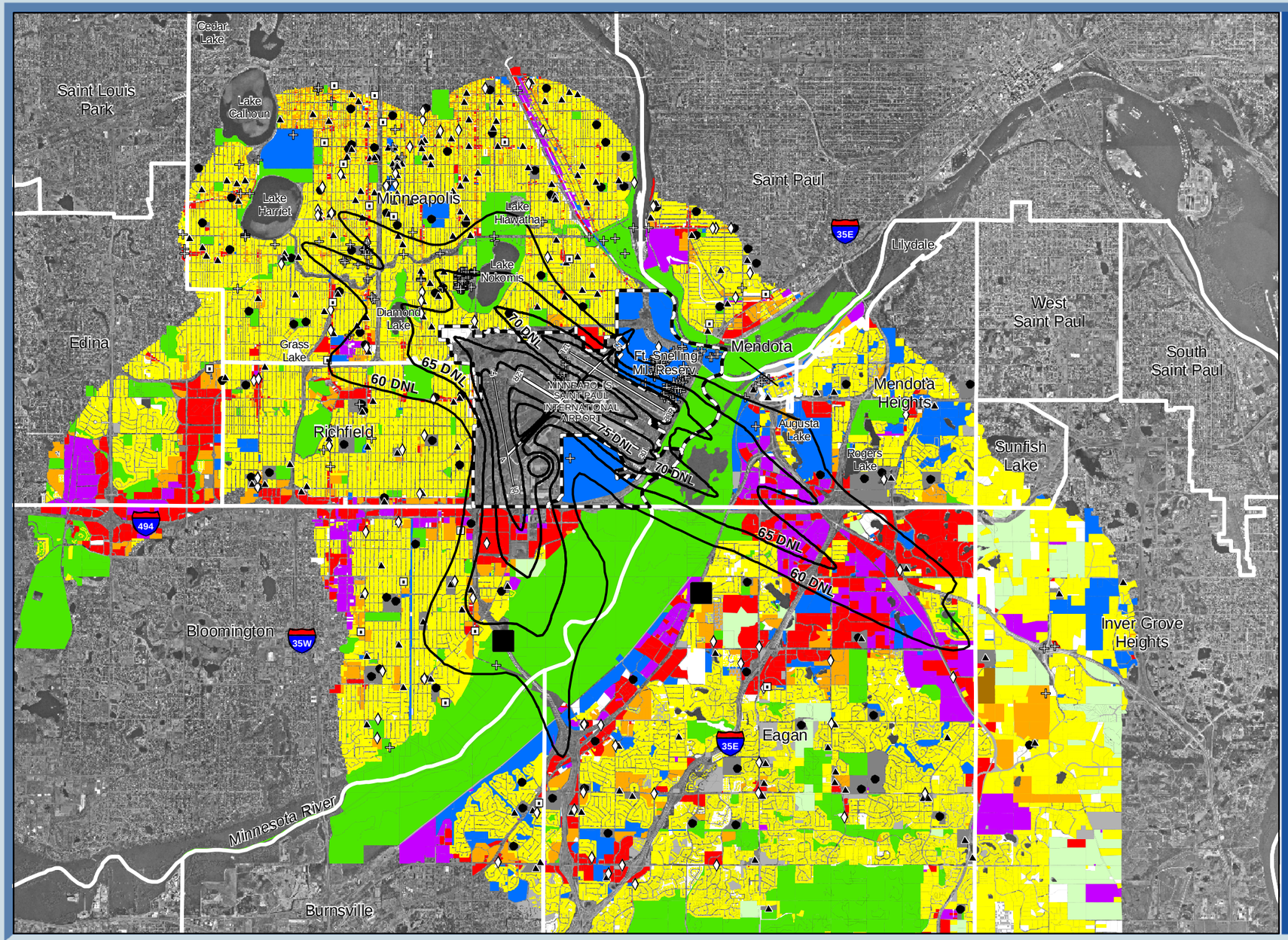
Figure 5-3 shows the 2007 Unmitigated DNL contours on existing land use. **Table 5.6** presents the distribution of noise-exposed land areas by land use for the 2007 Unmitigated DNL contours. Nearly 10,400 acres would be within the 60 DNL contour, 24-percent of which would be single-family residential use. Sixty-three percent of the acreage within the 60 DNL contour would be in the 60-64 DNL interval. Only 24 acres of land would be within the 75 DNL contour.

Table 5.7 contains the number of noise-sensitive structures for the 2007 Unmitigated DNL contours. There would be 161 noise-sensitive structures within the 60 DNL contour; approximately 54-percent of these would be within the 60-64 DNL interval. One school would exist in the 70-74 DNL interval. No noise-sensitive structures would exist within the 75 DNL contour. Most noise-sensitive structures would be within the City of Minneapolis. Appendix F details the noise-sensitive structure information presented in Table 5.7 by city.

Table 5.8 contains the estimated number of people and dwellings by city for the 2007 Unmitigated DNL contours. Within the 60 DNL contour there would be 40,431 people and 17,117 dwelling units, 70-percent of which would be within the 60-64 DNL interval. No off-airport/off-Ft. Snelling people or dwellings would be impacted by DNLs of 75 dB or greater. Most of the people within the 60 DNL contour would be in the City of Minneapolis. Richfield and Bloomington would also have a substantial number of dwellings and people within the contour. Mendota Heights would have the least number of impacted people and dwellings within the contours.

As indicated in the notes for Table 5.8, there are 29 single-family and 136 multi-family units scheduled for purchase and demolition by the MAC prior to the opening of Runway 17/35 in late 2005 per the mitigation in the Dual Track FEIS. As a result, these units are not included in the population and dwelling impact counts for both the 2007 Unmitigated and Mitigated DNL contours. However, the affected parcels are shown as single- and multi-family residential use on Figures 5-1 through 5-3 for the purpose of showing the existing land use.

HNTB



Legend of Land Uses

- Single Family Residential
- Multi-Family Residential
- Mobile Home Residential
- Recreation/Open Space
- Government/Public
- Commercial/Office
- Industrial
- Agriculture
- Vacant
- Unclassified
- Non-Residential Noise Sensitive

- Historic Site
- Nursing Home
- Preschool
- Place of Worship
- School
- Airport Boundary
- Jurisdiction Boundary

N

0 0.5 1 1.5 2 Statute Miles

SOURCE OF AERIAL PHOTOGRAPHY: The Metropolitan Council, Minneapolis, MN, April, 1997.
ORIGINAL LAND USE DATA: from the counties of Ramsey, Dakota, and Hennepin, and the municipalities of Bloomington, Burnsville, Eagan, Edina, Inver Grove Heights, Lilydale, Mendota, Mendota Heights, Minneapolis, Richfield, Saint Louis Park, Saint Paul, South Saint Paul, Sunfish Lake, and West Saint Paul, augmented with field data.

Year 2007 Unmitigated DNL Contours with Existing Land Use

Figure 5-3

Table 5.6

Estimated Off-Airport Acreage within the 2007 Unmitigated DNL Contours

Generalized Land Use	Acreage Within DNL Contour Interval				
	60-64 dB	65-69 dB	70-74 dB	75+ dB	Total
Single-Family Residential	1,807	565	105	-	2,477
Multi-Family Residential	210	99	10	-	319
Mobile Home Residential	-	-	-	-	-
Nursing Home	2	-	-	-	2
Place of Worship	59	16	-	-	75
School	53	4	4	-	61
Recreation/Open Space	2,229	1,319	590	-	4,138
Government/Public	539	100	-	1	640
Commercial/Office	821	306	238	10	1,375
Industrial	659	328	8	13	1,008
Agriculture	18	1	58	-	77
Vacant	92	40	6	-	138
Unclassified	46	31	-	-	77
Total	**6,535**	**2,809**	**1,019**	**24**	**10,387**
Compatible	**4,404**	**2,125**	**900**	**24**	**7,453**
Non-compatible	**2,131**	**684**	**119**	**-**	**2,934**

Source: HNTB analysis.

Table 5.7

Estimated Noise-Sensitive Structures within 2007 Unmitigated DNL Contours

Structure	Number Within DNL Interval				
	60-64 dB	65-69 dB	70-74 dB	75+ dB	Total
Schools	9	1	1	-	11
Places of Worship	19	8	-	-	27
Nursing Homes	1		-	-	1
Child Care/Pre-schools	9	4	-	-	13
Historic	49	60	-	-	109
Total	**87**	**73**	**1**	**-**	**161**

Excludes MSP Airport and Fort Snelling area

Source: HNTB analysis.

Table 5.8

Estimated Residential Land Use within 2007 Unmitigated DNL Contours

City	60-64 DNL		65-69 DNL		70-74 DNL		75+ DNL		Total	
	Dwelling Units	Population	Dwelling Units	Population	Dwelling Units	Population	Dwelling Units	Population	Dwelling Units	Population
Single Family										
Bloomington (a)	1,114	2,973	300	747	4	11	-	-	1,418	3,731
Burnsville	-	-	-	-	-	-	-	-	-	-
Eagan	504	1,594	12	39	-	-	-	-	516	1,633
Edina	-	-	-	-	-	-	-	-	-	-
Inver Grove Heights	-	-	-	-	-	-	-	-	-	-
Mendota	-	-	-	-	-	-	-	-	-	-
Mendota Heights	47	145	1	3	-	-	-	-	48	148
Minneapolis	5,950	15,558	2,653	6,944	323	845	-	-	8,926	23,347
Richfield	947	2,347	291	722	-	-	-	-	1,238	3,069
Total Single-Family	*8,562*	*22,617*	*3,257*	*8,455*	*327*	*856*	-	-	*12,146*	*31,928*
Multi-Family										
Bloomington (a)	417	693	860	1,428	-	-	-	-	1,277	2,121
Burnsville	-	-	-	-	-	-	-	-	-	-
Eagan	320	595	-	-	-	-	-	-	320	595
Edina	-	-	-	-	-	-	-	-	-	-
Inver Grove Heights	-	-	-	-	-	-	-	-	-	-
Mendota	-	-	-	-	-	-	-	-	-	-
Mendota Heights	42 (b)	71	-	-	-	-	-	-	42	71
Minneapolis	1,868	3,189	634	1,084	80	138	-	-	2,582	4,411
Richfield	704	1,225	38	66	8	14	-	-	750	1,305
Total Multi-Family	*3,351*	*5,773*	*1,532*	*2,578*	*88*	*152*	-	-	*4,971*	*8,503*
Grand Total	**11,913**	**28,390**	**4,789**	**11,033**	**415**	**1,008**	**-**	**-**	**17,117**	**40,431**

Notes: Includes existing NCP. Values do not include block intersect methodology. All values rounded to the nearest whole number, except for values that would round to zero, which are rounded up.
(a) Excludes 29 single-family and 136 multi-family units within the 65 DNL contour of the 2007 Unmitigated NEM scheduled for purchase and demolition by the MAC prior to the opening of Runway 17/35 in late 2005.
(b) Includes 40 units in Mendota Heights built since 2000 that are ineligible for the Sound Mitigation Program.

Source: HNTB analysis.

NOTES

[1] See 14 CFR 150.7 and 14 CFR Part 150 Table 1.

[2] "Guidelines for Considering Noise in Land Use Planning and Control," Federal Interagency Committee on Urban Noise, June 1980.

[3] Final Report of the Study Group on Compatible Land Use to the FAA Research, Engineering and Development Committee, 1995.

[4] Technical Memorandum to All Regions and AMA-600, Approval of Mitigation Measures in a Part 150 Program That Covers Areas Below DNL 65 dB, Lynn Sparks Pickard, Manager, Community and Environmental Needs Division, APP-600, June 25, 1995.

[5] JAZB is comprised of representatives from the MAC and the cities of Bloomington, Eagan, Mendota, Mendota Heights, Minneapolis, Richfield, St. Paul and Hennepin County.

Chapter Six
NOISE EXPOSURE MAPS

This chapter presents the MSP NEMs for 2002 and 2007, developed in accordance with the provisions of 14 CFR Part 150 *Airport Noise Compatibility Planning.*

Figures 6-1 through 6-3 are the updated MSP NEMs. The certification page at the front of this Study addresses Part 150 requirements regarding the accuracy of the maps and the opportunities provided for public review and input.

Figures 6-1 and 6-2 replace the previously accepted 1991 and 1996 NEMs, pending FAA acceptance of the 2002 and 2007 NEMs. Following FAA review and approval of the revised NCP, Figures 6-1 and 6-3 will represent the official maps.

6.1 YEAR 2002 EXISTING CONDITION NOISE EXPOSURE MAP

Figure 6-1 represents the NEM for existing conditions for the year of submission (2002), assuming the existing NCP, airport layout, operations, and other noise modeling considerations described in Chapter Four. Figure 6-1 is referred to as the 2002 Existing Conditions NEM, or 2002 NEM. From the estimates in Table 5.5, the 60 DNL contour of the 2002 NEM contains 33,466 dwelling units and 79,476 people. Seventy-four percent of the dwelling units are single-family structures. Approximately 76-percent of the affected people and dwelling units are within the 60-64 DNL interval.

6.2 YEAR 2007 UNMITIGATED NOISE EXPOSURE MAP

Figure 6-2 represents the NEM for forecast conditions for the fifth year following the existing conditions (2007), with the existing NCP, Dual Track FEIS runway use assumptions, airport layout that includes Runway 17/35, forecast operations, and other noise modeling assumptions described in Chapter Four. Figure 6-2 is referred to as the 2007 Unmitigated NEM. From the estimates in Table 5.8, the 60 DNL contour of the 2007 Unmitigated NEM contains 17,117 dwelling units and 40,431 people. Seventy-one percent of these dwelling units are single-family structures. Approximately 70-percent of the affected people and dwelling units are within the 60-64 DNL interval.

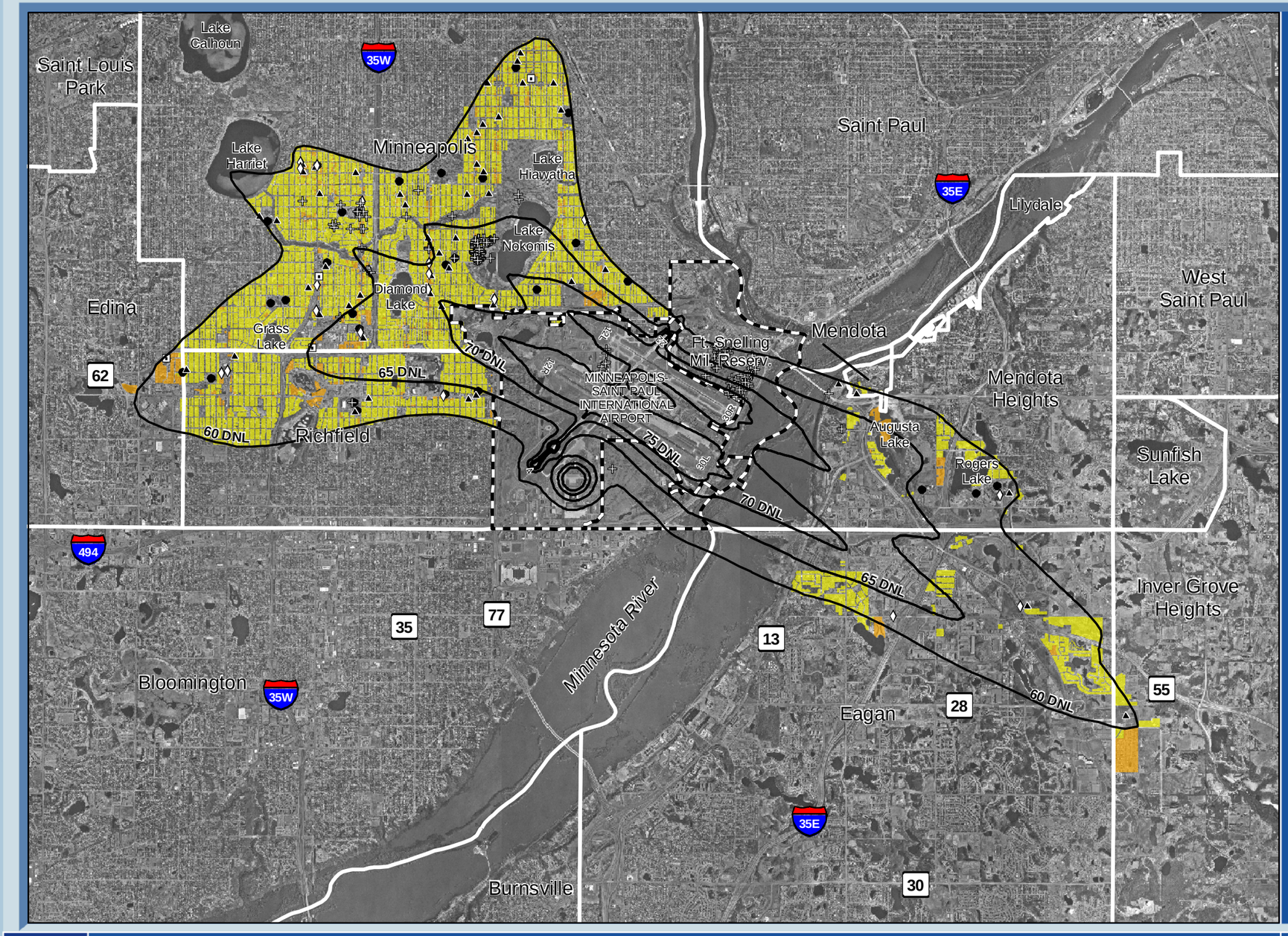
6.3 YEAR 2007 MITIGATED NOISE EXPOSURE MAP

Figure 6-3 represents the NEM for forecast conditions for the fifth year following the existing conditions (2007), with the implementation of the revised NCP noise abatement measures as described in Chapter Seven. The NEM includes the addition of Runway 17/35 and the resulting revised runway and flight track use. Figure 6-3 is referred to as the 2007 Mitigated NEM.

6.3.1 2007 Mitigated NEM Land Use Compatibility

Table 6.1 describes distribution of noise-exposed land areas, by land use within the 2007 Mitigated NEM. Nearly 10,400 acres would be within the 60 DNL contour,

HNTB



Legend of Land Uses

- Single Family Residential
- Multi-Family Residential
- Historic Site
- Nursing Home
- Preschool
- Place of Worship
- School
- Airport Boundary
- Jurisdiction Boundary

N

0 0.5 1 Statute Miles

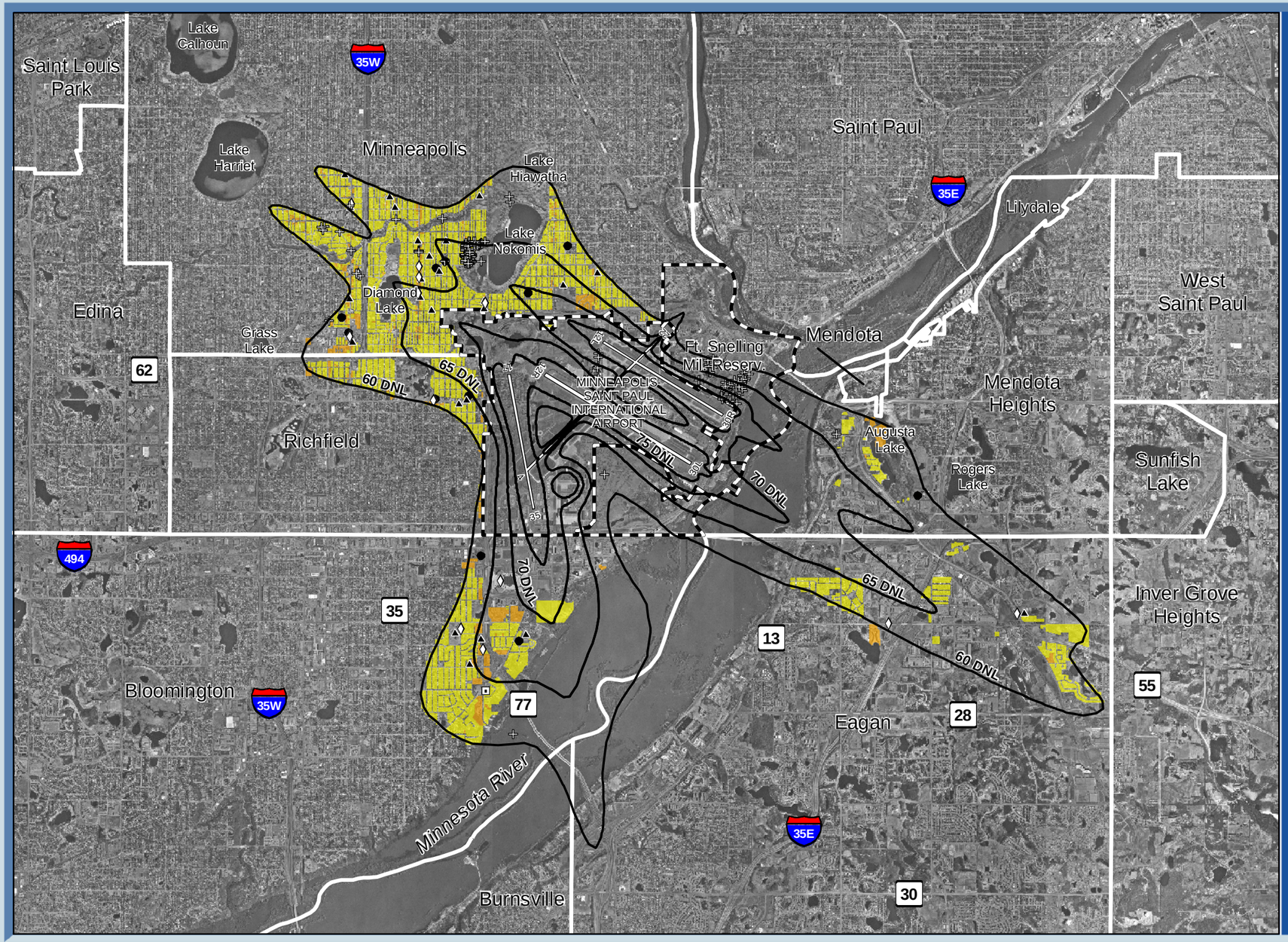
SOURCE OF AERIAL PHOTOGRAPHY: The Metropolitan Council, Minneapolis, MN, April, 1997.
ORIGINAL LAND USE DATA: from the counties of Ramsey, Dakota, and Hennepin, and the municipalities of Bloomington, Burnsville, Eagan, Edina, Inver Grove Heights, Lilydale, Mendota, Mendota Heights, Minneapolis, Richfield, Saint Louis Park, Saint Paul, South Saint Paul, Sunfish Lake, and West Saint Paul, augmented with field data.

Year 2002 Existing Condition Noise Exposure Map

Figure 6-1

Minneapolis-Saint Paul International Airport - Part 150 Update

HNTB



Legend of Land Uses

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- Multi-Family Residential
- Historic Site
- Nursing Home
- Preschool
- Place of Worship
- School
- Airport Boundary
- Jurisdiction Boundary

N

0 0.5 1 Statute Miles

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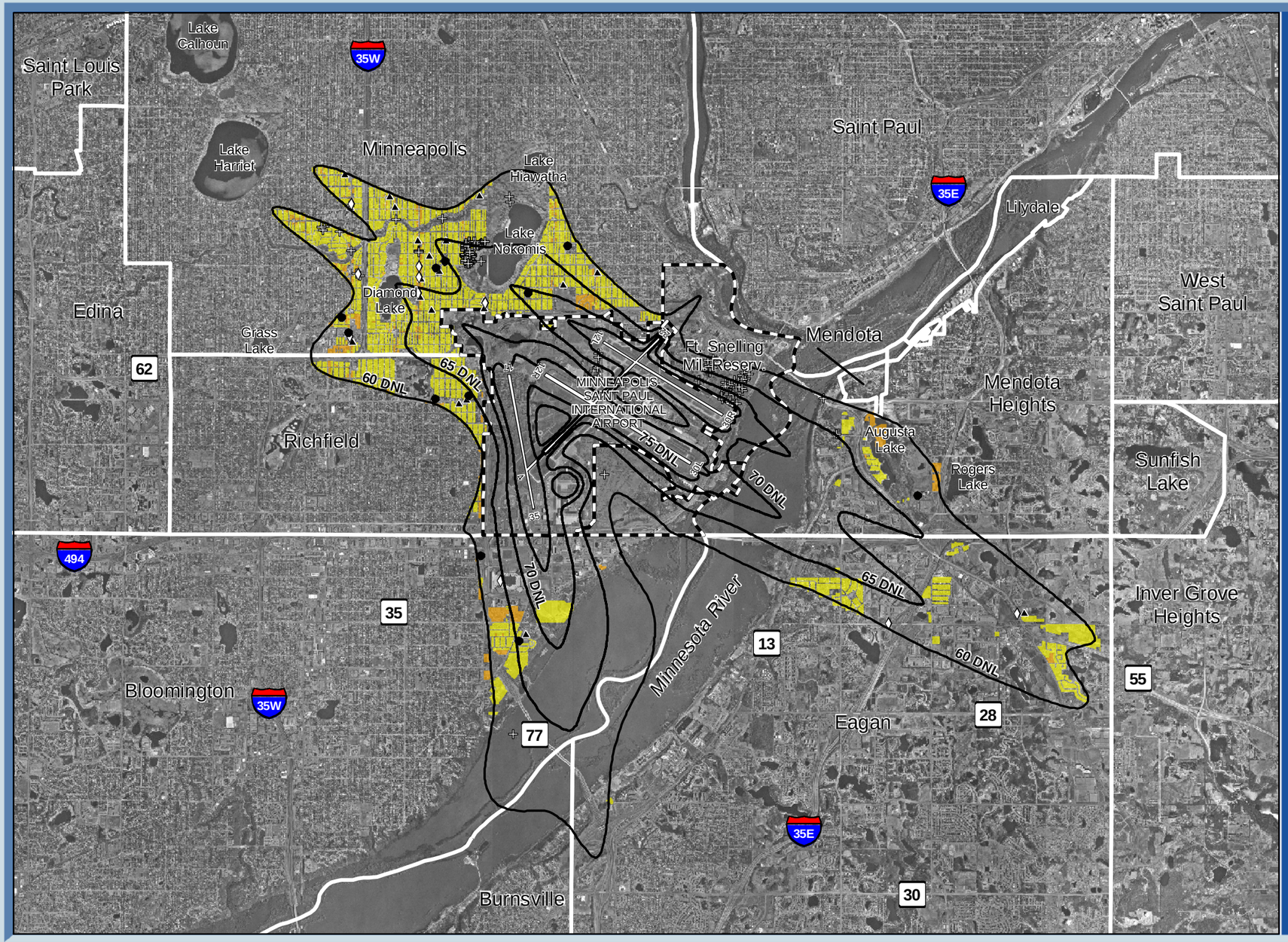
ORIGINAL LAND USE DATA: from the counties of Ramsey, Dakota, and Hennepin, and the municipalities of Bloomington, Burnsville, Eagan, Edina, Inver Grove Heights, Lilydale, Mendota, Mendota Heights, Minneapolis, Richfield, Saint Louis Park, Saint Paul, South Saint Paul, Sunfish Lake, and West Saint Paul, augmented with field data.

Year 2007 Unmitigated Noise Exposure Map

Figure 6-2

Minneapolis-Saint Paul International Airport - Part 150 Update

HNTB



Legend of Land Uses

- Single Family Residential
- Multi-Family Residential
- Historic Site
- Nursing Home
- Preschool
- Place of Worship
- School
- Airport Boundary
- Jurisdiction Boundary

N

0 0.5 1 Statute Miles

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Year 2007 Mitigated Noise Exposure Map

Figure 6-3

approximately 20-percent of which would be single-family residential use. Approximately 63-percent of the acreage within the 60 DNL contour would be in the 60-64 DNL interval. All land within the 75 DNL contour would be considered compatible from a land use perspective.

Table 6.2 shows the number of noise-sensitive structures in the 60 DNL contour of the 2007 Mitigated NEM. Table 6.2 lists five types of noise-sensitive structures, including schools, places of worship, nursing homes, historic structures, and pre-school/child-care facilities. For the 2007 Mitigated NEM, there would be 154 noise-sensitive structures within the 60 DNL contour. Approximately 58-percent of these would be within the 60-64 DNL interval. One school would exist in the 70-74 DNL interval. No noise-sensitive structures would exist within the 75 DNL contour. Appendix F details the noise-sensitive structure information presented in Table 6.2 by city. Most noise-sensitive structures would be located in the City of Minneapolis.

Table 6.3 shows the estimated population and dwelling units by city for the 2007 Mitigated NEM. There would be 14,671 dwelling units and 34,842 people within the 60 DNL contour. Approximately 73-percent of the dwelling units would be of single-family use. Approximately 73-percent of the affected people and dwelling units would be within the 60-64 DNL interval.

Table 6.1

Estimated Off-Airport Acreage within 2007 Mitigated DNL Contours

Generalized Land Use	Acreage Within DNL Contour Interval				
	60-64 dB	65-69 dB	70-74 dB	75+ dB	Total
Single-Family Residential	1,475	468	106	-	2,049
Multi-Family Residential	205	51	8	-	264
Mobile Home Residential	-	-	-	-	-
Nursing Home	-	-	-	-	-
Place of Worship	41	13	-	-	54
School	53	4	4	-	61
Recreation/Open Space	2,582	1,405	584	-	4,571
Government/Public	612	138	1	1	752
Commercial/Office	853	262	239	21	1,375
Industrial	565	328	16	13	922
Agriculture	18	-	59	-	77
Vacant	93	37	6	-	136
Unclassified	65	32	-	-	97
Total	**6,562**	**2,738**	**1,023**	**35**	**10,358**
Compatible	**4,788**	**2,202**	**905**	**35**	**7,930**
Non-compatible	**1,774**	**536**	**118**	**-**	**2,428**

Source: HNTB analysis.

Table 6.2

Estimated Noise-Sensitive Structures within 2007 Mitigated DNL Contours

Structure	Number Within DNL Interval				
	60-64 dB	65-69 dB	70-74 dB	75+ dB	Total
Schools	9	1	1	-	11
Places of Worship	16	7	-	-	23
Nursing Homes	-	-	-	-	-
Child Care/Pre-schools	9	2	-	-	11
Historic	55	54	-	-	109
Total	**89**	**64**	**1**	**-**	**154**

Note: Excludes MSP Airport and Fort Snelling area

Source: HNTB analysis.

Table 6.3

Estimated Residential Land Use within 2007 Mitigated DNL Contours

City	60-64 DNL		65-69 DNL		70-74 DNL		75+ DNL		Total	
	Dwelling Units	Population	Dwelling Units	Population	Dwelling Units	Population	Dwelling Units	Population	Dwelling Units	Population
Single Family										
Bloomington (a)	194	497	85	205	4	11	-	-	283	713
Burnsville	-	-	-	-	-	-	-	-	-	-
Eagan	452	1,446	7	23	-	-	-	-	459	1,469
Edina	-	-	-	-	-	-	-	-	-	-
Inver Grove Heights	-	-	-	-	-	-	-	-	-	-
Mendota	-	-	-	-	-	-	-	-	-	-
Mendota Heights	44	136	4	12	-	-	-	-	48	148
Minneapolis	5,898	15,421	2,535	6,635	300	785	-	-	8,733	22,841
Richfield	921	2,283	274	680	-	-	-	-	1,195	2,963
Total Single-Family	*7,509*	*19,783*	*2,905*	*7,555*	*304*	*796*	-	-	*10,718*	*28,134*
Multi-Family										
Bloomington (a)	611	1,014	84	139	-	-	-	-	695	1,153
Burnsville	-	-	-	-	-	-	-	-	-	-
Eagan	38	71	-	-	-	-	-	-	38	71
Edina	-	-	-	-	-	-	-	-	-	-
Inver Grove Heights	-	-	-	-	-	-	-	-	-	-
Mendota	-	-	-	-	-	-	-	-	-	-
Mendota Heights	273 (b)	429	-	-	-	-	-	-	273	429
Minneapolis	1,672	2,856	604	1,033	76	131	-	-	2,352	4,020
Richfield	549	955	46	80	-	-	-	-	595	1,035
Total Multi-Family	*3,143*	*5,325*	*734*	*1,252*	*76*	*131*	-	-	*3,953*	*6,708*
Grand Total	**10,652**	**25,108**	**3,639**	**8,807**	**380**	**927**	**-**	**-**	**14,671**	**34,842**

Notes: Includes revised NCP. Values do not include block intersect methodology. All values rounded to the nearest whole number, except for values that would round to zero, which are rounded up.
(a) Excludes 29 single-family and 136 multi-family units within the 65 DNL of the 2007 Mitigated NEM scheduled for purchase and demolition by the MAC prior to the opening of Runway 17/35 in late 2005.
(b) Includes 46 units in Mendota Heights built since 2000 that are ineligible for the Sound Insulation Program.

Source: HNTB analysis.

6.4 OVERVIEW OF LAND USE COMPATIBILITY IN NEMS

Table 6.4 summarizes the non-compatible land use for each of the three NEMs. None of the NEMs include people or dwelling units within the 75 DNL contour. As would be expected, the City of Minneapolis has the most population and dwelling units within the 60 DNL contour.

Table 6.4 shows the effect of the existing and proposed NCPs in the year 2007, relative to the existing NCP in the year 2002. By the year 2007, the population and dwelling units within the 60 DNL contour would be reduced by approximately 49-percent with the existing NCP as compared to 2002. The proposed NCP would reduce the population and dwelling units within the 60 DNL contour of the 2007 Mitigated NEM by nearly an additional 14-percent, relative to the 2007 Unmitigated NEM.

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Table 6.4

Summary of Residential Land Use within Noise Exposure Maps

Noise Exposure Map	60-64 DNL		65-69 DNL		70-74 DNL		75+ DNL		Total	
	Dwelling Units	Population	Dwelling Units	Population	Dwelling Units	Population	Dwelling Units	Population	Dwelling Units	Population
Year 2002 Existing Condition NEM	25,406	60,299	6,877	16,419	1,183	2,758	-	-	33,466	79,476
Year 2007 Unmitigated NEM (Existing NCP and Dual Track FEIS Assumptions)	11,913	28,390	4,789	11,033	415	1,008	-	-	17,117	40,431
Year 2007 Mitigated NEM (Proposed NCP)	10,652	25,108	3,639	8,807	380	927	-	-	14,671	34,842

Note: Values do not include block-intersect method.

Source: Tables 5.5, 5.8, and 6.3

Chapter Seven
NOISE ABATEMENT MEASURES

This chapter describes existing and potential noise abatement measures analyzed in the Study. Noise abatement measures consider changes to runway use, flight track use, and other operational procedures that determine where aircraft fly in the immediate vicinity of MSP.

Section 7.1 reviews existing noise abatement measures in the current NCP. Section 7.2 outlines the evaluation criteria used in consideration of modified and new noise abatement measures that are presented in Sections 7.3 and 7.4, respectively. A summary of measures recommended for inclusion in the updated NCP is in Section 7.5.

7.1 STATUS OF EXISTING NOISE ABATEMENT MEASURES

Descriptions of the existing noise abatement measures are provided in **Tables 7.1 through 7.11** along with the FAA's approval decision, implementation status (or reason for disapproval), measure effectiveness and whether the measure is carried forward to the recommended NCP. The verbatim descriptions of the existing noise abatement measures from the 1993 Study are in Section 1.4.

Table 7.1

Status of Existing NA-1: Metropolitan Aircraft Sound Abatement Council (MASAC)

Description	The existing wording of this measure in the FAA approved NCP is contained in Section 1.4.1. Per the existing measure, "MASAC…is comprised of representatives of the airline industry, municipalities surrounding the Airport, and various federal and state agencies. The MASAC should continue to be the official vehicle for addressing airport noise at MSP. Its objectives are to study and evaluate noise complaints, implement effective noise abatement measures, and provide public education in current noise abatement policies and possible future programs." Due to the disbandment of MASAC (as discussed in Section 1.4.1), MAC established the Noise Oversight Committee (NOC) in August 2002. The NOC's purpose is to bring industry and community representatives together to discuss noise issues at MSP and to bring policy recommendations to the MAC. See Sections 1.6.4 and 10.4.1 for additional information on the NOC.
FAA Decision	Approved.
Implementation Status or Reason for Disapproval	MASAC was disbanded in November 2000 due to airport user member resignations in relation to organizational by-law requirements.
Evaluation of Measure Effectiveness, Cost, and Benefit	Cooperative efforts have proven beneficial for discussion and investigation of community and air carrier concerns regarding aircraft-related noise exposure at MSP. This is only possible in a forum that provides a balanced review of all aspects associated with proposed noise mitigation efforts at the airport. In such circumstances, significant strides have been made at MSP related to community education, and efforts to address noise issues around MSP. MAC typically funds all of the associated efforts with budgets ranging from $100,000 to $200,000 annually for noise abatement evaluation, analysis, and potential implementation.
Study Considerations	Due to the disbandment of MASAC, in this Study the existing measure is modified to include the NOC as a successor to MASAC, for inclusion in the revised NCP.

Table 7.2

Status of Existing NA-2: Voluntary Noise Budget Program

Description	MAC adopted a phased-in noise budget ordinance for MSP as part of the NCP included in the 1987 Part 150 Study for MSP. MAC negotiated a voluntary noise budget with Northwest Airlines, Delta Air Lines, Continental Airlines, American Airlines, United Air Lines, and Trans World Airlines.
FAA Decision	Approved as a voluntary measure.
Implementation Status or Reason for Disapproval	Completed in 1992.
Evaluation of Measure Effectiveness, Cost, and Benefit	The Voluntary Noise Budget Program was completed in 1992, and effectively reduced overall noise exposure to communities near MSP to pre-established goals. Quantitative costs of the measure are not available.
Study Considerations	This existing measure is complete. A modified measure, Noise Management Program, is included in the revised NCP.

Table 7.3

Status of Existing NA-3: Voluntary Nighttime Limits on Flights

Description	The MSP Signatory Airlines all agreed to use their "best efforts" to limit nighttime activity to current levels and use Stage 3 aircraft during nighttime hours (10:30 p.m. – 6 a.m., all days of the week).[1]
FAA Decision	Approved as a voluntary measure.
Implementation Status or Reason for Disapproval	Ongoing.
Evaluation of Measure Effectiveness, Cost, and Benefit	The Voluntary Nighttime Limits on Flights was adopted by signatory airlines serving MSP. This measure reduced nighttime traffic, especially nighttime operation of Stage 2 aircraft, and effectively reduced noise exposure as a result. Quantitative costs of this measure are not available.
Study Considerations	The MSP nighttime hours were modified in January 1998 from the period 11 p.m. – 6 a.m. Monday through Friday, and 11 p.m. – 8 a.m. weekends to the period 10:30 p.m. to 6:00 a.m. Monday through Sunday, as part of the 1996 Noise Mitigation Committee's recommendation. For this Study, a modified version of this measure is included in the revised NCP.

Table 7.4

Status of Existing NA-4: Nighttime Powerbacks

Description	All airlines at MSP have agreed to eliminate "powerbacks" during nighttime hours. All nighttime flights will "push back" from the gate with a pushback tractor.
FAA Decision	Approved as a voluntary measure.
Implementation Status or Reason for Disapproval	Ongoing.
Evaluation of Measure Effectiveness, Cost, and Benefit	This measure effectively reduces nighttime ground noise at MSP. Quantitative costs of this measure are not available.
Study Considerations	For this Study, this measure is included in the revised NCP.

Table 7.5

Status of Existing NA-5: Engine Run-up Field Rule

Description	All airlines are required to conduct maintenance run-ups at a designated run-up pad, with aircraft heading in a specific direction to minimize noise in populated areas. Nighttime run-ups are prohibited unless pre-authorized by the MAC.
FAA Decision	Approved.
Implementation Status or Reason for Disapproval	Ongoing.
Evaluation of Measure Effectiveness, Cost, and Benefit	This measure effectively reduces nighttime ground noise at MSP, while providing air carriers sufficient flexibility to perform run-ups without affecting flight schedules. Airlines have agreed to work within the existing MSP Aircraft Engine Run-up procedures field rule. Quantitative costs of this measure are not available.
Study Considerations	The MSP Engine Run-Up Field Rule was updated in February 1999, as discussed in Section 4.3.5. Note that the rule change does not affect this measure, which requires compliance with the Run-Up Field Rule. For this Study, this measure is included in the revised NCP.

Table 7.6

Status of Existing NA-6: Training Restriction

Description	The major carriers at MSP have agreed not to conduct training operations at MSP. No other carriers conduct training flights at MSP at this time.
FAA Decision	Approved as a voluntary measure.
Implementation Status or Reason for Disapproval	Ongoing.
Evaluation of Measure Effectiveness, Cost, and Benefit	Few air carriers conduct training flights at MSP, given the high cost of operating at the Airport due to congestion and the high cost of training itself. This measure encourages training operations at other, more suitable airports. Quantitative costs of this measure are not available.
Study Considerations	For this Study, this measure is included in the revised NCP.

Table 7.7

Status of Existing NA-7: Operating Procedures

Description	The major carriers at MSP have agreed to the following: • Continuing use of noise abatement departure procedures. • Using minimum flap setting when landing. • Limiting the use of reverse thrust on landing during nighttime hours. • Complying with Eagan/Mendota Heights Corridor routing in cooperation with the FAA.
FAA Decision	Approved as a voluntary measure.
Implementation Status or Reason for Disapproval	Ongoing.
Evaluation of Measure Effectiveness, Cost, and Benefit	This measure encourages support and compliance with existing noise abatement procedures at MSP and reduces noise exposure as a result. Quantitative costs of this measure are not available.
Study Considerations	Revisions to the Eagan/Mendota Heights Corridor Procedure and NADP use are described in Section 7.3. For this Study, a modified version of this measure is included in the revised NCP.

Table 7.8

Status of Existing NA-8: Noise Surcharge Differential and Stage 3 Credit

Description	The Noise Surcharge/Differential Landing Fee is designed to recover the cost of noise monitoring and mitigation measures from the airlines. The fee is comprised of the following three parts: • The "Environmental Surcharge" is a per-operation charge imposed on every Stage 2 and Stage 3 landing and takeoff by a Signatory Airline at MSP. • The "Excess Stage 2 Fee" is a per-operation fee imposed on every excess Stage 2 operation at MSP; it equals 30-percent of the Environmental Surcharge. • The "Stage 3 Credit" is a per-operation credit against a Signatory Airline's total Environmental Surcharge and Excess Stage 2 Fees in a given year.
FAA Decision	Approved as a voluntary measure.
Implementation Status or Reason for Disapproval	Expired.
Evaluation of Measure Effectiveness, Cost, and Benefit	This measure provided incentive to use more Stage 3 aircraft as carriers flying Stage 2 aircraft were charged a monetary fee and carriers flying Stage 3 aircraft divided this collected fee among themselves. Total net income via this measure was $0.
Study Considerations	For this Study, this measure is modified to encourage the increased use of manufactured Stage 3 aircraft. It is included in the revised NCP.

Table 7.9

Status of Existing NA-9: Runway Use System (RUS)

Description	The RUS is intended to place aircraft arrivals and departures into the Eagan/Mendota Heights Corridor to the maximum extent possible. The next priority is to maximize the use of the crosswind runway (4/22) in an effort to reduce traffic from the parallel runways (11L/29R and 11R/29L[2]) to and from the northwest during light traffic hours. The proposed extension of Runway 4/22 would increase the number of hours the RUS can be used: from a current average of three hours per day to as many as nine hours per day, depending on wind conditions. The RUS consists of the following daytime and nighttime use priorities: Daytime Hours (0600-2300) • When operations require the use of the parallel runways, a configuration should be selected that will place the majority of traffic in the Eagan/Mendota Heights Corridor when feasible. • When feasible, maximize the use of Runway 4/22 and balance the use at both ends. • Utilize Runway 4/22 in conjunction with the Eagan/Mendota Heights Corridor as much as possible. Nighttime Hours (2300-0600) • Maximize use of the Eagan/Mendota Heights Corridor (head-to-head) when feasible. • If 4/22 is required, use in a balanced manner.
FAA Decision	Approved.
Implementation Status or Reason for Disapproval	Ongoing.
Evaluation of Measure Effectiveness, Cost, and Benefit	The RUS has been effective in routing aircraft over more compatible land use, to the extent possible, and thereby reducing noise impact. Quantitative costs for this measure are not available.
Study Considerations	The increased use of Runway 4/22 was not achieved due to prolonged local issues regarding proposed runway use and the subsequent need to update the Runway 22 Extension FEIS. For this Study, a modified version of this measure is included in the revised NCP.

Table 7.10

Status of Existing NA-10: Airport Noise and Operations Monitoring System (ANOMS)

Description	ANOMS is designed to provide MAC officials with accurate runway use counts specific to aircraft type, aircraft flight path information, and 24-hour noise monitoring data at selected sites within residential communities. The FAA has agreed to provide the MAC with computer-processed Automated Radar Terminal Systems (ARTS IIIA) data from Minneapolis TRACON for use in ANOMS. In addition to providing reliable airport operations data, ANOMS archives data for future airport decisions, validates complaint information, tracks effects of RUS operations, tracks effects of air traffic routing procedures, and assists in the correlation analyses for computer-generated noise contours.
FAA Decision	Approved.
Implementation Status or Reason for Disapproval	Ongoing; MAC's lease agreements include $500,000 for system upgrade and RMT enhancements to monitor Runway 17/35 operations.
Evaluation of Measure Effectiveness, Cost, and Benefit	ANOMS has proved to be an effective system for gathering and disseminating aircraft operational data at MSP. ANOMS allows MAC to objectively investigate noise issues and complaints. To date, the total expenditure on the MSP ANOMS system is $1.6 million since 1992, which includes the initial system cost of $1.2 million.
Study Considerations	For this Study, this measure is included in the revised NCP to ensure that ANOMS is continually updated as new technology is developed.

Table 7.11

Status of Existing NA-11: Noise Abatement Sensitivity Training

Description	MAC works with the airlines and ATC to encourage awareness of noise issues and to help increase compliance with current noise abatement procedures.
FAA Decision	Approved.
Implementation Status or Reason for Disapproval	Ongoing.
Evaluation of Measure Effectiveness, Cost, and Benefit	This measure provides a forum for MAC interaction with ATC, air carriers, and pilots on aircraft noise related issues. Quantitative costs for this measure are not available.
Study Considerations	For this Study, this measure is included in the revised NCP.

7.2 EVALUATION OF NOISE ABATEMENT MEASURES

Noise abatement measures are analyzed for their potential to reduce noise-impacted population within the 60 DNL contour. For a measure to be recommended in the NCP, it must be operationally feasible and follow existing FAA regulations regarding air traffic. Furthermore, the measure cannot unduly increase ATC workload and must be usable by aircraft pilots. In addition, the impact of a measure on airport efficiency is an important consideration in measure development, as proposed improvements cannot significantly reduce the airport's capacity or increase delay. Above all other considerations, a measure must maintain the safety of aircraft operations.

Noise abatement measures may reduce aircraft noise levels or mitigate noise impacting sensitive areas. The proposed aircraft noise abatement measures for MSP in this document were developed and analyzed per Part 150 guidelines and with input from airport staff, aeronautical users, the advisory committees, and the general public. Overall, potential noise abatement measures must be evaluated in terms of effectiveness, feasibility, and cost. The specific criteria that are used in this Study to evaluate potential noise abatement measures are shown in **Table 7.12**. Much of the evaluation conducted in this chapter is organized in the form of tables. This is done to provide structure and consistency for comparison.

Table 7.12

Noise Abatement Measure Evaluation Criteria

Description	Formal description of the proposed measure.
Local Approval	Disposition of local actions on the measure.
Potential Noise Benefit	Estimate potential population changes within the 60+ DNL contour of the 2007 Unmitigated NEM, in reference to existing land use, which could result from a proposed measure.
Effects on Airport Operations/ATC Considerations	Assess ATC and operational feasibility of a proposed measure, in reference to safety, ATC and airline guidelines, aircraft performance, navigation technology, etc. The evaluation of this criterion would be conducted in consultation with ATC and aeronautical users, as appropriate.
Impact on Airport Users	Quantitative cost of measure to aeronautical users, including airlines, resulting from increased delay, taxi distance, or additional flight distance.
Regional Economic Impacts	Qualitative assessment of regional impacts stemming from the measure; for example, airport access restrictions that would cause reduced airline service.
Quality of Service Impacts	Qualitative assessment of potential impacts to service for passengers, including reduced airline schedules and competition, increased delays, etc.
Airline and Airport Capital Costs	Quantitative costs of a measure, including infrastructure improvements, equipment acquisition, etc.
Ease of Implementation and Enforcement	Assessment of probability of successful and effective implementation and any environmental documentation required for FAA approval. To the extent possible, this criterion will also identify the parties responsible for enforcement of the measure.
Legal Factors	Legal constraints to implementation of a measure, including, but not limited to Part 161, federal grant assurances, airline lease agreements with Airport, etc.
Conclusions	Positive or negative recommendation on inclusion of the measure in the revised NCP.

7.3 PROPOSED MODIFICATIONS TO EXISTING NOISE ABATEMENT MEASURES

This section describes proposed modifications to existing, FAA-approved noise abatement measures. Proposed modified noise abatement measures include the following:

- MSP Airport Noise Oversight Committee (NOC)
- Noise Management Program
- Voluntary Reductions of Hushkit Operations
- Refinement of the Eagan/Mendota Heights Corridor Procedure
- Noise Abatement Departure Profiles
- Measures to Increase the Use of Manufactured Stage 3 Aircraft
- Runway Use System

The proposed modified measures are discussed in Sections 7.3.1 through 7.3.7. Each measure has an evaluation table that provides analyses of the measure and a conclusion regarding its inclusion in the final NCP. Supporting graphics are provided, as necessary.

7.3.1 Modified NA-1: MSP Airport Noise Oversight Committee

The existing NA-1 recommends the MASAC continue to be the official organizational body to address noise impact issues and questions around MSP. On October 31, 2000, ten airport user representatives on MASAC resigned from the Council. The resigning organizations included Airborne Express, DHL Worldwide Express, Federal Express, Mesaba Airlines, Northwest Airlines, Trans World Airlines, United Airlines, United Parcel Service, US Airways and the Airline Pilots Association. Concerns focused on the MASAC process and procedures. The catalyst for the resignations focused on concerns that MASAC had become an unbalanced community advocacy group and did not provide a viable framework for comprehensive discussions regarding noise abatement efforts at MSP. An eleventh airport user representative, Delta Airlines, resigned at a later date citing the same concerns.

As a result of the organizational balance required in the by-laws of MASAC, the Council was no longer able to conduct business and was therefore discontinued. See Sections 1.4.1 and 1.6.3 for more information on MASAC. The airport users stated that they were not willing to participate in any vestige of MASAC, but that they are willing to participate in efforts to establish a new NOC.

Following the discontinuation of MASAC in late 2000, a Blue Ribbon Panel was convened to formulate a structure for a new airport noise committee at MSP. The result was the formation of the NOC.

As described in Section 10.4.1, MAC established the NOC in August 2002 for the purpose of bringing airline industry and community representatives together to discuss noise issues at the MSP and to bring policy recommendations to the MAC.

Table 7.13 contains an evaluation of this measure.

Table 7.13

Evaluation of Modified NA-1: MSP Airport Noise Oversight Committee

Description	Due to the disbandment of MASAC, MAC established the Noise Oversight Committee (NOC) in August 2002. NOC's purpose is to bring industry and community representatives together to discuss noise issues at the MSP and to bring policy recommendations to the MAC. See Section 10.4.1 for additional information on NOC.
Local Approval	Measure approved by MSP Aviation Noise Blue Ribbon Panel (3 members from communities and three members from airport user organizations – appointed by the respective constituencies in an effort to develop a new MSP Airport Noise Oversight Committee). The NOC framework was approved by MAC on August 19, 2002.
Potential Noise Benefit	Provides a balanced forum for the development, evaluation and implementation of noise-reducing proposals around MSP.
Effects on Airport Operations/ATC Considerations	None.
Impact on Airport Users	Provide members to the Committee.
Regional Economic Impacts	None.
Quality of Service Impacts	None.
Airline and Airport Capital Costs	Organization support costs for MAC. Possible airline costs associated with mutually (airport user and community) acceptable operational or procedural noise reduction efforts.
Ease of Implementation and Enforcement	NOC began operations in June 2003.
Legal Factors	None; voluntary in nature.
Conclusions	This measure is critical to the effective management of aircraft noise impacts/issues and the successful implementation of noise mitigation measures around MSP. The NOC will ensure that all impacted parties (airport users and communities) are part of a balanced forum for the development, evaluation and implementation of noise-reducing proposals around MSP. As a result, the measure is included in the revised NCP.

7.3.2 Modified NA-2: Noise Management Program

This measure would replace the noise budget program, which was completed in 1992. **Table 7.14** contains an evaluation of this measure.

Table 7.14

Evaluation of Modified NA-2: Noise Management Program

Description	This measure requires MAC to consider incentives and disincentives to reduce the impact of aviation noise in the surrounds of MSP. The Noise Management Program would consist of voluntary incentives to promote reduction of noise impact. These incentives/disincentives would be developed after analysis of their potential benefit to the noise environment.
Local Approval	Measure approved by MASAC on September 29, 2000 and the MAC Commission on August 20, 2001.
Potential Noise Benefit	Reduction of the noise impact associated with MSP in the surrounding communities.
Effects on Airport Operations/ATC Considerations	None, measure(s) would be developed so as to not impact safety or capacity.
Impact on Airport Users	Potentially higher ticket prices, depending on the structure of the incentives or disincentives.
Regional Economic Impacts	None, voluntary measure.
Quality of Service Impacts	None.
Airline and Airport Capital Costs	Users agreeing to voluntary measure(s) may benefit relative to non-participating users.
Ease of Implementation and Enforcement	MAC would negotiate incentives program with MSP users as necessary.
Legal Factors	None; voluntary measure.
Conclusions	This measure will allow continued analysis of incentives/disincentives that may benefit the communities surrounding MSP. As a result, this measure is included in the revised NCP.

7.3.3 Modified NA-3: Voluntary Nighttime Limits on Flights

The existing NA-3 requests airlines to use their "best efforts" to limit nighttime activity to current levels and use Stage 3 aircraft during nighttime hours (10:30 p.m. to 6 a.m., all days of the week). Modified measure NA-3 considers an addendum to voluntarily reduce the use of hushkit aircraft.

The Airport Noise and Capacity Act of 1990 (ANCA) does not permit the operation of Stage 2 aircraft with a maximum takeoff weight greater than 75,000 pounds after December 31, 1999. In order to comply with the ANCA, many airlines chose to retrofit their existing Stage 2 aircraft with hushkits. The hushkits reduce engine noise using acoustical liners in the engine nacelles, and/or exhaust mixers that reduce the noise produced by engine exhaust. Hushkits allow older aircraft to meet Stage 3 certification standards, and operate indefinitely after the December 31, 1999, deadline. Note that for the purpose of this discussion, the term "Stage 2" refers to aircraft with a maximum takeoff weight greater than 75,000 pounds. Stage 2 aircraft with takeoff weights below 75,000 pounds, such as Lear 25 business jets, are permitted by ANCA to continue to operate in the United States.

Hushkit aircraft that operate at MSP include the B72Q, DC9Q, DC8Q, and B73Q (i.e., B737-200 with hushkit). The B737-200 is an older version of the B737; newer versions are manufactured to Stage 3 standards. In 2002, there were a total of about 348 average daily hushkit operations, while in 2007 a total of about 275 average daily hushkit operations are forecast.

Although hushkit aircraft meet the Stage 3 standard, they are substantially louder than most new aircraft manufactured to Stage 3 standards. As a result, the continued operation of hushkit aircraft has become an area of concern for communities near MSP. Reductions in the use of hushkit aircraft, with a corresponding increase in the use of manufactured Stage 3 aircraft, offer the greatest potential to significantly reduce noise exposure around MSP, especially at night.

Mandatory restrictions on the use of hushkit aircraft were not recommended in this Study, for the following reasons:

- While ANCA mandated the phase-out of Stage 2 aircraft, it also largely prohibits airports from imposing noise-based restrictions on aircraft.

- The manufacturing base and finances do not exist for the expedient replacement of all hushkitted aircraft. A restriction on the use of hushkitted aircraft would reduce air service at MSP, as replacement aircraft are not readily available for a national phase-out of the hushkitted fleet.

- The restriction would adversely impact air carriers and associated industries. For many cargo and freight carriers, their entire fleets consist of hushkit aircraft. Given the typical low utilization of cargo aircraft, the cargo carriers would be financially unable to purchase newly manufactured aircraft. The restriction would effectively bar these carriers from serving MSP.

- A Part 161 Study would be required to gain Federal approval to restrict hushkitted aircraft, with little chance of FAA approval and successful implementation.

A Part 161 Study requires that the economic costs and benefits of the restriction be considered. Given the severe economic impacts that the mandatory restriction would have on the local economy, it is unlikely that the noise benefit of the restriction would justify the economic costs.

The following initiatives for reducing the use of hushkit aircraft, especially at night, were considered.

- Moving some nighttime operations into the daytime, in effect "squeezing" the flight schedule, thereby reducing the number of night operations. However, qualitative SIMMOD trend analyses show that the increased delays resulting from a squeezed schedule would not offset the noise benefit (as defined by the cost to insulate fewer homes within the smaller noise contours).

- An analysis of airlines using MSP was conducted to estimate future aircraft purchases and the subsequent replacement of hushkit aircraft. During the past few years, airlines have accelerated their fleet modernization programs. Although the analysis shows promise, there are no guarantees of future purchases.

- *Voluntary agreements* on behalf of the airlines offer the best opportunity to expeditiously reduce night operation of hushkit aircraft. Although all airlines would not take part in the proposed voluntary reduction, the primary carrier at MSP has agreed to consider adopting a voluntary measure.[3]

Two options to voluntarily reduce hushkit operations were considered in the Study. Modified NA-3, Option 1, implements a voluntary reduction of hushkit operations (24 hours). Modified NA-3, Option 2, implements a voluntary reduction of hushkit aircraft during MSP nighttime hours and is essentially similar to the previous Stage 2 voluntary agreement that reduced the operation of Stage 2 aircraft at night (See NA-3 in Section 7.1). To date, all airlines at MSP have adopted the existing voluntary measure, which has proven to be effective.

Figure 7-1 shows Modified NA-3, Option 1 and 2, compared to the 2007 Unmitigated NEM. The two options consider a complete replacement of hushkit aircraft with appropriate manufactured Stage 3 aircraft, during (1) the entire day (24 hours) and during (2) MSP nighttime hours only (10:30 p.m. to 6:00 a.m.). Figure 7-1 shows that reducing hushkit operations throughout the entire 24-hour day would generate less overall noise exposure than reducing operations during only the MSP nighttime period. Although neither option is currently 100-percent achievable, they show the potential that reductions in hushkit operations offer to decrease noise exposure.

Tables 7.15 a**nd 7.16** contain detailed evaluations of Options 1 and 2, respectively.

Modified NA-3: Voluntary Reduction of Hushkit Operations

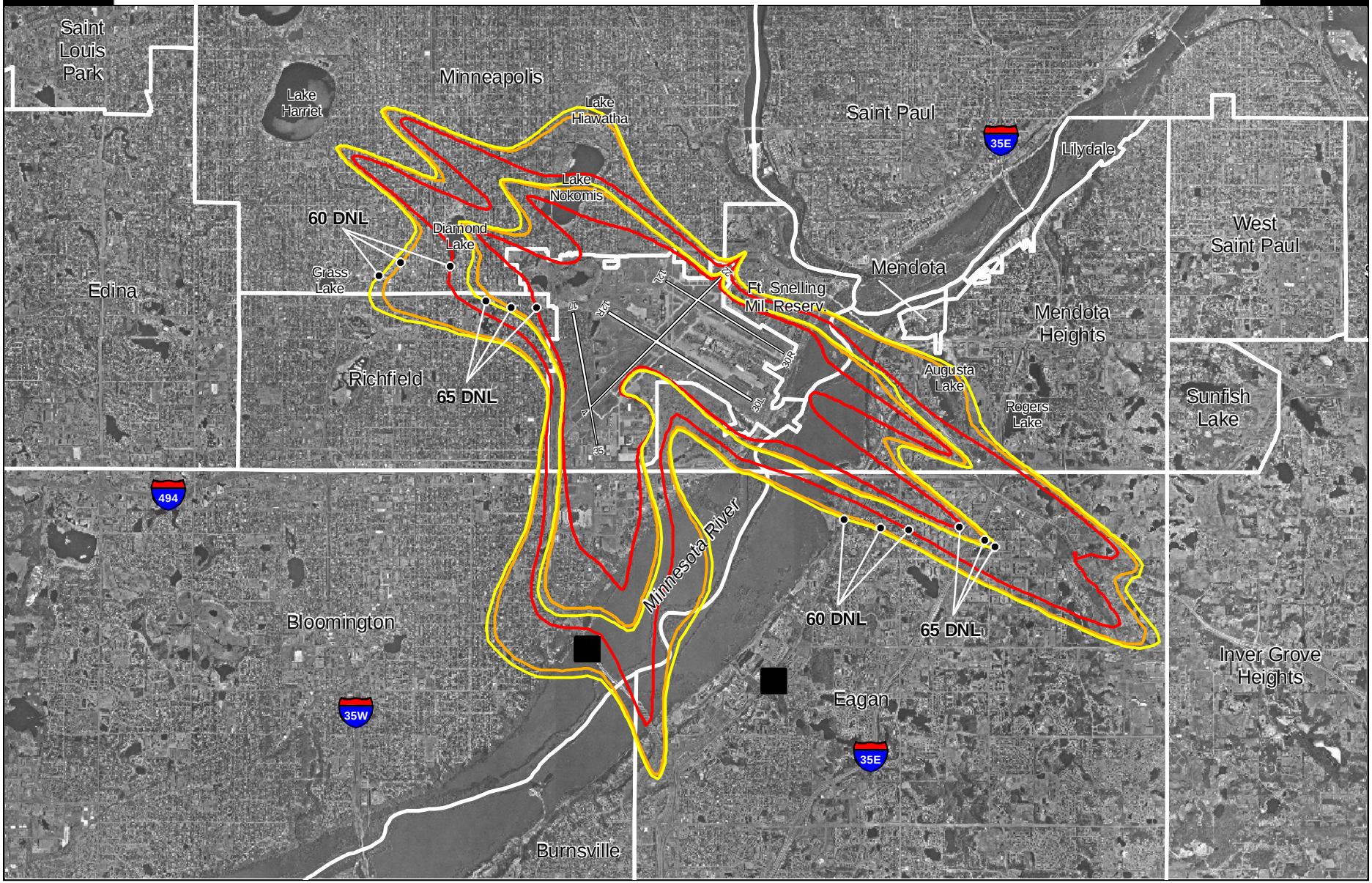


Figure 7-1

Table 7.15

Evaluation of Modified NA-3, Option 1: Voluntary Reduction of Hushkit Operations

Description	Voluntary reduction of all (24-hour) hushkit operations, including the following: • Airlines agree not to operate or schedule hushkit aircraft at MSP. • Exceptions permitted for emergencies, mechanical problems, ATC delays, and weather.
Local Approval	Not Applicable.
Potential Noise Benefit	Example noise analysis showed that the replacement of all hushkit aircraft, by manufactured Stage 3 aircraft, would reduce population within the 60 DNL contour by 17,323 people and 7,379 dwellings, relative to the 2007 Unmitigated NEM. This represents a decrease of about 43-percent over the 40,431 people and 17,117 dwellings in the 2007 Unmitigated NEM.
Effects on Airport Operations/ATC Considerations	None.
Impact on Airport Users	Only airlines with flight schedules and aircraft fleet mixes that allow them to reduce hushkit operations would take part in the program. Other airlines would likely elect not to participate in the program.
Regional Economic Impacts	None.
Quality of Service Impacts	None.
Airline and Airport Capital Costs	None. A voluntary reduction of hushkit operations would not prompt airlines to purchase new aircraft. As discussed above, only airlines with flight schedules and aircraft types that allow them to economically reduce hushkit operations would participate in the program. As a result, this measure has no capital costs.
Ease of Implementation and Enforcement	MAC would pursue voluntary agreements with airlines serving MSP. MAC would verify compliance with the voluntary agreements by monitoring flight operations using ANOMS.
Legal Factors	Minor.
Conclusions	This option is not practical or feasible due to the substantial number of daytime hushkit operations at MSP. As a result, this option is not included in the new NCP.

Table 7.16

Evaluation of Modified NA-3, Option 2: Voluntary Nighttime Limits on Flights

Description	Voluntary reduction of nighttime operations, including the following: • Airlines requested to limit operations of all aircraft during MSP nighttime hours (10:30 p.m. to 6 a.m., all days of the week). • Airlines agree not to operate or schedule hushkit aircraft during MSP nighttime hours (10:30 p.m. to 6 a.m.). • Exceptions permitted for emergencies, mechanical problems, ATC delays, and weather.
Local Approval	Approved by the MASAC OPS Committee on July 14, 2000, MASAC on July 25, 2000, and the MAC Commission on August 20, 2001.
Potential Noise Benefit	Example noise analysis showed that the replacement of MSP nighttime hushkit aircraft, by manufactured Stage 3 aircraft, would reduce population within the 60 DNL contour by 4,082 people and 1,867 dwellings, relative to the 2007 Unmitigated NEM. This represents a decrease of about 10-percent versus the 40,431 people and 17,117 dwellings in the 2007 Unmitigated NEM.
Effects on Airport Operations/ATC Considerations	None.
Impact on Airport Users	Only airlines with flight schedules and aircraft fleet mixes that allow them to reduce night hushkit operations would take part in the program. Other airlines would likely elect not to participate in the program.
Regional Economic Impacts	None.
Quality of Service Impacts	None.
Airline and Airport Capital Costs	None. A voluntary reduction of night hushkit operations would not prompt airlines to purchase new aircraft. As discussed above, only airlines with flight schedules and aircraft types that allow them to economically reduce hushkit operations would participate in the program. As a result, this measure has no capital costs.
Ease of Implementation and Enforcement	MAC would pursue voluntary agreements with airlines serving MSP. MAC would verify compliance with the voluntary agreements by monitoring flight operations using ANOMS.
Legal Factors	Minor.
Conclusions	Although the voluntary reduction program will not achieve 100-percent compliance, it offers the potential to significantly reduce noise exposure. As a result, this option is included in the revised NCP.

7.3.4 Modified NA-7, Part A: Refinement of the Eagan/Mendota Heights Corridor Procedure

The Eagan/Mendota Heights Corridor (referred to as the "Corridor") is an area that contains the Minnesota River and commercial and industrial land immediately east of MSP, as shown in Figure 4-3 and detailed in Sections 4.3.2 and 4.3.3. The Corridor has the lowest density residential population of any current noise-impacted area surrounding MSP. The goal of the Corridor procedure is to concentrate aircraft overflights over more compatible land use (non-residential), as compared to other areas around MSP.

7.3.4.1 History

Various adjustments and refinements to the Corridor procedure have occurred over the past 30 years. The Preferential Runway System (PRS), established in 1969, affirmed the use of the Corridor as the first priority for overflights. Corridor procedures were defined and implemented in 1974, and the existing Corridor procedures were established in the mid-1980s. The PRS was replaced by the RUS in 1991.

The use of the Corridor procedure has frequently been a controversial operational procedure. In the early 1990s, following several years of inconclusive deliberation on Corridor procedure alternatives by various groups, MAC made two proposals for altering Corridor operations: Crossing in the Corridor procedure, and North Corridor Boundary of 095-degrees. The proposals are described below.

MAC Proposal 1 – Crossing in the Corridor Procedure

During non-simultaneous departure operations, whenever possible, aircraft departing from Runway 12R should be assigned to a 105-degree heading, and aircraft departing from Runway 12L should be assigned a heading that will approximate a 118-degree track across the ground. This proposal, which became known as the Crossing in the Corridor procedure, routes departing aircraft into the center of the Corridor, and away from residential areas near the Corridor boundary.

Non-simultaneous departure conditions exist whenever departing aircraft are not using the parallel runways at the same time. If the time between departures is greater than two minutes, non-simultaneous departure conditions exist. If, for example, an aircraft has just departed from Runway 12R, and another aircraft will not depart from Runway 12L within at least two minutes, *non-simultaneous* departure conditions exist. If the time between departures is less than two minutes, *simultaneous* departure conditions exist and the crossing in the corridor procedure cannot be used, as it would route aircraft on converging headings. Simultaneous departures from parallel runways must be assigned divergent headings, per ATC regulations. Use of the procedure during heavy traffic would significantly reduce runway capacity.

Additionally, the procedure can only be used when there is a single controller managing traffic arriving and departing the parallel runways. Throughout most of the day, ATC staffs a separate local controller for each of the parallel runways. This means that one controller manages traffic on Runway 12L/30R, and another manages traffic on Runway 12R/30L. The two controllers essentially operate independently of each other. A single controller, managing both parallel runways, is necessary to determine that non-simultaneous departure conditions exist and to ensure the safety of the procedure.

Because of these factors, the Crossing in the Corridor procedure is typically used at night. The FAA approved an Environmental Assessment (EA) analyzing the procedure in February 1997, and the procedure was successfully implemented in May 1997. Use of the Crossing in the Corridor procedure was reaffirmed in the Low-Demand Flight Track analysis, as described in Section 7.4.1.

MAC Proposal 2 – North Corridor Boundary of 095-Degrees

During simultaneous departure conditions, the proposal recommends the establishment of a north Corridor boundary at a heading of 095-degrees. This is five-degrees south of the existing Corridor boundary, which is on a 090-degree heading. The existing south boundary, using the Runway 30L localizer, is maintained in the proposal. The 095-degree north corridor boundary proposal has not been implemented, but is analyzed in this Study. Additional discussion is provided in the analysis of NA-7, Part A, Option 1.

7.3.4.2 Eagan/Mendota Heights Corridor Procedure Analysis

Three options specific to Corridor procedures were analyzed in the Study:

- Option 1 - North Corridor Boundary of 095-Degrees, considers the establishment of a north Corridor boundary at a heading of 095-degrees, Five degrees south of the existing boundary.

- Option 2 - Symmetry, considers the establishment of a southern Corridor boundary at a heading of 150-degrees. This would establish a symmetrical Corridor procedure, with boundaries 30-degrees north and 30-degrees south of the extended runway centerline.

- Option 3 - Fan, considers the elimination of the Corridor procedure.

Option 1 - North Corridor Boundary of 095-Degrees

Option 1 is identical to MAC's Proposal 2, introduced in Section 7.3.4.1. The option would move the north Corridor boundary south from the existing heading of 090-degrees to a heading of 095-degrees. The existing south Corridor boundary would not be changed. The purpose of this option is to move jet departures away from residential areas north of Highway 110.

Per ATC procedures, successive departures from the same runway, and simultaneous departures from parallel runways, must be assigned headings that are at least 15-degrees divergent of each other. Divergent headings are assigned so that aircraft are heading away from each other, and to ensure adequate aircraft separation. Runway capacity is significantly reduced if sufficient divergent headings are not available, as intrail spacing (i.e., aircraft separation) must then be increased.

The existing Corridor procedure allows for three primary divergent headings from the parallel runways: 90-degrees, 105-degrees, and 120-degrees. This results in a 30-degree fan. Moving the north Corridor boundary south by even 5-degrees would reduce the fan to 25-degrees, allowing sufficient airspace for only two divergent flight tracks. The availability of only two divergent flight tracks would significantly reduce runway capacity, as two flight tracks would not permit the operation of successive and simultaneous departures from the parallel runways, as existing Corridor procedures permit.

Note that the aircraft routed via the 090, 105, and 120-degree headings from Runway 12L are modeled by tracks B, C-F, and G-H, respectively, as shown in Figure 4-6. Aircraft routed via the 090, 105, and 120-degree headings from Runway 12R are modeled by tracks A, B, and C-E, respectively, as shown in Figure 4-7. See Section 4.3.3 for additional information on modeled flight tracks.

For example, a departure from Runway 12R is assigned a 120-degree heading, and a simultaneous departure from Runway 12L is assigned a 105-degree heading. The aircraft are 15-degrees divergent of each other. The next, successive departure from Runway 12R is assigned a 105-degree heading, so that it is divergent from the aircraft that just departed from the same runway. The second simultaneous departure from Runway 12L is assigned a 090-degree heading, so that it is divergent from both the previous departure on the same runway and the departure from Runway 12R assigned to the 105-degree heading. This option would eliminate the availability of the 90-degree heading. Without the 090-degree heading, the second departure on Runway 12L would be delayed.

The FAA and ATC have previously stated opposition to this option.[4]

Figure 7-2 shows a comparison of the existing and Option 1 Corridor procedures, and the resulting noise contours. Evidenced by the proximity of the sets of contours in the figure, Option 1 does not significantly affect overall noise exposure, relative to the 2007 Unmitigated NEM.

Table 7.17 contains a detailed evaluation of Option 1.

Option 2 – Corridor Symmetry

Option 2 would move the south boundary of the Corridor to a heading of 150-degrees. The existing north Corridor boundary would not be changed. This would establish a symmetrical Corridor, with boundaries 30-degrees north and 30-degrees south of the extended centerline of Runways 12L and 12R, respectively.

The purpose of the option is to reduce jet overflights of homes east of the three-mile Corridor boundary. Although these homes are outside of the Corridor, they are overflown by departing aircraft that are prevented from turning south prior to the end of the Corridor. The option would not reduce overflights by eastbound aircraft, but it would allow southbound and westbound departures to turn sooner than existing Corridor Procedures permit.

Figure 7-3 shows a comparison of the existing and Option 2 Corridor Procedures, and the resulting noise contours. **Table 7.18** contains a detailed evaluation Option 2.

Modified NA-7, Part A, Option 1: North Corridor Boundary of 095°

2007 Unmitigated NEM

2007 Unmitigated NEM w/Modified NA-7, Part A, Option 1

0 1 2 Miles

N

Figure 7-2

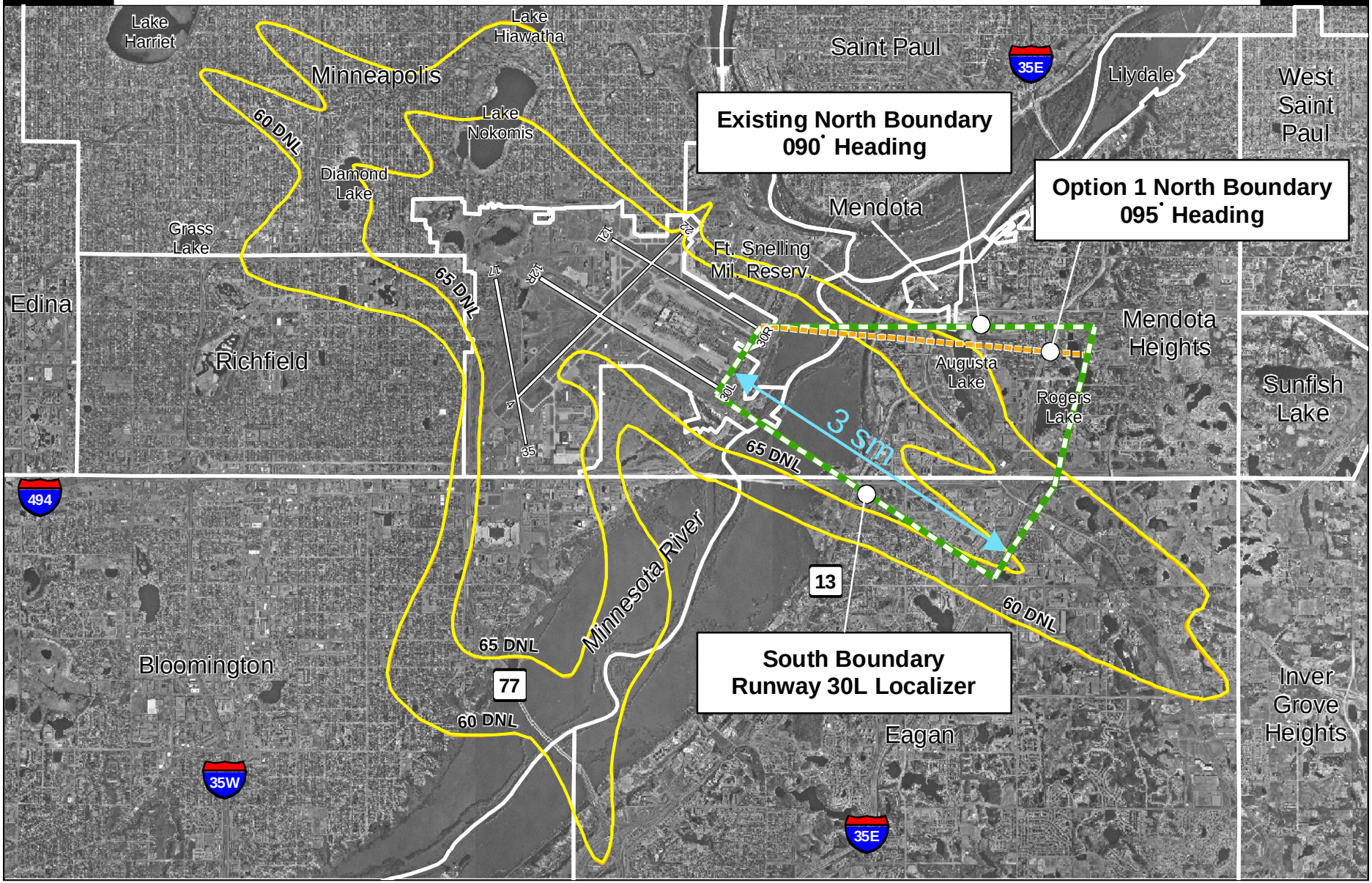


Table 7.17

Evaluation of Modified NA-7, Part A, Option 1: North Corridor Boundary of 095-Degrees

Description	The existing Corridor procedure would be amended to allow ATC to assign headings inclusive of 095-degrees to 120-degrees to jet aircraft departing from Runways 12L and 12R. As a result, the north boundary of the Eagan/Mendota Heights Corridor would be moved south from the existing heading of 090-degrees to a heading of 095-degrees. The existing south Corridor boundary would not be changed.
Local Approval	MASAC OPS accepted the consultant's recommendation to maintain the existing Corridor procedure.
Potential Noise Benefit	This alternative measure provides no substantial noise benefit. ANOMS data shows that approximately 73-percent of the departure aircraft that use the 090-degree heading are turboprop or piston prop aircraft. Because of the relatively quiet noise characteristics of these aircraft, and their predominant use of the 090-degree heading, there was no significant change in the DNL contour as a result of moving the flight track to a 095-degree heading. Additionally, the increased delay that would result from this option would likely result in increased nighttime aircraft operations, as delays cause aircraft operations to slip into the nighttime period; the potential increase in noise exposure resulting from increased delay was not analyzed and is not reflected in Figure 7-2.
Effects on Airport Operations/ATC Considerations	Departure runway capacity in east flow would be reduced significantly. SIMMOD analysis showed that delays would increase by an average of 6 minutes per departure in 2010 relative to the existing Corridor procedure. This equates to an increase in delay of approximately 41-percent. This would result in increased airline operating costs of approximately $155 million annually.
Impact on Airport Users	Increased delay would increase airline operating costs, and possibly discourage new airlines from entering the MSP market.
Regional Economic Impacts	Increased airline operating costs would likely be reflected in higher air fares and diminished economic growth for aviation-related companies.
Quality of Service Impacts	Service would be degraded, as increased delays would result in longer waits for departing aircraft and later arrivals at destinations.
Airline and Airport Capital Costs	None.
Ease of Implementation and Enforcement	MAC would request amendment of ATCT standard operating procedures regarding the Eagan/Mendota Heights Corridor Procedure. An environmental noise screen would be required.
Legal Factors	None.
Conclusions	This measure would significantly increase airport delay, while producing negligible noise benefits. As a result, this option is not included in the revised NCP.

Modified NA-7, Part A, Option 2: Corridor Symmetry

2007 Unmitigated NEM

2007 Unmitigated NEM w/Modified NA-7, Part A, Option 2

0 1 2 Miles

N

Figure 7-3

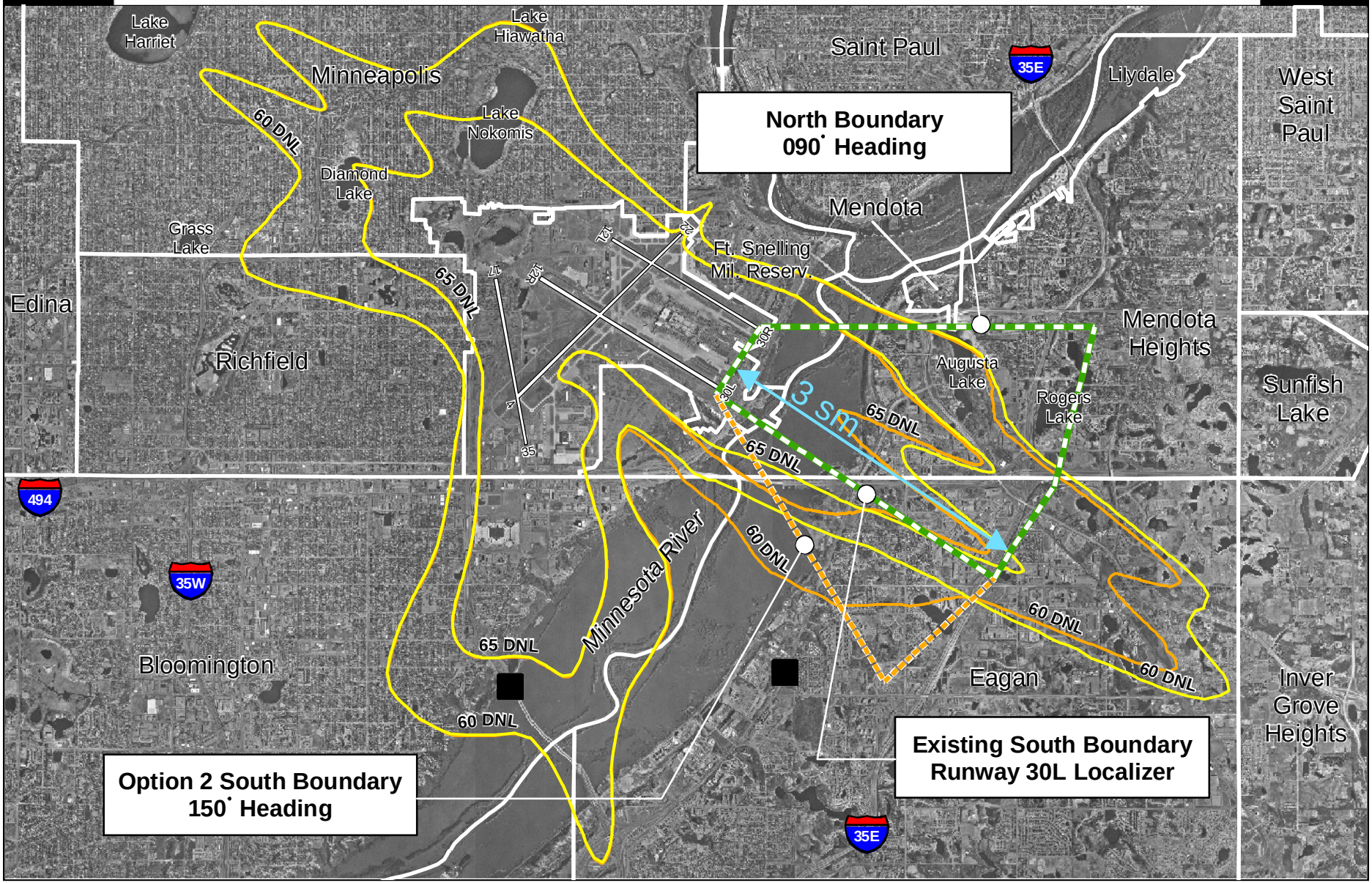


Table 7.18

Evaluation of Modified NA-7, Part A, Option 2: Corridor Symmetry

Description	The existing Corridor Procedure would be amended to allow ATCT to assign headings inclusive of 90-degrees to 150-degrees to jet aircraft departing from Runways 12L and 12R. As a result, the southern boundary of the Eagan/Mendota Heights Corridor would be moved south to a heading of 150-degrees. The existing north Corridor boundary would not be changed.
Local Approval	MASAC OPS accepted the consultant's recommendation to maintain the existing Corridor procedure.
Potential Noise Benefit	Overflights of homes east of the Corridor boundary would be reduced, but overflights would increase for homes south of the existing Corridor boundary. This area is largely residential, and is currently not impacted by Corridor operations. The option would increase population within the 60 DNL contour by approximately 236 people and 65 dwellings, relative to the 2007 Unmitigated NEM.
Effects on Airport Operations/ATC Considerations	Runway capacity would increase slightly, with a corresponding decrease in aircraft delays, as aircraft concentration and interactions in the Corridor would be reduced.
Impact on Airport Users	Flight time for southbound and westbound departures from Runways 12L and 12R would be slightly reduced.
Regional Economic Impacts	None.
Quality of Service Impacts	Reduced delays and more direct routings would improve quality of service.
Airline and Airport Capital Costs	Additional funding for the Sound Mitigation Program would be required to mitigate the additional 65 dwellings that would be impacted by this option.
Ease of Implementation and Enforcement	MAC would request amendment of ATCT standard operating procedures regarding the Eagan/Mendota Heights Corridor Procedure. Environmental documentation may be required for implementation.
Legal Factors	None.
Conclusions	The option shifts noise exposure from currently impacted homes and compatible land uses to non-impacted homes, and increases the total population within the 60 DNL contour. As a result, this option is not included in the revised NCP.

Option 3 – Fan

Option 3 would eliminate the Eagan/Mendota Heights Corridor Procedure. Aircraft would be assigned any heading deemed appropriate by ATCT.

The purpose of this option is to reduce jet overflights of homes east of the three mile Corridor boundary. Although these homes are outside of the Corridor, they are overflown by departing aircraft that are prevented from turning to the north and south. This option would not reduce overflights of eastbound aircraft, but it would allow northbound, southbound, and westbound departures to turn sooner than existing Corridor procedures permit.

Figure 7-4 shows a comparison of the existing Corridor Procedure and Option 3, and the resulting noise contours. **Table 7.19** contains a detailed evaluation of this option.

Table 7.19

Evaluation of Modified NA-7, Part A, Option 3: Fan

Description	The existing Corridor Procedure would be discontinued. Aircraft departing from Runways 12L and 12R would be assigned any heading deemed appropriate by ATCT.
Local Approval	MASAC OPS accepted the consultant's recommendation to maintain the existing Corridor procedure.
Potential Noise Benefit	Overflights of homes east of the Corridor boundary would be reduced, but overflights would increase for homes north and south of the existing Corridor boundaries. These areas are largely residential, and are not currently impacted by aircraft noise. The option would increase population within the 60 DNL contour by approximately 321 people and 138 dwellings as compared to the 2007 Unmitigated NEM.
Effects on Airport Operations/ATC Considerations	Runway capacity would increase slightly, with a corresponding decrease in aircraft delays, as aircraft concentration and interactions in the Corridor would be reduced.
Impact on Airport Users	Flight time for northbound, southbound, and westbound departures from Runways 12L and 12R would be slightly reduced.
Regional Economic Impacts	None.
Quality of Service Impacts	Reduced delays and more direct routings would improve quality of service.
Airline and Airport Capital Costs	Additional funding for the Sound Mitigation Program would be required to mitigate the additional 138 dwellings that would be impacted by this option.
Ease of Implementation and Enforcement	MAC would request amendment of ATCT standard operating procedures regarding the Eagan/Mendota Heights Corridor Procedure. Environmental documentation may be required for implementation.
Legal Factors	None.
Conclusions	The option shifts noise exposure from currently impacted homes and more compatible land uses to non-impacted homes, and increases the total population within the 60 DNL contour. As a result, this option is not included in the revised NCP.

Modified NA-7, Part A, Option 3: Fan

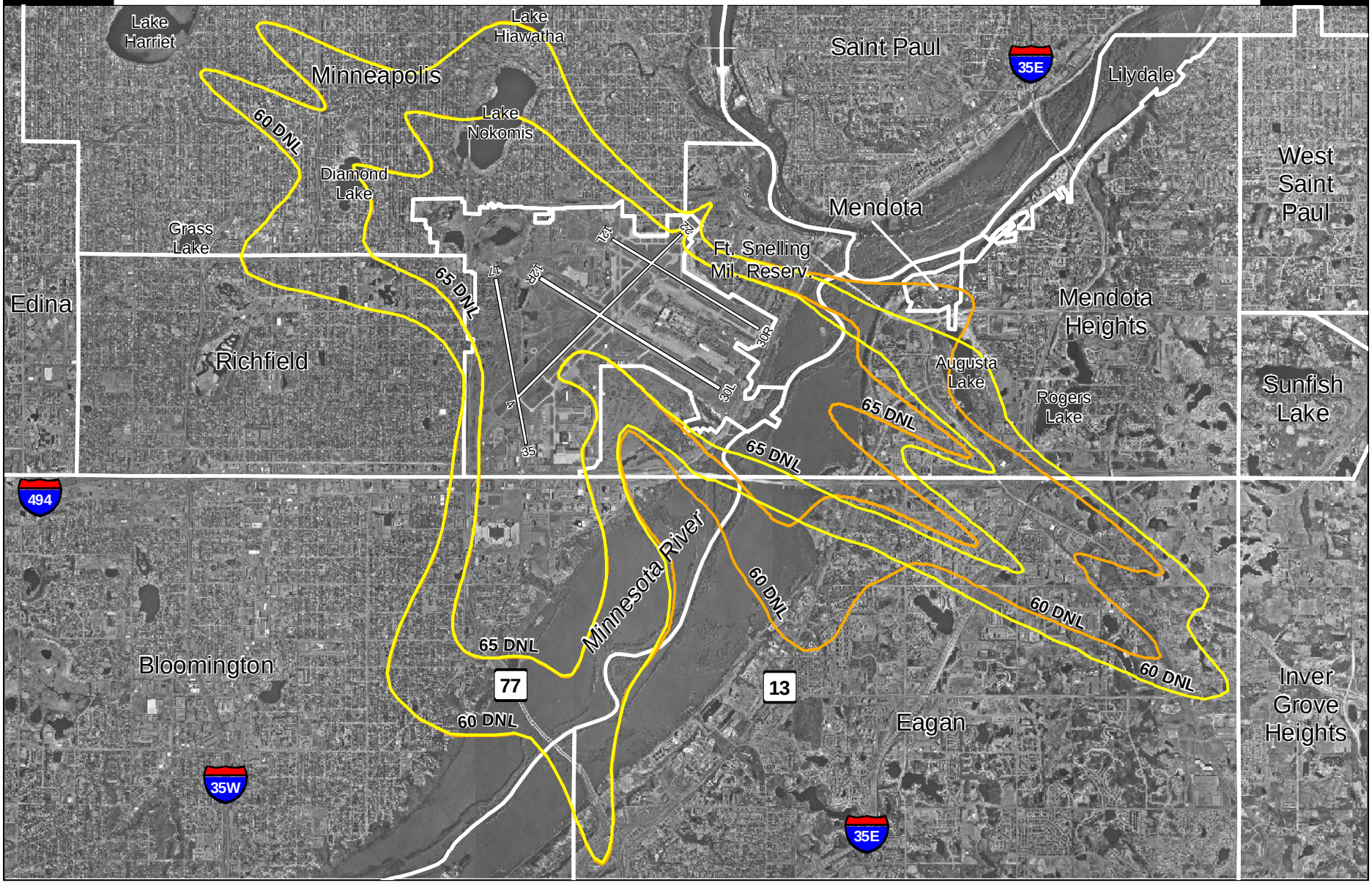


Figure 7-4

7.3.4.3 Summary of Modified NA-7, Part A: Refinement of Eagan/Mendota Heights Corridor Procedure

A feasible and beneficial alternative measure to reduce overall noise exposure in and around the Eagan/Mendota Heights Corridor Procedure was not identified in this Study. Few, if any, alternatives exist to reduce or shift overall noise exposure, as non-compatible land uses have developed outside of Corridor boundaries.

The proportion of overflights in and around the Corridor will be reduced in late 2005 when Runway 17/35 opens. Appendix E contains information on the 2007 No-Build Runway 17/35 Sensitivity Analysis, which shows the impact of reduced overflights. The reduction in the number of overflights will be temporary, however, due to continued traffic growth at MSP.

New technology, including GPS, may allow for future refinements to Corridor Procedures. The widespread use of quieter aircraft offers the best potential to reduce noise exposure.

In the absence of better alternatives, the Study recommends that the use of the Eagan/Mendota Heights Corridor Procedure continue in its existing form.

7.3.5 Modified NA-7, Part B: Noise Abatement Departure Profiles

Modified measure NA-7, Part B, identifies the specific Noise Abatement Departure Profile (NADP) to be used on each runway end at MSP. The purpose of this measure is to determine the appropriate NADP to reduce the population within the 60 DNL contour.

The operational characteristics and noise benefits of NADPs are discussed in Section 4.3.4 and Appendix D. There are two departure NADPs:

- **Close-In NADP** provides a slight reduction in noise exposure for homes in the immediate vicinity of the Airport, generally within approximately 3.5 statute miles of the start of takeoff (not from the end of the runway).

- **Distant NADP** provides a slight reduction in noise for homes that are not in the immediate vicinity of the Airport, typically beyond approximately 3.5 statute miles from the start of takeoff.

Existing FAA operational guidelines permit an Airport to designate NADPs by like runway end (e.g., Runways 30L and 30R). Thus, MAC formerly designated use of the Close-In NADP on Runways 30L and 30R, and the Distant NADP on Runways 12L and 12R. MAC cannot, for example, designate the Close-In NADP on Runway 30L and the Distant NADP on Runway 30R, as this could cause safety conflicts. This measure considered the appropriate NADP for the following groups of like runway ends: Runways 12L and 12R; 30L and 30R; 4; 22; 17; and 35. The lowest noise-impacted population within the 60 DNL contour for each runway group is used to determine the best NADP.

Today, the Distant NADP is currently used on all runway ends as discussed in Section 4.3.4. The Dual Track FEIS assumes use of the Distant NADP for Runway 17.

Generally, the Close-In NADP slightly reduces impacted population within the 65 DNL contour. The Distant NADP, however, reduces impacted population within the 60-65 DNL contour interval. As described in Section 4.3.4 and Appendix D, aircraft using

the Close-In NADP are generally slightly higher in altitude than aircraft using the Distant NADP. However, aircraft using the Close-In NADP are also slower and, more critically, at a higher engine thrust during certain segments outside of the 65 DNL contour; this increases noise exposure and the size of the 60-65 DNL contour interval.

MAC designated the Close-In NADP for use on Runways 30L and 30R in 1996. The 1996 analysis that recommended implementation of the Close-In NADP only considered impacts to the 65 DNL contours. This was appropriate at the time, as the 65 DNL contour was considered the threshold of impact. However, this Study considers impact within the 60 DNL contour and, as a result, the use of the Distant NADP yields a lower total impacted population.

Figure 7-5 compares the DNL contours of the Close-In and Distant NADPs (the latter is represented by the 2007 Unmitigated NEM which includes use of the Distant NADP on all runway ends). **Table 7.20** contains a detailed evaluation of this measure.

7.3.6 Modified NA-8: Measures to Encourage Use of Manufactured Stage 3 Aircraft

Modified measure NA-8 requires MAC to develop and implement measures to encourage aircraft operators to use manufactured Stage 3 aircraft. The purpose of this measure is to increase the use of manufactured Stage 3 aircraft at MSP. Successful implementation of this measure would reduce the noise impacts associated with some of the loudest aircraft at MSP.

Analysis of aircraft operations at MSP projected for 2007 indicate that noise impacts (i.e., population and dwelling counts) associated with aircraft operations could be reduced by about 10-percent if all night operations were conducted by manufactured Stage 3 aircraft. Additionally, noise impacts could be reduced by approximately 43-percent if all aircraft operations at MSP were conducted by manufactured Stage 3 aircraft.

Table 7.21 contains an evaluation of this measure.

Modified NA-7, Part B: Noise Abatement Departure Profiles

2007 Unmitigated NEM with use of Distant NADP on all Runways
2007 Unmitigated NEM with use of Close-In NADP on all Runways

0 1 2 Miles

N

Figure 7-5

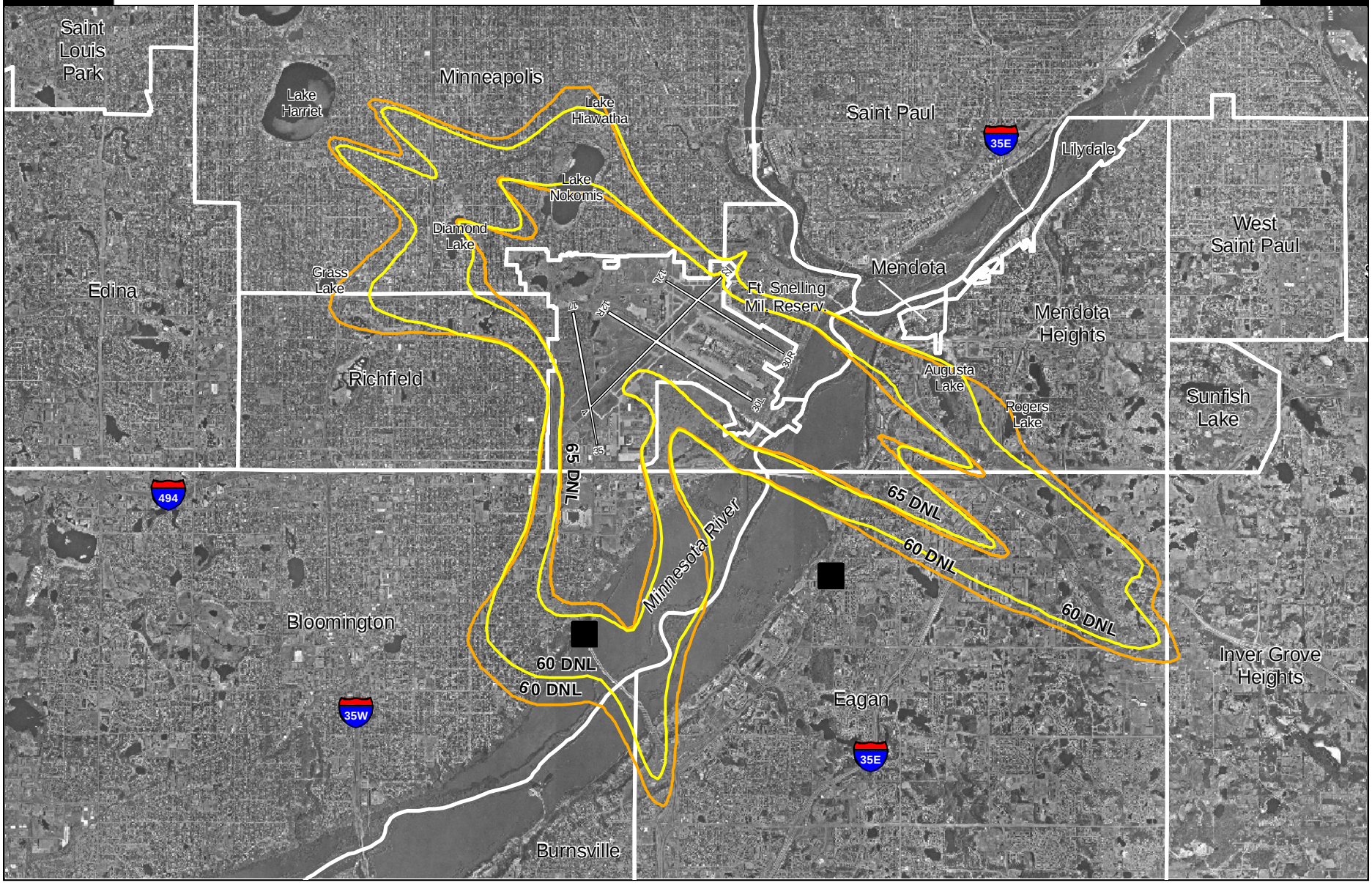


Table 7.20

Evaluation of Modified NA-7, Part B: Noise Abatement Departure Profiles

Description	This measure designates the Distant NADP for use on all Runways at MSP. This measure formalizes the existing use of the Distant NADP on Runways 12L, 12R, 30L, 30R, and 04/22, and formalizes the use of the Distant NADP on Runway 17/35. Due to the evaluation of this measure in the November 2001 Study and at the request of the MSP ATCT for operational reasons[5], the NADP on Runways 30L and 30R was changed from the Close-In NADP to the Distant NADP in July 2003.
Local Approval	Approved by the MASAC OPS Committee on April 14, 2000, MASAC on June 27, 2000, and the MAC Commission on August 20, 2001. NOC recommended implementation on June 26, 2003. MAC approved implementation of the Distant NADP on Runways 30L and 30R in July 2003.
Potential Noise Benefit	Use of the Close-In NADP on all runway ends would increase population within the 60 DNL contour by 7,707 people and 3,343 dwellings, relative to the current use of Distant NADP as shown in the 2007 Unmitigated NEM. Although use of the Distant NADP on all runway ends increases the number of homes within the 65 DNL contour by 2,193 people and 1,000 dwellings, the majority of these homes have been insulated as part of the 1996 Sound Insulation Program.
Effects on Airport Operations/ATC Considerations	None.
Impact on Airport Users	None. Minimal modification to airline operating procedure manuals.
Regional Economic Impacts	None.
Quality of Service Impacts	None.
Airline and Airport Capital Costs	None.
Ease of Implementation and Enforcement	Implemented by MAC in July 2003 in coordination with the airlines.
Legal Factors	None.
Conclusions	Although the Close-In NADP provides some noise relief to homes in the immediate vicinity of MSP, it increases the total number of people within the 60 DNL contour. Exclusive use of the Distant NADP would significantly reduce the number of people within the 60 DNL contour and, as a result, this option is included in the revised NCP.

Table 7.21

Evaluation of Modified NA-8: Measures to Encourage Use of Manufactured Stage 3 Aircraft

Description	MAC will continue to evaluate incentives to encourage the use of manufactured Stage 3 aircraft at MSP. This measure provides a means for MAC to investigate, at a later date, measures to encourage increased use of Manufactured Stage 3 aircraft. Any program developed under this measure is subject to approval by MAC, and the FAA, if mandatory, prior to implementation. This measure is not intended to recommend a specific program.
Local Approval	Approved by MASAC on September 26, 2000 and the MAC Commission on August 20, 2001.
Potential Noise Benefit	This measure would encourage airlines to use manufactured Stage 3 aircraft. Increased use of manufactured Stage 3 aircraft will reduce noise exposure at MSP.
Effects on Airport Operations/ATC Considerations	None.
Impact on Airport Users	Voluntary measure that applies only to airlines agreeing to participate in the program would receive incentives to operate manufactured Stage 3 aircraft. Only airlines with the ability to reallocate manufactured Stage 3 aircraft could benefit from the program.
Regional Economic Impacts	None.
Quality of Service Impacts	None.
Airline and Airport Capital Costs	To be determined based on future incentives for participation.
Ease of Implementation and Enforcement	MAC would investigate options to provide incentives for manufactured Stage 3 aircraft operations.
Legal Factors	Major. Airline lease agreements would have to be renegotiated.
Conclusions	This measure would provide a mechanism to encourage airlines to use manufactured Stage 3 aircraft. Increased use of manufactured Stage 3 aircraft will reduce noise exposure at MSP. In addition, airline contributions to noise reduction efforts would be proportional to the manufactured Stage 3 aircraft [noise exposure] contributions at MSP. This measure is included in the revised NCP.

7.3.7 Modified NA-9: Runway Use System

Modified measure NA-9 defines noise-sensitive runway use preferences employed by ATCT in prioritizing runway selection. This measure is an update of the existing measure NA-9, in order to include Runway 17/35 in the RUS.

The RUS establishes runway selection preferences based on impacted population (i.e., the runway that impacts the fewest people receives the highest preference); as a result, the RUS serves to reduce population within the 60 DNL contour.

The RUS is always in use, although to varying degrees depending on traffic levels. During peak operational periods, capacity and weather are the driving factors in runway selection, as discussed in Section 4.3.2. ATCT must select runways that maintain necessary airport capacity, and aircraft must takeoff and land into the wind. Although ATCT has limited flexibility in runway selection during high demand periods, the RUS can be employed in certain conditions. If prevailing winds are relatively calm, for example, the RUS is the mechanism that allows ATCT to select an east flow, and depart aircraft on Runways 12L and 12R, instead of Runways 30L and 30R.

Optimal noise benefits utilizing the RUS can only be obtained during mid- and low-demand periods, which typically occur at night and for limited periods during the daytime. During these periods, ATCT has some flexibility in runway selection. The RUS is used to make appropriate, noise-sensitive runway selection.

The existing RUS is described in Section 4.3.2 and establishes the operational preferences shown in **Table 7.22**.

Table 7.22

Existing Runway Use System

The existing RUS establishes the following runway use preferences:

Departures
1. Runways 12L and 12R
2. Balanced Use of Runway 4/22
3. Runways 30L and 30R

Arrivals
1. Runways 30L and 30R
2. Balanced Use of Runway 4/22
3. Runways 12L and 12R

- Departure preferences are separate and distinct from arrival preferences.
- Since departures are typically noisier than arrivals, ATCT first selects the departure runway, and then selects the appropriate arrival runway.[6]
- Balanced use means that ATCT will assign use of Runway 4 or Runway 22 with equal priority for noise abatement purposes; it does not mean that an equal number of aircraft will use either runway. Operational factors, such as wind, weather, and aircraft destination, will determine final selection of the use of Runway 4 or 22.

Source: MAC, HNTB analysis.

The following example demonstrates the use of the existing RUS. The example is for illustrative purposes only, and assumes that wind and traffic conditions permit the following runway selections.

- ATCT assigns departures to Runways 12L and 12R, per RUS guidelines.
- During mid- and high-demand periods, arrivals cannot use Runways 30L and 30R, as this would place departures and arrivals on converging courses.
  - During mid-demand periods, ATCT may place arrivals on Runway 4/22, the second preference for arrivals.
  - During high-demand periods, ATCT will place arrivals on Runways 12L

and 12R, establishing an east flow to achieve necessary runway capacity.

- During low-demand periods, ATCT may operate in a head-to-head mode with departures from Runways 12L and 12R, and arrivals to Runways 30L and 30R.
    - The use of head-to-head procedures is infrequent; if ATCT cannot use the procedure during a low-demand period, arrivals would be re-routed to the second arrival preference, and land on Runway 4/22.

The analysis for the revised RUS focused on the appropriate preference for Runway 17/35 in the RUS. Since much of the land off the departure end of Runway 17 and the arrival end of Runway 35 is commercial and river bottom, the insertion of Runway 17/35 into the RUS offers potential for noise abatement. The proportion of operations during high-, mid-, and low-demand time periods was quantified to determine the usability of a potential RUS. The analysis employed the following methodology:

- An Annual Average Week was constructed using 12 months of 2002 ANOMS data, and was projected to 2007 operational levels. Traffic levels on Sunday morning at MSP, for example, are typically lower than on Monday morning. The use of an annual average week allows day-of-the-week traffic level variances to be quantified.

- The Annual Average Week is divided into 15-minute segments. The number of arrivals and departures that occur during each segment was determined. The 15-minute segments were used, as opposed to more traditional one hour blocks, to quantify the variance in traffic levels that can occur within one hour.

- Each segment is classified as a low-, mid-, or high-demand time period by the total number of operations (i.e., arrivals plus departures) in that segment.

- The number of arrivals and departures that occur during each demand period was calculated in proportion to the number of annual average daily operations.

ATCT was consulted to determine appropriate cut-off limits for each demand period given traffic interactions and ATCT workload. For the purposes of this analysis, low-, mid-, and high-demand time periods are classified according to the criteria in **Table 7.23**.

Table 7.24 shows the proportions of arrivals and departures that occur during each of the demand periods. Operations that occur during high-demand periods use the FEIS daytime forecast runway use, as shown in Table 4.8, which is optimized for peak-hour operations. The runway selection for operations that occur during the low- and mid-demand periods is determined, in whole or in part, by the RUS.

Table 7.23

Traffic Demand Period Criteria

Demand Period	Traffic Demand (Operations per 15-minute segment)	RUS Status
Low	Less than 3.5	Traffic levels allow for maximum flexibility in runway selection and RUS implementation, including the use of unique procedures such as the Head-to-Head Procedure in the Corridor.
Mid	Between 3.5 and 15	Traffic levels allow for efficient selection of runways based on noise considerations, given requirements for runway crossings, capacity, etc.; moderate use of the RUS.
High	Greater than 15	The need to maintain operational capacity does not allow ATCT flexibility in runway selection; limited use of the RUS.

Source: ATCT and HNTB analysis.

Table 7.24

Proportion of Operations in Traffic Demand Periods

Demand Period	Day	Night	Total
Departures			
Low	0.0%	7.5%	0.6%
Mid	5.4%	29.9%	7.3%
High	94.6%	62.6%	92.2%
Total	100%	100%	100%
Arrivals			
Low	0.0%	23.2%	1.8%
Mid	6.6%	29.8%	8.4%
High	93.4%	47.0%	89.7%
Total	100%	100%	100%
Overall			
Low	0.0%	15.4%	1.2%
Mid	6.0%	29.9%	7.9%
High	94.0%	54.7%	91.0%
Total	100%	100%	100%

Note: Totals may not equal 100% due to rounding

Source: ANOMS, HNTB analysis.

During mid-demand periods, the analysis assumes that a proportion of arrival and departure traffic would be re-routed by the RUS, within the context of the runway configurations shown in Figure 4-4. The RUS shifts runway preferences during established operational modes without changing runway configurations. This allows, for example, a departure to use Runway 17 during an arrival bank that is using both parallel runways. During low-demand periods, runway selection is determined by the RUS, within applicable wind conditions and limits. Wind data specific to the low-demand periods were factored into this analysis. The analysis assumes that, during low-demand periods, head-to-head operations could occur as needed for aircraft in the Corridor and on Runway 17/35

Four RUS preference scenarios were considered in this analysis to determine the optimal preference for Runway 17/35 in the RUS.[7] **Table 7.25** shows the scenario that yields the smallest population and dwelling count within the 60 DNL contour. This

scenario is recommended as the revised RUS.

Table 7.26 shows the forecast annual average runway use with the RUS, compared to the unmitigated (FEIS) forecast annual runway use. For arrivals, the greatest change is for nighttime arrivals to Runway 30L where the percentage use would decrease by seven-percent from 32.1-percent to 25.1-percent. Nighttime arrivals to Runways 4 and 22 would increase by approximately four and two percent, respectively, from an unmitigated use of less than one percent. For departures, the greatest change is for nighttime departures from 12L, which would experience approximately a four percent increase from 10-percent to 14-percent.

Given the large number of hushkit Stage 3 aircraft that operate at MSP, and because hushkit Stage 3 aircraft are generally louder on takeoff than on arrival, departures have priority over arrivals for the purposes of RUS runway selection criteria. However, many manufactured Stage 3 aircraft are quieter on takeoff than on arrival. The continued modernization of the aircraft fleet at MSP may, at some point, require a re-examination of the RUS departure/arrival runway selection criteria.

It is important to note that the results derived in this analysis are not definitive. Variances in runway use will occur due to weather, safety, and aircraft interactions. It is not possible to quantify the exact times of the day when an RUS can be used, or when low, mid, and high-demand periods occur, as traffic conditions change daily. The delineation of low-, mid-, and high-demand periods is a tool needed to ensure that potential RUS scenarios are accurately modeled. The exclusion of a time period from a low- or mid-demand period in the model does not mean that the RUS could not be used in that time period if traffic conditions allow. Likewise, the inclusion of a time period in a low- or mid-demand period does not guarantee that the RUS will always be implemented. The final decision on runway selection is the responsibility and province of ATCT, regardless of the RUS.

Table 7.25

Revised Runway Use System

The revised RUS establishes the following runway use preferences:

Departures
1. Runways 12L and 12R
2. Runway 17
3. Balanced Use of Runway 4/22
4. Runways 30L and 30R

Arrivals
1. Runways 30L and 30R
2. Runway 35
3. Balanced Use of Runway 4/22
4. Runways 12L and 12R

- Departure preferences are separate and distinct from arrival preferences.
- Since departures are noisier than arrivals, ATCT first selects the departure runway, and then selects the appropriate arrival runway.[8]
- Balanced use means that ATCT will assign use of Runway 4 or Runway 22 with equal priority for noise abatement purposes; it does not mean that an equal number of aircraft will use either runway. Operational factors, such as wind, weather, and aircraft destination, will determine final selection of Runway 4 or 22.

Source: HNTB analysis.

Figure 7-6 shows the effect of the modified RUS on the DNL contours compared to the 2007 Unmitigated NEM. The modified RUS serves to lengthen/extend the contours along the extended centerline of Runway 4/22 and in the Corridor along the extended centerline of Runway 12L. However, as mentioned in the following table, these increases in contour area are offset by the slight recession and resultant diminished impact of the contours to the northwest of MSP due to the high population density in Minneapolis.

Table 7.27 contains a detailed evaluation of this measure.

Table 7.26

Revised RUS Forecast 2007 Annual Average Runway Use

Runway	Arrival			Departure			Total		
	Day	Night	Overall	Day	Night	Overall	Day	Night	Overall
4	0.0%	3.8%	0.3%	0.2%	0.4%	0.2%	0.1%	2.1%	0.3%
22	0.5%	2.4%	0.6%	0.1%	0.8%	0.1%	0.3%	1.6%	0.4%
12L	21.8%	17.2%	21.4%	8.9%	14.1%	9.3%	15.3%	15.6%	15.4%
12R	14.7%	12.4%	14.5%	15.9%	18.3%	16.1%	15.3%	15.3%	15.3%
30L	21.1%	25.1%	21.4%	15.0%	12.8%	14.8%	18.0%	19.0%	18.1%
30R	25.1%	26.4%	25.2%	22.7%	19.2%	22.4%	23.9%	22.8%	23.8%
17	0.0%	0.0%	0.0%	37.2%	34.6%	37.0%	18.6%	17.1%	18.5%
35	16.9%	12.7%	16.5%	0.0%	0.0%	0.0%	8.4%	6.4%	8.3%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%

Note: Totals may not equal 100% due to rounding

Change from Unmitigated FEIS Forecast 2007 Annual Average Runway Use

Runway	Arrival			Departure			Total		
	Day	Night	Overall	Day	Night	Overall	Day	Night	Overall
4	-0.1%	3.7%	0.2%	0.0%	0.2%	0.0%	-0.1%	2.0%	0.1%
22	0.0%	1.9%	0.1%	-0.1%	0.8%	-0.1%	0.0%	1.3%	0.1%
12L	0.0%	0.9%	0.3%	0.7%	3.8%	0.8%	0.3%	2.3%	0.6%
12R	-0.1%	-1.3%	-0.1%	0.0%	-2.3%	-0.5%	0.0%	-1.8%	-0.3%
30L	0.1%	-7.0%	-1.0%	-0.1%	-1.7%	-0.2%	-0.1%	-4.3%	-0.6%
30R	0.6%	2.1%	0.7%	-0.4%	-1.3%	-0.3%	0.1%	0.4%	0.2%
17	-0.1%	-0.1%	-0.1%	0.0%	0.7%	0.2%	-0.1%	0.1%	0.1%
35	-0.5%	-0.4%	-0.4%	-0.1%	-0.1%	-0.1%	-0.4%	-0.2%	-0.2%

Source: HNTB analysis.

Modified NA-9: Runway Use System

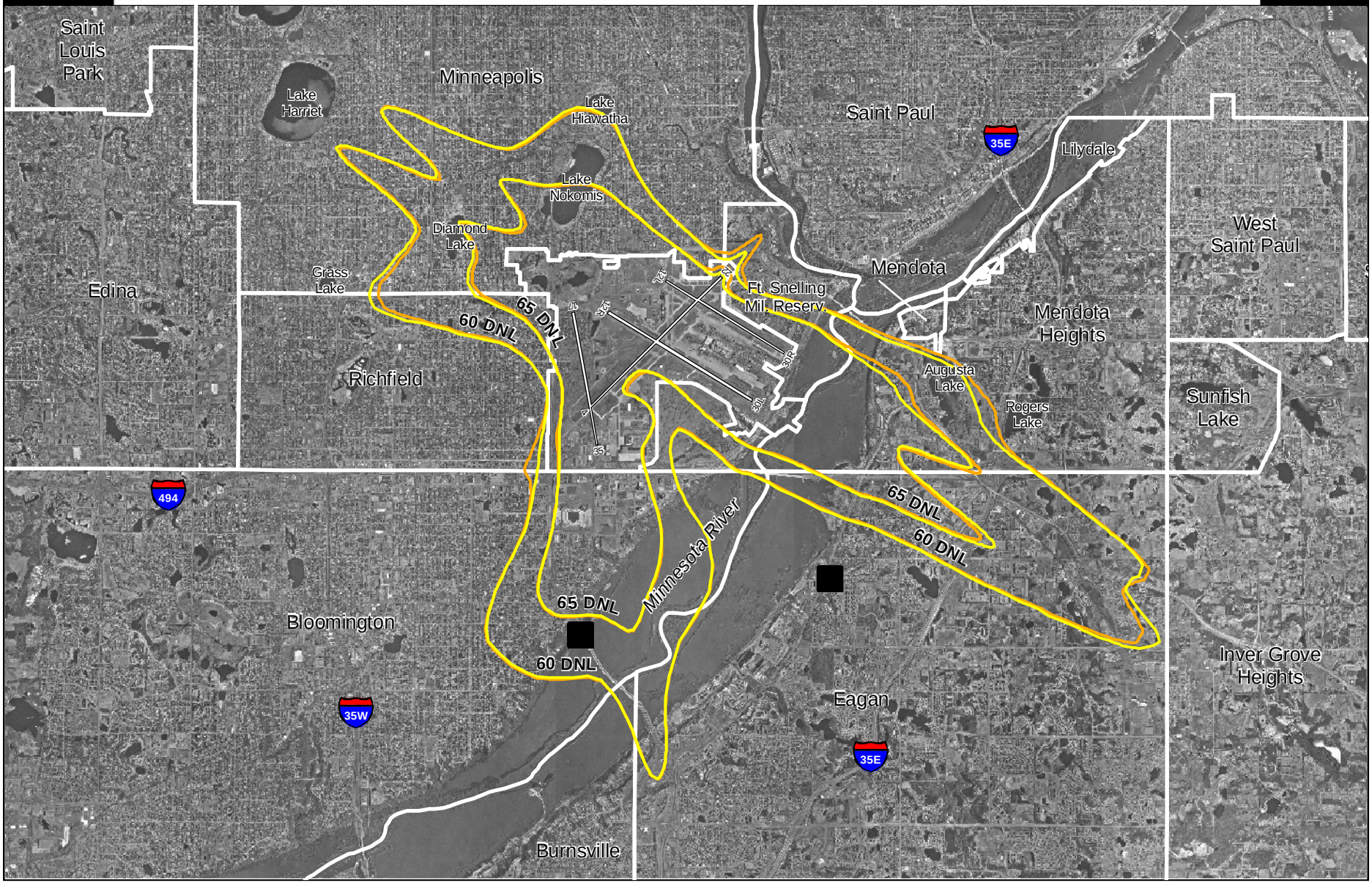


Figure 7-6

Table 7.27

Evaluation of Modified NA-9: Runway Use System

Description	This measure defines the following noise-sensitive runway use preferences for use by ATCT in runway selection, with "1" being the highest preference and "4" being the lowest preference: Departures: 1. Runways 12L and 12R (into the Eagan/Mendota Heights Corridor) 2. Runway 17 3. Balanced use of Runway 4/22 4. Runway 30L and 30R Arrivals: 1. Runways 30L and 30R (over the Eagan/Mendota Heights Corridor) 2. Runway 35 3. Balanced use of Runway 4/22 4. Runways 12L and 12R Departure preferences are separate and distinct from arrival preferences. Since departures are noisier than arrivals, ATCT first selects the departure runway, and then selects the appropriate arrival runway.[9] The preferences apply equally for daytime and nighttime operations. ATCT may use head-to-head operational procedures in the Corridor and on Runway 17/35, as needed. The RUS is intended to give ATCT guidance on appropriate, noise-sensitive runway selection when operational conditions allow for flexibility. This measure recognizes that capacity, wind, and safety are preeminent factors in runway selection, and the final decision on runway selection is the responsibility and province of ATCT.
Local Approval	Approved by the MASAC OPS Committee on July 14, 2000, MASAC on June 27, 2000, and the MAC Commission on August 20, 2001.
Potential Noise Benefit	This measure directs aircraft over primarily non-residential land use in the Eagan/Mendota Heights Corridor and the Minnesota River, to the maximum extent possible. The measure would reduce population within the 60 DNL contour by 1,406 people and 649 dwellings, as compared to the 2007 Unmitigated NEM.
Effects on Airport Operations/ATC Considerations	ATCT standard operating procedures would include an updated RUS upon opening of Runway 17/35.
Impact on Airport Users	A small number of aircraft may incur slight increases in flight and taxi time as they are re-routed to other runways. The flight and taxi times would be no longer than those incurred by the existing RUS.
Regional Economic Impacts	None.
Quality of Service Impacts	None.
Airline and Airport Capital Costs	None.
Ease of Implementation and Enforcement	MAC would request amendment of ATCT standard operating procedures to include the revised RUS.
Legal Factors	None.
Conclusions	This measure would provide a safe, reliable, and flexible guideline to aid ATCT in noise-sensitive runway selection. The modified RUS establishes an equitable and efficient priority for Runway 17/35 in the RUS. As a result, this option is included in the revised NCP.

7.4 PROPOSED NEW NOISE ABATEMENT MEASURES

Proposed new noise abatement measures analyzed in this Study include the following:

- Low-Demand Flight Tracks
- Runway 17/35 Flight Track Measures
- Future Technology and Global Positioning Satellite (GPS) Initiatives

These proposed new measures are discussed in the Sections 7.4.1 through 7.4.3. Each measure has an evaluation table that provides analyses of the measure and a conclusion regarding its inclusion in the final NCP. Supporting graphics are provided, as necessary.

7.4.1 Proposed NA-12: Low-Demand Flight Tracks

Proposed measure NA-12 designates certain departure flight tracks, by runway end, for preferred use during low-demand time periods.

The purpose of this measure is to give ATCT guidance on the selection of appropriate flight tracks during low-demand periods that will impact the fewest people. This measure does not imply *mandatory* use of the low-demand flight tracks by ATCT, and deviations are expected due to safety, aircraft performance, pilot compliance, weather, and traffic conflicts.

Single-event DC9Q contours, at a Sound Exposure Level (SEL) of 90 dB, were generated for each existing and forecast flight track. The flight tracks whose SEL contour contained the fewest people were considered for designation as low-demand flight tracks. Flight tracks, which disperse departure traffic away from the extended runway centerline, were also considered to separate arrival and departure traffic and avoid impacting the same people with both types of operations.

Figure 7-7 and **Table 7.28** describe the recommended low-demand flight tracks designated as a result of this analysis.

For modeling purposes, a low-demand period is said to exist whenever there are less than 3.5 operations in a 15-minute segment, or 14 operations in an hour. Low-demand periods occur primarily at night, and vary by day of the week and month. On average, low-demand periods occur between 12:15 a.m. and 5:30 a.m. Low-demand periods for a single runway may occur at other times, even though the other runways are considerably busier.

This measure includes the following provisions and considerations:

- Aircraft would not be re-routed significantly away from their destination (e.g., a westbound departure would not be re-routed to a southbound flight track). In the absence of a designated and applicable low-demand flight track, ATCT would assign the departure to an appropriate flight track.
- When applicable, ATCT would select a low-demand flight track that routes the departure on the most efficient course available. For example, a Runway 17 departure that would have been assigned to Track F under normal conditions would be assigned to Track D or the River Departure Procedure (DP) during a low-demand period; it would not be assigned to Track A or B.

Proposed NA-12: Low Demand Flight Tracks

Potential GPS/FMS Dependent Tracks

Existing or Planned Tracks

0 1 2 miles

N

Figure 7-7

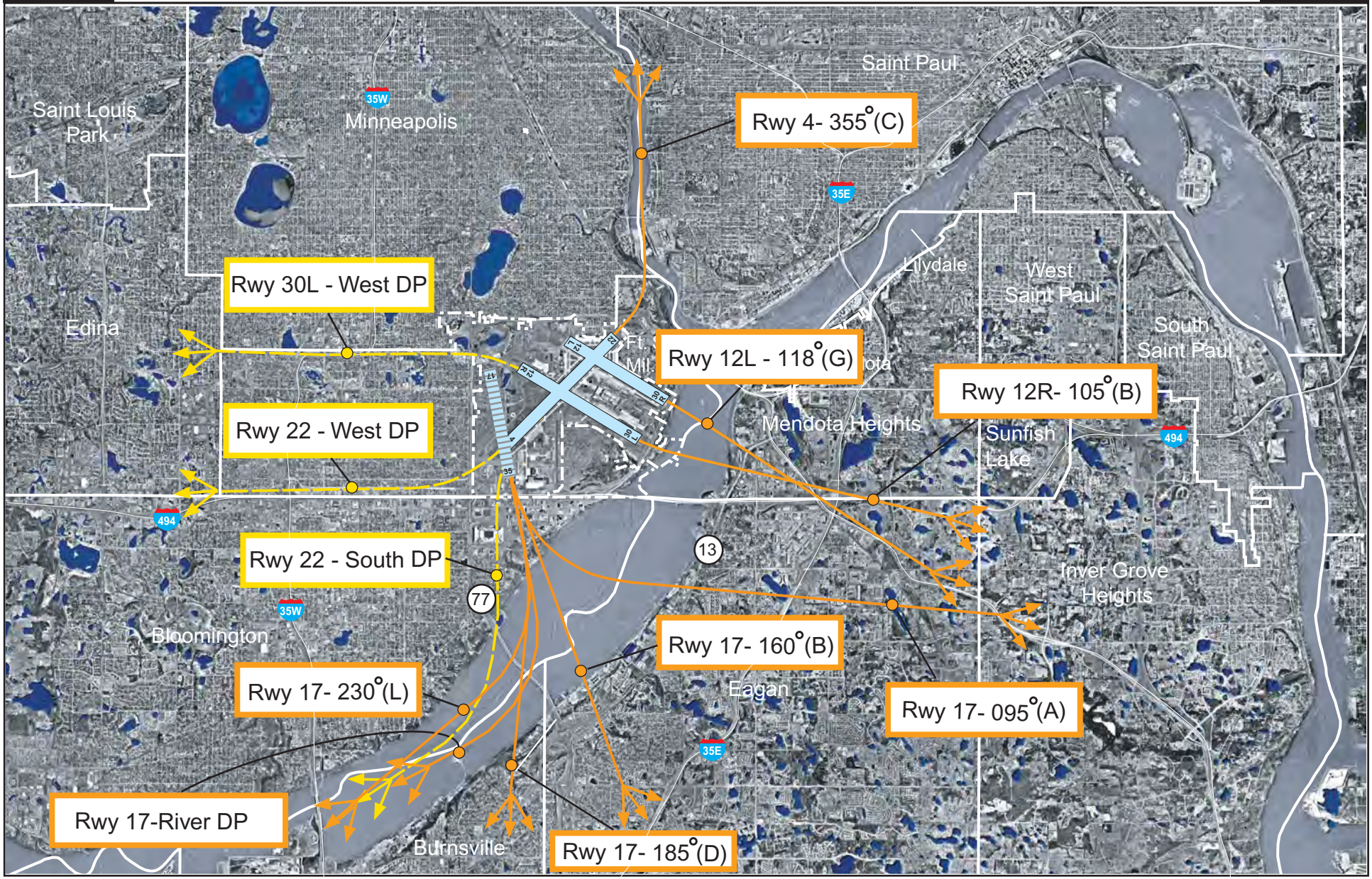


Table 7.28

Low-Demand Departure Flight Tracks

Runway 04	▪ **Heading 355-degrees - Flight Track C.** This heading directs aircraft over Fort Snelling, the Mississippi River, and industrial land use that border the river. Precise navigation of this route is not possible without external navigation to aid the pilot; therefore, this measure recommends that MAC coordinate with the FAA to develop a Departure Procedure (DP) that overflies the river basin, for use by non-heavy and high performance aircraft. Until the DP is available, the 355-degree true/353-degree magnetic heading would be used.
Runway 22	▪ **South DP.** Also known as the "Cedar Avenue DP," this measure recommends that MAC coordinate with the FAA to develop and implement a GPS/FMS DP that routes departures from Runway 22 east of Cedar Avenue, then southwest over the River. Although this DP has been examined in the past,[10] GPS may allow for its successful implementation. Additionally, since this DP is only intended for use during low-demand periods, it would not affect runway capacity. ▪ **West DP.** This measure recommends that MAC coordinate with the FAA to explore the potential for a GPS/FMS DP that overflies the I-494 highway corridor. This DP may not be feasible due to the close proximity of the highway to MSP and the quick turn that would be required for aircraft to follow the DP. Additionally, the potential for disproportionate noise impacts for homes near the I-494 highway corridor, as a result of concentrating flights over the highway, would have to be considered prior to implementation.
Runway 12L	▪ **Heading 118-degrees - Flight Track G.** This flight track is currently used as a low-demand flight track as part of the Crossing in the Corridor procedure detailed in Section 7.3.4. This measure recommends the continued use of the Crossing in the Corridor procedure.
Runway 12R	▪ **Heading 105-degrees - Flight Track B.** This flight track is currently used as a low-demand flight track as part of the Crossing in the Corridor procedure detailed in Section 7.3.4. This measure recommends the continued use of the Crossing in the Corridor procedure.
Runway 30L	▪ Due to the population density of communities off the departure end of Runway 30L, preferred flight tracks do not provide a noise benefit with existing technology. Designation of specific existing tracks for use during low-demand periods would concentrate flights on selected tracks and disproportionately impact the same people. However, future technology initiatives may allow for development of new routes, as noted below. ▪ **West DP.** This measure recommends that MAC coordinate with the FAA to explore the potential for a GPS/FMS DP that overflies the Trunk Highway 62 corridor. This DP may not be feasible due to the close proximity of the highway to MSP and the quick turn that would be required for aircraft to follow the DP. Additionally, the potential for disproportionate noise impacts for homes near the TH 62 highway corridor would have to be considered prior to implementation.
Runway 30R	▪ Due to the population density of communities off the departure end of Runway 30R, preferred flight tracks do not provide a noise benefit. Designation of specific tracks for use during low-demand periods would concentrate flights on select tracks and disproportionately impact the same people.
Runway 17	▪ **Heading 095-degrees – Flight Track A.** Routes aircraft over primarily commercial, industrial, and low density residential areas. ▪ **Heading 160-degrees – Flight Track B.** Routes aircraft away from the straight-in arrival flight track. ▪ **Heading 185-degrees – Flight Track D.** Routes aircraft away from the straight-in arrival flight track. ▪ **Heading 230-degrees – Flight Track L.** Routes aircraft over the Minnesota River area, in conjunction with Proposed NA-13, Option 2, and NA-15. ▪ **River Published DP.** Routes aircraft over the Minnesota River area, as Proposed NA-14.
Runway 35	▪ Due to the infrequent use of Runway 35 for departures, and the population density of communities off the end of the Runway, preferred flight tracks do not provide a noise benefit. Designation of specific tracks for use during low-demand periods would concentrate flights on select tracks and disproportionately impact the same people.

Source: HNTB analysis.

- Because relatively few operations would be re-routed to low-demand flight tracks, this measure would not change the DNL contours.

- The absence of a designated low-demand flight track over an area would not prevent overflights of that area during low-demand periods.

- Runway selection would take priority over low-demand flight track use. The use of a low-demand flight track comes into consideration *only* after runway selection is made by ATCT. Using this measure, ATCT would be able to slightly re-route a departure to an area with less impact (e.g., during a low-demand period, ATCT may, at its discretion, reassign a Runway 17 departure from Track F to the River DP).

- Because of the low utilization of this measure, and given the other factors in the determination of an assigned flight track (e.g., safety, aircraft performance, pilot compliance, weather, and traffic conflicts), monitoring ATCT compliance relative to low-demand flight track use would not be practical or possible.

Following are example scenarios that illustrate ATCT's use of low-demand flight tracks:

Example scenario #1:

- An aircraft is departing for Phoenix at 5:00 a.m.

- Runways 12L, 12R, 17, and 22 are available for takeoff, given the current winds.

- Low-demand conditions exist.

- The RUS takes priority over low-demand flight track procedures. Following RUS priorities, the aircraft is assigned to Runway 12R or 12L for takeoff.

- Per low-demand flight track procedures, the aircraft is assigned to a 105-degree heading from Runway 12R or a heading along a 118-degree ground track from Runway 12L.

- If Runway 12L and 12R were not available, the aircraft would be assigned to Runway 17 for departure per the RUS, and directed to the River DP or Track D.

- If Runway 17 were not available, the aircraft would be assigned to Runway 22 and use the South (Cedar Avenue) DP.

Example scenario #2:

- An aircraft is departing for Phoenix at 2:00 p.m.

- Runways 30L, 30R, 22, and 17 are available for takeoff, given current winds.

- Low-demand conditions do not exist, as MSP is in the middle of an arrival bank.

- Per RUS priorities, the aircraft is assigned to Runway 17 for takeoff.

- The aircraft taxies to Runway 17, and is ready for takeoff.

- Although several departures are taxiing to Runway 17 for takeoff, the next departure will not be ready for takeoff for another few minutes.

- As a result, low-demand flight track procedures can be used for this flight, assuming there are no other traffic conflicts.

- The Runway 17 low-demand tracks

available are Tracks A, B, D, and L. The River DP is not available, because the flight is in the middle of the day, as discussed in Proposed NA-14. Tracks A and B would significantly route the aircraft off course. Track L is assigned because it is the most efficient low-demand routing for that flight.

The development of some of the DPs will require the use of GPS/FMS technology. Determination of the feasibility and subsequent development of DPs will require additional coordination between MAC, ATC, and FAA.

Table 7.29 contains a detailed evaluation of this measure.

Table 7.29

Evaluation of Proposed NA-12: Low-Demand Flight Tracks

Description	This measure designates certain flight tracks, by runway end, for preferred use during low-demand time periods, as shown in **Figure 7-7**. This measure also recommends that MAC investigate the feasibility of select DPs, as described in Table 7.28. The purpose of this measure is to give ATCT guidance on the selection of appropriate flight tracks during low-demand periods that will impact the fewest people.
Local Approval	Approved by the MASAC OPS Committee on May 1, 2000, MASAC on June 27, 2000, and the MAC Commission on August 20, 2001.
Potential Noise Benefit	The relatively small number of operations that would be re-routed to low-demand flight tracks would not affect the DNL contours. However, this measure has the potential to reduce overflights of densely populated residential areas.
Effects on Airport Operations/ATC Considerations	ATCT operating procedures would be modified to include low-demand flight tracks.
Impact on Airport Users	A small increase in flight time would occur for aircraft re-routed to low-demand flight tracks. Given the relatively low number of operations that would be re-routed to low-demand flight tracks, however, the annual operating cost of this measure is minimal.
Regional Economic Impacts	None.
Quality of Service Impacts	None.
Airline and Airport Capital Costs	None.
Ease of Implementation and Enforcement	MAC would request amendment of ATCT standard operating procedures. Because of the low utilization of this measure, and given the other factors in the determination of assigned flight track (e.g., safety, aircraft performance, pilot compliance, weather, and traffic conflicts), monitoring ATCT compliance relative to low-demand flight track use would not be practical or possible. Determination of the feasibility and subsequent development of DPs, to include the use of GPS/FMS technology, will require additional coordination between MAC, ATCT, and FAA.
Legal Factors	None.
Conclusions	Since this measure has the potential to minimize impacted population during low-demand periods, it is included in the revised NCP.

7.4.2 Proposed NA-13, -14, -15, and –16: Runway 17/35 Flight Track Measures

The Dual Track FEIS Record of Decision states that noise abatement measures could be evaluated for Runway 17 departure flight tracks to avoid populated areas close to the Airport. This section considers potential measures for the Runway 17/35 flight tracks. These measures seek to reduce population within the 60 DNL contour and to mitigate the northward shift of the unmitigated westbound flight tracks (versus FEIS projections) over residential areas of Bloomington, as discussed in Section 4.3.3.

In addition to reduced impacted population, the measures must accomplish the following:

- Avoid as much as possible increased overflight of communities outside the 60 DNL contour,
- Maintain runway capacity,
- Be operationally feasible by ATC, and
- Provide positive guidance to aircraft to reasonably follow desired flight tracks.

Numerous measures for the Runway 17 departure flight tracks were considered in the Study analyses. The measures presented in this section (NA-13 through -16) are the primary measures presented to the MASAC OPS Committee. The measures do not consider the elimination of flight tracks. Although a measure could theoretically restrict the initial headings assigned by ATCT to departing aircraft thereby "eliminating" a flight track, aircraft must still fly to their destination. As a result, after the handoff from ATCT, the TRACON would turn the departing aircraft toward its destination on the eliminated heading, regardless of the measure. The elimination of a flight track would simply delay the aircraft's turn, and move the flight track to another nearby location.

7.4.2.1 Proposed NA-13, Option 1: Runway 17 Departure 105-Degree Hybrid Fan Procedure

Proposed measure NA-13, Option 1, changes the unmitigated flight tracks to avoid, as much as possible, the most severely impacted homes in the immediate vicinity of Runway 17 departure flight tracks. **Figure 7-8** shows the modeled flight tracks for Option 1 mentioned in the following paragraphs.

Eastbound flight tracks, including Tracks A, H, I, B, and C, are unchanged from the unmitigated flight tracks. Jet and turboprop aircraft are permitted to turn immediately off the runway end, to headings inclusive of 95-degrees to 170-degrees.

Westbound aircraft would be directed to use the following combination of turn points and headings to avoid populated areas near the Airport:

- Jet aircraft would be directed to fly on a straight-out flight track (Track C – 170-degrees) until reaching a turn point located 1.7 NM from the start of takeoff roll.
- Distance Measuring Equipment (DME) would be used to mark the turn point. DME gives the distance from the aircraft to a radio navigational aid (NAVAID) in tenths of a nautical mile. Use of a DME fix allows for relatively precise determination of the turn point.
- After reaching the turn point/DME fix, jet aircraft would turn to a heading between 171-degrees and 200-degrees.

Proposed NA-13, Option 1: Runway 17 105° Hybrid Fan

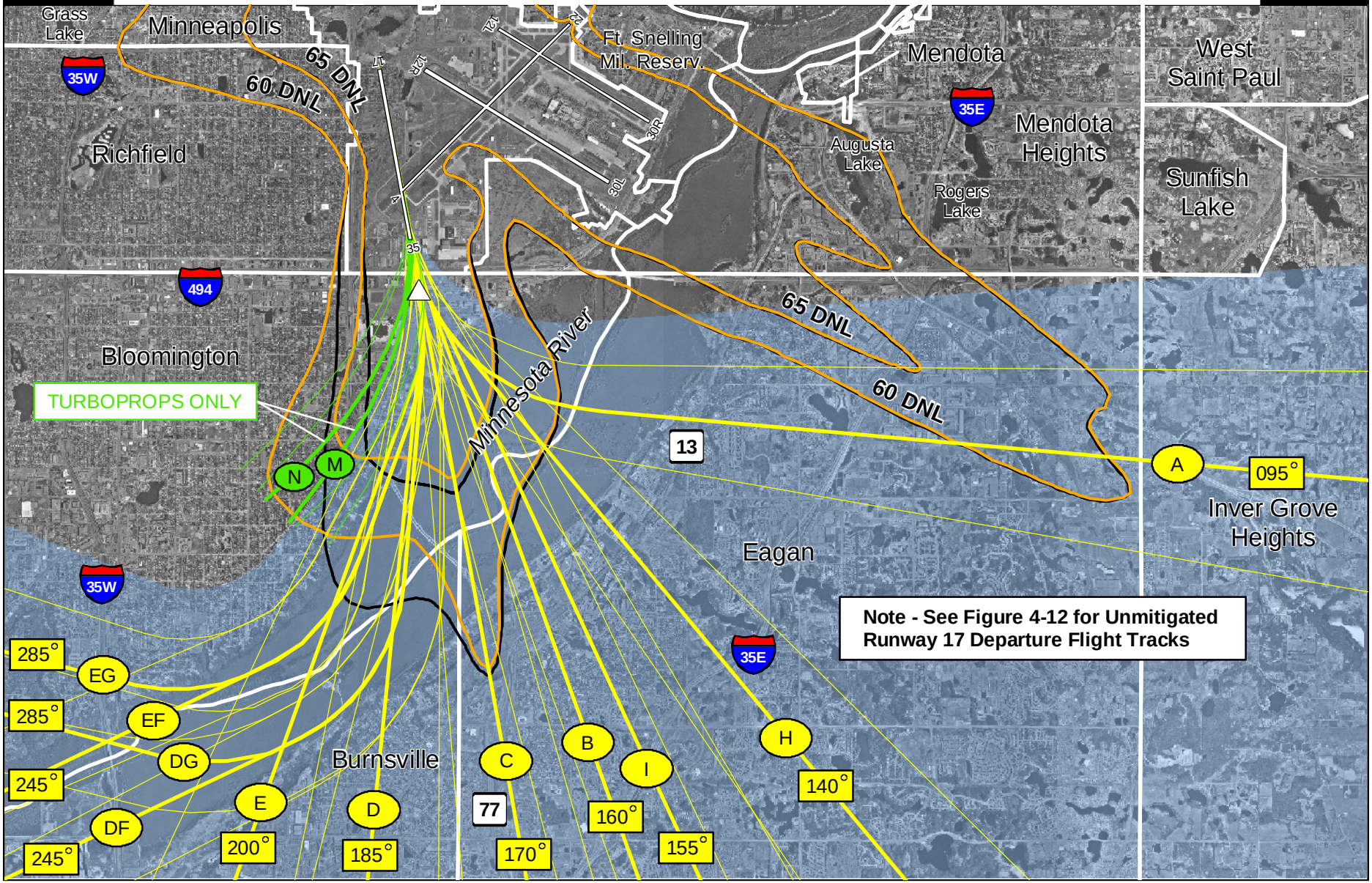
2007 Unmitigated NEM
2007 Unmitigated NEM with Modified NA-13, Option 1
NA-13, Option 1 Core & Sub Flight Tracks and Fan

0 1 2 Nautical Miles

DME Turn Point/Fix 1.7 NM

N

Figure 7-8



Most aircraft would be concentrated on the 185-degree (Track D) and 200-degree headings (Track E).

- The initial departure heading of between 171-degrees and 200-degrees would be assigned by the ATCT during the takeoff clearance. Published departure procedures would instruct the pilot to delay the turn until reaching the turn point/DME fix.

After takeoff, the ATCT would hand off the departing aircraft to the TRACON. During a handoff, ATC facilities transfer control of the aircraft. The TRACON must establish radar contact and positively identify the specific aircraft to complete the transfer. The ATCT and TRACON also communicate with the pilot. The entire handoff takes a few moments.

- Prior to the end of the handoff, most departing aircraft would have reached the turn point, turned to assigned heading, and climbed past 3,000 feet MSL.

- TRACON would direct aircraft that would have been on the unmitigated flight Tracks F (245-degree heading) and G (285-degree heading) to make a second turn to a 245-degree or 285-degree heading, as needed. The new heading would direct the aircraft toward "gates." At the gates, aircraft are handed off from the TRACON to the Air Route Traffic Control Center (ARTCC).

- Most jet aircraft would make the second turn toward the west departure gates over the Minnesota River area. Some aircraft would make the turn prior to the river, and some would make the turn after crossing the south bank of the river.

- Westbound turboprop aircraft would be permitted to turn to westbound headings immediately off the end of the runway (Tracks M and N). This segregates slower turboprop aircraft from faster jet aircraft.

Table 7.30 shows the flight track use for this measure. As discussed, Option 1 separates jets from turboprops. The jet use is similar to the unmitigated flight track use. Option 1 employs (new) tracks DF, DG, EF and EG to model the first and second turns aircraft would fly after reaching the first fix, instead of Unmitigated tracks L, F and G. Turboprops are modeled to predominantly use tracks D and N.

The second turn point cannot be precisely controlled using another DME point or altitude restriction, as this would create excessive workload for ATC. Ongoing analysis of this measure and discussions with ATC, lead to a determination that a substantial number of aircraft would be turned by TRACON sooner than projected. The aircraft could potentially make the second turn almost immediately after reaching the first turn point. This would negate much of the noise benefits of this measure.

Figure 7-8 compares the DNL contours from the 2007 Unmitigated NEM to those for Proposed NA-13, Option 1. The 60 dB and 65 DNL contours for Option 1 recede to the east and are more concentrated over the Minnesota River area than the 2007 Unmitigated NEM, thus impacting less area and people south of Runway 17/35.

Table 7.31 contains a detailed evaluation of this measure.

Table 7.30

Proposed NA-13, Option 1: Forecast Runway 17 105-Degree Hybrid Fan Departure Flight Track Use

Track (a)	Heading (Degrees)	2007 Unmitigated NEM	Proposed NA-13, Option 1	
		All Aircraft (b)	Jet Use (b)	Turboprop Use (b)
A	95	10.1%	10.1%	-
H	140	5.1%	5.1%	19.9%
I	155	4.0%	4.0%	-
B	160	8.0%	8.0%	-
C	170	17.3%	17.3%	10.1%
D	185	8.5%	8.5%	30.0%
DF	185/245	-	4.7%	-
DG	185/285	-	5.3%	-
E	200	22.3%	22.3%	-
EF	200/245	-	6.9%	-
EG	200/285	-	7.8%	-
M	215	-	-	10.0%
L	230	7.9%	-	-
N	230	-	-	30.0%
F	245	7.9%	-	-
G	285	8.9%	-	-
Total		100%	100%	100%

(a)Track designators K and L not used.
(b) Daytime and nighttime flight track use is equal
Note: Totals may not equal 100% due to rounding.

Source: Dual Track FEIS, ATCT, and HNTB analysis.

Table 7.31

Evaluation of Proposed NA-13, Option 1: Runway 17 Departure 105-Degree Hybrid Fan Procedure

Description	This measure establishes a hybrid fan, encompassing the 095-degree to 200-degree headings. Eastbound departures, inclusive of the 095-degree to 170-degree headings, are permitted to turn immediately off the end of the runway. Westbound departures, inclusive of the 171-degree to 200-degree headings, are permitted to turn upon reaching a turn point that is located on the straight out track at 1.7 NM from the arrival end of Runway 17. The turn point is marked by a DME fix. ATCT may not assign jet aircraft to an initial heading west of 200-degrees. TRACON may assign headings west of 200-degrees. Westbound turboprop aircraft are permitted to turn immediately off the end of the runway. This is needed to separate the slow turboprop aircraft from faster jet aircraft.
Local Approval	MASAC OPS Committee approved this measure on May 12, 2000, however, ATCT's latter determination that this measure was not operationally feasible resulted in further evaluation of alternative measures, including Proposed NA-13, Option 2.
Potential Noise Benefit	As modeled, this measure reduces overflights of homes in the immediate vicinity of the departure end of Runway 17. Impacted population within the 60 DNL contour is reduced by 2,525 people and 967 dwellings, as compared to the 2007 Unmitigated NEM.
Effects on Airport Operations/ATC Considerations	Departure runway capacity would be reduced by 3-4 operations per hour, as divergent headings immediately off the end of the runway are not permitted for westbound aircraft.
Impact on Airport Users	Small increases in delay are possible with reduced runway capacity. Additionally, small increases in flight time are possible as aircraft are delayed from turning to assigned heading. The average flight distance of westbound aircraft could increase by as much as 5 NM, and may result in an increase in operating costs of as much as $1.6 million annually.
Regional Economic Impacts	None.
Quality of Service Impacts	Small increases in departure delay are possible.
Airline and Airport Capital Costs	None.
Ease of Implementation and Enforcement	MAC would coordinate with ATC and FAA to implement the westbound departure procedures and the DME fix. Implementation would include published instructions for pilots, and amendment of the ATCT standard operating procedures. Environmental documentation may be required for implementation.
Legal Factors	None.
Conclusions	Although this measure will reduce impacted population within the 60 DNL contour, a substantial number of westbound aircraft would be able to turn sooner than intended. The aircraft would overfly densely populated residential areas. As a result, this measure is not included in the revised NCP. The MASAC OPS Committee reevaluated this measure in light of potential operational deficiencies, and directed that additional measures be considered, including NA-13, Option 2 - 2.5 NM Turn Point Procedure.

7.4.2.2 Proposed NA-13, Option 2: Runway 17 Departure 2.5 NM Turn Point Procedure

Proposed measure NA-13, Option 2, changes the unmitigated flight tracks to avoid, as much as possible, homes in the immediate vicinity of Runway 17 that are the most impacted by noise.

This measure is similar in concept and intent to Proposed NA-13, Option 1, the 105-Degree Hybrid Fan, but includes improvements to provide sufficient positive guidance to aircraft in order to avoid populated areas. **Figure 7-9** shows the modeled flight tracks for Option 2 mentioned in the following paragraphs.

Eastbound flight tracks, including Tracks A, H, I, B, and C, are unchanged from the unmitigated flight tracks. Jet and turboprop aircraft are permitted to turn immediately off the runway end, to headings inclusive of 95-degrees to 170-degrees.

Westbound aircraft are directed to follow specific instructions, including the use of turn points and headings, to avoid populated areas near MSP.

- Jet aircraft would be directed to fly on a straight-out flight track (Track C – 170-degrees) until reaching a specified turn point. The analysis considered two turn points, located at 2.2 and 2.5 NM from the start of takeoff roll.

- DME would be used to mark the turn point. DME gives the distance from the aircraft to a radio navigation aid (NAVAIDS) in tenths of a nautical mile. Use of a DME fix allows for relatively precise determination of the turn point.

- After reaching the turn point/DME fix, jet aircraft would turn to their initial assigned heading, inclusive of 171-degrees to 285-degrees.

- The initial departure heading of between 171-degrees and 285-degrees would be assigned by the ATCT during the takeoff clearance. Published departure procedures would instruct the pilot to delay the turn until reaching the turn point/DME fix.

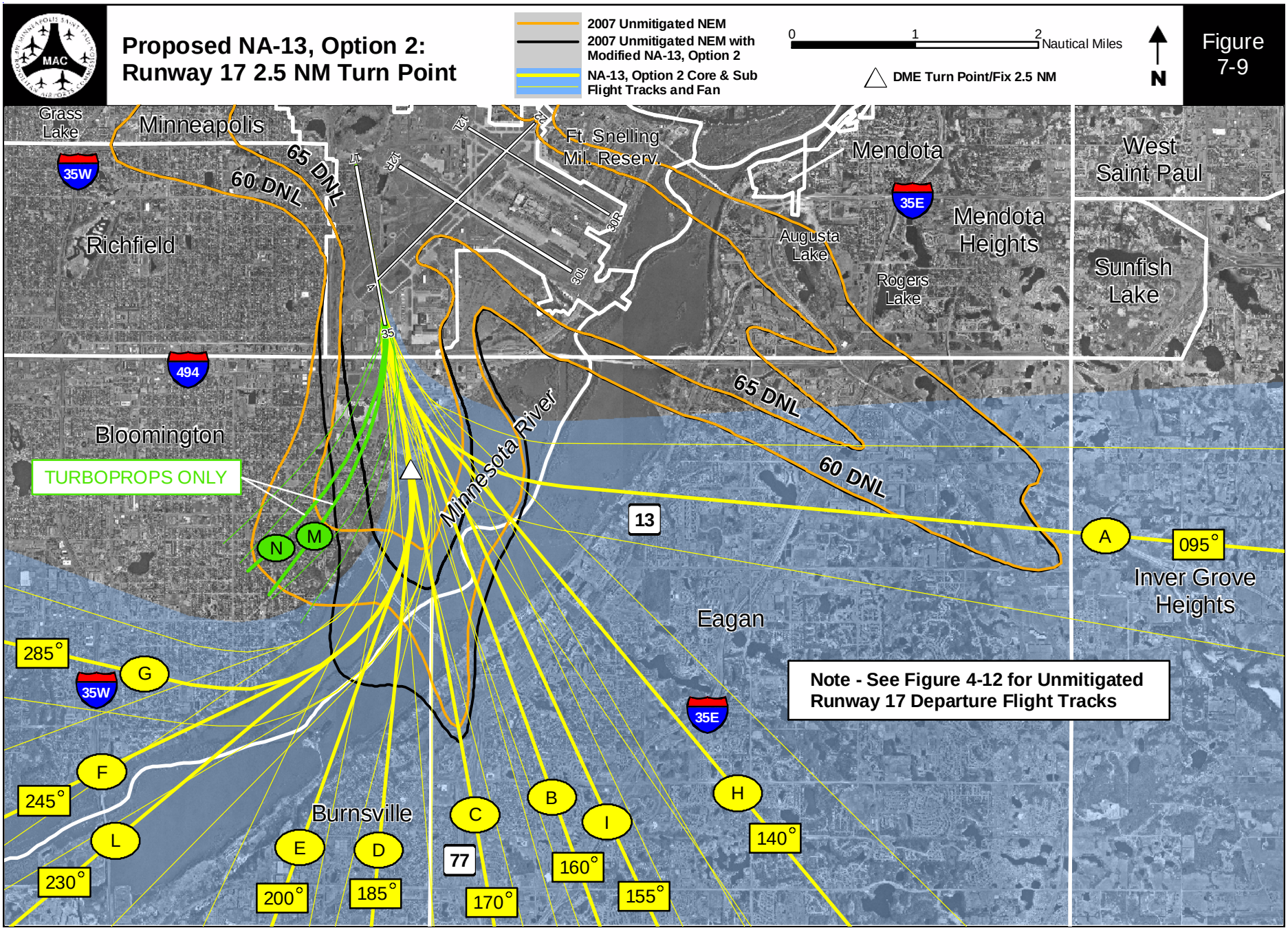
- ATCT will hand off the departing aircraft to the TRACON. The TRACON establishes radar contact with the aircraft and gives it further directions towards its departure gate, at which point the aircraft transitions to the en route environment.

- Westbound turboprop aircraft are permitted to turn to westbound headings immediately off the end of the runway (Tracks M and N). This segregates slower turboprop aircraft from faster jet aircraft.

This measure maintains the original intent of Proposed NA-13, Option 1, the 105-degree Hybrid Fan, and incorporates several improvements. Relative to Option 1, the single turn point departure procedure of Option 2 is simpler and easier to implement. A turn point, identified by a DME fix, provides positive guidance to departing aircraft, to ensure that the aircraft fly on the desired flight track. Additionally, the use of a single turn point and the ability of the ATCT to assign an initial heading that leads directly to the departure gate simplifies ATC workload.

Because westbound departing aircraft are delayed from turning, the most severe noise impacts occur over predominantly commercial areas and the Minnesota River area. The use of a single DME turn point increases pilot compliance with the intended

Proposed NA-13, Option 2: Runway 17 2.5 NM Turn Point



procedure, and avoids increased overflights of communities south of the river.

Jet flight track use is unchanged from the 2007 Unmitigated NEM, as shown in Tables 4.9 and 4.10. Turboprop aircraft flight track use is the same as for Proposed NA-13, Option 1, as shown in Table 7.30.

The analysis considered two turn point locations, at 2.2 and 2.5 NM from the start of takeoff roll. The 2.2 NM scenario was initially considered, as it routes aircraft 0.5 NM further south than the 105-degree Hybrid Fan (which used a 1.7 NM turn point). Although the 2.2 NM scenario provides substantial reductions in impacted population, the City of Bloomington and the MASAC OPS Committee requested consideration of a turn point location beyond 2.2 NM to reduce overflights of homes located on the river bluff.[11] As a result, the 2.5 NM scenario was considered. The 2.5 NM scenario provides additional reductions in impacted population, decreases over-flights over Bloomington, and avoids increased overflights of communities south of the river.

Figure 7-9 compares the DNL contours for the 2007 Unmitigated NEM to those for Option 2. Similar to Option 1, Option 2 would extend the noise exposure over the Minnesota River area and decrease exposure south of Runway 17/35.

Table 7.32 contains a detailed evaluation of this measure.

Table 7.32

Evaluation of Proposed NA-13, Option 2: Runway 17 Departure 2.5 NM Turn Point Procedure

Description	This measure routes westbound jet departures to avoid residential areas in the immediate vicinity of the departure end of Runway 17. Eastbound departures, inclusive of the 095-degree to 170-degree headings, are permitted to turn immediately off the end of the runway. Westbound departures are permitted to turn to their initial assigned heading, inclusive of 171-degrees to 285-degrees, upon reaching a turn point that is located on the straight out track at 2.5 NM from the arrival end of Runway 17. The turn point is marked by a DME fix. ATCT may assign westbound jet aircraft to an initial heading of 171-degrees to 285-degrees, as needed. Published departure procedures would instruct the pilot to delay the turn until reaching the 2.5 NM turn point. Westbound turboprop aircraft are permitted to turn immediately off the end of the runway.
Local Approval	Approved by the MASAC OPS Committee on August 11, 2000, MASAC on August 22, 2000, and the MAC Commission on August 20, 2001.
Potential Noise Benefit	Because westbound departing aircraft are delayed from turning, this measure directs higher noise exposure over predominantly commercial areas and the Minnesota River area. Impacted population within the 60 DNL contour is reduced by 4,349 people and 1,926 dwellings, as compared to the 2007 Unmitigated NEM.
Effects on Airport Operations/ATC Considerations	Departure runway capacity would be reduced by 3-4 operations per hour, as divergent headings immediately off the end of the runway are not permitted for westbound aircraft.
Impact on Airport Users	Small increases in delay are possible with reduced runway capacity. Additionally, small increases in flight time are possible as aircraft are delayed from turning to assigned heading. The average flight distance of westbound aircraft could increase by as much as 2 NM, and may result in an increase in operating costs of as much as $625,000 annually.
Regional Economic Impacts	None.
Quality of Service Impacts	Small increases in departure delay are possible.
Airline and Airport Capital Costs	None.
Ease of Implementation and Enforcement	MAC would coordinate with ATC and FAA to implement the westbound departure procedures and the DME fix. Implementation would include published instructions for pilots, and amendment of the ATCT standard operating procedures. MAC published an Environmental Assessment for the Runway 17 2.5 NM Turn Point Procedure in October 2002; FAA issued a Finding of No Significant Impact (FONSI)/Record of Decision(ROD) in August 2003. Thus, the procedure is approved for implementation concurrently with the opening of Runway 17/35.
Legal Factors	None.
Conclusions	This measure would provide a simple, viable departure procedure that directs aircraft away from residential areas close to the departure end of Runway 17, while avoiding increased overflights of other communities. Although this measure would slightly reduce runway capacity, it would provide substantial noise benefits. As a result, this measure is included in the revised NCP.

7.4.2.3 Proposed NA-14: Runway 17 River Published Departure Procedure

Proposed measure NA-14 establishes a published DP that routes aircraft south and west over the Minnesota River area. The purpose of this measure is to route aircraft directly over the river, avoiding overflight of residential areas.

As shown in **Figure 7-10**, the DP would direct aircraft to fly a straight-out heading of 170-degrees until reaching a DME turn point located 3.0 NM from the start of takeoff roll. At the turn point, the aircraft would turn to a heading of 245-degrees to overfly the river.

Several conditions are necessary for use of the River DP. Use of a River DP is limited to low-demand periods when the procedure would not reduce runway capacity. Successive departures from Runway 17 must be delayed in order to provide adequate separation for an aircraft using the River DP. During high- and mid-demand periods, this would substantially reduce runway capacity. Additionally, published DPs are assigned as part of an aircraft's flight plan, which is usually determined about 30 minutes prior to takeoff. For most of the day, ATC cannot predict traffic levels 30 minutes into the future. After midnight, however, ATC can reasonably assume that traffic levels will be low enough to permit use of the River DP without affecting runway capacity. As a result, the River DP could typically be used between 12:15 a.m. and 5:30 a.m.

Use of the River DP is included as part of Proposed NA-12, Low-Demand Flight Tracks (Section 7.4.1). As such, it is intended for use by south- and westbound departure aircraft. It would not be appropriate to assign an eastbound departure to the River DP, as this would significantly re-route the aircraft. The annual average daily use of the River DP is estimated to be 0.6-percent during the nighttime.

This measure could be enhanced with the future use of GPS/FMS departure procedures.

Table 7.33 contains a detailed evaluation of this measure.

Proposed NA-14 and NA-15: Runway 17 River Departure Procedures

Proposed NA-14 - Runway 17 River Departure Procedure

Proposed NA-15 - Runway 17 River Departure Heading

△ DME Turn Point/Fix 3.0NM

0 1 2 miles

N

Figure 7-10

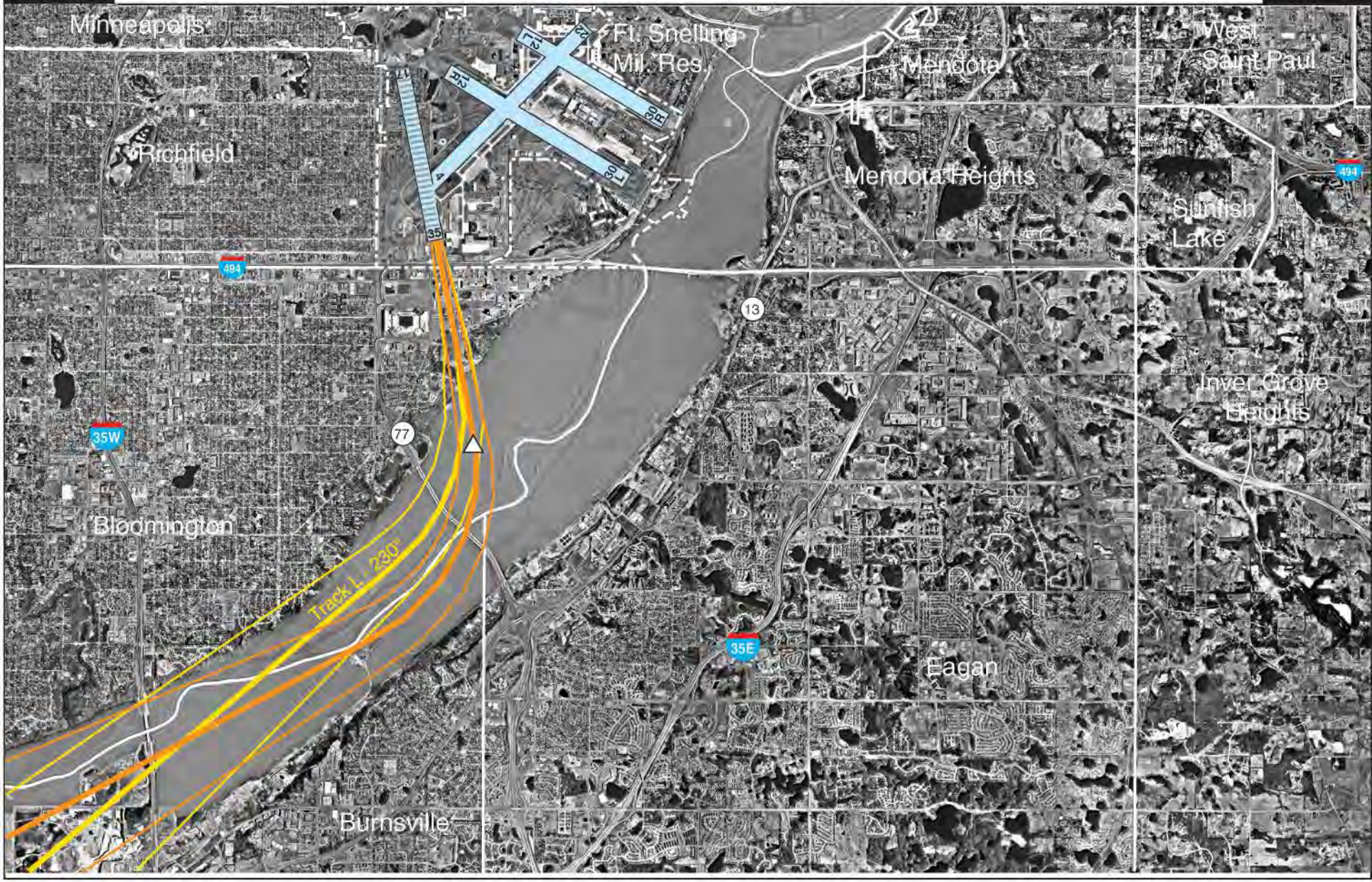


Table 7.33

Evaluation of Proposed NA-14: Runway 17 River Published Departure Procedure

Description	This measure implements a published departure procedure (DP) that routes aircraft south and west over the Minnesota River area. The DP would direct aircraft to fly a straight-out heading of 170-degrees until reaching a DME turn point located 3.0 NM from the start of takeoff roll. At the turn point, the aircraft would turn to a heading of 245-degrees to overfly the river area.
Local Approval	Approved by the MASAC OPS Committee on August 11, 2000, MASAC on August 22, 2000, and the MAC Commission on August 20, 2001.
Potential Noise Benefit	Because of the relatively low use of the River DP, this measure does not significantly change overall noise exposure. However, the River DP would provide noise abatement by directing the aircraft away from residential areas.
Effects on Airport Operations/ATC Considerations	Minor.
Impact on Airport Users	Small increases in flight time are possible as aircraft would be re-routed onto the River DP. The average flight distance of westbound aircraft could increase by as much as 10 NM, and may result in an increase in operating costs of as much as $10,000 annually.
Regional Economic Impacts	None.
Quality of Service Impacts	None.
Airline and Airport Capital Costs	None.
Ease of Implementation and Enforcement	MAC would coordinate with ATC and FAA to implement the published DP and the DME fix. Implementation would include published instructions for pilots, and amendment of the ATCT standard operating procedures. MAC published an Environmental Assessment for the Runway 17 2.5 NM Turn Point Procedure, including the Runway 17 River DP, in October 2002; FAA issued a FONSI/ROD in August 2003. Thus, the procedure is approved for implementation concurrently with the opening of Runway 17/35.
Legal Factors	None.
Conclusions	Since this measure effectively routes night departure traffic over the Minnesota River area and avoids residential areas, it is included in the revised NCP.

7.4.2.4 Proposed NA-15: Runway 17 River Departure Heading

Proposed measure NA-15 designates the 230-degree heading as the River Heading and is dependent on Proposed NA-13, Option 2, the 2.5 NM Turn Point Procedure. The 230-degree heading (Track L) routes aircraft over the Minnesota River area, as shown in Figure 7-10.

Because the River Heading can be assigned by ATCT at the takeoff clearance, and is not part of the aircraft's flight plan, it can be used during all demand periods. ATCT would assign the River Heading to south- and westbound departure traffic when conditions allow. The River Heading would not be used when there are multiple, successive departures flying in the same direction.

Use of the River Heading is included as part of Proposed NA-12, Low-Demand Flight Tracks (Section 7.4.1). As such, it is intended for use by south- and westbound departure aircraft. It would not be appropriate to assign an eastbound departure to the River Heading, as this would significantly re-route the aircraft.

Table 7.34 shows Runway 17 departure flight track use with Proposed NA-15. All flight track use is the same as in the 2007 Unmitigated NEM except for tracks E, L, F and G. Annual average daytime use of the River Heading (track L) would be increased by nearly 4-percent from approximately 8-percent to 12-percent. Annual average nighttime use of track L would be doubled - increased from approximately 8-percent to 16-percent. Increases in use of track L would be offset by decreases in use of tracks E, F and G during daytime and nighttime periods.

Table 7.35 contains a detailed evaluation of this measure.

Table 7.34

Proposed NA-15: Forecast Runway 17 River Departure Heading Flight Track Use

Track (a)	Heading (degrees)	Unmitigated NEM (All Aircraft)	Jet Use	
			Day	Night
A	95	10.1 %	10.1%	10.1%
H	140	5.1 %	5.1%	5.1%
I	155	4.0 %	4.0%	4.0%
B	160	8.0 %	8.0%	8.0%
C	170	17.3 %	17.3%	17.3%
D	185	8.5 %	8.5%	8.5%
E	200	22.3 %	20.3%	17.7%
L	230	7.9 %	11.5%	16.0%
F	245	7.9 %	7.2%	6.3%
G	285	8.9 %	8.1%	7.1%
Total			100%	100%

a) Track designator K not used.
Note: Totals may not equal 100 % due to rounding.
Source: Dual Track FEIS, ATCT, and HNTB analysis.

Table 7.35

Evaluation of Proposed NA-15: Runway 17 River Departure Heading

Description	This measure designates the 230-degree heading, when used in conjunction with Proposed NA-13, Option 2—the 2.5 NM Turn Point Procedure—as the River Heading. The 230-degree heading (Track L) routes aircraft over the Minnesota River area.
Local Approval	Approved by the MASAC OPS Committee on August 11, 2000, MASAC on August 22, 2000, and the MAC Commission on August 20, 2001.
Potential Noise Benefit	Because of the relatively low use of the River Heading, this measure does not significantly change overall noise exposure. However, the River Heading would provide noise abatement by directing the aircraft away from residential areas.
Effects on Airport Operations/ATC Considerations	None.
Impact on Airport Users	Small increases in flight time are possible as aircraft are re-routed onto the River Heading. The average flight distance of westbound aircraft could increase by as much as 7.5 NM, and may result in an increase in operating costs of as much as $430,000 annually.
Regional Economic Impacts	None.
Quality of Service Impacts	None.
Airline and Airport Capital Costs	None.
Ease of Implementation and Enforcement	MAC would coordinate with ATC and FAA to implement the River Heading procedure. Implementation would include published instructions for pilots, and amendment of the ATCT standard operating procedures. MAC published an Environmental Assessment for the Runway 17 2.5 NM Turn Point Procedure, including the Runway 17 River Departure Heading, in October 2002; FAA issued a FONSI/ROD in August 2003. Thus, the procedure is approved for implementation concurrently with the opening of Runway 17/35.
Legal Factors	None.
Conclusions	Since this measure effectively routes night departure traffic over the Minnesota River area and avoids residential areas, it is included in the revised NCP.

7.4.2.5 Proposed NA-16: Runway 35 River Visual Approach Procedure

Proposed measure NA-16 considers a river visual approach procedure (RVAP) for Runway 35 that routes arriving aircraft over the Minnesota River Valley area. The purpose of this measure is to reduce impacted population within the 60 DNL contour, and reduce overflights of residential areas.

Figure 7-11 depicts the modeled flight tracks representing the RVAP. As the aircraft nears MSP, it would turn to final approach and align with Runway 35. A RVAP would allow an approximate two NM straight, stabilized final approach to Runway 35.

Several issues would need to be resolved prior to implementation of this measure, including airspace design, FAA concurrence, and flight testing. Also, additional analysis would be required to determine if the procedure could be safely used at night.

The noise analysis of this measure included use of the RVAP during daylight hours only and during the entire day. For the daylight hours (i.e., between sunrise and sunset) only scenario, the annual average daily use of the RVAP is estimated to be 75-percent of daytime arrivals and 11-percent of nighttime arrivals to Runway 35.

Figure 7-11 compares DNL contours from the 2007 Mitigated NEM with and without the RVAP. The RVAP is compared to the 2007 Mitigated NEM, instead of the 2007 Unmitigated NEM, in order to demonstrate the potential benefit of routing both arriving and departing aircraft from Runway 17/35 over the Minnesota River Valley area. The location of the arrival lobe of the 60 DNL contour would shift to the southwest, so that the lobe would be over the Minnesota River area, and not aligned with Runway 35.

Table 7.36 contains a detailed evaluation of this measure.

Proposed NA-16: Runway 35 River Visual Approach Procedure

2007 Mitigated NEM
2007 Mitigated NEM w/Runway 35 River Approach Procedure use during Daylight Only
2007 Mitigated NEM w/Runway 35 River Approach Procedure use during Day and Night
River Visual Approach Procedure Track

Figure 7-11

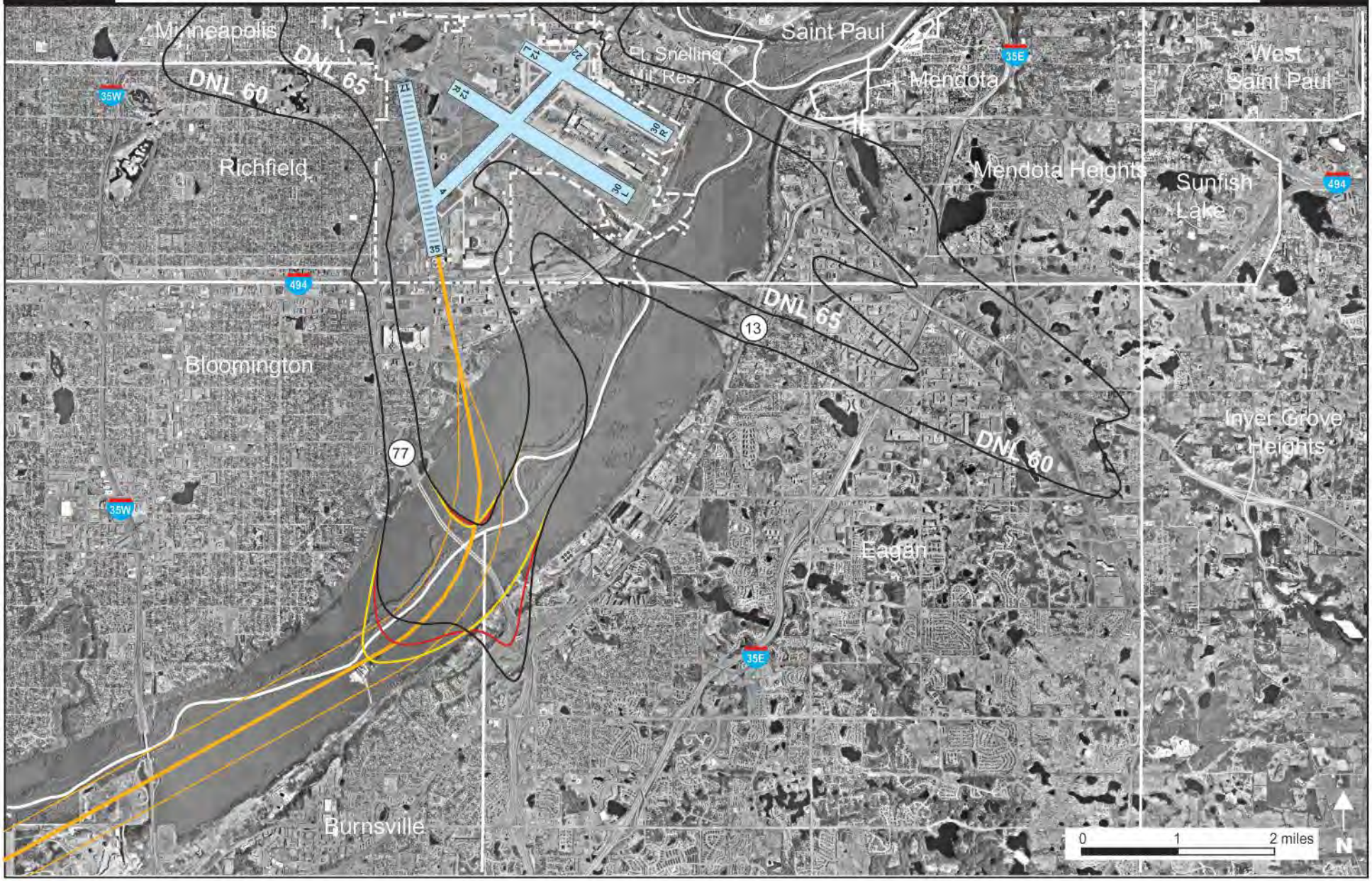


Table 7.36

Evaluation of Proposed NA-16: Runway 35 River Visual Approach Procedure

Description	This measure requires that MAC and the FAA investigate a river visual approach procedure (RVAP) for Runway 35 that routes arriving aircraft over the Minnesota River area. Aircraft using the RVAP would approach from the southwest, and fly a 65-degree heading over the Minnesota River area. As the aircraft nears MSP, it would turn to final approach and align with the runway. A RVAP would allow for approximately a 2 NM straight, stabilized final approach to Runway 35.
Local Approval	Approved by the MASAC OPS Committee on October 13, 2000, MASAC on October 24, 2000, and the MAC Commission on August 20, 2001.
Potential Noise Benefit	Use of the RVAP would yield a small reduction in the population and dwellings within the 60 DNL of the 2007 Mitigated NEM. The measure would significantly reduce overflights of residential areas south of the river. The location of the arrival lobe of the 60 DNL contour would shift to the southwest, so that the lobe would be over the Minnesota River area, and not aligned with Runway 35.
Effects on Airport Operations/ATC Considerations	Arrival airspace design and ATCT procedures would be adjusted for use of the RVAP.
Impact on Airport Users	Small increases in flight time are possible as aircraft are re-routed onto the RVAP. Because the design of the RVAP and surrounding airspace has not yet been determined, it is not possible to evaluate operating costs for this measure.
Regional Economic Impacts	None.
Quality of Service Impacts	None.
Airline and Airport Capital Costs	None.
Ease of Implementation and Enforcement	MAC would coordinate with ATC, FAA, air carriers, and airline pilot groups to determine the feasibility and details of the procedure. Environmental documentation may be required for implementation.
Legal Factors	None.
Conclusions	This measure prescribes that MAC coordinate with the FAA to determine the feasibility of the RVAP. If the procedure is determined to be feasible, MAC will coordinate with the FAA to implement the procedure. Although several issues need to be addressed for successful implementation, the potential reductions in overflights of residential areas would be beneficial. As a result, this measure is included in the revised NCP.

7.4.2.6 Summary of Runway 17/35 Flight Track Measures

Four measures to reduce overall noise exposure from operations using Runway 17/35 were identified in this Study. Proposed NA-13, Option 2, the Runway 17 Departure 2.5 NM Turn Point Procedure, reduces noise exposure for homes in the immediate vicinity of the departure runway end by delaying westbound jet aircraft turns until they are over the Minnesota River area. Proposed NA-14 and NA-15 provide additional mitigation, as they re-route departing jet aircraft over the Minnesota River area when conditions allow. Additionally, the use of a River Visual Approach Procedure, as detailed in proposed NA-16, offers the potential to reduce noise exposure from arrivals to Runway 35.

Table 7.37 shows forecast Runway 17 departure flight track use with the implementation of Proposed NA-13, Option 2, and NA-14 and NA-15. The tracks listed in Table 7.36 for the Recommended Measures are shown in Figure 7-9. The tracks listed for the 2007 Unmitigated NEM are depicted in Figure 4-12. The jet use for the recommended measures is nearly identical to the unmitigated use except for tracks E, L, J, F and G. Of these five tracks, the greatest change would be for Track L, the River Heading track. Track L would increase from nearly eight-percent to approximately 12-percent and 15-percent during the day and night periods, respectively.

Table 7.37

Forecast Runway 17 Departure Flight Track Use with Proposed NA-13, Option 2, and NA-14 and -15

Track (a)	Heading (degrees)	Unmitigated NEM (All Aircraft)	Recommended Measures		
			Jet Use		Turboprop Use
		Day/Night	Day	Night	Day/Night
A	95	10.1%	10.1%	10.1%	-
H	140	5.1%	5.1%	5.1%	19.9%
I	155	4.0%	4.0%	4.0%	-
B	160	8.0%	8.0%	8.0%	-
C	170	17.3%	17.3%	17.3%	10.1%
D	185	8.5%	8.5%	8.5%	30.0%
E	200	22.3%	20.3%	17.7%	-
L	230	7.9%	11.5%	15.4%	-
M	215	-	-	-	10.0%
N	230	-	-	-	30.0%
J	River	-	-	0.6%	-
G	285	8.9%	8.1%	7.1%	-
F	245	7.9%	7.2%	6.3%	-
Total		100%	100%	100%	100%

(a) Track designator K not used
Note: Totals may not equal 100% due to rounding

Source: Dual Track FEIS, ATCT, and HNTB analysis.

7.4.3 Proposed NA-17: Future Technology and Global Positioning System Initiatives

Proposed measure NA-17 requires that the MAC continue to investigate the application of future technologies, including the Global Positioning System (GPS), for noise mitigation purposes.

Although operational procedures to be used in conjunction with GPS and the National Airspace System have yet to be fully developed, GPS may allow for noise abatement measures that are not possible with existing technology. Potential uses at MSP include:

- Refinement and improved compliance with Eagan/Mendota Heights Corridor Procedures.
- Establishment of DPs over highway corridors and other compatible land uses that are not possible with existing NAVAIDS.
- Curved approaches to runways.
- Increased use and enhanced pilot compliance with procedures such as the Runway 17 River DP.
- Allow the development of procedures such as the Runway 22 South DP.
- Precise navigation of desired flight tracks.

As future technology noise abatement measures are identified, MAC will coordinate with the FAA and other agencies to implement the procedures at MSP.

Future technology initiatives will not substantially reduce overall noise exposure, but it offers the potential to reduce noise exposure for specific areas in certain, limited situations.

Additional information on GPS Initiatives is contained in Appendix G. **Table 7.38** contains a preliminary evaluation of this measure.

Table 7.38

Evaluation of Proposed NA-17: Future Technology and Global Positioning System Initiatives

Description	MAC will continue to actively investigate the use of future technologies, including GPS, for noise mitigation purposes. As future technology noise abatement measures are identified, MAC will coordinate with the FAA and other agencies to implement the procedures at MSP.
Local Approval	Approved by MASAC OPS on July 14, 2000, by MASAC on July 25, 2000, and the MAC Commission on August 20, 2001.
Potential Noise Benefit	Future technologies offer the potential to route aircraft over specific points in order to avoid residential areas, and thus reduce noise exposure to those residential areas.
Effects on Airport Operations/ATC Considerations	To be determined as future technology initiatives evolve.
Impact on Airport Users	
Regional Economic Impacts	
Quality of Service Impacts	
Airline and Airport Capital Costs	
Ease of Implementation and Enforcement	
Legal Factors	
Conclusions	Since future technology has the potential to precisely direct GPS-equipped aircraft and reduce noise exposure as a result, this measure is included in the revised NCP.

7.5 SUMMARY OF RECOMMENDED NOISE ABATEMENT MEASURES

This section contains a summary of the recommended noise abatement measures and the effect of their implementation on the DNL contours of the 2007 Unmitigated NEM, in the form of the 2007 Mitigated NEM (as discussed in Section 7.5.1).

Table 7.39 summarizes the noise abatement measures recommended for inclusion in the revised NCP. The new NCP contains 17 noise abatement measures, 11 of which were derived from existing NCP noise abatement measures. Six new measures (NA-12 through NA-17) are borne wholly out of measures analyzed as a part of this Study.

Recommended measures NA-1, NA-2 and NA-10 are administrative noise abatement measures. Recommended measures NA-7, NA-9, NA-12, NA-13, NA-14, NA-15, and NA-16 provide for noise abatement through flight procedures. Although the effect on noise exposure is difficult to quantify for the remaining measures, their intent is considered sufficient to warrant inclusion in the revised NCP.

7.5.1 2007 Mitigated DNL Contours

DNL contours for the 2007 Mitigated NEM, as shown in Figure 6-3, were prepared in consideration of the revised NCP. Since the future impact of measures NA-2, -3, -8, -16, and -17 is difficult to predict, they were not included in the 2007 Mitigated NEM. Furthermore, NA-16 was not included in the 2007 Mitigated NEM as the measure has not yet been deemed operationally feasible. FAA approval of NA-16 requires MAC and the FAA to investigate the feasibility of the RVAP.

Figure 7-12 shows a comparison of the DNL contours for the 2007 Unmitigated NEM and the 2007 Mitigated NEM. There are three areas of interest in Figure 7-12: (1) cities of Minneapolis and Richfield, (2) City of Bloomington, and the (3) Eagan/Mendota Heights Corridor area. Reductions and shifts in the DNL contours are seen in the former two areas while slight increases in extent of the contours are evident in the latter area (the Corridor). The cities of Minneapolis and Richfield would benefit due to the RUS (NA-9) while the City of Bloomington would primarily benefit from the Runway 17 departure procedure measures (NA-13, -14 and -15). The RUS (NA-9) would be the primary cause of the increase in exposure in the Corridor.

As shown in **Table 9.1**, the population within the 60 DNL contour of the 2007 Mitigated NEM is reduced by 5,589 people and 2,446 dwellings, relative to the 2007 Unmitigated NEM. These decreases are primarily due to the shrinking and movement of the contour in the cities of Minneapolis, Bloomington and Richfield.

Table 7.39

Summary of Recommended Noise Abatement Measures

Recommended Noise Abatement Measures for Revised NCP	**Existing Measure and Name (if different)**	**Proposed or Modified Measure**
NA-1 MSP Airport Noise Oversight Committee	NA-1	Modified NA-1
NA-2 Noise Management Program*****	NA-2 – Voluntary Noise Budget Program	Modified NA-2
NA-3 Voluntary Nighttime Limits on Flights*****	NA-3	Modified NA-3, Option 2
NA-4 Nighttime Powerbacks	NA-4	No change
NA-5 Engine Run-Up Field Rule	NA-5	No change
NA-6 Training Restriction	NA-6	No change
NA-7 Operating Procedures	NA-7	Modified NA-7 Part A[12]- Corridor Modified NA-7 Part B - NADPs
NA-8 Measures to Encourage Use of Manufactured Stage 3 Aircraft*****	NA-8 – Noise Surcharge Differential and Stage 3 Credit	Modified NA-8
NA-9 Runway Use System (RUS)	NA-9	Modified NA-9
NA-10 Airport Noise and Operations Monitoring System (ANOMS)	NA-10	No change
NA-11 Noise Abatement Sensitivity Training	NA-11	No change
NA-12 Low-Demand Flight Tracks	-	Proposed NA-12
NA-13 Runway 17 Departure 2.5 NM Turn Point Procedure	-	Proposed NA-13, Option 2
NA-14 Runway 17 River Departure Procedure	-	Proposed NA-14
NA-15 Runway 17 Departure River Heading Flight Track	-	Proposed NA-15
NA-16 Runway 35 River Visual Approach Procedure*****	-	Proposed NA-16
NA-17 Future Technology and Global Positioning System (GPS) Initiatives*****	-	Proposed NA-17

*****Not included in 2007 Mitigated NEM.

Comparison of DNL Contours for the 2007 Unmitigated NEM and 2007 Mitigated NEM

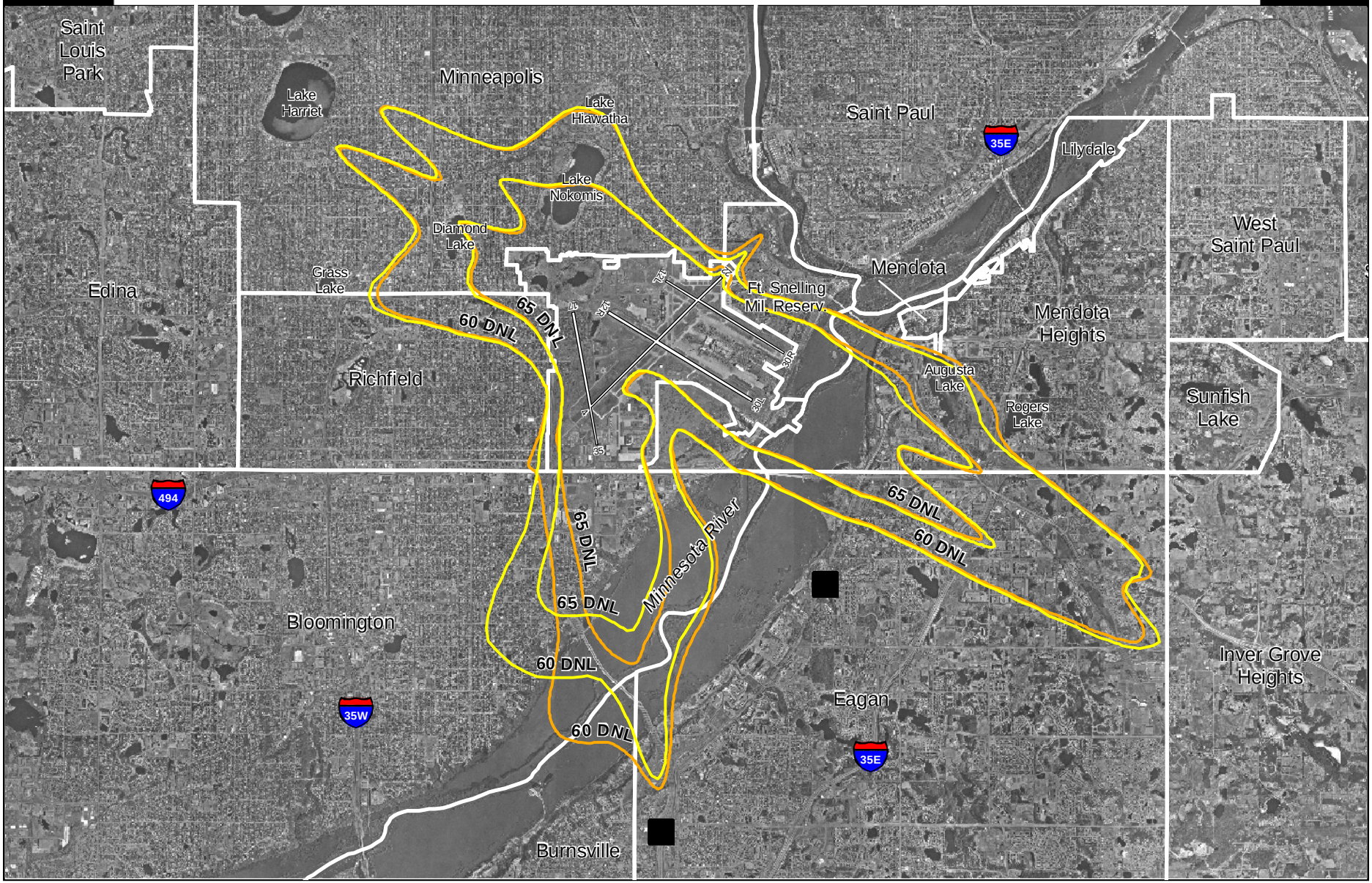
2007 Unmitigated NEM

2007 Mitigated NEM

0 1 2 Miles

N

Figure 7-12



NOTES

[1] MAC modified the nighttime hours to the current designation (10:30 p.m. to 6:00 a.m., for all days of the week) in January 1998. Previously, the nighttime hours were from 11:00 p.m. to 6:00 a.m. Monday through Friday, and 11:00 p.m. to 8:00 a.m. Saturday and Sunday.

[2] Runway 11L/29R is now Runway 12L/30R, while Runway 11R/29L is now Runway 12R/30L. Runway numbers reflect the magnetic bearing of the runway: as magnetic declination shifts, the runways must be renumbered.

[3] MASAC OPS minutes for June 9, 2000, meeting.

[4] MASAC OPS minutes for March 10, 2000, meeting.

[5] Letter from MSP ATCT to MAC, May 21, 2003.

[6] Hushkit Stage 3 aircraft are generally louder on takeoff than on arrival. However, many manufactured Stage 3 aircraft are quieter on takeoff than on arrival. Given the large number of hushkit aircraft that operate at MSP, departures have priority over arrivals for the purposes of RUS runway selection criteria. However, for NA-9, the continued modernization of the aircraft fleet at MSP may, at some point, require a re-examination of the RUS departure/arrival runway selection criteria.

[7] Additional information on RUS scenarios analyzed is described in MASAC OPS minutes for the March 24, 2000, and May 5, 2000, meetings.

[8] See note 6.

[9] Ibid.

[10] Cedar Avenue routing for Runway 22 DP was proposed in the 1993 NCP as measure NA-13. The measure was disapproved by the FAA due to flight safety concerns and adverse effect on operational efficiency.

[11] MASAC OPS minutes for June 9, 2000, meeting.

[12] Analysis of NA-7, Option 1, did not identify a feasible alternative to the existing Eagan/Mendota Heights Corridor Procedure. As such, continued use of the existing Corridor Procedure is recommended in the revised NCP.

Chapter Eight
LAND USE COMPATIBILITY MEASURES

The MAC, in cooperation with the MC, the MASAC, and the local noise-impacted communities, has worked to minimize new non-compatible land uses and to mitigate existing non-compatible land uses in the areas surrounding MSP. They cooperatively prepared and implemented land use regulations, as discussed in Chapter Five, which have proven to be effective in the prevention of new non-compatible development.

This chapter reviews the existing land use measures and their implementation (Section 8.1) and evaluates proposed modifications to the existing measures (Section 8.2). Potential new land use measures are evaluated in Section 8.3. A summary of the recommended land use measures is then presented in Section 8.4.

In addition to operational noise abatement measures, a comprehensive NCP includes land use (LU) measures that seek to (1) correct existing non-compatible land uses around the airport after the application of the noise abatement elements described in Chapter Seven, and (2) prevent the development of future non-compatible land uses around the Airport.

8.1 STATUS OF EXISTING LAND USE MEASURES

Tables 8.1 through 8.8 briefly describe each of the eight existing land use measures. Information is provided on the implementation status of the existing land use measures, their effectiveness, and an assessment of their applicability to the revised NCP. See Chapter One for the verbatim language of each measure.

The eight land use measures in the 1993 NCP included five preventive measures approved within the original 1987 Part 150 Study (LU-1 through LU-5) and three corrective measures developed within the 1993 Update (LU-6 through LU-8). The measures were designed to address existing non-compatible land uses and reduce future non-compatible development by encouraging compatible development, such as industrial or commercial development, and discouraging noise-sensitive land uses, such as schools and residential neighborhoods. All of these measures have been implemented except LU-7.

Table 8.1

Status of Existing LU-1: Amend Local Land Use Plans to Bring them into Conformance with Metropolitan Council's Noise Compatibility Guidelines

Description	This preventive measure involves the coordination of the MAC, the MC, and the local communities to revise the noise compatibility guidelines in the Aviation Policy Plan of the Metropolitan Development Guide (MDG). This measure would apply regulatory actions that would inhibit non-compatible development.
Implementation Status	The 1996 update of the Aviation Policy Plan identified a MSP Noise Policy Area for application of the land use compatibility guidelines. The Aviation Policy Plan used the federal DNL noise descriptor, noise compatibility guidelines to the 60 DNL contour, and a noise buffer zone that extends one-mile beyond the 60 DNL contour. Revised systems statements were transmitted to affected communities around MSP for use in updating their comprehensive plans. As of June 2004, the status of the individual community comprehensive plans as it relates to the MC requirements for comprehensive plan update is as follows: • Minneapolis: Complete - Aviation element is complete and in conformance; City is not recommending large-scale land use changes concerning aircraft noise. Undeveloped land is essentially not available. Corrective measures in the form of home and school noise attenuation have been underway for many years. • Mendota: Complete - Plan is in conformance. • Mendota Heights: Complete - Plan is in conformance. • Sun Fish Lake: Complete - Plan is in conformance. • Inver Grove Heights: Complete - Plan is in conformance. • Eagan: Complete - Plan is in conformance. • Burnsville: Complete - Plan is in conformance. • Bloomington: Complete - Plan is in conformance. • Richfield: Complete - Plan is in conformance.
Evaluation of Measure Effectiveness, Cost, and Benefit	A majority of the area within noise-impacted cities is extensively developed, limiting the effectiveness and benefit of the measure to existing areas. However, there is potential for benefit in the future as communities change land uses. The costs associated with this measure are administrative.
Study Considerations	For this Study, this is a valid measure for inclusion in the revised NCP, with modification to incorporate the MC's Transportation Policy Plan and for the areas subject to noise compatibility guidelines per the FAA-accepted 2007 NEM and the one-mile noise buffer zone.

Table 8.2

Status of Existing LU-2: Zone for Compatible Development

Description	This preventive measure involved the coordination of the MAC and the local jurisdictions to review the existing zoning policies in the Airport Noise Zones and to rezone, if necessary, to ensure consistency with the Aviation Policy Plan of the MDG. This effort primarily applies to undeveloped or major redevelopment parcels in the Cities of Eagan, Mendota Heights, Inver Grove Heights, Bloomington, and Richfield.
Implementation Status	Local communities have conducted review and rezoning actions.
Evaluation of Measure Effectiveness, Cost, and Benefit	A majority of the area within noise-impacted cities is extensively developed, limiting the effectiveness and benefit of the measure to existing areas. There is potential for benefit in the future as communities look towards compatible zoning near noise-impacted areas (i.e., Richfield development corridor along Cedar Avenue). The costs associated with this measure are administrative.
Study Considerations	For this Study, this is a valid measure for inclusion in the revised NCP with modification to the areas subject to noise impact zoning per the FAA-accepted 2007 NEM and the one-mile noise buffer zone.

Table 8.3

Status of Existing LU-3: Apply Zoning Performance Standards

Description	This preventive measure involved requests by the MAC and the MC for noise-impacted local jurisdictions to adopt the model ordinance for aircraft noise attenuation. Adoption of the State Land Use Compatibility Guidelines in 1983 was accompanied by passage of a law [MS 473.192] titled "Metropolitan Area Aircraft Noise Attenuation Act." The Act allowed metropolitan municipalities to adopt and enforce ordinances and controls to regulate building construction methods and materials for the purpose of attenuating aircraft noise in habitable buildings in and around the Airport Noise Zones. More specifically, this legislation allows communities to establish aircraft noise overlay zoning and building codes that are stricter than the Minnesota State Uniform Building Code. The model ordinance does not apply to remodeling or rehabilitating an existing residential building or to the construction of an appurtenance to an existing residential building. The model ordinance provides for the following: • Finding that aircraft noise is a problem for the city and its citizens. • Establishing aircraft noise overlay zoning districts. • Identifying exterior noise levels and interior noise performance standards. • Identifying compatible/non-compatible land uses. • Establishing structural acoustic requirements. • Defining processes for inspection and enforcement.
Implementation Status	The model ordinance has been adopted as-is by the Cities of Mendota Heights and Sunfish Lake. The City of Inver Grove Heights has also adopted an ordinance per MS 473.192. All other MSP noise impact area communities have indicated that they have comparable or stricter local ordinances/controls in effect.
Evaluation of Measure Effectiveness, Cost, and Benefit	A majority of the area within the noise-impacted cities is extensively developed, thus limiting the effectiveness and benefit to existing areas of the measure. There is potential for benefit in the future as communities look to develop (especially communities located some distance from MSP, such as Burnsville). The costs associated with this measure are administrative (adoption, implementation and enforcement of model ordinance). Additionally, increased construction costs related to NLR requirements have not been quantified by local construction firms.
Study Considerations	For this Study, this is a valid measure for inclusion in the revised NCP with modification to the areas subject to zoning performance standards per the FAA-accepted 2007 NEM and the one-mile noise buffer zone.

Table 8.4

Status of Existing LU-4: Establish a Public Information Program

Description	Develop and distribute informational materials concerning aircraft noise and NCP elements to prevent non-compatible land use.
Implementation Status	The MC prepared a Builder's Guide in 1989 as a local planning assistance effort to provide builders, developers, architects, engineers, and building inspectors with information to help communities implement the compatibility guidelines. The information was primarily for construction of new single-family development since it was the most likely noise-sensitive land use to occur in undeveloped areas around MSP. Several communities with housing subdivisions in the MSP Noise Policy Area have used the guide. The MC updated the Builder's Guide in 1999. The MAC has a dedicated website (www.macnoise.com) for noise issues, including detailed levels of information on operations and noise exposure levels. The website has been continuously updated during the development of this Study to include the latest information under consideration, as discussed in Chapter Ten.
Evaluation of Measure Effectiveness, Cost, and Benefit	The public information program allows new and existing homeowners to become aware of building construction requirements and potential noise levels prior to construction, potentially alleviating future noise compatibility issues. The public has been able to follow and participate in the Study. The costs of this measure are administrative.
Study Considerations	For this Study, this is a valid measure for inclusion in the revised NCP with modification in language to continue the established program using the latest approaches in public information dissemination.

Table 8.5

Status of Existing LU-5: Revise Building Codes

Description	As a preventive strategy, MC proposed modifications to the State Building Code to require noise level reduction for new construction in areas impacted by aircraft noise as defined by the MDG Aviation Policy Plan. The local communities are required to adopt these revisions.
Implementation Status	MAC supported the efforts of MC to modify the State Building Code to require specified interior noise level reduction for new construction in the Aircraft Noise Zones for MSP. The building code was revised and subsequently adopted by local communities in compliance with the MDG Aviation Policy Plan. See Existing LU-1 (Table 8.1) for specifics on communities with conforming comprehensive plans.
Evaluation of Measure Effectiveness, Cost, and Benefit	Structures built after 1983 have been required to achieve interior sound levels referenced in Table 7 of the MDG Aviation Policy Plan (note that the same standards are incorporated into the Transportation Policy Plan). Assuming the acoustical levels required are achieved, additional sound insulation in newly constructed structures is unnecessary making participation in the Sound Mitigation Program unnecessary.
Study Considerations	For this Study, this is a valid measure for inclusion in the revised NCP with modification to the areas subject to revised building codes per the FAA-accepted 2007 NEM and the one-mile noise buffer zone.

Table 8.6

Status of Existing LU-6: Land Acquisition Program

Description	As a corrective measure, the MAC would purchase land primarily within the 65 DNL contour of the 1996 NEM at fair market value in neighborhoods identified by each participating city. If not converted by the MAC to airport use, the property would be sold by the MAC providing its use be non-residential and compatible with airport operations. Under the land acquisition program for MSP, property would be acquired only at the initiative and with the approval of the local jurisdiction, where it has been established that there is a reasonable consensus among residents to vacate the area. The neighborhood boundaries were identified by each participating city and may include areas outside the 65 DNL contour.
Implementation Status	The land acquisition program has been a vital tool for the MAC in mitigating the extreme examples of non-compatible land uses around MSP. For example, it has been used successfully to purchase the New Ford Town/Rich Acres area just west of the Airport and east of Highway 77 in Richfield. Based on the high level of noise in the New Ford Town and Rich Acres area, the City of Richfield requested that the MAC acquire 335 single-family homes and 67 apartment units. The buildings were later purchased and removed as part of the new Runway 17/35 project.
Evaluation of Measure Effectiveness, Cost, and Benefit	The population within the 65 DNL contour was reduced with this measure. Additionally there is no potential for future redevelopment to non-compatible land uses. The cost of the New Ford Town and Rich Acres acquisition was approximately $50 million.
Study Considerations	For this Study, this is a valid measure for inclusion in the revised NCP. The measure will apply to the 65 DNL contour of the FAA-accepted 2007 NEM.

Table 8.7

Status of Existing LU-7: Purchase Guarantee Program

Description	As with most purchase guarantee programs, if aircraft noise levels were found to be intolerable by individual homeowners and the owner had made a "bona fide effort" to sell the property, the owner-occupied property would be acquired by the MAC at a fair market value and would be returned to residential use with appropriate sound insulation measures, releases, and restrictions. The Purchase Guarantee Program is not intended nor designed to acquire all, or a substantial portion, of a designated area, but rather to provide the homeowner the opportunity to sell his home at a guaranteed fair market value on a house-by-house basis prior to participating in the MAC Sound Insulation Program. Purchase Guarantee Program eligibility is limited to homeowners residing within the 1996 65 DNL contour in neighborhoods identified by each individual city.
Implementation Status	This program has not been implemented nor requested by local governments.
Evaluation of Measure Effectiveness, Cost, and Benefit	Not applicable.
Study Considerations	For this Study, this is a valid measure for inclusion in the revised NCP. The measure will apply to the 65 DNL contour of the FAA-accepted 2007 NEM.

Table 8.8

Status of Existing LU-8: Part 150 Sound Insulation Program (Residential, School, and Other Public Buildings)

Description	This corrective measure was designed to alleviate the impact of aircraft noise by providing indoor environments where normal activities could be enjoyed without interruption. The program funds structural modifications to public and private buildings that reduce the amount of noise entering such environments from the outside. The 65 DNL contours from the 1996 NEM were used to determine program eligibility in neighborhoods identified by each individual city upon approval by the FAA. The Residential Sound Insulation Program was designed to reduce interior noise levels by 5 dB, achieved by utilizing a combination of the following structural modification techniques: • Repair/replacement of exterior windows. • Addition of exterior acoustic storm windows. • Repair/replacement of existing prime doors. • Addition of exterior acoustic storm doors. • Addition of cellulose wall and attic insulation. • Baffling of roof vents and chimney treatment. • Addition of central air conditioning. Typical structural modification techniques applied to schools could include the following elements, depending on the specific characteristics of each building: • Addition of secondary roof system and suspended ceilings. • Acoustic window replacement and reduction of existing window areas. • Repair of existing doors and construction of new entrance vestibules. • Baffling of air intakes and exhaust. • Addition of air conditioning.
Implementation Status	**Figure 8-1** shows the block completion status of the existing Sound Insulation Program. Upon program completion in 2004, 7,690 single-family homes and 752 multi-family units had been completed. A multi-family unit for MSP's implementation program is defined as a dwelling unit inside a structure consisting of four or more apartments or dwelling units. MAC has also implemented a school insulation program. This program was initiated before the residential program, with St. Kevin's School of Minneapolis beginning renovations in 1981. Since then, nine additional schools have been insulated in Minneapolis. Five school sound insulation projects have been completed in the City of Richfield, and two projects have been completed in Mendota Heights. In total, 17 schools have been included in the Sound Insulation Program.
Evaluation of Measure Effectiveness, Cost, and Benefit	The program has increased the number of compatible homes by 7,690 single-family homes and 752 multi-family units. As the program has progressed techniques have improved and home owners have been typically pleased with the program. The total program cost associated with the completed homes over the 12-year period,

Table 8.8

Status of Existing LU-8: Part 150 Sound Insulation Program (Residential, School, and Other Public Buildings)

	including construction and administrative costs, is approximately $226 million. The insulation costs per home during the period have ranged from an average low of $17,300 in 1995 to an average high of $45,000 in 2001. The reasons for the rising trend in insulation costs are: removal of the $25,000 per home cap, increased material and labor charges, increased home size, work in areas subject to historic/preservation district regulations, added indoor air quality testing, and increased numbers of hot-water heated homes entering the program that require mechanical modifications. MAC has spent approximately $45 million on school sound insulation projects.
Study Considerations	This is a valid measure for inclusion in the revised NCP, with modification of the applicable areas to include noise sensitive structures within the 60 DNL contour of the FAA-accepted 2007 NEM consistent with the mitigation package approved by the MAC as part of this Study process.

8.1.1 Residential Sound Insulation Program History

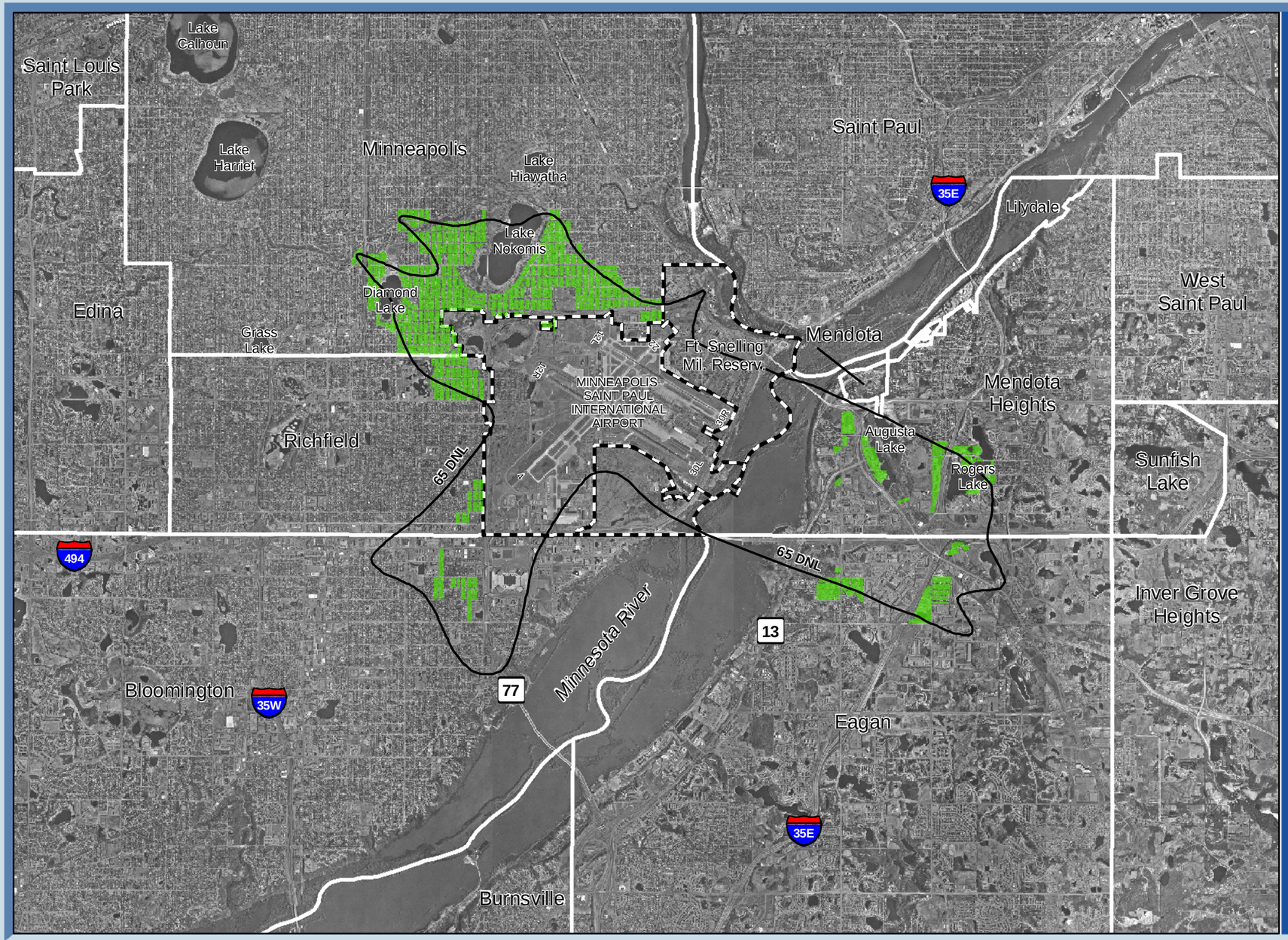
As the Residential Sound Insulation Program is a large and visible part of the NCP at MSP, this section provides a history of the program through planning, adjustments, and continued implementation.

1989-1991: Planning

During the drafting of the Part 150 Study Update in 1990, MAC developed a series of "base-case" assumptions that represented the initial Residential Sound Insulation Program framework. These assumptions were eventually incorporated into the Residential Sound Insulation Pilot Program during the planning period and included the following primary components:

- NLR goals and insulation modification packages that differed among 1996 DNL contour areas:
  - A NLR goal of 10-15 decibels was established for eligible homes within DNL contours equal to or greater than 75 dB. Due to these higher noise exposure levels, this insulation modification package included window and door treatments, wall and ceiling treatments, "quiet room" treatment (for a pre-selected room of choice), vent baffling, attic insulation, and central air conditioning.
  - A NLR goal of 5-10 decibels was established for eligible homes within the 70-74 DNL contour interval. This modification package included window and door treatments, limited wall treatments, vent baffling, wall and attic insulation, and central air conditioning.
  - A NLR goal of 0-5 decibels was established for eligible homes within the 65-69 DNL contour interval and included window and door treatments, wall and attic insulation and central air conditioning.
- $25,000 limit on all sound insulation modifications. Due to administrative bidding requirements, MAC established a cap limit of $25,000 per home for sound insulation modifications.

HNTB



- Blocks Completed
- 1996 65 DNL Contour
- Airport Boundary
- Jurisdiction Boundary

N

0 0.5 1 Statute Miles

SOURCE OF AERIAL PHOTOGRAPHY: The Metropolitan Council, Minneapolis, MN, April, 1997.
ORIGINAL LAND USE DATA: from the counties of Ramsey, Dakota, and Hennepin, and the municipalities of Bloomington, Burnsville, Eagan, Edina, Inver Grove Heights, Lilydale, Mendota, Mendota Heights, Minneapolis, Richfield, Saint Louis Park, Saint Paul, South Saint Paul, Sunfish Lake, and West Saint Paul, augmented with field data.

Residential Sound Insulation Program - Block Completion Status

Figure 8-1

- Establishment of the Bulk Contract Bid Method. Within the "Bulk" Contract Bid Method, numerous design packages (ranging from 5 to 60 homes) were combined into large, single bid packages. Having no previous sound insulation program implementation experience, MAC believed that this bid method would simplify the bid/award process, reduce paperwork, and maximize project management efficiency.

- Establishment of 44 Sound Transmission Class (STC) requirements for all acoustic products. During the Part 150 Study Update development in 1990, MAC did not have field-verified data that defined how well Twin City homes were attenuating aircraft noise before receiving Sound Insulation Program acoustic modifications. According to FAA assumptions, a typical U.S. home attenuated between 20-24 decibels on average. Using this assumption, MAC established 44 STC requirements for all approved Sound Insulation Program acoustic products.

- City-Specific Block Prioritization System. Since the eligible homes contained within the 65 DNL contour of the 1996 NEM were located within five different cities (Minneapolis, Richfield, Bloomington, Eagan, Mendota Heights), MAC allowed each city to develop their own unique method of prioritizing eligible homes. These strategies included lotteries, blocks based on geographical distance from the airport, and DNL.

- Allocation of annual MSP Part 150 Funding. Due to recommendations from all five participating cities, MAC developed an annual funding allocation system consisting of a *base* allocation and a *remainder* allocation based directly on population of eligible properties within the 65 DNL contour of the 1996 NEM. Using this system, each participating city would first receive a base allocation which would represent five percent of the annual Part 150 budget. The remaining 75 percent of the annual Part 150 budget were divided among the cities, based on actual population percentages within the 65 DNL contour of the 1996 NEM.

1992-1996: Program Adjustments

After the initial Residential Sound Insulation Program development during the 1989-1991 time period, MAC implemented a 143-home Pilot Program in 1992 in an effort to test the base-case assumptions. During the 1992 pilot year, MAC experienced several implementation problems, ranging from contractor performance issues, field construction problems, problems resulting from the Bulk Bidding Method, lack of desirable acoustic products, block prioritization inconsistencies, and high construction costs. Based on this experience, MAC made considerable adjustments to the Sound Insulation Program during the next several years. The following is a summary of the primary program changes:

- Elimination of the Bulk Bidding Method, and adoption of a Single Parcel Bidding Method where each home is an independent design and construction contract.

- Elimination of the 44 STC acoustic requirements for all approved Program acoustic products and adoption of a 40 STC standard.

- Elimination of city-specific home prioritization and the development of a universal block prioritization system based on noise (DNL noise contours and ANOMS flight tracks).

- Elimination of different NLR goals for homes in different DNL contour areas, and the establishment of a universal "5-Decibel Reduction Package" for all homes within the 1996 65-75 DNL contour interval.

- Introduction of homeowner choices (selection of bidding contractor, product styles and colors) and the establishment of a Sound Insulation Program product showroom to display all approved program products to eligible homeowners.

- Introduction of additional product styles and colors, which could include wood-frame windows with exterior acoustic storms, steel-insulated doors with exterior acoustic storms, decorative wood doors, and vinyl acoustic replacement windows.

- Elimination of the $25,000 cap due to larger homes and higher construction costs.

- Introduction of a maximum 30-day construction period to eliminate long construction periods.

- Introduction of Homeowner Orientation Sessions to better inform eligible homeowners of Sound Insulation Program processes and responsibilities.

- Introduction of Contractor Orientation Sessions to better inform certified contractors of the program specifications, product installation techniques, and construction expectations.

- Introduction of contractor penalties (suspensions, removal) in the event of construction deficiencies.

8.2 PROPOSED MODIFICATIONS TO EXISTING LAND USE MEASURES

The MASAC OPS Committee reviewed 15 land use measures in total. Eight of the fifteen were existing 1993 Study measures (LU-1 through LU-8), modified in language only to make them current in date and mitigation area. The MASAC OPS Committee endorsed the continuance of the original eight land use measures with modifications for currency and mitigation area at the May 1, 2000, MASAC OPS Committee meeting.

Tables 8.1 through 8.8 describe the modifications made to the eight existing land use measures. For preventive measures LU-1, LU-2, LU-3, and LU-5, the land use measures have been modified to include the 60 DNL contour plus a one-mile buffer as the boundary of application. The boundaries of corrective measures LU-6 and LU-7 maintain their limit at the 65 DNL contour, while the boundary of corrective strategy LU-8 has been modified to include the 60 DNL contour. Thus, the following existing measures are carried forward into the revised NCP with modifications:

- LU-1 Amend Local Land Use Plans to bring them into Conformance with MC's Noise Compatibility Guidelines

- LU-2: Zone for Compatible Development

- LU-3: Apply Zoning Performance Standards

- LU-4: Continue a Public Information Program/System

- LU-5: Revise Building Codes

- LU-6: Acquire Developed Property in Non-Compatible Use

- LU-7: Property Purchase Guarantee Program

- LU-8: Sound Mitigation Program

8.2.1 Further Discussion of LU-8: Sound Mitigation Program

Because the Sound Mitigation Program for MSP has encompassed many years, thousands of homes and 17 schools, the boundary of the program, prioritization of the program, and the actual sound insulation requirements are of utmost concern to the communities that participate in the program. In addition, the elements of an extended mitigation program to the 60 DNL are required to be evaluated under the 1996 legislation (which maintains MSP at its present location) and with the incorporation of the 1996 Noise Mitigation Program as a mitigation measure into the Dual Track FEIS/ROD.

8.2.1.1 Boundary Development

Regarding the boundary determination, during the Study process the MAC and MASAC once again attempted to seek approval from the FAA to develop neighborhood and natural boundaries that reflect current conditions at the outer edge of the 60 DNL contour to the maximum extent possible. To establish a boundary adjustment proposal, the MAC and the MASAC conducted a study that defined neighborhoods and natural boundaries in portions of Minneapolis, Richfield, Bloomington, Eagan, Mendota Heights, and Inver Grove Heights using criteria that was applied consistently throughout the impacted communities. Note that this analysis was originally developed for the November 2001 Study, and that the percentages referenced in this section are relative to the MASAC analysis of the 2005 Mitigated NEM. See Appendix L for a comparison of the 2005 and 2007 Mitigated NEMs. The following six scenarios were evaluated:

- *Blocks intersected by the 60 DNL contour*. This boundary determination practice is being used for the current Residential Sound Insulation Program out to the 1996 65 DNL contour. Historically it has been considered fair and equitable. This method of boundary determination would include homes physically located beyond the 60 DNL contour.

- *Blocks completely within the 60 DNL contour*. This boundary definition would decrease the number of dwellings eligible for the Sound Mitigation Program by approximately 32-percent, relative to the baseline block intersect method and the 2005 Mitigated NEM. With this scenario, many homes physically located within the 60 DNL contour would be excluded from the Sound Mitigation Program.

- *Half blocks completely within the 60 DNL contour*. This boundary definition would decrease the number of dwellings eligible for the Sound Mitigation Program by approximately 31-percent, relative to the baseline block intersect method and the 2005 Mitigated NEM. With this scenario, many homes physically located within the 60 DNL contour would be excluded from the Sound Mitigation Program. Also, the eligibility area is not as clearly defined as with the use of blocks.

- *Half blocks intersected by the 60 DNL contour*. This boundary definition would decrease the number of dwellings eligible for the Sound Mitigation Program by approximately one-percent, relative to the baseline block intersect method and the 2005 Mitigated NEM.

This method of boundary determination would include homes physically located beyond the 60 DNL contour. Additionally, the eligibility area is not as clearly defined as with the use of complete (full) blocks.

- *Parcels intersected by the 60 DNL contour.* This boundary definition would decrease the number of dwellings eligible for the Sound Mitigation Program by approximately 11-percent, relative to the baseline block intersect method and the 2005 Mitigated NEM. This method of boundary determination would include only homes physically located within the 60 DNL contour. The method of boundary determination may be considered unfair and subjective by homeowners at the edge of the contour.

- *Natural boundaries.* The method for determining the sound insulation boundary included consideration of naturally occurring features (e.g., lakes, creeks, rivers, and open spaces) within reasonable distance from contour edge. Major thorough-fares with wide rights-of-way and major city streets were used as a natural boundary. Where no reasonable natural boundary existed, the 60 DNL contour line was used as the boundary. This boundary definition would increase the number of dwellings eligible for the Sound Mitigation Program by approximately 21-percent, relative to the baseline block intersect method and the 2005 Mitigated NEM. This method of boundary determination would extend the sound insulation boundaries well beyond the 60 DNL contour in some locations. This type of boundary determination was considered in the 1993 Study and rejected by the FAA.

During the 1993 Study review process, FAA rejected a boundary proposal that included blocks outside of the 65 DNL contour line. These areas included natural boundaries, such as rivers, lakes, and major community roads. FAA strongly considered rounding off eligible properties to those that completely fell within the 65 DNL contour. MAC and MASAC then developed a block intersect boundary that was eventually approved by FAA. With this boundary definition, an entire block was considered to be eligible for the Sound Insulation Program if any part of the block was intersected by the 1996 65 DNL contour.

Following FAA guidance, community input, and the critical time-sensitive nature of the Sound Mitigation Program in terms of construction scheduling, MASAC and MAC endorsed the continued use of the FAA-approved block intersect method at MSP for this revision to the NCP, but with expansion of the block intersect method to the 60 DNL contour line. During the spring of 2004, continued debate on the Sound Mitigation Program focused on either the block or parcel intersect boundary definition, in recognition of the previous MAC and MASAC position for use of the block intersect method at MSP and the fact that the parcel intersect method has been FAA-approved for use at other airports around the United States. At the May 5, 2004, MAC Planning and Environment Committee meeting, MAC staff presented information on airports that have used a block intersect method, including those that incorporate a natural boundary (see Appendix N for more information). On July 19, 2004, MAC approved use of the block intersect boundary definition for the Sound Mitigation Program. As stated previously, the natural boundary method was previously rejected by FAA for the MSP Sound Insulation Program out to the 65 DNL contour. In order to expedite FAA approval of this Study, the block

intersect method is again being used/requested to determine eligibility.

Figure 8-2 illustrates the recommended boundary for the proposed program. Figure 8-2 also shows the delineation of blocks intersected by one-dB level increments within the 60-64 DNL contours and also the 65 DNL, as relevant to the discussion of the mitigation package in Section 8.2.1.5. The delineation of contour boundaries to identify which properties were eligible for the Sound Mitigation Program required extensive coordination with community interests.

8.2.1.2 Consideration of Ambient Noise

During the public deliberations for this 2004 Study, several questions were raised about the application of ambient noise to the DNL contours and determination of eligibility for the Sound Mitigation Program. Part 150 permits land that would otherwise be considered to be non-compatible to be shown as compatible on the NEMs (and hence ineligible for a Sound Mitigation Program) if the "self-generated noise from that use and/or the ambient noise from other non-aircraft and non-airport uses is equal to or greater than the noise from aircraft and airport sources."[1] However, there is no requirement that ambient noise levels actually be considered in determining eligibility, and most airport sponsors do not include ambient noise as an eligibility factor. This is due to the technical challenges in measuring ambient noise for a widespread area and the community disruption that would likely result from use of ambient noise in the Sound Mitigation Program. Also, it is important to note that ambient noise levels cannot be used to change the location of the DNL noise contours. FAA documentation for the NEM Checklist (Appendix A) states that "[self-generated or ambient noise] may not be used to adjust the outlines of the noise contours resulting from aircraft operations." Given these factors, MAC does not intend to consider ambient noise levels in determining the location of DNL contours or the eligibility of homes for the Sound Mitigation Program. Moreover, the 1993 Study assessed ambient noise levels for the purpose of land use planning but not for eligibility in the Sound Mitigation Program.[2]

8.2.1.3 Comparison of Existing and Proposed Residential Sound Mitigation Program

Table 8.9 provides a distribution of the existing Residential Sound Mitigation Program (including dwelling units provided with mitigation through the existing program) compared to the proposed program. The dwelling unit counts in Table 8.9 are derived from the 2007 Mitigated NEM as shown in Figure 8-2 and assume that the block intersect method is FAA-approved in the new program. Also, the dwelling unit counts use the Part 150 dwelling unit count method in which a parcel with one dwelling unit is defined as a single family home and a parcel with more than one unit is defined as a multi-family home. Using this methodology, a total of 5,354 single-family and 2,979 multi-family dwelling units will be added to the Residential Sound Mitigation Program (not including 46 new dwelling units in Mendota Heights, as identified in Table 8.9). Note that the Part 150 method is consistent with the dwelling unit counts presented elsewhere in this Study (as defined in Section 5.4)

Table 8.10 shows the same information presented in Table 8.9, but instead uses the *implementation method* for counting dwelling units. The Residential Sound Mitigation Program defines a single family home as a parcel with between one and three units. This method of determining dwelling counts is called the implementation method.

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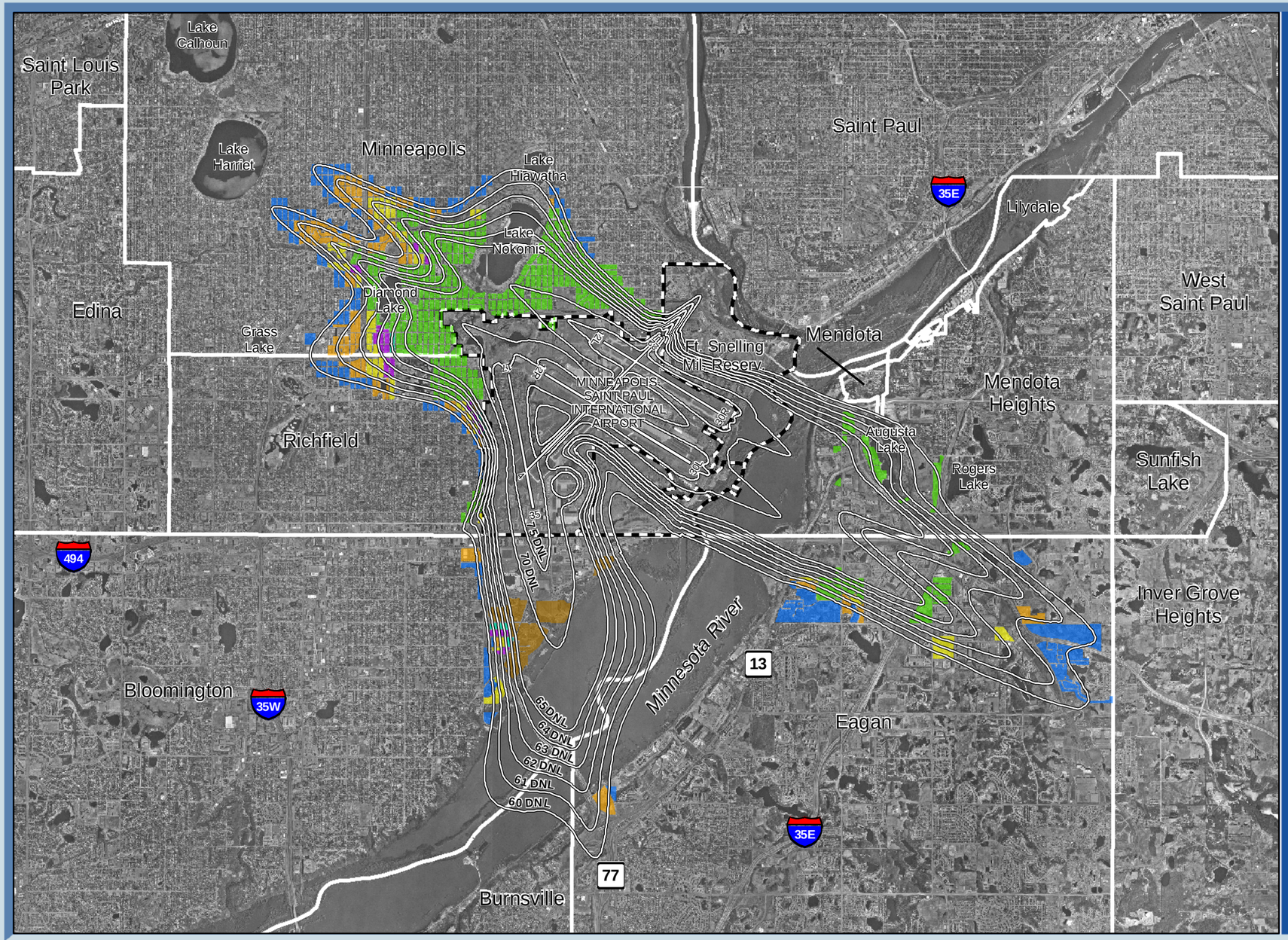
HNTB



Blocks Completed in 1996 NEM Sound Insulation Program

Residential Blocks Recommended for Inclusion in Future Sound Mitigation Program:

- Within 60 DNL Contour
- Within 61 DNL Contour
- Within 62 DNL Contour
- Within 63 DNL Contour
- Within 64 DNL Contour
- Within 65+ DNL Contour

- 2007 Mitigated DNL Contour
- Airport Boundary
- Jurisdiction Boundary

N

0 0.5 1 Statute Miles

SOURCE OF AERIAL PHOTOGRAPHY: The Metropolitan Council, Minneapolis, MN, April, 1997.
ORIGINAL LAND USE DATA: from the counties of Ramsey, Dakota, and Hennepin, and the municipalities of Bloomington, Burnsville, Eagan, Edina, Inver Grove Heights, Lilydale, Mendota, Mendota Heights, Minneapolis, Richfield, Saint Louis Park, Saint Paul, South Saint Paul, Sunfish Lake, and West Saint Paul, augmented with field data.

Proposed Sound Mitigation Program Boundary

Figure 8-2

The dwelling unit counts derived from the implementation method have typically been presented at Planning and Environment Committee and MAC Commission meetings. Using this methodology, a total of 5,941 single-family and 2,392 multi-family dwelling units will be added to the Residential Sound Mitigation Program (excluding 46 new dwelling units in Mendota Heights that would be ineligible for the program, as discussed in the next paragraph).

Note that both the *Part 150 method* and *implementation method* include the same numbers of new dwellings (8,333 units) and total dwellings (16,648 units) in the Sound Mitigation Program. Also, both Tables 8.9 and 8.10 exclude 46 new dwelling units in Mendota Heights built since 2000 that are ineligible for the Sound Mitigation Program per FAA policy as described in Section 5.2.1. Furthermore, both Tables 8.9 and 8.10 exclude 29 single-family and 136 multi-family units within the 65 DNL contour in the City of Bloomington that are being acquired prior to the opening of Runway 17/35 in late 2005.

Table 8.9

Summary of Existing Program Compared to Proposed Program
(Part 150 Method)

City	Count	Dwelling Units Within DNL (dB) Interval									
		Single Family					Multi-Family				
		60-64	65-69	70-74	75+	Total	60-64	65-69	70-74	75+	Total
Minneapolis	1996 EDC	2,788	2,798	472	-	6,058	390	301	421	-	1,112
	Additional for 2007	3,773	-	-	-	3,773	1,560	-	-	-	1,560
	Total	6,561	2,798	472	-	9,831	1,950	301	421	-	2,672
Bloomington (a)	1996 EDC	-	-	-	-	-	-	-	-	-	-
	Additional for 2007	142	120	37	-	299	348	447	-	-	795
	Total	142	120	37	-	299	348	447	-	-	795
Richfield	1996 EDC	261	328	-	-	589	48	32	-	-	80
	Additional for 2007	782	8	-	-	790	572	14	-	-	586
	Total	1,043	336	-	-	1,379	620	46	-	-	666
Eagan	1996 EDC	176	25	-	-	201	-	-	-	-	-
	Additional for 2007	492	-	-	-	492	38	-	-	-	38
	Total	668	25	-	-	693	38	-	-	-	38
Mendota Heights	1996 EDC	44	4	-	-	48	227	-	-	-	227
	Additional for 2007	-	-	-	-	-	- (b)	-	-	-	-
	Total	44	4	-	-	48	227	-	-	-	227
All Cities	1996 EDC	3,269	3,155	472	-	6,896	665	333	421	-	1,419
	Additional for 2007	5,189	128	37	-	5,354	2,518	461	-	-	2,979
	Total	8,458	3,283	509	-	12,250	3,183	794	421	-	4,398

Notes:

- "Part 150 Method" refers to a dwelling unit count method with single family home equal to one unit and multi-family as two or more units.
- EDC = Eligible Dwellings Completed.
- "1996 EDC" refers to those dwellings initially eligible within the 65 DNL contour of the 1996 NEM.
- "Additional for 2007" refers to additional dwelling units eligible in the 60 DNL contour of the 2007 Mitigated NEM using the block intersect method. Homes within the 60-64 DNL contour are potentially eligible for the Sound Mitigation Program if they do not have air-conditioning and elect to participate in the program. Homes within the 60-64 DNL that currently have air-conditioning would not be eligible for the program.
- Burnsville, Edina, Inver Grove Heights, and Mendota do not have dwellings within the 60 DNL contour.
- (a) Excludes 29 single-family and 136 multi-family units within the 65 DNL contour of the 2007 Mitigated NEM scheduled for purchase and demolition by the MAC prior to opening of Runway 17/35 in late 2005.
- (b) Excludes 46 new dwelling units in Mendota Heights built since 2000 that are ineligible for the Sound Mitigation Program.

Source: MAC

Table 8.10

Summary of Existing Program Compared to Proposed Program
(Implementation Method)

City	Count	Dwelling Units Within DNL (dB) Interval									
		Single Family					Multi-Family				
		60-64	65-69	70-74	75+	Total	60-64	65-69	70-74	75+	Total
Minneapolis	1996 EDC	3,068	3,072	504	-	6,644	110	27	389	-	526
	Additional for 2007	4,291	-	-	-	4,291	1,042	-	-	-	1,042
	Total	7,359	3,072	504	-	10,935	1,152	27	389	-	1,568
Bloomington (a)	1996 EDC	-	-	-	-	-	-	-	-	-	-
	Additional for 2007	148	120	37	-	305	342	447	-	-	789
	Total	148	120	37	-	305	342	447	-	-	789
Richfield	1996 EDC	291	328	-	-	619	18	32	-	-	50
	Additional for 2007	845	8	-	-	853	509	14	-	-	523
	Total	1,136	336	-	-	1,472	527	46	-	-	573
Eagan	1996 EDC	176	25	-	-	201	-	-	-	-	-
	Additional for 2007	492	-	-	-	492	38	-	-	-	38
	Total	668	25	-	-	693	38	-	-	-	38
Mendota Heights	1996 EDC	46	4	-	-	50	225	-	-	-	225
	Additional for 2007	- (b)	-	-	-	-	-	-	-	-	-
	Total	46	4	-	-	50	225	-	-	-	225
All Cities	1996 EDC	3,581	3,429	504	-	7,514	353	59	389	-	801
	Additional for 2007	5,776	128	37	-	5,941	1,931	461	-	-	2,392
	Total	9,357	3,557	541	-	13,455	2,284	520	389	-	3,193

Notes:

- "Implementation Method" refers to a dwelling unit count method with single family home equal to one to three units.
- EDC = Eligible Dwellings Completed.
- "1996 EDC" refers to those dwellings initially eligible within the 65 DNL contour of the 1996 NEM.
- "Additional for 2007" refers to additional dwelling units eligible in the 60 DNL contour of the 2007 Mitigated NEM using the block intersect method. Homes within the 60-64 DNL contour are potentially eligible for the Sound Mitigation Program if they do not have air-conditioning and elect to participate in the program. Homes within the 60-64 DNL that currently have air-conditioning would not be eligible for the program.
- Burnsville, Edina, Inver Grove Heights, and Mendota do not have dwellings within the 60 DNL contour.
- (a) Excludes 29 single-family and 136 multi-family units within the 65 DNL contour of the 2007 Mitigated NEM scheduled for purchase and demolition by the MAC prior to opening of Runway 17/35 in late 2005.
- (b) Excludes 46 new dwelling units in Mendota Heights built since 2000 that are ineligible for the Sound Mitigation Program.

Source: MAC

8.2.1.4 Priority Scheme for Sound Mitigation Program

At several meetings, both MASAC and MASAC OPS considered the priority by which sound insulation would be provided. After much deliberation, the following *verbatim* priority recommendations for residential sound insulation were determined (note that the language has been revised in this Study to reflect the 2007 DNL contours instead of the 2005 DNL contours):

1. "*Complete the insulation of single-family and duplex homes within the 1996 DNL 65 and greater DNL noise contours.*

2A. *Complete the sound insulation of multi-family residential structures within the 1996 DNL 65 and greater noise contours in conjunction with priority #2B, and then sequencing to #2C below upon FAA approval of the Study document.*

2B. *Complete the sound insulation of single-family and duplex homes that fall within the 2007 DNL 65 and greater DNL noise contours.*

2C. *Complete the sound insulation of eligible single-family and duplex homes that fall within the 2007 DNL 60 to 64 noise contours.*

3. *Complete the sound insulation of multi-family residential structures within the 2007 DNL 65 and greater DNL noise contours in conjunction with priority 2C above upon FAA approval of the Part 150 Update document.*

4. *Complete the sound insulation of multi-family residential structures within the 2007 DNL 60 to 64 noise contours.*

5. *Complete the sound insulation of nursing homes and places of worship with regular weekday daycare/nursery school programs within the 2007 DNL 60 contour."*

The MASAC OPS Committee approved these priorities on August 11, 2000. The priorities listed above will serve to guide the MAC in the development of a proposed Sound Mitigation Program upon approval of the NCP and availability of funding.

8.2.1.5 Sound Mitigation Packages

In an effort to reach a final recommendation on the 2007 65-75 DNL and 60-64 DNL residential sound mitigation packages, MAC considered a variety of insulation packages, based on past program experience and input from MASAC and NOC. The options presented conform to the primary goals found in the "Guidelines for the Sound Insulation of Residences Exposed to Aircraft Operations," published by the FAA. The guidelines state that "the two primary goals of a residential sound insulation program are the improvement of the noise environment for community members and better relations between the [airport] and its neighbors."

Section 1.3 discusses the history of this Study. The following two paragraphs provide additional history on the various sound mitigation package recommendations made during the Study. In August 2001, after receiving testimony at several Planning and Environment Committee meetings and two public meetings, the MAC Commission resolved to provide homes within the 2005 60-64 DNL contour interval the same five-decibel reduction package offered to homeowners in the 1996 65-75 DNL contour interval. This decision was subject to a $150 million budget (1998 dollars) spread between 2003 and 2010. However, at the December 2001 Commission meeting,

the August 2001 Commission action was rescinded. At the April 2002 Commission meeting, action was taken on a revised sound mitigation package that included a five-decibel reduction package for homes within the 65-75 and 63-64 DNL contours, and a mechanical package for homes within the 60-62 DNL contours. Provisions were also made for acoustical testing to ensure an interior noise level of 45 dB and for reimbursement for sound insulation work in lieu of the mechanical package. In May 2002, after consideration of the events of September 11, 2001, the MAC withdrew the Study from FAA to update the forecast and the associated noise contours. As part of this process, in consideration of financial constraints after September 11, 2001, the appropriate mitigation package was reconsidered.

On March 24, 2004, NOC recommended a mitigation package based on the block intersect method that would offer homeowners the five-decibel reduction package in the 2007 65-75 DNL contours. In addition, a five-decibel reduction package would be offered to homeowners in the 62-64 DNL contours and a sound insulation package not to exceed $13,500 per home for residences within the 60-61 DNL contours. However, on July 13, 2004, the MAC Planning and Environment Committee recommended a mitigation package based on the block intersect method that would include a five-decibel reduction package for homes within the 65 DNL and greater contours. Within the 60 to 64 DNL contour interval, homes without preexisting air conditioning would be offered air conditioning contingent upon the homeowner paying 50-percent of the cost.

On July 19, 2004, the MAC Commission modified the Planning and Environment Committee recommendation as follows:

- 2007 65-75 DNL Sound Mitigation Package: MAC will continue to offer homes within the 2007 65-75 DNL contour interval the same five-decibel reduction package offered to homeowners in the 1996 65-75 DNL contour interval. This includes 461 multi-family units and one school (Trinity School in Bloomington). The program boundary would be based on the block intersect method.

- 2007 60-64 DNL Sound Mitigation Package: MAC will offer single family homes within the 2007 60-64 DNL contour interval a mechanical (i.e., air-conditioning only) package if they do not already have air-conditioning installed. To participate in the program, homeowners would pay the following share of the mechanical package costs:
  - 10-percent within the 64 DNL contour,
  - 20-percent within the 63 DNL contour,
  - 30-percent within the 62 DNL contour,
  - 40-percent within the 61 DNL contour, and
  - 50-percent within the 60 DNL contour.

  The program boundary would be based on the block intersect method.

Figure 8-2 shows the delineation of blocks intersected by one-dB level increments within the 60-64 DNL contours and also the 65 DNL. In order to assist residents with the proposed co-pay obligation, MAC has directed staff to develop a program with the Center for Energy and Environment to offer low-interest loans to homeowners.

The Sound Mitigation Program would have several other provisions, as outlined in the complete MAC Commission action. Other elements of the Study are also addressed in

the complete MAC Commission action of November 15, 2004, which is transcribed *verbatim* as follows:

"Authorize staff to revise the Part 150 program as necessary to submit the approved program to the FAA for review and approval.

1. *That subject to items 5, 6, and 7 below, all homes within the 2007 65 75 DNL contour be eligible to receive the current residential noise mitigation package based on block rounding.*

2. *That subject to items 5, 6 and 7 below, all homes in the 2007 60 64 DNL contour would be eligible for the following noise mitigation option:*

   That the Commission amend the previous Commission action to make residential homes and schools in the approved 2007 60-64 DNL contours eligible to receive the mechanical package if they do not have air conditioning. Residential homeowners would be subject to a copay based on the following percentages: 64 DNL – 10%, 63 DNL – 20%, 62 DNL – 30%, 61 DNL – 40%, 60 DNL – 50%. Program eligibility would be based on block rounding.

3. *That completion of the sound insulation program continue to be contingent upon MAC maintaining a bond rating of at least A.*

4. *That staff be directed to update the Part 150 program and associated noise contours in 2007, or sooner should there be changes in Airport activity or use that would have a significant impact on the contour.*

5. *That the homes included in the programs identified in items 1 and 2 will be increased or reduced based upon future Part 150 contours developed by the Metropolitan Airports Commission and approved by the Federal Aviation Administration.*

6. *That an avigation release condition be obtained from those homeowners receiving noise mitigation.*

7. *That homeowners who decline to participate shall not be permitted to enter the program at a later date.*

8. *That the term "residential" is defined as a one, two and three dwelling unit in a single structure.*

9. *That the residential noise mitigation program be terminated following the completion of those homes located in the then approved 60 64 DNL.*

10. *Incorporate the current mitigation package for 461 multi-family units within the 2007 65 DNL contour and Trinity School into the Part 150 program.*

11. *Direct staff to work with the Center for Energy and Environment to develop and implement a low interest loan program to assist eligible homeowners with the co-pay requirement."*

8.3 POTENTIAL NEW LAND USE MEASURES

Seven potential new land use measures are considered in this Study. Each potential measure is evaluated in terms of the six factors shown in **Table 8.11**. Evaluations of the seven potential land use measures are found in **Tables 8.12 through 8.18.** The tables describe each of the seven land use measures and their reason(s) for elimination or adoption.

Six of the potential land use measures (LU-9 through LU-14) were evaluated at the June 9, 2000, MASAC OPS Committee meeting, resulting in the endorsement of one additional land use measure (LU-14: Creation of Sound Barriers/Buffers).

Extensive study of a potential new measure to mitigate residential land uses exposed to low-frequency noise began in December 1998 via the Low-Frequency Noise Policy Committee. The MAC Full Commission endorsed the measure on September 18, 2000, and indicated that it should be included in the revised NCP. The low-frequency noise mitigation measure was included in the November 2001 Study as proposed measure LU-10. However, subsequent review by FAA and the Federal Interagency Committee on Aviation Noise (FICAN) was not favorable, as discussed in Section 8.3.1. As a result, the low-frequency noise mitigation measure is no longer included in the recommended revised NCP.

Table 8.11

Evaluation Criteria for Potential New Land Use Measures

Criteria	Description
Area to which Measure would be Applied	This factor defines (1) the DNL contour intervals within which the measure would be applied and/or (2) the types of land uses within the applicable contour intervals that would be addressed
Anticipated Benefits	This factor describes the potential benefits of the measure. Potential benefits could be of a direct nature (restricting additional residential development in areas impacted by airport noise), indirect nature (permitting informed decisions by potential buyers), or remedial nature (providing acceptable interior noise levels).
Costs	This factor identifies public and private sector costs associated with implementing the measure and potential eligibility for federal funds.
Effect on Property Values	Qualitative assessment of measure's potential impact on real property values.
Effect on Tax Base	Qualitative assessment of measure's potential impact on local property tax revenues.
Political Acceptability	This factor describes the interests that may be adversely affected by the potential measure. Such interests could include existing land owners concerned about potential impacts on property values, neighbors concerned about the potential character change of the neighborhood, or developers opposed to limitations or conditions that might be placed on the development of land.

Table 8.12

Evaluation of Potential Measure 9: Dedication of Avigation Easements (Corrective)

Description	This measure would require the dedication of avigation easements permitting aircraft overflights to the MAC as a condition of building permits for specified noise-sensitive land uses in noise-impacted areas. The measure would require the purchase of avigation easements outright from existing non-compatible properties.
Area to which Measure would be Applied	Jurisdictions within the 60 DNL of the 2007 Mitigated NEM, including portions of Burnsville, Bloomington, Eagan, Mendota Heights, Minneapolis, and Richfield.
Anticipated Benefits	Would provide protection for airport sponsor from litigation due to airport operations. Property owners would relinquish right to sue.
Costs	MAC administration; costs of easements could be extensive depending on community negotiations.
Effect on Property Values	Possible impact on market value of properties involved, although experience with appraisal of avigation easements at other airports indicates that this effect is slight.
Effect on Tax Base	Minimal.
Political Acceptability	Homeowners and/or developers oppose the measure due to the potential for reducing marketability. Homeowners who have already received mitigation (sound insulation) have no incentive to accept avigation easement.
Conclusion	This measure was rejected because it is inconsistent with previous practice and is therefore politically unacceptable. Avigation easements are unnecessary if other measures, such as noise insulation and purchase guarantee programs, continue to be implemented.

Table 8.13

Evaluation of Potential Measure 10: Dedication of Avigation Easements (Preventive)

Measure	**Dedication of Avigation Easements**
Description	This measure would require the dedication of avigation easements permitting aircraft overflights to the MAC as a condition of building permits for specified noise-sensitive land uses in noise-impacted areas. The measure would require the dedication of avigation easements as a condition for obtaining building permits for new or substantially reconstructed structures.
Area to which Measure would be Applied	Jurisdictions within the 60 DNL of the 2007 Mitigated NEM, including portions of Burnsville, Bloomington, Eagan, Mendota Heights, Minneapolis, and Richfield.
Anticipated Benefits	• Would provide protection for airport sponsor from litigation due to airport operations. Property owners would relinquish right to sue. • Notifies potential homebuilders of noise environment before building, and alerts buyer that buildings must be built to higher standard. • Helps to notify infill builders and potential homeowners of the noise environment as well.
Costs	MAC administration; costs of easements could be extensive depending on community negotiations.
Effect on Property Values	Possible impact on market value of properties involved, although experience with appraisal of avigation easements at other airports indicates that this effect is slight.
Effect on Tax Base	Minimal.
Political Acceptability	Homeowners and/or developers oppose the measure due to the potential for reducing marketability.
Conclusion	This measure was rejected because it is inconsistent with previous practice and is therefore politically unacceptable. Avigation easements are unnecessary if other measures, such as noise insulation and purchase guarantee programs, continue to be implemented. This measure is similar in effect to a disclosure policy, which has yet to be authorized for the area. In addition to being politically unacceptable, this would create restrictions on properties further from MSP than those that are currently being insulated.

Table 8.14

Evaluation of Potential Measure 11: Fair Property Disclosure Policy

Description	This preventive measure incorporates aircraft noise information in sales documents for existing and new residential development. This technique would require the disclosure of aircraft noise levels by property owners and their agents.
Area to which Measure would be Applied	Jurisdictions within the 60 DNL of the 2007 Mitigated NEM, including portions of Burnsville, Bloomington, Eagan, Mendota Heights, Minneapolis, and Richfield.
Anticipated Benefits	Potential buyers are allowed an informed decision regarding airport-related impacts; however, disclosure of noise levels typically occurs at or near closing after the potential buyer has committed substantial time and effort to the purchase.
Costs	Administrative costs associated with changing statute to include noise disclosure.
Effect on Property Values	Minimal, although it is possible that if the measure were to decrease the number of potential buyers (by eliminating those considering noise to be a significant issue) there could be some impact on property value.
Effect on Tax Base	Minimal.
Political Acceptability	Developers may oppose measure due to potential negative effect on marketing residential developments.
Conclusion	This measure was rejected because significant legal and administrative issues remain unsolved. Similar noise compatibility benefits could be obtained to some degree through public information programs.

Table 8.15

Evaluation of Potential Measure 12: Land Banking

Description	This preventive measure involves the fee-simple purchase of privately-owned, vacant land by a local public agency to prevent non-compatible land use development and to hold such property for later public use not necessarily related to aviation.
Area to which Measure would be Applied	Vacant parcels within the 60 DNL of the 2007 Mitigated NEM that are located in the cities of Burnsville, Bloomington, Eagan, Mendota Heights, Minneapolis, and Richfield.
Anticipated Benefits	Eliminates potential for development of non-compatible land uses within the 60 DNL contour.
Costs	MAC cost of property acquisition and administrative costs of program administration.
Effect on Property Values	Could reduce property values if compatible land use has less taxable value than existing land use.
Effect on Tax Base	Could reduce tax base for multiple jurisdictions.
Political Acceptability	Since the program would be voluntary and property owners would receive fair market value for development rights, little opposition would be anticipated from affected property owners. Since potential public uses of acquired property must conform to the comprehensive plan and zoning ordinance, as well as to land use compatibility guidelines (see Table 5.2), the public sector may not want to purchase land with limited use.
Conclusion	This measure was rejected because it would have significant impact on local development and land use regulation. Also, because of the relatively sparse amount of vacant developable land remaining in the noise impact area, the costs to administer a program would be much higher than any derived benefits.

Table 8.16

Evaluation of Potential Measure 13: Transfer of Development Rights

Description	This preventive measure involves the purchase of an interest in privately-owned vacant land which permits the MAC to prohibit any and all uses of the land that could be adversely impacted by aircraft noise. Development potential would be transferred from properties within Aircraft Noise Zones to designated receiving areas outside of the noise zones.
Area to Which Measure Would be Applied	Jurisdictions within the 60 DNL of the 2007 Mitigated NEM. Vacant portions of the following communities are included within the 60 DNL of the 2007 Mitigated NEM: Burnsville, Bloomington, Eagan, Mendota Heights, Minneapolis, and Richfield.
Anticipated Benefits	Eliminates non-compatible land use within selected area.
Costs	MAC costs for acquiring interest in the property or properties and administrative costs of program administration. Cost of development rights for residential property would essentially equal the total acquisition costs, including appraisal costs.
Effect on Property Values	Could reduce property values if compatible land use has less taxable value than existing land use.
Effect on Tax Base	Could reduce tax base for multiple jurisdictions.
Political Acceptability	Since the program would necessarily be voluntary and property owners would receive fair market value for development rights, little opposition would be anticipated. Should the program result in development of non-residential uses in residential areas, some residents could oppose the measure.
Conclusion	This measure was rejected because it would have significant impact on local development and land use regulation beyond the area impacted by airport noise. Also, because of the relatively sparse amount of developable vacant land remaining in the noise impact area, the costs to administer a program would be much greater than any derived benefits.

Table 8.17

Evaluation of Potential Measure 14: Creation of Sound Buffers/Barriers

Description	This corrective measure consists of the combined use of sound barrier walls and/or berms and natural landscaping to reduce aircraft-related noise for the communities surrounding MSP. Potential locations for noise barriers would be evaluated. Possible locations include areas between Runway 17/35 and Richfield.
Area to which Measure would be Applied	Areas adjacent to runways and taxiways at MSP. Portions of the following communities are adjacent to runways and taxiways at MSP: Minneapolis, Bloomington, and Richfield.
Anticipated Benefits	Potential for reducing noise impact from taxing and takeoff operations in proximity to these operations. Reduces noise levels from ground operations for close-in residents. Specific benefits cannot be determined without design and acoustical analysis. Barrier design and detailed acoustical analysis are required to determine feasibility and benefits.
Costs	Cost of study, administrative costs, and ultimately design and construction costs.
Effect on Property Values	None or beneficial effect as airport noise levels would be reduced.
Effect on Tax Base	None projected. However, the tax base would be reduced if residential properties were acquired to provide buffer/berm area.
Political Acceptability	Community representation on MASAC requested that this measure be included within the updated NCP.
Conclusion	Due to the political acceptability and the need for further study, this measure is included in the revised NCP.

Table 8.18

Evaluation of Potential Measure 15: Mitigate Residential Land Uses Exposed to Low-Frequency Aircraft Noise

Description	The purpose of this corrective measure is to mitigate the impact of low-frequency aircraft noise primarily through the Residential Sound Mitigation Program. Implementation of the measure would be based on the Low-frequency Noise Policy Committee's recommendations, which are detailed in Appendix H of this Study.
Area to which Measure would be Applied	In jurisdictions which experience 70 dB LFSL and higher, which includes areas within Richfield, Minneapolis, and Bloomington. Specific elements of the mitigation are related to the Low-frequency Sound Level (LFSL) dose identified for the zone where each residential unit is located, as portrayed by Figure H-7. LFSL is defined in Chapter Two. Single-family residences eligible for low-frequency mitigation fall into three categories: (1) those previously insulated under the MSP Residential Insulation Program; (2) those eligible under the MSP Residential Sound Insulation Program, but not yet insulated; and (3) those not eligible under the existing MSP Residential Sound Mitigation Program, but eligible for low-frequency mitigation. Multi-family units within the 1996 NEM have been mitigated as part of the existing Residential Sound Mitigation Program. Treatment in all zones would be provided as shown in Table H.3 (Appendix H) and further described below. *Low-frequency Mitigation Measures where LFSL Dose is 70 dB to 77 dB* In this zone, residences that have received insulation under the MSP Residential Insulation Program would receive no further insulation treatment. Residences that have not received insulation would be insulated under the MSP Residential Insulation Program. All residences would receive additional treatment to control residual rattling of windows and objects as described in Appendix B of the full report of the Low-Frequency Noise Policy Committee. *Low-frequency Mitigation Measures where LFSL Dose is 78 dB to 86 dB* In this zone, residences that have received insulation under the MSP Residential Insulation Program would receive treatment to increase LFSL reduction by at least 5 dB (to 20 dB). Residences that have not received insulation would be insulated under the MSP Residential Insulation Program modified to increase interior LFSL reduction by at least 5 dB (to 20 dB). All residences would receive additional treatment to control residual rattling of windows and objects as described in Appendix B of the full report of the Low-Frequency Noise Policy Committee. *Low-frequency Mitigation Measures where LFSL Dose is 87 dB and higher* In this zone, land use conversion is the preferred method of mitigation. Inclusion of a measure to mitigate impacts of low-frequency aircraft noise would require expansion of the MSP Residential Sound Mitigation Program to include techniques to control aircraft noise-induced rattling in single-family and multi-family residential units. These additions to the existing program would require development of procedures to meet the new needs. It would also require one or more field tests of techniques to increase LFSL reduction in residential units.
Anticipated Benefits	Reduction of low-frequency noise impacts in the applied areas within the 70 dB LFSL and higher. Reduction in community annoyance due to rattling of building elements and furnishings induced by low-frequency aircraft noise during takeoff roll and reverse thrust.
Costs	Yet to be determined, pilot program necessary to determine costs.
Effect on Property Values	Should improve property values due to additional mitigation.
Effect on Tax Base	None.
Political Acceptability	Mitigation of LFSL impacts has been the subject of considerable political debate. It was decided that mitigation of LFSL impacts would be considered in the Study as discussed in the Dual Track FEIS and follow-on discussions with the City of Richfield.

Table 8.18

Evaluation of Potential Measure 15: Mitigate Residential Land Uses Exposed to Low-Frequency Aircraft Noise

Conclusion	MAC endorsed the measure on September 18, 2000, and indicated that it should be included in the revised NCP. The low-frequency noise mitigation measure was included in the November 2001 Study as proposed measure LU-10. However, subsequent review by FAA and the Federal Interagency Committee on Aviation Noise (FICAN) was not favorable, as discussed in Section 8.3.1. As a result, the low-frequency noise mitigation measure is not included in the revised NCP.

8.3.1 Further Discussion of Potential Measure: Mitigate Residential Land Uses Exposed to Low-Frequency Aircraft Noise

The November 2001 Study included a land use measure (LU-10) that called for the mitigation of residential land uses exposed to low-frequency noise impacts. As a result of recent and ongoing developments on a national level relative to low-frequency noise and the federal research that will be taking place on the topic, this measure is not included in the revised NCP.

By way of background, the MSP Low-Frequency Noise Policy Committee completed its work in August 2000 and planned to submit the final Expert Panel report as part of the 2001 Study which was being prepared at the time. MAC approved the report at its September 18, 2000, meeting and directed staff to incorporate it into the 2001 Study. To facilitate the FAA's review of the report, however, the MAC forwarded it to Ms. Nancy Nistler, manager of the local FAA Airports District Office, on September 20, 2000. MAC subsequently submitted the Study to the FAA in November 2001, which included the Low-Frequency Noise Policy Committee's expert panel report. As discussed in Section 1.3, the November 2001 Study was pulled from FAA consideration in May 2002 to update the forecast to take into consideration the effect of the terrorist events of September 11, 2001, on the aviation industry.

The FAA, in cooperation with the Federal Interagency Committee on Aviation Noise (FICAN), then began a review of the report and its findings.[3] To assist in its review, in June 2001, FICAN met with Sandy Fidell and Andrew Harris, two members of the three-member expert panel, to discuss the report. In April 2002, the FICAN issued its findings on the expert's four areas of consensus, which included: (1) effects of low-frequency noise, (2) a descriptor for low-frequency noise (LFSL), (3) the relationship between low-frequency noise and annoyance, and (4) acceptability criteria for low-frequency noise.

In summary, FICAN in its report said:

- The Low-Frequency Noise Policy Committee expert panel report did not adequately prove that the presence of vibration increases annoyance;

- The noise metric developed and used in the panel's threshold proposal (LFSL) is artificially constructed with no scientific justification and serves as a surrogate for assessing the effect of perceptible vibration in lieu of direct, physical measurement;

- The process for determining a relationship between low-frequency noise and annoyance was inadequate

given the ill-conceived social survey used in the report and the absence of RMS acceleration measurements of vibration; and

- It is premature to consider adopting LFSL and the impact criteria without further research. This research would need to address the interaction between (1) building construction, (2) the contribution of loudness to annoyance and (3) the contribution of rattle to annoyance.

Following the FICAN's report, in a letter dated August 14, 2002, the FAA summarized the FICAN's findings and said it concurred with the FICAN that "the MSP study failed to demonstrate that there would be increased annoyance to residents of Richfield due to low-frequency aircraft noise." However, the letter also stated that the FAA "has an interest in pursuing additional study in this area" and recommended that "further low-frequency noise study be conducted as part of the FAA's continuing program of Research and Development (R&D) on aircraft noise." The letter also said that, "while it is not possible at this time to predict when the FAA might be able to fund a follow-up low-frequency noise study, you have our assurance that when funds become available consideration will be given to this work."

In late 2002, as part of a Federal DOT appropriations bill, legislation was passed that directed the FAA to "…conduct, in concert with an affected airport, a further study of low-frequency aircraft noise. The flaws identified with the previous low-frequency noise impact study should be corrected with this follow-on study." The FAA Center of Excellence is in the process of beginning research into low-frequency noise.

As a result of the lack of Federal support for the MSP low-frequency noise analysis and associated mitigation measure, the measure is not included in the revised NCP. Consistent with their previous positions, MAC is fully supportive of adequately describing low-frequency noise while realizing any defensible policy must be firmly grounded in accurate information.

8.4 SUMMARY OF RECOMMENDED LAND USE MEASURES

The recommended land use compatibility measures are a result of comprehensive analyses that integrates local goals and objectives. At the June 27, 2000, MASAC meeting, the full Council endorsed the MASAC OPS Committee's recommendations and approved land use measures LU-1 through LU-9 as summarized in **Tables 8.19 through 8.27**.

Also, at the May 23, 2000, meeting, the MASAC requested modification to the MC's Aviation Policy Plan and Land Use Compatibility Guidelines to reflect language that designates the 60 DNL contour as the land use planning standard for all corrective and/or preventive land use measures (per LU-1). With MC's endorsement, land use planning language would be consistent for all communities within the 2007 NEM. See Section 5.3 for information on the current status of MC revision to the land use compatibility guidelines per the Transportation Policy Plan.

In addition to the factors used in Section 8.3, these tables provide additional information on the following:

- Responsible agency**:** Identification of the public agency(-ies) responsible for implementing the proposed measure. A variety of local jurisdictions have implementation responsibility for

regulatory and policy techniques for land use controls. Such jurisdictions include the MC and individual city governments. For corrective and remedial techniques, the airport sponsor (MAC) is the responsible agency. Also, the FAA may participate in funding remedial measures that are part of an approved NCP.

- Implementation**:** This factor summarizes administrative and other actions necessary to implement the measure, and identifies any legal factors to be considered.

- Anticipated Funding Sources and Schedule are also discussed.

The implementation of approved NCP land use measures is eligible for federal funding. However, funding for these measures is limited and subject to certain criteria. For measures that consider acquisition, the FAA typically encourages residential acquisition within the 75 DNL contour and supports it within the 70 DNL contour. Additionally, the FAA typically considers remedial measures within the 65 DNL contour but, as discussed in Chapter Five, the FAA will also consider remedial measures as low as the 60 DNL if certain conditions are met. This NCP evaluates proposed land use measures in accordance with these guidelines.

Lastly, **Table 8.28** summarizes the measures recommended for inclusion in the updated NCP. The new land use program contains nine measures, eight of which were derived from existing NCP land use measures. One new measure (LU-9) was developed through this Study.

Table 8.19

Recommended Measure LU-1: Amend Local Land Use Plans to Bring them into Conformance with Metropolitan Council's Noise Compatibility Guidelines

Description	This measure involves the coordination of the MAC, the MC, and the local communities to revise land use plans and policies to be consistent with the noise compatibility guidelines set forth in the Aviation Policy Plan of the MDG. Noise compatibility guidelines in the MDG are being revised to designate the 60 DNL as the land use planning standard for the application of preventive and corrective land use measures, as discussed in Section 5.3 regarding the Transportation Policy Plan.
Area to which Measure would be Applied	All parcels located within the 60 DNL contour of the FAA-accepted 2007 NEM are assumed to be included. The MDG noise compatibility guidelines include a one-mile buffer area beyond the 60 DNL contour, which provides additional flexibility to communities in implementing measures reflecting local land use concerns.
Responsible Agency(-ies)	MAC, MC, and noise-impacted jurisdictions.
Compatibility Benefits	Based on local land use controls, the measure will increase the amount of compatible land use around MSP over time.
Political Acceptability	Community objection is not anticipated.
Implementation	MC revises the noise compatibility guidelines set in the Transportation Policy Plan to incorporate the 60 DNL threshold as non-compatible for new or major redevelopment. Local jurisdictions adopt guidelines during their Comprehensive Plan update process.
Possible Costs	MC and local government administrative costs.
Anticipated Funding Sources	MC and local governments.
Schedule	Ongoing.

Table 8.20

Recommended Measure LU-2: Zone for Compatible Development

Description	Based on the MC land use planning language, communities should adopt zoning classifications and ordinances that prevent future non-compatible land use.
Area to which Measure would be Applied	All parcels located within the 60 DNL contour of the FAA-accepted 2007 NEM are assumed to be included. The MDG noise compatibility guidelines include a one-mile buffer area beyond the 60 DNL contour, which provides additional flexibility to communities in implementing measures reflecting local land use concerns.
Responsible Agency(-ies)	MAC, MC, and noise-impacted jurisdictions.
Compatibility Benefits	Based on local land use controls, the measure will aid in the prevention of future non-compatible land use around MSP over time.
Political Acceptability	Developers and/or property owners may oppose the measure due to the potential for reducing areas of residential development.
Implementation	MC revises the noise compatibility guidelines set in the Transportation Policy Plan to incorporate the 60 DNL threshold as non-compatible for new or major redevelopment. Local jurisdictions adopt guidelines during their Comprehensive Plan update process. Based on Land Use Planning act revisions, local authorities must make zoning consistent with land use plans.
Possible Costs	MC and local government administrative costs.
Anticipated Funding Sources	MC and local governments.
Schedule	Ongoing.

Table 8.21

Recommended Measure LU-3: Apply Zoning Performance Standards

Description	This measure involves requests by the MAC and the MC for impacted local jurisdictions to adopt new ordinances for home construction consistent with the Model Ordinance for Aircraft Noise Attenuation.
Area to which Measure would be Applied	All parcels located within the 60 DNL contour of the FAA-accepted 2007 NEM are assumed to be included. The MDG noise compatibility guidelines include a one-mile buffer area beyond the 60 DNL contour, which provides additional flexibility to communities in implementing measures reflecting local land use concerns.
Responsible Agency(-ies)	MAC, MC, and noise-impacted jurisdictions.
Compatibility Benefits	Based on local land use controls, the measure will aid in the prevention of future non-compatible land use around MSP over time.
Political Acceptability	Developers may object due to higher construction costs.
Implementation	This measure involved requests by the MAC and the MC for local jurisdictions to adopt the model ordinance for Aircraft Noise Attenuation. Using the model ordinance, local communities establish aircraft noise overlay zoning and building codes stricter than the Minnesota State Uniform Building Code.
Possible Costs	MC and local government administrative costs.
Anticipated Funding Sources	MC and local governments.
Schedule	Ongoing.

Table 8.22

Recommended Measure LU-4: Continue Public Information Program/System

Description	This measure proposes to continue the development and distribution of information concerning aircraft noise exposure and NCP elements, fully utilizing state-of-the-art information technology and other multimedia opportunities.
Area to which Measure would be Applied	Communities affected by aircraft noise in the vicinity of MSP.
Responsible Agency(-ies)	MAC.
Compatibility Benefits	Increase public awareness; assist residents in understanding NCP.
Political Acceptability	Community objection is not anticipated.
Implementation	MAC adopts revised measure; organizes, and manages the program.
Possible Costs	MAC administrative costs. Possible community administrative costs.
Anticipated Funding Sources	MAC, MC, and local governments.
Schedule	Ongoing.

Table 8.23

Recommended Measure LU-5: Revise Building Codes

Description	This measure supports revision of state and local building codes to ensure interior NLR as a result of new building techniques.
Area to which Measure would be Applied	All parcels located within the 60 DNL contour of the FAA-accepted 2007 NEM are assumed to be included. The MDG noise compatibility guidelines include a one-mile buffer area beyond the 60 DNL contour, which provides additional flexibility to communities in implementing measures reflecting local land use concerns.
Responsible Agency(-ies)	State legislature.
Compatibility Benefits	Reduce interior noise levels in newly constructed homes and buildings.
Political Acceptability	Developers may object due to potentially higher building costs.
Implementation	Minnesota State Uniform Building Code would be modified to require specific NLR for new construction in the aircraft noise zones for MSP.
Possible Costs	State administrative costs. Possible community administrative costs.
Anticipated Funding Sources	State.
Schedule	At the discretion of state legislature.

Table 8.24

Recommended Measure LU-6: Acquire Developed Property in Non-Compatible Use

Description	This measure allows for acquisition of property only at the initiative and with the approval of the local jurisdiction, and where it has been established that there is reasonable consensus among residents to vacate the area.
Area to which Measure would be Applied	Non-compatible parcels located within the 65 DNL of the FAA-accepted 2007 NEM, as mutually agreed to by MAC and respective communities.
Responsible Agency(-ies)	MAC and local governments. FAA approval required for funding.
Compatibility Benefits	Remove most non-compatible residential areas from within selected areas.
Political Acceptability	Some communities may request acquisition potential extended to the 60 DNL.
Implementation	MAC identifies eligible areas in consultation with local governments.
Possible Costs	MAC property acquisition and administrative costs.
Anticipated Funding Sources	MAC, airlines, and FAA.
Schedule	Under consideration.

Table 8.25

Recommended Measure LU-7: Property Purchase Guarantee Program

Description	As with most purchase guarantee programs, if aircraft noise levels were found to be intolerable by individual homeowners and the owner had made a "bona fide effort" to sell the property, the owner-occupied property would be acquired by the MAC at a fair market value and would be returned to residential use with appropriate sound insulation measures, releases, and restrictions. The Purchase Guarantee Program is not intended nor designed to acquire all, or a substantial portion, of a designated area, but rather to provide the homeowner the opportunity to sell his home at a guaranteed fair market value on a house-by-house basis prior to participating in the MAC Sound Mitigation Program. Purchase Guarantee Program eligibility is limited to homeowners residing within the 65 DNL contour of the FAA-accepted 2007 NEM in neighborhoods identified by each individual city. This program would be developed in coordination with other mitigation measures.
Area to which Measure would be Applied	Alleviate noise impacts in areas where neighborhood stability could be maintained and existing residential development is considered acceptable within the 65 DNL contour.
Responsible Agency(-ies)	MAC and local governments.
Compatibility Benefits	Enable residents who desire to relocate due to noise impacts to do so, thereby reducing noise concerns.
Political Acceptability	Some communities may want guarantee extended to the 60 DNL contour.
Implementation	MAC identifies eligible areas and eligibility requirements in consultation with local governments.
Possible Costs	MAC cost of initial acquisition, which would be offset by selling property. MAC program administrative costs.
Anticipated Funding Sources	MAC, airlines, and FAA.
Schedule	Under consideration.

Table 8.26

Recommended Measure LU-8: Sound Mitigation Program

Description	Provide sound mitigation in coordination with other operational noise abatement measures to noise-sensitive structures within the 60 DNL contour of the FAA-accepted 2007 NEM. Mitigation would be provided to single family and multi-family dwellings within the 65 DNL and single-family dwellings within the 60-64 DNL contour. For the purposes of the Sound Mitigation Program, a single family home is defined as a parcel with between one and three units, while a multi-family home has four or more units. Mitigation would also be provided to the Trinity School in the city of Bloomington within the 65 DNL contour. This measure would make all sound mitigated structures compatible. The mitigation package and related provisions are discussed in Section 8.2.1.5.
Area to which Measure would be Applied	Since 1998 changes in FAA policies make new non-compatible development ineligible for remedial noise compatibility funding, only existing residences within the 60 DNL contour are assumed to be included. MASAC/MASAC OPS Committee, NOC, and local communities have identified a sound mitigation boundary that includes blocks included within or intersected by the 2007 Mitigated NEM 60 DNL contour. Figure 8-2 illustrates the recommended sound mitigation boundary for the proposed Sound Mitigation Program. Table 8.10 provides the number of dwelling units to be included in the new Sound Mitigation Program.
Responsible Agency(-ies)	MAC and local governments. FAA approval required for funding elements of the program.
Compatibility Benefits	Reduce the impact of aircraft noise by providing indoor locations where normal activities can be enjoyed without interruption.
Political Acceptability	Airlines, Air Transport Association (ATA) object to extending program to 60 DNL contour and to using block intersect method for determining eligibility. FAA may need confirmation from local jurisdictions that land use guidelines consider residential land use within the 60 DNL contour as being non-compatible without attenuation. Some communities object to 60 DNL contour as boundary of mitigation eligibility. Communities object to a mitigation package that varies from the existing program beyond the 65 DNL contour.
Implementation	MAC identifies eligible areas and eligibility requirements in consultation with local governments. The mitigation of homes in the 60-64 DNL interval would be phased to first treat homes exposed to 64 DNL and progress to successively lower DNLs. The MAC Commissioners have resolved to terminate the program following completion of those homes in the 60-64 DNL contour interval.
Possible Costs	MAC administration and mitigation costs. Given the recommended package, the Residential Sound Mitigation Program is expected to cost approximately $55.9 million for single-family dwellings and $7 million for multi-family dwellings, for a total residential cost of $62.9 million. Approximately $42.4 million would be paid by the Airport and $20.5 million would be funded by homeowners, assuming that all eligible homeowners participate. Mitigation of the Trinity School is estimated to cost $5 million, which would be funded by MAC.

Table 8.26

Recommended Measure LU-8: Sound Mitigation Program

	In order to assist residents with the proposed co-pay obligation, MAC has directed staff to develop a program with the Center for Energy and Environment to offer low-interest loans to homeowners.
Anticipated Funding Sources	Funding of the Sound Mitigation Program in the 65 DNL contour would be accomplished with the use of AIP monies upon FAA approval. Airport funding for the Sound Mitigation Program in the 60-64 DNL contour interval would currently be funded per airline lease agreements and PFCs.
Schedule	New program would begin after approval of the NCP by FAA.

Table 8.27

Recommended Measure LU-9: Creation of Sound Buffers/Barriers

Description	This measure consists of the combined use of sound barrier walls, berms, and/or natural landscaping to reduce ground-level aircraft-related noise for the communities surrounding MSP.
Area to which Measure would be Applied	Areas at MSP border adjacent to non-compatible development.
Responsible Agency(-ies)	MAC and local governments. FAA approval required for funding.
Compatibility Benefits	Reduced noise levels from ground operations for close-in residents. Specific benefits cannot be determined without design and acoustical analysis.
Political Acceptability	Communities may object if this measure is not applied to all airport boundary areas. Potential concern for visual impacts.
Implementation	MAC conducts ground noise study to determine levels and potential buffer/barrier locations. Barrier design and detailed acoustical analysis are required to determine feasibility and benefits.
Possible Costs	The cost of a ground noise study for Anchorage International Airport was recently estimated at approximately $250,000. The study includes consideration of taxi, run-up, and start of take-off roll operations. Study costs may be eligible for FAA funding if part of an approved NCP, although actual funds may be less depending upon availability of funds. Construction costs: detailed analysis required to determine range of construction costs. Potential property acquisition: detailed analysis required to determine necessity of property acquisition.
Anticipated Funding Sources	MAC and FAA. FAA funding possible if included in an approved NCP. FAA participation would likely be contingent on the potential effectiveness of barriers and/or buffers in reducing community noise concerns.
Schedule	Under consideration.

Table 8.28

Summary of Recommended Land Use Measures

Recommended Land Use Program for Revised NCP	Existing Measure and Name (if different)	Proposed New or Revised Measure
LU-1: Amend Local Land Use Plans to Bring them into Conformance with Metropolitan Council's Noise Compatibility Guidelines	LU-1	LU-1[(1)]
LU-2: Zone for Compatible Development	LU-2	LU-2[(1)]
LU-3: Apply Zoning Performance Standards	LU-3	LU-3[(1)]
LU-4: Continue Public Information Program /System	LU-4	LU-4; continues and enhances already established program.
LU-5: Revise Building Codes	LU-5	LU-5[(1)]
LU-6: Acquire Developed Property in Non-Compatible Use	LU-6	Unchanged.
LU-7: Property Purchase Guarantee Program	LU-7	Unchanged.
LU-8: Sound Mitigation Program	LU-8	LU-8; based on the recommended mitigation package out to the 60 DNL contour.
LU-9: Creation of Sound Buffers/Barriers	—	Potential LU-14

[(1)] MDG Aviation Policy Guide includes 1-mile buffer beyond Dual Track FEIS 60 DNL contour.

NOTES

1 14 CFR A150.101 (e) (5).

2 1993 Part 150 Study Update, Section 2.3.3, pp.2-19 to 2-21.

3 The FICAN was established in 1993 to "provide forums for debate over needs for future aviation noise research and to encourage new development efforts in this area. All federal agencies concerned with aviation noise are represented on the Committee."

Chapter Nine
RECOMMENDED REVISED NOISE COMPATIBILITY PROGRAM

As discussed in Section 1.6, the MAC had overall responsibility for the conduct of the Study, including ultimate responsibility for the recommendation of measures for inclusion in the revised NCP. *All of the final NCP measures that this Study proposes for implementation are recommendations of the MAC.*

Section 9.1 summarizes the noise abatement and land use measures that the MAC proposes for inclusion in the revised NCP. Section 9.2 summarizes program benefits. Section 9.3 summarizes NCP implementation documentation requirements set forth in the FAA's NCP checklist.

9.1 PROGRAM SUMMARY

The revised NCP for MSP includes 26 measures: 17 noise abatement measures and nine land use measures.

Sections 9.1.1 and 9.1.2 define the noise abatement and land use measures, respectively. Chapters Seven and Eight contain the analyses that led to the selection of those measures.

9.1.1 Noise Abatement Measures

The revised NCP includes the 17 noise abatement measures that follow. The descriptions indicate which measures are changed from the 1993 Study, and what FAA and MAC actions are required to implement the change.

Noise Abatement Measure 1: MSP Airport Noise Oversight Committee. This modified measure recommends that MAC establish a successor organization for the now defunct MASAC. *The MSP Airport Noise Oversight Committee would provide a balanced forum for interested parties to consider noise mitigation initiatives in the context of benefit, feasibility, and fiscal considerations.*

Noise Abatement Measure 2: Noise Management Program - *This modified measure would require the MAC to consider incentives and disincentives to reduce the impact of aviation noise in the surrounds of MSP.*

Noise Abatement Measure 3: Voluntary Nighttime Limits on Flights - This measure proved effective to reduce nighttime flights of Stage 2[1] aircraft. *This measure is modified to reflect the revised MSP nighttime hours of 10:30 p.m. to 6:00 a.m. and to ask airlines to reduce the use of hushkit aircraft during the nighttime.*

Noise Abatement Measure 4: Nighttime Powerbacks — All airlines at MSP have agreed to eliminate "powerbacks" during nighttime hours. All nighttime flights will "push back" from the gate with an aircraft tug. *(No change from the current program.)*

Noise Abatement Measure 5: Engine Run-Up Field Rule — All airlines are required to conduct maintenance run-ups at a designated run-up pad, and comply with the MSP Run-Up Field Rule. *(No change from the current program.[2])*

Noise Abatement Measure 6: Training Restriction — The major carriers at MSP have agreed not to conduct training operations (e.g., touch-and-go operations) at MSP. *(No change from the current program.)*

Noise Abatement Measure 7: Operating Procedures — Airlines operating at MSP have agreed to comply with airport operating procedures. *This measure is modified to reflect the use of the Distant NADP on all runway ends.*

Noise Abatement Measure 8: Measures to Encourage Use of Manufactured Stage 3 Aircraft — The 1993 Study established the Noise Surcharge/Differential Landing Fee to recover some of the costs of noise monitoring and mitigation measures from the airlines. *This modified measure would require the MAC to develop and implement measures to encourage aircraft operators to use manufactured Stage 3 aircraft.*

Noise Abatement Measure 9: Runway Use System (RUS) — This measure prioritizes noise-sensitive runway selection. *This measure is modified to include Runway 17/35 in the runway selection prioritization.*

Noise Abatement Measure 10: Airport Noise and Operations Monitoring System (ANOMS) — ANOMS continues to be a vital tool for collecting operational data on aircraft movements. *(No change from the current program.)*

Noise Abatement Measure 11: Noise Abatement Sensitivity Training — MAC works with the airlines and ATC to encourage awareness of noise issues and to help increase compliance with current noise abatement procedures. *(No change from the current program.)*

Noise Abatement Measure 12: Low-Demand Flight Tracks — This measure would designate certain flight tracks, by runway end, for preferred use during low-demand time periods. *(New measure.)*

Noise Abatement Measure 13: Runway 17 Departure 2.5 NM Turn Point Procedure — This measure would reduce noise exposure for homes in the immediate vicinity of the departure runway end by delaying westbound jet aircraft turns until they are over the Minnesota River area. *(New measure.)*

Noise Abatement Measure 14: Runway 17 River Departure Procedure — This measure would establish a published procedure to route departing jet aircraft over the Minnesota River area when conditions allow. *(New measure.)*

Noise Abatement Measure 15: Runway 17 Departure River Heading Flight Track — This measure would route departing jet aircraft over the Minnesota River area when conditions allow. *(New measure.)*

Noise Abatement Measure 16: Runway 35 River Visual Approach Procedure — This measure would recommend that MAC and the FAA investigate a visual arrival procedure to Runway 35 that routes arriving aircraft over the Minnesota River, in order to reduce noise exposure and overflights of areas north and south of the river. *(New measure.)*

Noise Abatement Measure 17: Future Technology and Global Positioning System (GPS) Initiatives — This measure would recommend that the MAC and the FAA investigate the potential use of emerging GPS technologies for noise mitigation purposes, and implement beneficial procedures as necessary. *(New measure.)*

9.1.2 Land Use Measures

The 1993 Study included eight land use measures, of which there were three remedial and five preventive measures. The revised NCP includes all of the previous measures: six without revision and two with revisions to reflect current conditions and policies. One additional remedial measure is included in the revised NCP.

Preventive Measures

Continued application of these measures is recommended to maintain the current compatible development trends in the airport environs.

Land Use Measure 1: Amend Local Land Use Plans to Bring them into Conformance with Metropolitan Council's Noise Compatibility Guidelines **—** This measure continues to inhibit non-compatible development; residential and other noise-sensitive land uses (e.g., schools, places of worship, hospitals, etc.) are considered non-compatible (i.e., conditional/provisional) uses to one statute mile beyond the 60 DNL contour as stated within the Metropolitan Development Guide 1996 Aviation Policy Plan and updates to the policy in the Transportation Policy Plan. *(No change from the current program.)*

Land Use Measure 2: Zone for Compatible Development **—** This measure continues to ensure zoning consistency with the Aviation Chapter of the Metropolitan Development Guide, which considers land use compatibility to one statute mile beyond the 60 DNL contour as stated within the Metropolitan Development Guide 1996 Aviation Policy Plan and updates to the policy in the Transportation Policy Plan. *(No change from the current program.)*

Land Use Measure 3: Apply Zoning Performance Standards **—** This measure continues to allow metro municipalities to adopt and enforce ordinances and controls to regulate building construction methods and materials for the purpose of attenuating aircraft noise in habitable buildings in and around the Airport Noise Zone. The 1996 Metropolitan Development Guide Aviation Policy Plan and updates to the policy in the Transportation Policy Plan consider zoning to one statute mile beyond the 60 DNL contour. *(No change from the current program.)*

Land Use Measure 4: Continue Public Information Program/System **—** The 1993 Study established this program to develop and distribute informational materials concerning aircraft noise. *This measure would continue the program and promote the use of state-of-the-art technology and other multimedia resources.*

Land Use Measure 5: Revise Building Codes **—** The 1993 Study established this measure to modify the State Building Code to require specified interior Noise Level Reduction for new construction in the Airport Noise Zones for MSP. *(No change from the current program.)*

Remedial Measures

The 1993 Study's remedial measures have been revised to incorporate existing conditions.

Land Use Measure 6: Acquire Developed Property in Non-Compatible Use — The previous measure was designed to alleviate aircraft noise effects in areas on non-compatible land use within the 65 DNL contour. *This measure is modified to allow for acquisition of property only at the initiative, and with the approval, of local jurisdictions for non-compatible parcels*

located within the 65 DNL contour of the 2007 Mitigated NEM.

Land Use Measure 7: Property Purchase Guarantee Program — This measure was designed to assure homeowners that their property would be acquired at a fair market value and returned to residential use with appropriate sound insulation measures, releases, and restrictions if the owner had made a "bona fide effort" to sell the property. *(No change from the current program.)*

Land Use Measure 8: Sound Mitigation Program (Residential, School, and Other Public Buildings) — The previous measure provided for sound attenuation out to blocks intersected by the 65 DNL contour. *This measure is modified to include blocks intersected by the 60 DNL contour of the 2007 Mitigated NEM consistent with the mitigation package approved by the MAC as part of this Study process.*

Land Use Measure 9: Creation of Sound Buffers/Barriers — This new measure would allow for sound barrier walls and/or berms and natural landscaping to reduce aircraft noise for the communities surrounding MSP. *(New measure.)*

9.2 OVERALL BENEFITS OF THE PROPOSED REVISED NOISE COMPATIBILITY PROGRAM

The noise abatement elements of the revised NCP will enhance the effectiveness of the existing NCP in reducing non-compatible land use in the MSP environs. The land use elements include preventive measures to deter future non-compatibility.

With the implementation of the proposed noise abatement elements of the revised NCP, the areas of non-compatible land use (according to land use guidelines discussed in Chapter Five) will be reduced. These areas are shown in Figures 6-1 and 6-3 for the existing and five-year mitigated forecast conditions. The general areas of non-compatible land use are: (1) areas of residential use within planned industrial use areas surrounding the Airport, and (2) areas of residential use within well-established residential communities that will not be re-zoned. Once treated, residential dwellings mitigated under LU-8 would be considered compatible under Part 150.

Table 9.1 summarizes the residential population within the existing conditions and five-year forecast contours for the current and proposed revised NCPs. The last line of the table summarizes the overall benefit due to forecast changes in the fleet mix and the noise abatement elements of the revised NCP.

9.3 NCP IMPLEMENTATION

Part 150 includes extensive requirements related to NCP implementation, including:

- Identification of the time period covered by the program.
- Identification of parties responsible for implementation of each program element.
- Indication that responsible parties have agreed to implement the measure.
- Schedule for implementation of the program.
- Essential government actions.
- Anticipated funding sources.

Tables 9.2 and 9.3 summarize implementation details for each proposed element of the revised NCP in the noise

abatement and land use categories, respectively. The following subsections discuss the primary requirements of NCP implementation (i.e., the first three bullets in this section) as summarized in Tables 9.2 and 9.3.

Table 9.1

Comparison of the Estimated Residential Population within the Existing Condition and 5-Year Forecast NEMs for the Existing and Proposed NCPs

NCP	Population and Dwelling Units within 60 DNL Contours			
	2002 Existing Condition NEM		2007 NEM (5-Year Forecast NEM)	
	Dwelling Units	Population	Dwelling Units	Population
Existing NCP	33,466	79,476	17,117	40,431
Proposed NCP	N/A	N/A	14,671	34,842
Reduction (Effect of NCP Revision)	N/A	N/A	2,446	5,589

Note: Numbers do not consider the proposed block intersect method.

Source: Table 6.4

Table 9.2

Summary of NCP Implementation Details for Proposed Noise Abatement Elements of Revised NCP

Proposed Measure	Implementation Actions and Responsible Parties	Anticipated Costs and Funding Sources	Anticipated Schedule
1. MSP Airport Noise Oversight Committee	Continue existing Noise Oversight Committee operation.	MAC administrative costs	First meeting conducted in June 2003.
2. Noise Management Program	MAC coordinates with FAA, NOC, and airlines to investigate feasibility and implementation of potential measures.	MAC administrative costs	Process initiated immediately following NCP approval.
3. Voluntary Nighttime Limits on Flights	MAC coordinates with airlines to implement voluntary agreements.	MAC administrative costs	Process initiated immediately following NCP approval.
4. Nighttime Powerbacks	Continue existing measure.	MAC administrative costs	Ongoing.
5. Engine Run-Up Field Rule	Continue existing measure.	MAC administrative costs	Ongoing.
6. Training Restriction	Continue existing measure.	MAC administrative costs	Ongoing.

Table 9.2

Summary of NCP Implementation Details for Proposed Noise Abatement Elements of Revised NCP

Proposed Measure	Implementation Actions and Responsible Parties	Anticipated Costs and Funding Sources	Anticipated Schedule
7. Operating Procedures	MAC coordinates with FAA and airlines to implement program.	MAC administrative costs	Ongoing for Eagan/Mendota Heights Corridor Procedure; NADP implementation complete in July 2003.
8. Measures to Encourage Use of Manufactured Stage 3 Aircraft	MAC coordinates with airlines to implement program.	MAC administrative costs	Process initiated immediately following NCP approval.
9. Runway Use System (RUS)	MAC would request amendment of ATCT standard operating procedures to include measure. FAA reviews, approves, and implements.	MAC and FAA administrative costs	Implementation concurrent with opening of Runway 17/35. Revised RUS was assumed in the Runway 17 Departure Procedure EA; FONSI/ROD issued in August 2003.
10. Airport Noise and Operations Monitoring System (ANOMS)	Continue existing measure.	MAC administrative costs	Ongoing.
11. Noise Abatement Sensitivity Training	Continue existing measure.	MAC administrative costs	Ongoing.
12. Low-Demand Flight Tracks	MAC would request amendment of ATCT standard operating procedures to include measure. FAA reviews, approves, and implements.	MAC and FAA administrative costs	Process initiated immediately following NCP approval.
13. Runway 17 Departure 2.5 NM Turn Point Procedure	MAC has requested amendment of ATCT standard operating procedures to include measure. FAA reviews, approves, and implements.	MAC and FAA administrative costs	EA prepared for flight procedure; FONSI/ROD issued in August 2003. Procedure is approved for implementation concurrent with opening of Runway 17/35.
14. Runway 17 River Departure Procedure	MAC has requested amendment of ATCT standard operating procedures to include measure. FAA reviews,	MAC and FAA administrative costs	EA prepared for flight procedure; FONSI/ROD issued in August 2003.

Table 9.2

Summary of NCP Implementation Details for Proposed Noise Abatement Elements of Revised NCP

Proposed Measure	Implementation Actions and Responsible Parties	Anticipated Costs and Funding Sources	Anticipated Schedule
	approves, and implements.		Procedure is approved for implementation concurrent with opening of Runway 17/35.
15. Runway 17 Departure River Heading Flight Track	MAC has requested amendment of ATCT standard operating procedures to include measure. FAA reviews, approves, and implements.	MAC and FAA administrative costs	EA prepared for flight procedure; FONSI/ROD issued in August 2003. Procedure is approved for implementation concurrent with opening of Runway 17/35.
16. Runway 35 River Visual Approach Procedure	MAC coordinates with FAA to investigate feasibility and implementation of the measure.	MAC and FAA administrative costs	Process initiated immediately following NCP approval.
17. Future Technology and Global Positioning System (GPS) Initiatives	MAC coordinates with FAA to investigate feasibility and implementation of potential measures.	MAC and FAA administrative costs	Process initiated immediately following NCP approval.

Table 9.3

Summary of NCP Implementation Details for Proposed Land Use Elements of Revised NCP

Proposed Measure	Implementation Actions and Responsible Parties	Anticipated Costs and Funding Sources	Anticipated Schedule
1. Amend Local Land Use Plans to Bring them into Conformance with Metropolitan Council's Noise Compatibility Guidelines	MC revises the noise compatibility guidelines set forth in Aviation Chapter of the MDG; local jurisdictions adopt guidelines during their Comprehensive Plan update process.	Community and MC administrative costs. MC and local government funding.	On-going.
2. Zone for Compatible Development	After MC revises noise compatibility guidelines and local jurisdictions adopt comprehensive plan updates; local authorities make zoning consistent with land use plans.	MC and local administrative costs. Local government funding.	Upon local approval.
3. Apply Zoning Performance Standards	Local jurisdictions to adopt Model Ordinance for Aircraft Noise Attenuation; local communities establish aircraft noise overlay zoning and building code restrictions.	MC and community administrative costs. Local government funding	Upon County approval.
4. Continue Public Information Program/System	MAC adopts revised measure; organizes and manages the program.	MAC and possible community administration costs. MAC/FAA Part 150 funding.	Continuing.
5. Revise Building Codes	State Building Code modified to require specific interior NLR for new construction in aircraft noise zones for MSP.	State and possible community administration costs. Local government funding.	After modification of State Building Code.
6. Acquire Developed Property in Non-Compatible Use	MAC identifies eligible areas in consultation with local governments and residents.	MAC acquisition and administrative costs. Potentially funded with AIP monies.	Process initiated immediately following NCP approval.
7. Property Purchase Guarantee Program	MAC identifies eligible areas in consultation with local governments and volunteer residents.	MAC acquisition and administrative costs. Potentially funded with airline, AIP, and PFC monies.	Following NCP approval and request of local jurisdiction.
8. Sound Mitigation Program (Residential, School, and Other Public Buildings)	MAC identifies eligible areas in consultation with local governments.	MAC cost of offering recommended mitigation program. MAC/FAA Part 150 funding according to MSP Airline Agreement. AIP funds in 65-75 DNL contours and potential for PFC funding in 60-64 DNL contours.	Program initiated immediately following NCP approval.
9. Creation of Sound Buffers/Barriers	MAC conducts feasibility study to determine optimal buffer/barrier location(s) and design, including assessing cost/benefit. MAC potentially administers barrier construction contract.	Feasibility study, and potential property acquisition and construction costs. MAC and FAA Part 150 funding.	Process initiated immediately following NCP approval.

9.3.1 Time Period Covered by the Revised NCP

In the absence of unanticipated changes in forecast conditions, the revised NCP and related revised NEMs cover 5 years from the date of submission. It is recognized that implementation of Runway 17/35 will need to be validated relative to the assumptions on runway use and operational use as detailed in this Study. The MAC proposes to update the NEMs in the year 2007. As part of the NEM update, proposed mitigation boundaries may change due to expansion or reduction of the 60 DNL contour in the forecast year (potentially 2012).

9.3.2 Implementation Responsibility

Part 150 requires that the NCP clearly identify the person(s) or entity(ies) responsible for implementing each recommended element.

According to the FAA's definition of implementation responsibility[3], the MAC, as airport operator, must initiate the implementation of all noise abatement measures. Clearly, however, the FAA and ATC have key roles in the implementation of aircraft operational measures. Since the FAA is responsible for air traffic control, it must develop and provide instructions to pilots related to preferred runway use and noise abatement flight tracks. Both air carriers and pilots have supporting roles in the implementation of aircraft operational measures, as they must support and comply with noise abatement procedures, consistent with the safe operation of aircraft.

The MAC, local jurisdictions, and FAA share responsibility for the implementation of land use measures. The MAC will seek assistance from the MC and city governments in the publicity and administration of land use measures. Local jurisdictions are responsible for the implementation and enforcement of land use controls. The FAA is involved in the implementation of land use measures through program approval and funding assistance.

The MAC has the lead responsibility for continuing program measures, such as ANOMS and the NOC. The FAA may assist by providing funding and in ongoing program review. The MC and city governments would assist in ongoing program review.

9.3.3 Indication of Agreement to Implement

As the lead agency in the implementation of all measures, the MAC clearly agrees to its responsibilities. Through the MAC staff, the consulting team members have discussed the proposed NCP elements with the FAA and local government representatives. While local governments have voiced their support for many of the operational noise abatement measures, they have indicated their strong opposition to the recommended mitigation package element and co-pay for homes within the 60-64 DNL of the Sound Mitigation Program (LU-8). In opposing the recommended mitigation package element, some communities have also questioned the need for designation of the 60 DNL as the local threshold of noise sensitive non-compatibility and extension of the preventive land use measures to the 60 DNL. Conversely, some airlines expressed concerns about mitigation costs with a 5-dB package given the financial condition of the airline industry, as well as the high level of sound attenuation already provided by typical home construction in the communities surrounding MSP.

See Appendix N (Volume III, Part V) for Study comments and responses regarding NCP implementation. As discussed in General Response #3, MAC has sought to balance the needs of both community and airline stakeholders throughout the development of the NCP. The recommended NCP in this document represents a balanced approach to aircraft noise and land use compatibility.

9.3.4 Further Environmental Review

Federal, state, or local regulations may require further environmental review prior to the implementation of some NCP measures (e.g., departure track changes for Runway 17). The MAC will not initiate the implementation of any measure until it, the FAA, or other responsible agency has satisfied any such requirements.

In particular, the FAA may approve some noise abatement measures "subject to environmental review." The FAA will determine environmental review requirements when an official FAA "action" is contemplated, such as the design and implementation of flight procedures.

NOTES

[1] Stage 2 aircraft with a maximum takeoff weight greater than 75,000 pounds.

[2] The MSP Field Run-Up Rule was modified in February 1999. Note that this does not change NA-5, which requires compliance with the Run-Up Field Rule.

[3] As set forth in FAA Advisory Circular (AC) 150/5020-1, "Noise Control and Compatibility Planning for Airports", August 5, 1982.

Chapter Ten
PUBLIC INVOLVEMENT SUMMARY

This Study began in late 1998 and has been conducted through the development of draft documents including extensive consultation with local communities and members of the airport "public." The airport public includes those with aviation interests, potentially impacted residents of the airport environs, and local, state, and federal officials. The public involvement process has far exceeded Part 150 requirements.

The MAC and its consultants used the following eight principal mechanisms in pursuing public input:

- MASAC, including written background material and formal briefings;
- MASAC OPS Committee, including written background material and formal briefings;
- Runway 17/35 City Committee, including written background material and formal briefing meetings;
- NOC, as a successor to MASAC, including written background material, formal briefings, and public input meetings;
- MAC Planning and Environment Committee and Full Commission meetings;
- Multiple public workshops, including newspaper advertisements and direct mailings to potentially interested groups and individuals;
- Distribution of "MASAC News" and "MSP Noise News" newsletters;
- Public hearings; and
- MSP Part 150 Update section at the www.macnoise.com website.

With the November 2001 Study, the principal means of public input on the development of the NEMs, land use measures, and noise abatement measures were briefings at MASAC OPS Committee meetings, followed by briefings to the full MASAC after receiving approval on specific measures from the MASAC OPS Committee. For this edition of the Study, the principal means of public input on the development of the revised forecast, INM input data, and draft NEMs were briefings to the NOC, and follow-up briefings to the MAC Planning and Environment Committee and the MAC Full Commission as the Study progressed through the MAC's committee structure.

As discussed in Section 1.3, MAC submitted the Study to FAA in November 2001 for review, acceptance of the NEMs, and approval of the NCP. However, in May 2002, after consideration of the events of September 11, 2001, the MAC withdrew the Study from the FAA to update the forecast numbers and the associated noise contours. As such, many of the meetings up to 2001 were related to the November 2001 Study. Subsequent meetings were more focused toward the revised forecasts, NEMs, and Sound Mitigation Program in this Study.

Sections 10.1 and 10.2 summarize the role of the advisory committees and the MAC. Section 10.3 reviews the public workshops conducted for the Study process. Section

10.4 discusses additional forums for dissemination of information and gathering of public input for the study. Section 10.5 reviews the public hearings and written comments and responses. Appendices J, M, and N provide the supporting material for this chapter.

10.1 ADVISORY COMMITTEES

The MAC established multiple advisory committees to oversee issues pertaining to aviation-related noise at MSP. These advisory committees included representatives from a broad spectrum of entities with interest in the Study process and its products. The MASAC and the MASAC OPS Committees served in an advisory capacity in an effort to gather input from an informed, well-established, and well-represented group. NOC served as a successor organization to MASAC and MASAC OPS and fulfilled a similar role. The Runway 17/35 City Committee served in an advisory capacity in an effort to gather consensus on Runway 17 departure tracks. Appendix J lists the advisory committee members.

The advisory committee members were responsible for representing their constituents throughout the study process by commenting on the adequacy and accuracy of collected data, assumptions, and technical analyses. The advisory committees also served as a forum in which the varied interest groups could share their perspectives on the use of the airport facilities and aircraft noise issues. More specifically, the advisory committees provided extensive input on the following topics:

- Forecast and fleet mix (including forecast assumptions) and INM methodology/data.
- Correlation of the INM noise model with monitored noise levels around MSP and the methodology used to forecast noise exposure.
- Aircraft noise abatement measures.
- Existing and proposed land use measures and mitigation projects.
- Boundaries defining Sound Mitigation Program eligibility.
- Mitigation priorities for single-family, multi-family, schools/daycare facilities.

Each of the Advisory Committees met several times during the course of the study process. All facets of the Study process were discussed. The membership was encouraged to offer feedback and input on the progress to date, either at these formal meetings or at a later date, with the appropriate staff member. **Table 10.1** lists the dates of the advisory committee meetings, and Appendix M (Volume II, Parts I and II) and Appendix N (Volume III, Part II) contain the meeting summaries.

10.1.1 MASAC Newsletter

A newsletter was developed, entitled "MASAC News." Four quarterly issues were developed and distributed, informing the general public, as well as those already participating in the Study, about the study's progress, upcoming meetings, and existing noise concerns. Appendix M (Volume II, Part III) contains copies of these newsletters.

Table 10.1

Schedule of Advisory Committee Meetings

Committee	Date	Time	Topic
MASAC	February 23, 1999	7:30 p.m.	Introduction to the Study
	November 30, 1999	7:30 p.m.	Study Schedule
	January 25, 2000	7:30 p.m.	Summary of Study Workshop Comments
	March 28, 2000	7:30 p.m.	Past Studies/NCP Alternative Discussed
	April 25, 2000	7:30 p.m.	Study Review of Progress and Associated Items
	May 23, 2000	7:30 p.m.	Review of Preliminary Recommended Noise Abatement Measures
	June 27, 2000	7:30 p.m.	Noise Compatibility Program (NCP) Mitigation Measures
	July 25, 2000	7:30 p.m.	Fleet Mix Considerations and GPS/Future Technology Considerations
	August 22, 2000	7:30 p.m.	Runway 17 Departure Tracks and Contour Boundary/Priority Recommendation
MASAC OPS Committee	May 14, 1999	10:00 a.m.	Introduction to Study
	June 11, 1999	10:00 a.m.	Eagan/Mendota Heights Corridor Departure Procedures
	July 9, 1999	10:00 a.m.	Study Chronology
	August 13, 1999	10:00 a.m.	Land Use and Zoning Information Dissemination
	September 10, 1999	10:00 a.m.	INM Input/1999 Validation Contour
	October 8, 1999	10:00 a.m.	Runway 17/35 Noise Abatement Departure Procedures
	November 12, 1999	9:00 a.m.	2005 Forecast Contour, Fleet Mix and Potential Mitigation Measures
	December 10, 1999	9:00 a.m.	Residential Sound Mitigation Programs
	January 7, 2000	9:00 a.m.	Land Use Data Inconsistencies
	February 11, 2000	9:00 a.m.	1999 Validation, Existing Conditions 2000 and 2005 Projected Contours
	March 10, 2000	9:00 a.m.	Existing Conditions 2000 and 2005 Projected Contours
	March 24, 2000	10:30 a.m.	Runway Use Alternatives
	April 14, 2000	10:30 a.m.	Dual Track SIMMOD results
	May 5, 2000	10:30 a.m.	Runway 17/35 Flight Track Alternatives
	May 12, 2000	10:30 a.m.	Fleet Mix Alternatives/Land Use Measures
	June 9, 2000	9:00 a.m.	Land Use Measures/Noise Abatement Department Procedures
	July 14, 2000	9:00 a.m.	105-degree Hybrid Departure Fan Procedure Analysis
	July 28, 2000	9:00 a.m.	Runway 17 Departure Flight Tracks
	August 11, 2000	9:00 a.m.	Low Demand Flight Tracks/Runway 17 Departure Track Analysis
Runway 17/35 City Committee	January 11, 2000	1:00 p.m.	Runway 17 Departure Track Analysis
	March 16, 2000	10:15 a.m.	Runway Use Alternatives for Runway 17/35
	April 13, 2000	10:15 a.m.	Runway 17/35 Runway Use System
	April 26, 2000	10:15 a.m.	Runway 17 Departure Track Analysis
NOC	June 26, 2003	1:30 p.m.	Update on MSP Forecasting Effort and Review of NOC Work to be Conducted as Part of the Noise Contour Generation Process
	July 17, 2003	1:30 p.m.	Review and Approval of Forecast Assumptions
	August 21, 2003	1:30 p.m.	Review and Approval of INM Input Methodology/Data
	September 18, 2003	1:30 p.m.	Update on Study Schedule
	October 23, 2003	1:30 p.m.	Review and Approval of 2002 and Forecast 2007 Operation and Fleet-Mix Numbers
	November 20, 2003	1:30 p.m.	Review of Forecast with Removal of Five RJ85s; Review of INM Runway and Flight Track Use Inputs Incorporating the Forecast and Fleet Mix Numbers
	January 15, 2004	1:30 p.m.	Update on Contour Development and Additional INM Aircraft Profile Review Being Conducted
	February 19, 2004	1:30 p.m.	Review of Study Draft 2002 and 2007 Noise Contours
	March 11, 2004	1:30 p.m.	Planning Timeline and 65/60 DNL Mitigation Thresholds, Status of Properties on Perimeter Blocks and Mitigation Program Review (included review of package options and cost estimates relative to the Revised Draft 2007 Mitigated DNL Contour)

Table 10.1

Schedule of Advisory Committee Meetings

Committee	Date	Time	Topic
	March 24, 2004	1:30 p.m.	Noise Mitigation Package Option Recommendation was made
	October 21, 2004	1:30 p.m.	Review of Part 150 Update Public Comment Summary and Remaining Schedule

Source: MAC

10.2 MAC MEETINGS

The MAC Planning and Environment Committee and the MAC Full Commission also held several meetings related to the Study. As the meetings were open to the public, the date, time, and topic of the meetings are presented in **Table 10.2.** Throughout the Study process MAC allowed comments at Planning and Environment Committee and Full Commission meetings whenever people wished to comment on Study related items, even if the items were not on the agenda.

10.3 PUBLIC WORKSHOPS

Table 10.3 provides the times and dates of the public workshop meetings conducted during the Study. Appendix M (Volume II, Part III) and Appendix N (Volume III, Part I) provides the sign-in sheets, brochures, and comments received at each of the public workshop meetings. Following are descriptions of the three primary meetings that discussed initial development of the NEMs and NCP.

Public Meeting #1 — Three informal workshop-formatted public meetings were held at locations listed in Table 10.3 on September 28, 29, and 30, 1999 for the general public, between the hours of 5 p.m. and 8 p.m. A total of 312 people signed in at the meetings. Representatives of the MAC and the consultant team were available to answer any questions from the public. Comment forms were available for participants to submit a written comment either at the meeting or by mail to the MAC. The purpose of this meeting was to maintain public involvement in the development of the Study. In addition, this meeting provided basic information on the INM and validation of its use, the existing land use validation, and the study schedule. As a result of this effort, 36 written comments were received. Following are the comments received most frequently during this comment period:

- How are noise abatement procedures developed?
- When will their homes be insulated and who will fund the mitigation program?
- The workshop is useful, but when will real solutions be discussed by the MAC?
- When we moved to the area, we did not realize the Airport would expand to a size where it would begin to infringe on our lives.

Public Meeting #2 — Three public workshop meetings were held at locations listed in Table 10.3 on November 30, and December 1 and 2, 1999, between the hours of 5 p.m. and 8 p.m. A total of 1,026 people signed in at the meetings. Representatives of the MAC and the consultant team were available to answer any questions from the public. Comment forms were available for participants to submit a written comment either at the meeting or by mail to the MAC.

The purpose of this meeting was to maintain public involvement in the development of the Study. In addition, this meeting provided basic information on the 2005 unmitigated contour with 2005 fleet mix; land use and noise abatement measures to be analyzed; the INM and land use validation; and the study schedule. As a result of this effort, 26 written comments were received. Following are the comments received most frequently during this comment period:

- How can the MAC allow the Airport to degrade the quality of life to the residents within the Minneapolis area?
- Significant impact to those on the ground should include areas within the 55 and 60 DNL contours and not be limited to those areas within the 65 DNL contour.
- Residents are experiencing deafening noise due to aircraft-related operations at MSP.
- When we moved to the area, we did not realize the Airport would expand to a size where it would begin to infringe on our lives.

Table 10.2

Schedule of MAC Committee Meetings

Committee	Date	Time	Topic
Planning and Environment	November 1, 1999	1:00 p.m.	Study Progress Report
	September 5, 2000	1:00 p.m.	Study Noise Abatement Plan Update – Status Report
	November 6, 2000	1:00 p.m.	64-60 DNL Contour
	December 5, 2000	1:00 p.m.	Study Public Hearing Report
	March 6, 2001	1:00 p.m.	Sound Mitigation Program – 60-64 DNL contour
	March 19, 2001	11:00 a.m.	Continued Discussion - Sound Mitigation Program – 60-64 DNL contour
	April 3, 2001	1:00 p.m.	Sound Mitigation Program – 60-64 DNL contour
	May 8, 2001	1:00 p.m.	Sound Mitigation Program – 60-64 DNL contour
	June 5, 2001	1:00 p.m.	Sound Mitigation Program – 60-64 DNL contour
	July 10, 2001	1:00 p.m.	Sound Mitigation Program – 60-64 DNL contour – Option 6A
	August 7, 2001	1:00 p.m.	Sound Mitigation Program – 60-64 DNL contour
	December 4, 2001	1:00 p.m.	Sound Mitigation Program – 60-64 DNL contour
	February 4, 2003	1:00 p.m.	Forecast Overview
	April 9, 2003	9:00 a.m.	Forecast Update
	May 7, 2003	9:00 a.m.	Review of Forecast Assumptions
	June 4, 2003	9:00 a.m.	Review of Forecast Assumptions
	August 6, 2003	9:00 a.m.	Review of NOC input and approval of forecast assumptions
	September 3, 2003	9:00 a.m.	Review of INM input methodology/data and NOC recommendation
	October 8, 2003	9:00 a.m.	Review of Draft Forecast Numbers
	November 5, 2003	9:00 a.m.	Review and approval of 2002 and Forecast 2007 Operations and Fleet-Mix Numbers and INM Input Methodology/Data for Use in the 2002 and unmitigated 2007 DNL contours

Table 10.2

Schedule of MAC Committee Meetings

Committee	Date	Time	Topic
	December 3, 2003	9:00 a.m.	Review of 2004 NOC workplan and SMAAC letter
	January 7, 2004	9:00 a.m.	Update on aircraft profile revisions and DNL contour development process
	February 4, 2004	9:00 a.m.	Review of Study draft 2002 and 2007 DNL contours and discussion of SMAAC complaint
	March 3, 2004	9:00 a.m.	Study Planning Timeline and 65/60 DNL Mitigation Thresholds, Status of Properties on Perimeter Blocks and Mitigation Program Review. Directed MAC Staff to Update 2007 Forecast/Contour to Incorporate Five RJ85 Aircraft Back into the Fleet Mix
	May 5, 2004	9:00 a.m.	Consideration of Input Related to Possible Mitigation Packages
	July 13, 2004	9:00 a.m.	Recommendation on mitigation package for Sound Mitigation Program
	November 3, 2004	9:00 a.m.	Review of written comments and responses; recommend to the Full Commission that the Study be approved and submitted to FAA.
Commission	November 20, 2000	1:00 p.m.	Study Update Briefing
	March 19, 2001	1:00 p.m.	Sound Mitigation Program – 60-64 DNL contour
	April 16, 2001	1:00 p.m.	Public Meeting Report- Residential Sound Mitigation Program
	June 18, 2001	1:00 p.m.	Sound Mitigation Program – 60-64 DNL contour
	July 16, 2001	1:00 p.m.	Sound Mitigation Program – 60-64 DNL contour – Option 6A
	August 20, 2001	1:00 p.m.	Sound Mitigation Program – 60-64 DNL contour and authorization to submit Study to FAA.
	November 19, 2001	1:00 p.m.	Sound Mitigation Program – 60-64 DNL contour
	December 17, 2001	1:00 p.m.	Sound Mitigation Program – 60-64 DNL contour
	January 22, 2002	1:00 p.m.	Sound Mitigation Program – 60-64 DNL contour; Discussion deferred to April 15, 2002
	April 15, 2002	1:00 p.m.	Sound Mitigation Program – 60-64 DNL contour
	May 20, 2002	1:00 p.m.	Withdrawal of Submittal to FAA
	June 16, 2003	1:00 p.m.	Review of Forecasting Assumptions
	August 18, 2003	1:00 p.m.	Review and Approval of Forecasting Assumptions
	November 17, 2003	1:00 p.m.	Approval of 2002 and Forecast 2007 Operations and Fleet-Mix Numbers and INM Input Methodology/Data for Use in the 2002 and 2007 DNL Contours.
	March 15, 2004	1:00 p.m.	NWA presentation regarding the Study
	May 17, 2004	1:00 p.m.	Heard public comments on possible Sound Mitigation Program package options
	July 19, 2004	1:00 p.m.	Recommendation on mitigation package for Sound Mitigation Program
	November 15, 2004.	1:00 p.m.	Study approval and authorization for MAC staff to submit the Study to FAA

Source: MAC

Table 10.3

Schedule of Public Workshops, Meetings, and Hearings

Event	Date	Time	Location
Public Workshop #1	September 28, 1999 September 29, 1999 September 30, 1999	5-8 p.m. 5-8 p.m. 5-8 p.m.	Comfort Inn, Bloomington Royal Cliff Conference Center, Eagan Holiday Inn Select, Eagan
Public Workshop #2	November 30, 1999 December 1, 1999 December 2, 1999	5-8 p.m. 5-8 p.m. 5-8 p.m.	Nokomis Community Center, Minneapolis Royal Cliff Conference Center, Eagan Courtyard by Marriott, Mendota Heights
Public Workshop #3	May 22, 2000 May 23, 2000 May 24, 2000 May 25, 2000	5-8 p.m. 5-8 p.m. 5-8 p.m. 5-8 p.m.	Pearl Park Community Center, Minneapolis Eagan City Hall, Eagan Pearl Park Community Center, Minneapolis Royal Cliff Conference Center, Eagan
Public Hearing and Workshop	November 8, 2000 November 9, 2000	5-9 p.m. 5-9 p.m.	Thunderbird Hotel, Bloomington Thunderbird Hotel, Bloomington
MAC Planning and Environment Committee Public Meeting (Sound Mitigation Program 60-64 DNL contour insulation package)	April 11, 2001	7:00 p.m.	Thunderbird Hotel, Bloomington
MAC Planning and Environment Committee Public Meeting (Sound Mitigation Program 60-64 DNL contour insulation package)	July 25, 2001	7:00 p.m.	Thunderbird Hotel, Bloomington
Public Workshop on Forecast Assumptions	May 22, 2003	4-8 p.m.	Double Tree Grand Hotel, Bloomington
Public Workshop on Draft Forecast and INM Inputs	October 23, 2003	4-8 p.m.	MAC General Offices
Public Workshop on Draft 2002 and 2007 DNL Noise Contours and NCP	February 19, 2004	4-8 p.m.	MAC General Offices
Public Hearing and Workshop	September 7, 2004	4-10 p.m.	Thunderbird Hotel, Bloomington

Source: MAC

Public Meeting #3 — Four informal workshop-formatted public meetings were held at locations listed in Table 10.3 on May 22, 23, 24, and 25, 2000, between the hours of 5 p.m. and 8 p.m. A total of 1,124 people signed in at the meetings. Representatives of the MAC and the consultant team were available to answer any questions from the public. Comment forms were available for participants to submit a written comment either at the meeting or by mail to the MAC. The purpose of this meeting was to maintain public involvement in the development of the Study. In addition, this meeting provided basic information on the preliminary 2005 mitigated contour and recommended land use and noise abatement measures. As a result of this effort, 123 written comments were received. Following are the comments received most frequently during this comment period:

- The existing and proposed changes to noise-related impacts due to the Airport are unacceptable.
- Aircraft should not be directed over residential property, but directed over commercial areas.
- What areas will be included in mitigation measures (e.g., Sound Mitigation Program, property acquisition, etc.)?
- Aircraft operations between the hours of 10 p.m. and 6 a.m. should be banned. (No night flights).

The MAC went to great lengths to invite potentially interested residents to the public meetings. Prior to the third public meeting, approximately 3,000 invitation postcards were sent via direct mail, and a display-type ad was run in the local newspapers for each series of workshops. Appendix M contains copies of these postcards and newspaper advertisements and the meeting sign-in sheets.

10.3.1 MAC Planning and Environment Committee Public Meetings

The MAC Planning and Environment Committee held two public meetings to gather public comments and testimony on the Residential Sound Mitigation Program (measure LU-8). The date, time, and place of the public meetings are shown in Table 10.3. The MAC Planning and Environment Committee members discussed the available options for expansion of the Residential Sound Mitigation Program to the 60 DNL contour of the 2005 Mitigated NEM as part of the November 2001 Study process. In general, the public comments favored the full five-decibel reduction package for all homes within the 60-64 DNL. The transcripts of the public meetings are included in Appendix M (Volume II, Part V).

10.3.2 Additional Public Workshops

As shown in Table 10.3, three additional public workshops were held preceding this edition of the Study. The workshops presented the draft forecast, INM inputs and methodology, the revised 2002 and 2007 DNL contours developed for this Study, and the MAC-approved NCP elements. A description of the workshops follows. Materials from the workshops are available in Appendix N (Volume III, Part I).

Public Workshop on Forecast Assumptions – One informational workshop-formatted public meeting was held at the location listed in Table 10.3 on May 22, 2003, for the general public, between the hours of 4:00 p.m. and 8 p.m. A total of 81 people signed in at the meeting. Representatives from the MAC and the consultant team were available to

answer any questions from the public. Comment forms were available for participants to submit written comment either at the meeting or by mail to the MAC. The purpose of this meeting was to maintain public involvement in the development of the Study. In addition, this meeting provided basic information on the forecast process and the recommended forecast assumption areas and associated options. As a result of this effort, four written comments were received. A summary of the comments received follows:

- Will there be a public hearing and public input as part of the process? Concerned about the public process.
- Seeking information on forecast projections and contours.
- Concerns about the effects of noise on health and learning.
- NOC should discuss the forecasting assumptions.
- Given past forecasts, efforts should be taken to ensure forecast is not understated.

Public Workshop on Draft Forecast and INM Inputs – One informational workshop-formatted public meeting was held at the location listed in Table 10.3 on October 23, 2003, for the general public, between the hours of 4:00 p.m. and 8 p.m. A total of 31 people signed in at the meeting. Representatives from the MAC and the consultant team were available to answer any questions from the public. Comment forms were available for participants to submit written comment either at the meeting or by mail to the MAC. The purpose of this meeting was to maintain public involvement in the development of the Study. In addition, this meeting provided basic information on the forecast assumptions, draft forecast numbers, the INM modeling process, the INM inputs and remaining process. As a result of this effort, two written comments were received. A summary of the comments received follows:

- ANOMS operations data is under representing base case operations data.
- The comprehensive handouts detailing the data covered were excellent and were an improvement over past meetings. However, the source of the data is questionable, and the word average or typical is used extensively to describe the data.

Public Workshop on Draft 2002 and 2007 DNL Noise Contours and NCP – One informational workshop-formatted public meeting was held at the location listed in Table 10.3 on February 19, 2004, for the general public, between the hours of 4:00 p.m. and 8 p.m. A total of 211 people signed in at the meeting. Representatives from the MAC and the consultant team were available to answer any questions from the public. Comment forms were available for participants to submit written comment either at the meeting or by mail to the MAC. The purpose of this meeting was to maintain public involvement in the development of the Study. In addition, this meeting provided basic information on the draft 2002 base case and 2007 unmitigated and mitigation noise contours, forecast assumptions and draft forecast numbers, INM inputs, NCP elements, program considerations and next steps. As a result of this effort, 12 written comments were received. A summary of the comments received follows:

- Noise contours do not consider monitored values, ignore peak noise

annoyance, and do not appear to consider elevation.

- Noise does not change from the area just inside the contour to areas just outside the contour.

- Encourage MAC to extend the full noise mitigation package to all residents in the 60-65 DNL zone.

- Forecast and contours should be based on as much actual data as possible.

- The contours do not reflect what people experience.

In addition to the above numbered communications, several letters were received by the MAC from the South Metro Airport Action Council and the Rogers Lake East Airport Noise Reduction Committee. Those letters are included as part of the Study process and are provided in Appendix N (Volume III, Part IV).

Again, extensive efforts were taken to invite interested parties and publicize the meetings. Outreach efforts included newspaper ads, postcards, newsletters, and the website.

10.4 ADDITIONAL CONSULTATION MECHANISMS

In addition to the above listed meetings and workshops, several other mechanisms have been put in place to ensure channels for information dissemination and opportunities for input on airport noise issues. These include the MSP NOC and the NOC input form, Quarterly Airport Noise Public Input Meetings, the MSP Noise News newsletter, and the MAC noise program website at www.macnoise.com. The materials related to these efforts are provided in Appendix N (Volume III). These ongoing MSP noise program activities contributed to the public process associated with the Study. The following sections describe these additional consultation activities and their contribution to the Study process.

10.4.1 MSP Airport Noise Oversight Committee and the NOC Input Form

Following the discontinuation of MASAC in late 2000, a Blue Ribbon Panel was convened to formulate a structure for a new airport noise committee at MSP. The result was the formation of the MSP NOC.

MAC established the NOC in August 2002. Its purpose is to bring industry and community representatives together to discuss noise issues at the MSP and to bring policy recommendations to the MAC Planning and Environment Committee.

The cities of Minneapolis, Richfield, Bloomington, Eagan and Mendota Heights each have a representative on the committee. The cities of Burnsville, Inver Grove Heights, St. Paul, St. Louis Park, and Sunfish Lake are represented through an at-large membership. The at-large members rotate representation duties on an annual basis. Each city is responsible for appointing its representative.

The airline industry is represented by a scheduled air carrier, a cargo carrier, a charter operator, a Chief Pilot of an airline serving MSP, the Minnesota Business Aviation Association (MBAA) and an at-large member. All of the industry representatives are appointed by the MSP Airport and Airline Affairs Committee, with the exception of the MBAA representative, who is appointed by MBAA.

Shortly after the first NOC meeting on June 26, 2003, NOC determined that a structured process needed to be established for

receiving and considering public comments as possible NOC discussion items. Remaining cognizant of the lessons learned from MASAC, NOC developed a NOC input form and implemented by-law language outlining the NOC process for considering items requested for review by the public.

With the addition of the NOC input form there are three main channels that the public has to provide input into the NOC agenda. These include: (1) NOC Input Form, (2) Quarterly Noise Public Input Meetings, and (3) contacting an individual's NOC representative.

When a NOC input form is received by MAC staff, the form is forwarded to each NOC member, or only those specified by the submitter, for consideration. If a NOC member determines that the issue should be brought forward to the Committee, there is a process outlined in the bylaws for considering these NOC member requests. The bylaws, under Article VIII, provision five, reads as follows:

> *"Committee members can propose an item that is not included on the work plan for Committee consideration to either co-chair for approval and inclusion on the agenda. Approved agenda items proposed by Committee representatives will be added to the agenda of a future meeting at which time the representative proposing the item, and any individuals designated by the member to speak to the topic, will be given a specific amount of time, agreed to by both Co-Chairs, to present the item to the Committee. The Committee will consider the agenda item and make a determination whether the item should be added as a future agenda item, for more in-depth discussion and consideration, or dismissed from further discussion. This determination shall be made by a vote of at least four members of either the user representative group or city representative group."*

The above process requires that an individual have the support of at least one NOC representative to have an item brought forward for consideration as a topic on the NOC agenda. It is a NOC member's responsibility to decide whether or not to bring forward concerns or comments raised by their respective constituencies.

Some Study related comments have been received via the above process (i.e., NOC input form) and were provided to NOC members and MAC Commissioners for their consideration as they moved forward with the Study. Materials related to this input are provided in Appendix N (Volume III, Part II).

10.4.2 Quarterly Airport Noise Public Input Meetings

MAC Aviation Noise and Satellite Program staff sponsors quarterly public input meetings where concerned residents can receive updates on the NOC and its activities, be briefed on noise related issues, operational levels, and procedures around the Airport, and have the opportunity to provide comments and voice concerns on airport noise issues.

A memo summarizing comments received at the input meetings is forwarded to the MAC Commissioners and NOC members and a briefing of all comments and input forms received at the input meetings are provided as an agenda item at the next NOC meeting. Additionally, all verbal comments made at the public input meetings are responded to

in writing by MAC staff and made available on the MAC Noise Program Web site at www.macnoise.com.

All completed NOC input forms received at the input meetings are forwarded to each NOC member, or only those specified by the submitter, for consideration.

Table 10.4 shows the topics presented to input meeting attendees regarding the Study throughout the course of the forecast and contour updates in 2004. Materials related to these meetings are provided in Appendix N (Volume III, Part I).

Table 10.4

Summary of Quarterly Airport Noise Public Input Meetings

Date	Topic
October 22, 2002	Outlined NOC initial action items including noise contour update/development.
January 28, 2003	Outlined the 2003 Study schedule.
April 22, 2003	Discussed Study progress made to date and the anticipated schedule for the remainder of 2003.
July 22, 2003	Discussed progress made to date by the NOC regarding the 2007 operations forecast. Outlined the 2003 NOC work plan, which included extensive work on the Study. Reviewed the assumptions used in the development of the 2007 operations forecast and the future date that the Commission would be reviewing the assumptions.
October 28, 2003	Discussed progress made to date by the NOC including their endorsement and recommendation of the 2007 operations forecast assumptions, their recommendation of the INM input methodology and data used for the development of the 2002 existing condition and 2007 unmitigated noise contours and their endorsement and recommended approval of the draft 2002 and forecast 2007 aviation activity forecast numbers and fleet mix. Discussed the draft 2004 NOC work plan which includes work on the Study.
January 27, 2004	Reviewed NOC accomplishments in 2003 including (1) review and endorsement of Distant NADP on Runways 30L and 30R, (2) development of NOC input form and associated processes, (3) reviewed and recommended Study forecasting assumptions, (4) reviewed and recommended forecast (including daytime/nighttime split), fleet mix numbers, and INM inputs, (5) reviewed forecast number and fleet mix integrated into INM flight tracks and runway use, (6) reviewed 2004 NOC work plan. In addition, reviewed the Study process to-date and the remaining schedule including upcoming MAC Planning and Environment Committee meetings, NOC meetings and public comment period and public hearing that will be included in the Study process. Informed attendees that as the process moves forward the MAC will be reconsidering its position on Sound Mitigation Program policy issues, such as boundary definition and package options including consideration of the 65 and 60 DNL contour areas.
April 27, 2004	Discussed Study including: (1) review of the Revised 2002 and 2007 forecast operations, (2) review of the revised draft 2007 Mitigated noise contours, (3) review of the dwelling unit counts for Sound Mitigation Program mitigation consideration, (4) review of the April 2002 Commission mitigation package recommendation and the March 24, 2004, NOC mitigation package recommendation, (5) reviewed contour boundary considerations including block and parcel methods, (6) reviewed remaining Study process, (7) reviewed the interactive contour mapping application on the www.macnoise.com website.

Table 10.4

Summary of Quarterly Airport Noise Public Input Meetings

Date	Topic
July 27, 2004	Discussed Study including: (1) proposed mitigation area/boundary and dwelling unit counts, (2) July 19, 2004 MAC proposed Part 150 mitigation package, (3) remaining Part 150 Update schedule, (4) how to receive a copy of the Draft August 2004 Part 150 Update Document and/or places to view the draft document.
October 26, 2004	Discussed Study including: (1) public comment period, and public hearing process, (2) summary of public comments received during the public comment period and public hearing, (3) remaining Part 150 Update schedule.

Source: MAC

10.4.3 MSP Noise News Newsletter

The MAC Aviation Noise and Satellite Program office publishes a quarterly newsletter, the MSP Noise News. The distribution list includes over 3,800 homeowners around MSP. Individuals can sign up to receive the newsletter if they are interested. Individuals are provided several methods to subscribe to the publication, including the MAC Noise Program Website. Copies of the newsletters can also be downloaded directly from the website. The distribution list includes the Minnesota Legislative Reference Library and many city council members around the Airport.

The newsletter has included extensive information on the Study and provided information on how people could become involved in the process. The following is a summary of the Study related articles that have been published in the newsletter.

Volume 1, Issue 1 (March 2002): Article on the submission of the November 2001 Study to the FAA. Outlined the public hearings and workshops held during the development of the Study and gave a history of the Part 150 program at MSP.

Volume 1, Issue 2 (June 2002): Article on the MAC approval of the 60-64 DNL contour mitigation package at the April 15, 2003 Commission meeting. Article on the MAC's decision to withdraw the 2001 Study from the FAA with the intention of updating the noise contours to reflect a year 2002 existing conditions and a 2007 forecast DNL contours.

Volume 1, Issue 3 (September 2002): Article on the MAC's approval for the formation of the MSP NOC. Article states that the NOC will receive public input through several new and established communication channels. Listed date, time and location of the first scheduled public input meeting.

Volume 1, Issue 4 (December 2002): Article discussing the upcoming efforts to update MSP's forecast annual operations number for 2007 and the MAC's intent to revise the previously submitted noise contours to reflect a year 2002 existing conditions and a 2007 forecast DNL contours. Included contact information to obtain future meeting dates and times associated with the forecasting process and the Study. Listed date, time and location of next public input meeting.

Volume 2, Issue 1 (April 2003): Article on the MAC beginning the process of updating

the Study operations forecast and noise contours. Stated that the public would have the opportunity to learn more about the forecasting process at a public workshop in May. Listed date, time and location of next public input meeting.

Volume 2, Issue 2 (June 2003): Article on the MAC's decision at their June 16, 2003 meeting to have the NOC review the forecasting assumptions and provide input before the commission would take action. Outlined all of the assumptions that the NOC would review. Article reported on the NOC's first meeting and their plan to review and provide input on the forecast noise exposure maps and eligibility areas for MAC's mitigation programs. Listed date, time and location of next public input meeting.

Volume 2, Issue 3 (September 2003): Article informing the public of a future workshop on the draft forecast numbers and INM inputs. Article reported progress made by the NOC including their work on the operations forecast and INM inputs. Listed date, time and location of next public input meeting.

Volume 2, Issue 4 (December 2003): Article on the MAC's intent to publish and review the draft 2007 NEM at the February 4, 2004, MAC Planning and Environment Committee meeting. Discussed that a future workshop will be held on the draft NEM and a notice will be posted on the Noise Program Website at www.macnoise.com, published in local newspapers and stated that a post card would be sent to all of the MSP Noise News recipients notifying them of the workshop date, time and location. Included an article on the progress made to date by the NOC and their continued work on the Study. Listed date, time and location of next public input meeting.

Volume 3, Issue 1 (April 2004): Article on the Sound Mitigation Program debate focusing on the issues at the center of the discussion including the mitigation package and contour rounding methodology (i.e., block and parcel intersect methods). Included an article on the revised draft 2007 forecast numbers including the addition of the five RJ85 aircraft back into the fleet mix and information on the Study workshop that was held on February 19, 2004. Additionally, the newsletter included an article on the new flight track mapping application on the noise website and information reminding readers that the revised draft 2007 DNL noise contours are available via the interactive Study noise contour mapping application on the website. Upcoming meeting dates and times for the NOC, MAC Planning and Environment Committee, Public Input Meeting and MAC Full Commission were provided for the months of April, May and June 2004.

Volume 3, Issue 2 (July 2004): Article on the July 19, 2004 MAC proposed Part 150 Update mitigation package. Included articles covering information on the Part 150 Update public comment period, recommended NCP elements including land use and noise abatement measures, contour map indicating mitigation areas and the interactive contour mapping application available on the Internet at www.macnoise.com.

10.4.4 MAC Noise Program Website (www.macnoise.com)

In an effort to provide information/data to the public, the MAC Aviation Noise and Satellite Programs office has developed an Internet website consisting of a vast amount of information relative to noise issues at the MAC system of airports. Through the integrated use of several software packages, MAC staff has provided access to various reports, analyses and information. In

addition, interactive database query modules are available providing information on aircraft operations, noise, flight tracks, and noise contours.

There are several areas of the site, which focus on the Study and associated items related to public input. Specifically, these pages are the Part 150 Update page, interactive contour mapping application, the meetings and events calendar, NOC page, and the What's New page. Materials regarding the website are provided in Appendix N (Volume III, Part I).

The following provides further description of each of these pages:

- Interactive Contour Mapping Application – This application, which is available on the www.macnoise.com website, allows visitors to enter their address and locate it on a map relative to the revised draft 2007 mitigated noise contour lines. Additionally, from this application users can view a list of the 17 related NCP noise abatement measures including specifics on the Runway Use System (RUS) and Runway 17 2.5 Nautical Mile Turn Point Departure Procedure flight tracks.

- Part 150 Update Page – Extensive information on the Study process at MSP, current status of the update effort, information on the NCP elements and links to further information on the Sound Mitigation Program, the Integrated Noise Model, Part 150 frequently asked questions and Study presentations given by MAC staff.

- Meetings and Events Calendar – Listing of all NOC meetings, public input meetings and Study meetings and workshops.

- Noise Oversight Committee Page – Links to all of the NOC meeting minutes and agendas, 2004 NOC work plan, meeting schedule, public input channels and public input meetings information. Additionally, the NOC Input Form is available and comments and responses from Public Input Meetings are available for review.

- What's New Page – Articles on important Study developments and public meetings.

Throughout the lengthy Study process (as well as with any noise related initiatives) MAC has been committed to developing processes and implementing procedures that strive for information dissemination, and provide opportunities for communities and residents around the airport to submit their comments for consideration as policy decisions are made. This is accomplished through a balanced approach that must consider the perspectives of the communities around the airport as well as the users of the facility.

10.5 PUBLIC HEARINGS AND WRITTEN COMMENTS/ RESPONSES

One set of public hearings was held in November 2000, while another public hearing was held on September 7, 2004, to address revisions to the Study.

10.5.1 November 2000 Public Hearings and Written Comments/Responses

A draft MSP Study was published on October 6, 2000. Public workshops and hearings were held on November 8 and 9, 2000. A total of 541 people attended the two public meetings. The transcripts of the public hearings are provided in Appendix M (Volume II, Part IV).

The public comment period closed on November 15, 2000. MAC received 31 formal comment letters. Two of the comment letters were from members of the Minnesota House of Representatives, two were from airline representatives, five were from individual cities, one was from a neighborhood association, one was from a local noise organization, and the remaining comments were from concerned citizens. Additionally, 42 people completed comment forms that were provided at the public hearing and submitted as part of the official record.

In general there were eight major topics commented on at the public hearing and within the letters and forms. The following list summarizes the topics and key issues identified from airline and community representatives concerning the recommended NCP of the draft Study:

1. Mitigation to the 60 DNL contour. In general, the community comments support noise mitigation measures to the 60 DNL contour and beyond, while the airline comments support the current FAA extent for significant noise as the 65 DNL contour. Airlines do not support mitigation in the 60-64 DNL contour area.

2. Mitigation of Low Frequency Noise. The airlines state that funding and scientific consensus for mitigation of Low Frequency Noise is premature, while the communities support the inclusion of mitigation for Low Frequency Noise.

3. Lack of cost-benefit analysis for the mitigation programs proposed. Airlines support an extensive cost-benefit analysis for the proposed mitigation measures and question the funding sources to complete the proposed noise mitigation measures. Although community members were generally silent on this issue, a standard cost-benefit analysis is not required by Part 150 and would be difficult to complete as the benefits to the communities are in many ways intangible, but will serve to stabilize the community. Community stabilization was one of the main objectives stated in the 1996 MSP Noise Mitigation Program Report.

4. Inclusion of measures that support a voluntary reduction in hushkit operations during nighttime hours, as well as measures that encourage the use of manufactured Stage 3 aircraft. Community comments support strong language with significant incentives that encourage reductions in hushkit aircraft operations, increase the use of manufactured Stage 3 aircraft and many even proposed mandatory restrictions. Airlines' concerns focus on the national and international implications of a de facto hushkitted aircraft restriction that may bypass a Part 161 evaluation process.

5. Consideration of a new airport in replacement of MSP. Community comments suggested moving the airport due to the operational growth rates and noise impacts on the heavily populated urban areas. Airlines were silent on this issue.

6. Use of the projected forecast levels used in the Dual Track FEIS. Community comments expressed concern about the forecasted growth rates compared to the Dual Track FEIS growth forecasts and the ability of the existing airport to accommodate the 2005 and 2020 anticipated operational levels. Airlines were silent on this topic.

7. Involvement of MASAC, users, community planners, and the general public during the development of the draft Study. Airlines expressed concern that they were not adequately consulted prior to and during the development of the noise abatement measures. The communities had few comments concerning their participation in the Study process.

8. Implementation of the proposed Residential Sound Mitigation Program. Community comments expressed concern for the sequencing of single-family and multi-family homes, the amount of time required to complete the Sound Mitigation Program and supported maintaining the same elements of the existing mitigation program. Airline comments on this issue stressed their concern about providing any type of mitigation beyond the 65 DNL contour.

The comments received are provided in Appendix M (Volume II, Part IV). The comments from the formal public hearing and all written comments are paraphrased in a table in Appendix M (Volume II, Part IV); responses are also provided. The November 2001 Study was revised according to the responses provided. None of the proposed noise abatement or land use measures were changed due to the comments provided by the public; however, additional details were added.

10.5.2 September 2004 Public Hearing and Written Comments/Responses

The August 6, 2004, publication of the draft Study included the revised forecasts, NEMs, and a revised recommended Sound Mitigation Program. Note that the NCP recommendations from the November 2001 Study have not changed, except for mitigation package revisions to the Residential Sound Mitigation Program (LU-8) and removal of the Low-Frequency Noise Mitigation (LU-10) measure. Publication of the August 2004 draft Study was accomplished by distribution within the MAC and its advisory committees, online at www.macnoise.com, and by public review at Airport offices and local libraries. A public workshop and hearing was held on September 7, 2004, to consider the revisions to this Study. A total of 185 people signed into the hearing. The transcripts of the public hearings are provided in Appendix N (Volume III, Part V).

The public comment period closed on September 14, 2004. Approximately 130 individuals submitted written comments during the comment period and 33 persons submitted oral comments at the public hearing. The comments received were comprised of statements from elected officials, municipal representatives, and residents. The comments focused on concerns regarding and objections to the proposed Residential Sound Mitigation Program (LU-8). In general, the following points summarize consistent and reoccurring comments:

- MAC is not following through on its commitment to mitigate out to the 60 DNL. Past commitments should be kept.

- The sound mitigation package for the 60-64 DNL contour does not comply with the 1996 Dual Track Legislation, Dual Track FEIS and ROD, and the MSP Noise Mitigation Program. Also, the mitigation package is not consistent with supplemental information that MAC provided to the EQB.

- MAC has not engaged the communities in a cooperative process regarding the sound mitigation package.

- Homes that already have central air still need mitigation.
- The requirement for a co-pay to participate in the Sound Mitigation Program discriminates financially.
- The sound mitigation package discriminates against multi-family and condo dwelling owners.
- The DNL contour lines are inaccurate.
- Residents have not been included in the Sound Insulation Program even though homes only one block away have participated in the program.
- Residents have quality of life concerns as a result of aircraft noise. Residents state that aircraft noise has only gotten worse in the past and that they believe it will continue to get worse in the future.
- Residents bought homes, made home improvements, and made other decisions with the understanding that the 5 dB sound insulation program package would be carried forward for the 60-64 DNL contour.
- Home values have decreased as a result of aircraft noise for homes that have not received the sound insulation package.
- Budget is not a consideration in the package decision. Funds were set aside for the Sound Mitigation Program.
- Pilots deviate from flight tracks.
- Aircraft operators ignore the curfew on nighttime flights at MSP.

During the public comment period, MAC received no comments supporting the proposed mitigation package for homes within the 60 to 64 DNL.

The comments received are provided in Appendix N (Volume III, Part V), including the comments from the formal public hearing and all written comments paraphrased in a table; responses are also provided. The November 2004 Study was revised according to the responses provided; however, none of the proposed noise abatement or land use measures were changed due to the comments provided by the public.

Following approval by the MAC Planning and Environment Committee and the MAC Full Commission, this Study is submitted to FAA for review, acceptance of the NEMs, and approval of the NCP.

APPENDIX A

NEM AND NCP CHECKLISTS

Table A.1

Part 150 Noise Exposure Map Checklist (page 1 of 5)
Source: Federal Aviation Administration, 1989

Airport Name: Minneapolis-St. Paul International Airport	REVIEWER: _____		
	Yes/No/NA	Page/Other Reference	Notes/ Comments
I. IDENTIFICATION AND SUBMISSION OF MAP DOCUMENT			
A. Is this submittal appropriately identified as one of the following, submitted under Part 150:			
1. a NEM only	No		
2. a NEM and NCP	Yes	Sponsor Certification	
3. a revision to NEMs which have previously been determined by FAA to be in compliance with Part 150?	Yes		
B. Is the airport name and the qualified airport operator identified?	Yes	1-1	
C. Is there a dated cover letter from the airport operator which indicates the documents are submitted under Part 150 for appropriate FAA determinations?	Yes	Letter of Transmittal	
II. CONSULTATION: [150.21(B), A150.105(A)]			
A. Is there a narrative description of the consultation accomplished, including opportunities for public review and comment during map development?	Yes	Chapter 10	
B. Identification:			
1. Are the consulted parties identified?	Yes	Chapter 10	
2. Do they include all those required by 150.21(b) and 150.105(a)?	Yes	Chapter 10	
C. Does the documentation include the airport operator's certification, and evidence to support it, that interested persons have been afforded adequate opportunity to submit their views data, and comments during map development and in accordance with 150.21(b)?	Yes	Certification follows Title page, Chapter 10 provides consultation	
D. Does the document indicate whether written comments were received during consultation and, if there were comments, that they are on file with the FAA region?	Yes	Chapter 10	Comments provided in Appendix M (Volume II, Parts III and IV) and Appendix N (Volume III, Parts II, IV, and V).

Table A.1

Part 150 Noise Exposure Map Checklist (page 2 of 5)
Source: Federal Aviation Administration, 1989

Airport Name: Minneapolis-St. Paul International Airport	REVIEWER: _____		
	Yes/No/ NA	Page/Other Reference	Notes/ Comments
III. GENERAL REQUIREMENTS: (150.21)			
A. Are there two maps, each clearly labeled on the face with year (existing condition year and 5-year)?	Yes	Chapter 6	
B. Map currency:			
1. Does the existing condition map year match the year on the airport operator's submittal letter?	No		2002 NEM submitted in 2004
2. Is the 5-year map based on reasonable forecasts and other planning assumptions and is it for the fifth calendar year after the year of submission?	No	Chapter 3	
3. If the answer to 1 and 2 above is no, has the airport operator verified in writing that data in the documentation are representative of existing condition and 5-year forecast conditions as of the date of submission?	Yes	Section 1.1.1	
C. If the NEM and NCP are submitted together:			
1. Has the airport operator indicated whether the 5-year map is based on 5-year contours without the program vs. contours if the program is implemented?	Yes	Chapter 6	2007 Mitigated NEM is with revised NCP
2. If the 5-year map is based on program implementation:			
a. are the specific program measures which are reflected on the map identified?	Yes	Chapter 9	
b. does the documentation specifically describe how these measures affect land use compatibility's depicted on the map?	Yes	Chapter 8	
3. If the 5-year NEM does not incorporate program implementation, has the airport operator included an additional NEM for FAA determination after the program is approved which shows program implementation conditions and which is intended to replace the 5-year NEM as the new official 5-year map?	Yes	Chapter 6	2007 Unmitigated NEM is without the revised NCP

Table A.1

Part 150 Noise Exposure Map Checklist (page 3 of 5)
Source: Federal Aviation Administration, 1989

Airport Name: Minneapolis-St. Paul International Airport	REVIEWER: _____		
	Yes/No/NA	Page/Other Reference	Notes/ Comments
IV. MAP SCALE, GRAPHICS, AND DATA REQUIREMENTS: [A150.101, A150.103, A150.105, 150.21(A)]			
A. Are the maps of sufficient scale to be clear and readable (they must be not be less than 1" to 8,000'), and is the scale indicated on the maps?	Yes	Figures 6-1 through 6-3	1"≅ 1 statute mile
B. Is the quality of the graphics such that required information is clear and readable?	Yes		
C. Depiction of the airport and its environs.			
1. Is the following graphically depicted to scale on both the existing condition and 5-year maps:			
a. airport boundaries	Yes	Figures 6-1 through 6-3	
b. runway configurations with runway and numbers	Yes	Figures 6-1 through 6-3	
2. Does the depiction of the off-airport data include:			
a. a land use base map depicting streets and other identifiable geographic features	Yes	Figures 6-1 through 6-3	
b. area within 65 L_{dn} (or beyond, at local discretion.)	Yes	Figures 6-1 through 6-3	To the 60 dB DNL contour
c. clear delineation of geographic boundaries and the names of all jurisdictions with planning and land use control authority within the 65 L_{dn} (or beyond, at local discretion).	Yes	Figures 6-1 through 6-3	
D. 1. Continuous contours for at least L_{dn} 65, 70, and 75?	Yes	Figures 6-1 through 6-3	
2. Based on current airport and operational data for the existing condition year NEM, and forecast data for the 5-year NEM?	Yes	Section 1.1.1 and Chapter 3	
E. Flight tracks for the existing condition and 5-year forecast timeframes (these may be on supplemental graphics which must use the same land use base map as the existing condition and 5-year NEM), which are numbered to correspond to accompanying narrative?	Yes	Figures 4-6 through 4-15	Based on radar data
F. Locations of any noise monitoring sties (these may be on supplemental graphics which must use the same land use base map as the official NEMs)	Yes	Figure 4-19	Permanent monitoring sites

Table A.1

Part 150 Noise Exposure Map Checklist (page 4 of 5)
Source: Federal Aviation Administration, 1989

Airport Name: Minneapolis-St. Paul International Airport	REVIEWER: _____		
	Yes/No/NA	Page/Other Reference	Notes/ Comments
G. Noncompatible land use identification:			
1. Are noncompatible land uses within at least the 65 L_{dn} depicted on the maps?	Yes	Figures 6-1 through 6-3	
2. Are noise sensitive public buildings identified?	Yes	Figures 6-1 through 6-3	
3. Are the noncompatible uses and noise sensitive public buildings readily identifiable and explained on the map legend?	Yes	Figures 6-1 through6-3	
4. Are compatible land uses, which would normally be considered noncompatible, explained in the accompanying narrative?	Yes	Tables 8.8 and 8.26	
V. NARRATIVE SUPPORT OF MAP DATA: [150.21(A), A150.1, A150.101, A150.103]			
A. 1. Are the technical data, including data sources, on which the NEMs are based, adequately described in the narrative?	Yes	Chapters 4 and 5	
2. Are the underlying technical data and planning assumptions reasonable?	Yes	Chapters 4 and 5	
B. Calculation of Noise Contours:			
1. Is the methodology indicated?	Yes	Chapter 4	
a. is it FAA approved?	Yes		INM
b. was the same model used for both maps?	Yes		INM 6.1
c. has AEE approval been obtained for use of a model other than those which have previous blanket FAA approval?	NA		
2. Correct use of noise models:			
a. does the documentation indicate the airport operator has adjusted or calibrated FAA-approved noise models or substituted one aircraft type for another?	Yes	Chapter 4	User-defined takeoff profiles
b. if so, does this have written approval from AEE?	Yes		Letter attached at end of Checklist
3. If noise monitoring was used, does the narrative indicate that Part 150 guidelines were followed?	Yes		Noise monitoring via ANOMS

Table A.1

Part 150 Noise Exposure Map Checklist (page 5 of 5)
Source: Federal Aviation Administration, 1989

Airport Name: Minneapolis-St. Paul International Airport	REVIEWER: _____		
	Yes/No/NA	Page/Other Reference	Notes/ Comments
4. For noise contours below 65 L_{dn}, does the supporting documentation include explanation of local reasons? (Narrative explanation is desirable but not required.)	Yes	Chapters 5 and 8	Minimum DNL of 60 dB
C. Noncompatible Land Use Information:			
1. Does the narrative give estimates of the number of people residing in each of the contours (L_{dn} 65, 70 and 75, at a minimum) for both the existing condition and 5-year maps?	Yes	Tables 5.5, 5.8, 6.3, and 6.4	
2. Does the documentation indicate whether Table 1 of Part 150 was used by the airport operator?	Yes	Section 5.2 describes Federal compatibility guidelines	Table 5.1 provides Federal criteria
a. If a local variation to Table 1 was used:			
(1) does the narrative clearly indicated which adjustments were made and the local reasons for doing so?	Yes	Section 5.2	
(2) does the narrative include the airport operator's complete substitution for Table 1?	Yes	Table 5.2	
3. Does the narrative include information on self-generated or ambient noise where compatible/ noncompatible land use identifications consider non-airport/aircraft sources?	NA	Section 8.2.1	
4. Where normally noncompatible land uses are not depicted as such on the NEMs, does the narrative satisfactorily explain why, with reference to the specific geographic areas?	NA		
5. Does the narrative describe how forecasts will affect land use compatibility?	Yes	Section 5.5.2	
VI. MAP CERTIFICATIONS: [150.21(B), 150.21(E)]			
A. Has the operator certified in writing that interested persons have been afforded adequate opportunity to submit views, data, and comments concerning the correctness and adequacy of the draft maps and forecasts?	Yes	Certification following Title page	
B. Has the operator certified in writing that each map and description of consultation and opportunity for public comment are true and complete?	Yes	Certification following Title Page	

Table A.2

Part 150 Noise Compatibility Program Checklist (page 1 of 5)
Source: Federal Aviation Administration, 1989

Airport Name: Minneapolis-St. Paul International Airport	REVIEWER: _____		
	Yes/No/NA	Page/Other Reference	Notes/ Comments
I. IDENTIFICATION and SUBMISSION of PROGRAM:			
A. Submission is properly identified:			
1. FAR 150 NCP?	No		
2. NEM and NCP together?	Yes		
3. Program Revision?	Yes		
B. Airport and Airport Operator's name identified?	Yes	1-1	Section 1.6 describes roles and responsibilities
C. NCP transmitted by airport operator's cover letter?	Yes		
II. CONSULTATION: [150.23]			
A. Documentation includes narrative of public participation and consultation process?	Yes	Chapter 10	
B. Identification of consulted parties:			
1. all parties in 150.23(c) consulted?	Yes	Chapter 10	
2. public and planning agencies identified?	Yes	Appendix J	
3. agencies in 2., above, correspond to those indicated on the NEM?	Yes	NCP and NEM combined effort	
C. Satisfies 150.23(d) requirements:			
1. documentation shows active and direct participation of parties in B., above?	Yes	Chapter 10 and Appendix J	
2. active and direct participation of general public?	Yes	Chapter 10	
3. participation was prior to and during development of NCP and prior to submittal to FAA?	Yes	Chapter 10	Public Information meetings, MASAC/MASAC Ops meetings, NOC, MAC P&E and Full Commission meetings
4. indicates adequate opportunity afforded to submit views, data, etc.?	Yes	Public workshops and meetings	
D. Evidence included of notice and opportunity for a public hearing on NCP?	Yes	Chapter 10	

Table A.2

Part 150 Noise Compatibility Program Checklist (page 2 of 5)
Source: Federal Aviation Administration, 1989

Airport Name: Minneapolis-St. Paul International Airport	REVIEWER: _____		
	Yes/No/NA	Page/Other Reference	Notes/ Comments
E. Documentation of comments:			
1. includes summary of public hearing comments, if hearing was held?	Yes	Chapter 10, Appendix M (Volume II, Part IV), and Appendix N (Volume III, Part V).	Verbatim transcripts provided
2. includes copy of all written material submitted to operator?	Yes	Chapter 10, Appendix M (Volume II, Part IV), and Appendix N (Volume III, Parts II, IV, and V).	
3. includes operator's response/disposition of written and verbal comments?	Yes	Appendix M (Volume II, Part IV) and Appendix N (Volume III, Parts II, IV, and V).	Responses provided in tabular format or as correspondence to commenters.
F. Informal agreement received from FAA on flight procedures?	Yes	Table 9.2, Appendix M (Volume II, Parts I and II).	EA prepared for Runway 17 flight procedures; FONSI/ROD issued in August 2003. MASAC/ MASAC Operations Minutes
III. NOISE EXPOSURE MAPS: [150.23, B150.3; 150.35(f)] (This section of the checklist is not a substitute for the Noise Exposure Map checklist. It deals with maps in the context of the Noise Compatibility Program submission.)			
A. Inclusion of NEMs and supporting documentation:			
1. Map documentation either included or incorporated by reference?	Yes	Chapter 6	
2. Maps previously found in compliance by FAA?	NA		NEM submitted with NCP
3. Compliance determination still valid?	NA		
4. Does 180-day period have to wait for map compliance finding?	Yes		
B. Revised NEMs submitted with program: (Review using NEM checklist if map revisions included in NCP submittal)			
1. Revised NEMs included with program?	Yes	Chapter 6 and 9	
2. Has airport operator requested FAA to make a determination on the NEM(s) when NCP approval is made?	Yes		

Table A.2

Part 150 Noise Compatibility Program Checklist (page 3 of 5)
Source: Federal Aviation Administration, 1989

Airport Name: Minneapolis-St. Paul International Airport	REVIEWER: _____		
	Yes/No/NA	Page/Other Reference	Notes/ Comments
C. If program analysis uses noise modeling:			
1. INM, HNM or FAA-approved equivalent?	Yes	Chapter 4	INM
2. Monitoring in accordance with A150.5?	Yes	Chapter 4	Noise monitoring used to correlate INM output
D. Existing condition and 5-year maps clearly identified as the official NEMs?	Yes	Figures 6-1 through 6-3	
IV. CONSIDERATION of ALTERNATIVES: [B150.7, 150.23(e)]			
A. At a minimum, are the alternatives below considered?			
1. land acquisition and interests therein, including air rights, easements, and development rights?	Yes	Chapter 8	
2. barriers, acoustical shielding, public building soundproofing	Yes	Chapter 8	
3. preferential runway system	Yes	Chapter 7	
4. flight procedures	Yes	Chapter 7	
5. restrictions on type/class of aircraft (at least one restriction below must be checked):			
a. deny use based on Federal standard	No		
b. capacity limits based on noisiness	No		
c. noise abatement takeoff/approach procedures	Yes	Chapter 7	
d. landing fees based on noise or time of day	Yes	Chapter 7	Based on noise
e. nighttime restrictions	Yes	Chapter 7	Voluntary
B. Responsible implementing authority identified for each considered alternative?	Yes	Chapters 7, 8 and 9	
C. Analysis of alternative measures:			
1. measures clearly described?	Yes	Chapters 7 and 8	
2. measures adequately analyzed?	Yes	Chapters 7 and 8	
3. adequate reasoning for rejecting alternatives?	Yes	Chapters 7 and 8	
D. Other actions recommended by the FAA?	No		

Table A.2

Part 150 Noise Compatibility Program Checklist (page 4 of 5)
Source: Federal Aviation Administration, 1989

Airport Name: Minneapolis-St. Paul International Airport	REVIEWER: _____		
	Yes/No/NA	Page/Other Reference	Notes/ Comments
V. ALTERNATIVES RECOMMENDED for IMPLEMENTATION: [150.23(e), B150.7(c); 150.35(b), B150.5]			
A. Document clearly indicates:			
1. alternatives recommended for implementation?	Yes	Chapter 9	
2. final recommendations are airport operator's, not those of consultant or third party?	Yes	Certification following Title page	
B. Do all program recommendations :			
1. relate directly or indirectly to reduction of noise and noncompatible land uses?	Yes		
2. contain description of contribution to overall effectiveness of program?	Yes	Chapter 9	
3. noise/land use benefits quantified to extent possible?	Yes	Chapter 9	
4. include actual/anticipated effect on reducing noise exposure within noncompatible areas shown on NEM?	Yes	Figures 6-2, 6-3 and 8-2.	
5. effects based on relevant and reasonable expressed assumptions?	Yes	Chapters 7 and 8	
6. have adequate supporting data to support its contribution to the noise/land use compatibility?	Yes	Chapters 4 to 8	
C. Analysis appears to support program standards set forth in 150.35(b) and B150.5?	Yes	Chapters 7, 8, and 9	
D. When use restrictions are recommended:			
1. Are alternatives with potentially significant noise/compatible land use benefits thoroughly analyzed so that appropriate comparisons and conclusions can be made?	NA		
2. use restrictions coordinated with APP-600 prior to making determination on start of 180-days?	NA		

Table A.2

Part 150 Noise Compatibility Program Checklist (page 5 of 5)
Source: Federal Aviation Administration, 1989

Airport Name: Minneapolis-St. Paul International Airport	REVIEWER: _____		
	Yes/No/NA	Page/Other Reference	Notes/ Comments
E. Do the following also meet Part 150 analytical standards?:			
1. formal recommendations which continue existing practices?	Yes	Chapter 9	
2. new recommendations or changes proposed at end of Part 150 process?	Yes	Chapter 9	
F. Documentation indicates how recommendations may change previously adopted plans?	Yes	Chapters 7 to 9	
G. Documentation also:			
1. identifies agencies which are responsible for implementing each recommendation?	Yes	Chapter 9	
2. indicates whether those agencies have agreed to implement?	Yes	Chapter 9	See Section 9.3.3 for a discussion of support and opposition to NCP.
3. indicates essential government actions necessary to implement recommendations?	Yes	Chapter 9	
H. Time frame:			
1. includes agreed-upon schedule to implement alternatives?	Yes	Chapter 9	
2. indicates period covered by the program?	Yes	Chapter 9	
I. Funding/Costs:			
1. includes costs to implement alternatives?	Yes	Chapter 9	
2. includes anticipated funding sources?	Yes	Chapter 9	
VI. PROGRAM REVISION: [150.23(e)(9)] Supporting documentation includes provision for revision?	Yes	Chapter 9	

U.S. Department
of Transportation
**Federal Aviation
Administration**

800 Independence Ave., S.W.
Washington, D.C. 20591

OCT 23 2001

Kent Duffy
HNTB
99 Canal Center Plaza
Alexandria, VA 22314

Dear Mr. Duffy:

The Office of Environment and Energy has reviewed the profiles submitted for use in the 14 CFR Part 150 Update for Minneapolis-St. Paul International Airport (MSP). This submission requests modification of the departure profiles for 27 aircraft types to include Close-In and Distant Noise Abatement Departure Procedures.

Our office approves the use of these modified profiles for the 14 CFR Part 150 Update for Minneapolis-St. Paul International. Please understand that this approval for use of the modified departure profiles is limited to this particular 14 CFR Part 150 Update for MSP. Any additional projects or non-standard INM input for MSP will require separate approval as will use of these profiles for another site.

The modified profiles for the A306, B717, DC86, A310/330, B733, DC87, B734, B735, BA46, B73Q, B742, B763, and B752 are approved; however, in the absence of documented operating procedures, the decision to use these profiles is a modeling issue and is not subject to this review. In addition, the methodology used to model the DC-9 de-rated takeoff did not require any modifications to the standard INM departure profiles, therefore these profiles were not considered in this review.

Sincerely,

J. DiPardo

Joe Dipardo
AEE/Noise Division
Office of Environment and Energy

U.S. Department
of Transportation
**Federal Aviation
Administration**

800 Independence Ave., S.W.
Washington, DC 20591

FEB 25 2004

Kent Duffy
HNTB
99 Canal Center Plaza
Alexandria, VA 22314

Dear Mr. Duffy:

The Office of Environment and Energy has reviewed the profiles in the Addendum to FAA Profile Review Checklist, December 2003 submitted for use in the 14 CFR Part 150 Update for Minneapolis-St. Paul International Airport (MSP). This submission requests modification of the departure profiles for 7 aircraft types to include Close-In and Distant Noise Abatement Departure Procedures.

Our office approves the use of the modified profiles for the B762, A319, A320, A330, B753, DC10, and MD81 aircraft for use in the 14 CFR Part 150 Update for Minneapolis-St. Paul International. Please understand that this approval for use of the modified departure profiles is limited to this particular 14 CFR Part 150 Update for MSP. Any additional projects or non-standard INM input for MSP will require separate approval as will use of these profiles for another site.

Sincerely,

Joseph DiPardo
Noise Division
Office of Environment and Energy

APPENDIX B

AIRSPACE AND AIR TRAFFIC CONTROL

The National Airspace System (NAS) is a complex network of air navigation facilities, air traffic control facilities, airports, technology, and appropriate rules and regulations. ATC uses highly technical, intricate procedures to direct aircraft. This appendix only details areas of the NAS that impact operations in the immediate vicinity of MSP (up to and including 3000 feet of altitude). Detailed operational procedures unique to MSP are discussed in Chapters Four and Seven.

BACKGROUND

The Federal Aviation Act of 1958 established the FAA and made it responsible for the control and use of navigable airspace within the United States. The FAA created the National Airspace System (NAS) to protect persons and property on the ground, and to establish a safe and efficient airspace environment for civil, commercial, and military aviation. The NAS is made up of a network of air navigation facilities, air traffic control facilities, airports, technology, and appropriate rules and regulations that are needed to operate the system. This appendix details the various components of the NAS, and then describes how these components interact to ensure safe and efficient air travel.

AIRSPACE

Aircraft flying in the United States are subject to varying degrees of control depending on their operating rules, airspace type, and meteorological conditions. The airspace that aircraft operate within is divided into many different blocks of airspace segregated by geography, altitudes, and location. The control of aircraft operating in the airspace is exercised from a network of air traffic control (ATC) facilities. The ATC system operates within a framework of laws and regulations to provide for the safe operation of aircraft. Accuracy of communication and air navigation is required to maintain the air traffic control system and use of Federal airways and routes.

Section 4.2.3 discusses flight rules and weather conditions.

Airspace is broadly classified as either controlled or uncontrolled. Controlled airspace is intended to ensure separation of IFR traffic from other aircraft, both IFR and VFR. It is supported by ground-to-air communications, navigation aids, and air traffic services. Aircraft operating within controlled airspace are subject to varying requirements for positive air traffic control.

NAVIGATION SYSTEM

ATC is in contact with and navigational service is available to aircraft in all phases of flight – departure, en route, and arrival. Several navigational systems are available, all comprising of ground-based transmission facilities and receiving instruments on aircraft. Navigational aids (NAVAIDS) often provide navigation to a broad area of airspace.

A non-directional beacon (NDB) is a general purpose, low-frequency radio beacon that transmits a non-directional signal. An aircraft equipped with direction finding equipment can determine a bearing to or from the radio beacon, and use this to navigate.

The most common and important NAVAID is the VHF omni-directional radio range (VOR) station. The VOR is a ground-based NAVAID which transmits high frequency radio signals (known as radials) 360 degrees in azimuth from the station. A pilot can select a specific radial from a VOR, and use this to fly to or from another point. Two VORs can be used to triangulate an aircraft's position. A pilot can also use distance measuring equipment (DME) to measure an aircraft's distance from a properly-equipped VOR. Some VORs are also co-located with TACAN (tactical air navigation equipment), which is used by the military. These installations are known as VORTAC, and operate in the same way as a VOR station. VOR radials are often used to define both low altitude (Victor) and high altitude (Jet) federal airways. They are also sometimes used to direct aircraft into and out of airports.

Aircraft also use "fixes" for navigational purposes. A fix is a defined geographic point, with a single five-letter name. It is known to both air traffic controllers and pilots, and is identified on air navigation charts. Latitude/longitude designations and radials are used to define fixes. The intersection of specific radials from two VORs, or a specific radial and a distance from DME equipment are the two most common methods used to identify a fix location.

Satellite navigation, using the Global Positioning System (GPS), is intended to replace ground-based NAVAIDS. GPS will become the primary NAVAID used by pilots and ATC. The GPS equipment uses a database of fix locations. GPS determines the aircraft's position, in latitude and longitude, and computes a course between the aircraft's position and a selected fix. Additional information on GPS is contained in Appendix G.

NAVAIDS are also used to guide an aircraft for landing at an airport during the arrival portion of flight. The procedures used with these NAVAIDS are known as Instrument Approach Procedures, and are used to guide aircraft to a specific runway for landing in IMC. An instrument approach procedure that uses VORs and NDBs as the primary NAVAID are known as non-precision approaches, because they only provide horizontal (position) guidance and do not provide exact altitude guidance. An Instrument Landing System (ILS) is known as a precision approach, because it provides precision altitude guidance for an aircraft as it is guided to the runway. It also has more precise horizontal (position) guidance than a VOR or NDB system.

AIR TRAFFIC CONTROL FACILITIES

The FAA provides air traffic control service through a number of facilities and assigned areas of air traffic control responsibility. The following provides a brief description of the different types of air traffic control facilities.

Air Route Traffic Control Centers (ARTCC)

The FAA has established Air Route Traffic Control Centers (ARTCC), known as Centers, in the continental United States to control aircraft operating under instrument flight rules (IFR) within controlled airspace and while in the en route phase of flight. ARTCCs also provide limited air traffic service to VFR aircraft operating in controlled airspace. An ARTCC assigns specific routes and altitudes along federal airways to maintain separation and orderly air traffic flow. The

ARTCC uses radio communication and long range radar with automatic tracking capability to provide en route air traffic services. An ARTCC splits its airspace into sectors and assigns a controller or team of controllers to each sector. As an aircraft travels through the ARTCC, one sector hands off control to another. Each sector guides the aircraft using discrete radio frequencies.

Terminal Radar Approach Control (TRACON)

The ARTCC delegates certain airspace to local terminal facilities, which assume responsibility for the orderly flow of air traffic arriving and departing from major airports, such as MSP. These facilities provide radar vectoring, sequencing, and separation of IFR aircraft. They also provide air traffic service to aircraft operating from smaller airports within the TRACON's boundaries, and traffic advisories for VFR aircraft operating in the area.

TRACONs can be located at an ATCT or in close proximity to the airport. TRACON's use radar to guide aircraft, and therefore they do not have to be located at an airport facility. Like ARTCCs, a TRACON's airspace may also be divided into a number of different sectors to make the workloads of air traffic controllers manageable.

Airport Traffic Control Tower (ATCT)

Traffic at busy airports is controlled by an ATCT. ATCTs are located at the airport and provide local air traffic control, usually within five nautical miles of the airport. Air traffic controllers in towers primarily use sight to track and control aircraft.

Large commercial airports, such as MSP, typically have several runways that can be used simultaneously. As a result, these airports operate in a safe, systematic departure and arrival configuration (or flow) that is based on the prevailing winds and the physical layout of the runways. MSP typically operates in an east or west flow. If airports are in close proximity to each other (such as MSP and St. Paul Downtown Airport, or Flying Cloud Airport), operations at the airports must be able to smoothly interact. This requires extensive planning and coordination between the air traffic control facilities, including ATCTs, TRACONs, and ARTCCs that operate within an area.

PHASES OF FLIGHT

All of the components of the National Airspace System, including airports, navigational aids, air traffic control, and aircraft must be able to interact so that aircraft can safely and efficiently travel from one place to another. This appendix has, thus far, discussed the various components of the NAS, but will now detail how these systems interact. An aircraft traveling from one place to another goes through three phases of flight: departure (takeoff), en route (cruise), and arrival (landing); during each of these phases, different components of the NAS are used. Noise abatement procedures are also used at some airports, and are integrated with the ATC system and routes assigned to aircraft.

Departure Phase

An aircraft operating on an IFR flight plan will receive an ATC clearance, specifying the air routes and initial altitudes that are to be used on the flight. The clearance may come in the form of a departure procedure (DP). A DP is a standardized ATC departure procedure, containing a group of procedures that would otherwise be transmitted piece by piece, used at certain airports to simplify clearance delivery procedures. As discussed earlier, many busy airports have a systematic and coordinated arrival and departure flow. As a result, many aircraft may receive the same clearance to depart from the airport and transition to the en route portion of their flight; a DP permits the controller to relay this clearance simply and quickly without having to repeat the information for every flight. The ATCT will transmit this clearance to the pilot, and will also give clearance for the aircraft to taxi to the runway. The ATCT will also give clearance for the aircraft to takeoff.

Shortly after takeoff, the aircraft is handed off to the TRACON. The TRACON acquires the aircraft on radar, and the pilot switches radio frequencies. The TRACON controller will vector the aircraft to follow a specific course or to avoid other air traffic, and will give it instructions to climb to certain altitudes. The TRACON directs the aircraft to a specific departure gate, which is a designated area of airspace where the aircraft is handed off to the ARTCC.

En Route Phase

By definition, the en route system of air traffic control is that part of the system devoted to controlling IFR aircraft between the terminal area of origination and the terminal area of destination. For this study, the term “en route system” includes all routes and procedures 3,000 feet and higher. This definition is consistent with the definition of airport traffic areas and environmental review procedures. The “roof” of the airport traffic area is 3,000 feet above ground level (AGL). FAA Order 1050.1D establishes 3,000 feet AGL as the altitude above which changes in en route procedures, airport approach procedures and airport departure procedures are normally categorically excluded from the requirement for an environmental assessment (EA) or environmental impact statement (EIS).

The pilot of the aircraft will initially contact the ARTCC by switching to another discrete radio frequency, and the ARTCC will detect the aircraft on its long-range radar. ARTCC will vector and direct aircraft so that it is adequately separated from other air traffic, and will direct the aircraft along its assigned route. The route will consist of a combination of VORs, airways, fixes, and radar vectors. The ARTCC will also direct the aircraft to climb to its cruise altitude. The aircraft will be handed off to different sectors and ARTCCs as it traverses along the route towards its destination.

Arrival Phase

When the aircraft comes within a couple hundred miles of its destination, the ARTCC will direct it to begin a descent to a specified lower altitude. The aircraft may be routed using a standard terminal arrival route (STAR). A STAR is very similar to a DP; it contains a group of

procedures, including routes and fixes, to be used by the aircraft as it approaches the airport. Like a DP, a STAR is intended to simplify clearance delivery procedures.

The ARTCC will direct the aircraft along a route (and to an arrival gate) used to funnel traffic into a specific airport when using a given north, south, east, or west flow. The controllers at the ARTCC merge aircraft along these routes, and provide sequencing and adequate separation from other air traffic. They will then transfer control of the aircraft to the appropriate TRACON at the arrival gate. This transfer is usually completed within approximately 20 nautical miles of the destination airport.

After the TRACON controllers establish communication with the aircraft, they provide approach control services by instructing the pilot to fly along specific routes, using fixes, NAVAIDS, and vectors. During IMC conditions, the TRACON will also direct the aircraft to an instrument approach for landing at the destination airport.

The TRACON will often route the aircraft to the airport using a local traffic pattern. The pattern is used by aircraft operating to and from an airport, to ensure that all aircraft use similar procedures and follow similar routes to and from the runways. If at all possible, aircraft should land and takeoff into the prevailing wind. This reduces takeoff and landing distance, and also helps to create an orderly traffic flow. The terminology used to describe the different legs of the traffic pattern are based upon the leg position relative to the direction of the prevailing wind and the runway. An aircraft taking off is flying into the wind, and hence the leg is known as the "upwind" leg. An aircraft that is flying perpendicular to the wind, on the departure side of the runway, is on the "crosswind" leg of the pattern. An aircraft flying parallel and towards the arrival end of the runway is on the "downwind" leg. The "base" leg is also perpendicular to the prevailing wind, and is intended as a "base" as the aircraft begins it approach for landing on the runway. The last leg, when the aircraft is aligned with the runway for landing, is known as "final." For jet airline traffic, the traffic pattern is usually fairly "wide," meaning it is flown several miles away from the airport. During IMC conditions, the pattern flown may be very wide, and pattern legs are used mainly to describe the aircraft's relative position to the airport.

The TRACON hands the aircraft off to the airport's ATCT when it is within approximately five to 10 nautical miles of the airport, or when the ATCT has visual contact with the aircraft. The ATCT gives the aircraft final clearance to land, and the aircraft safely completes it flights using the various components of the NAS.

APPENDIX C

SUPPLEMENTAL NOISE MODELING DATA

Table C.1

Modeled 2002 Average Daily Flight Operations

Operational Category	Aircraft Type	Departures			Arrivals			Total		
		Day	Night	Total	Day	Night	Total	Day	Night	Total
NW/PJ	A319	50.8055	1.7397	52.5452	50.9280	1.6172	52.5452	101.7335	3.3569	105.0904
	A320	69.6685	5.3206	74.9891	69.3133	5.6758	74.9891	138.9818	10.9964	149.9782
	B712	4.9562	0.2493	5.2055	4.2439	0.9616	5.2055	9.2001	1.2109	10.4110
	B72Q	12.7461	1.2086	13.9547	11.7013	2.2534	13.9547	24.4474	3.4620	27.9094
	B733	18.0521	0.6438	18.6959	16.8055	1.8904	18.6959	34.8576	2.5342	37.3918
	B734	0.2082	0.0138	0.2220	0.2061	0.0159	0.2220	0.4143	0.0297	0.4440
	B735	9.4795	0.9781	10.4576	9.6220	0.8356	10.4576	19.1015	1.8137	20.9152
	B738	8.0770	0.9918	9.0688	7.1590	1.9098	9.0688	15.2360	2.9016	18.1376
	B73Q	1.0383	0.0993	1.1376	0.9896	0.1480	1.1376	2.0279	0.2473	2.2752
	B752	49.8559	3.4311	53.2870	48.3983	4.8887	53.2870	98.2542	8.3198	106.5740
	B753	1.6795	0.0247	1.7042	1.6254	0.0788	1.7042	3.3049	0.1035	3.4084
	D93Q	101.8904	5.8483	107.7387	104.6480	3.0907	107.7387	206.5384	8.9390	215.4774
	D95Q	40.9994	3.2772	44.2766	42.9631	1.3135	44.2766	83.9625	4.5907	88.5532
	F100	14.3547	1.7138	16.0685	14.3890	1.6795	16.0685	28.7437	3.3933	32.1370
	MD81	0.1973	0.0090	0.2063	0.1934	0.0129	0.2063	0.3907	0.0219	0.4126
	MD83	11.4089	1.5939	13.0028	12.2603	0.7425	13.0028	23.6692	2.3364	26.0056
NW/PJ Total		395.4175	27.1430	422.5605	395.4462	27.1143	422.5605	790.8637	54.2573	845.1210
NH/PH	B744	2.8913	0.0759	2.9672	2.5425	0.4247	2.9672	5.4338	0.5006	5.9344
	B763	0.0192	0.0027	0.0219	0.0192	0.0027	0.0219	0.0384	0.0054	0.0438
	DC10	9.1662	0.4028	9.5690	8.5746	0.9944	9.5690	17.7408	1.3972	19.1380
	L101	0.2712	0.0451	0.3163	0.2219	0.0944	0.3163	0.4931	0.1395	0.6326
NH/PH Total		12.3479	0.5265	12.8744	11.3582	1.5162	12.8744	23.7061	2.0427	25.7488
RJ	BA46/RJ85	31.9342	1.4986	33.4328	33.0273	0.4055	33.4328	64.9615	1.9041	66.8656
	CARJ	44.3143	3.1678	47.4821	44.8252	2.6569	47.4821	89.1395	5.8247	94.9642
	E135	0.1178	-	0.1178	0.1178	-	0.1178	0.2356	-	0.2356
	E145	4.9616	0.0110	4.9726	4.9027	0.0699	4.9726	9.8643	0.0809	9.9452
RJ Total		81.3279	4.6774	86.0053	82.8730	3.1323	86.0053	164.2009	7.8097	172.0106
RP	BE58	0.3397	0.1068	0.4465	0.3205	0.1260	0.4465	0.6602	0.2328	0.8930
	DHC6	5.8356	0.0137	5.8493	5.8438	0.0055	5.8493	11.6794	0.0192	11.6986
	SF34	78.2082	5.3589	83.5671	78.9479	4.6192	83.5671	157.1561	9.9781	167.1342
RP Total		84.3835	5.4794	89.8629	85.1122	4.7507	89.8629	169.4957	10.2301	179.7258
CH	A306	1.3825	1.2069	2.5894	1.6547	0.9347	2.5894	3.0372	2.1416	5.1788
	A310	0.0192	0.1207	0.1399	0.1234	0.0165	0.1399	0.1426	0.1372	0.2798
	B742	0.0137	0.0137	0.0274	0.0219	0.0055	0.0274	0.0356	0.0192	0.0548
	B763	0.0086	0.0298	0.0384	0.0192	0.0192	0.0384	0.0278	0.0490	0.0768
	DC10	1.7802	1.4319	3.2121	1.7528	1.4593	3.2121	3.5330	2.8912	6.4242
	DC8Q	0.8229	1.0451	1.8680	0.0960	1.7720	1.8680	0.9189	2.8171	3.7360
	MD11	0.0686	0.0192	0.0878	0.0411	0.0467	0.0878	0.1097	0.0659	0.1756
CH Total		4.0957	3.8673	7.9630	3.7091	4.2539	7.9630	7.8048	8.1212	15.9260
CJ	B72Q	2.0106	1.7939	3.8045	1.4409	2.3636	3.8045	3.4515	4.1575	7.6090
	B752	0.0467	0.2359	0.2826	0.1372	0.1454	0.2826	0.1839	0.3813	0.5652
	D93Q	0.2359	0.8119	1.0478	0.4252	0.6226	1.0478	0.6611	1.4345	2.0956
	FA20	0.5321	0.2606	0.7927	0.4389	0.3538	0.7927	0.9710	0.6144	1.5854
	LJ25	0.1536	0.0219	0.1755	0.1426	0.0329	0.1755	0.2962	0.0548	0.3510
	LJ35	0.0582	0.0159	0.0741	0.0439	0.0302	0.0741	0.1021	0.0461	0.1482
CJ Total		3.0371	3.1401	6.1772	2.6287	3.5485	6.1772	5.6658	6.6886	12.3544
CP	BE58	3.9061	3.9279	7.8340	7.3073	0.5267	7.8340	11.2134	4.4546	15.6680
	C441	0.0411	0.0027	0.0438	0.0246	0.0192	0.0438	0.0657	0.0219	0.0876
	CV58	0.0165	0.0082	0.0247	0.0192	0.0055	0.0247	0.0357	0.0137	0.0494
	DC3	0.0055	0.0082	0.0137	0.0064	0.0073	0.0137	0.0119	0.0155	0.0274
	DHC6	1.2426	1.4950	2.7376	2.3024	0.4352	2.7376	3.5450	1.9302	5.4752
	SEPF	0.1097	0.0274	0.1371	0.1157	0.0214	0.1371	0.2254	0.0488	0.2742
CP Total		5.3215	5.4694	10.7909	9.7756	1.0153	10.7909	15.0971	6.4847	21.5818
GJ	ASTR	1.1605	0.0728	1.2333	1.1309	0.1024	1.2333	2.2914	0.1752	2.4666
	C500	0.5448	0.0276	0.5724	0.5420	0.0304	0.5724	1.0868	0.0580	1.1448
	C55B	0.7452	0.0789	0.8241	0.7300	0.0941	0.8241	1.4752	0.1730	1.6482
	C650	1.9799	0.3263	2.3062	2.1431	0.1631	2.3062	4.1230	0.4894	4.6124
	C750	1.8941	0.1549	2.0490	1.9301	0.1189	2.0490	3.8242	0.2738	4.0980
	CL60	1.5066	0.1138	1.6204	1.5042	0.1162	1.6204	3.0108	0.2300	3.2408
	FA20	1.4219	0.2068	1.6287	1.4739	0.1548	1.6287	2.8958	0.3616	3.2574
	GLF2	0.8763	0.0584	0.9347	0.8158	0.1189	0.9347	1.6921	0.1773	1.8694
	GLF4	0.9196	0.0456	0.9652	0.8988	0.0664	0.9652	1.8184	0.1120	1.9304
	GLF5	0.3181	0.0304	0.3485	0.3196	0.0289	0.3485	0.6377	0.0593	0.6970
	LJ25	0.6278	0.0607	0.6885	0.6359	0.0526	0.6885	1.2637	0.1133	1.3770
	LJ35	9.4166	0.7897	10.2063	9.4653	0.7410	10.2063	18.8819	1.5307	20.4126
	MU30	2.3001	0.1609	2.4610	2.3173	0.1437	2.4610	4.6174	0.3046	4.9220
GJ Total		23.7115	2.1268	25.8383	23.9069	1.9314	25.8383	47.6184	4.0582	51.6766
GP	BE58	3.0756	0.2861	3.3617	2.2310	1.1307	3.3617	5.3066	1.4168	6.7234
	DHC6	3.1783	0.2354	3.4137	3.0817	0.3320	3.4137	6.2600	0.5674	6.8274
	SEPV	2.1219	0.1904	2.3123	1.9196	0.3927	2.3123	4.0415	0.5831	4.6246
GP Total		8.3758	0.7119	9.0877	7.2323	1.8554	9.0877	15.6081	2.5673	18.1754
MJ	C17A	0.0247	-	0.0247	0.0207	0.0040	0.0247	0.0454	0.0040	0.0494
	C5	0.0219	-	0.0219	0.0219	-	0.0219	0.0438	-	0.0438
	F16	0.0466	-	0.0466	0.0466	-	0.0466	0.0932	-	0.0932
	F18	0.0137	0.0082	0.0219	0.0219	-	0.0219	0.0356	0.0082	0.0438
	T37	0.0274	-	0.0274	0.0274	-	0.0274	0.0548	-	0.0548
	T38	0.0329	-	0.0329	0.0329	-	0.0329	0.0658	-	0.0658
MJ Total		0.1672	0.0082	0.1754	0.1714	0.0040	0.1754	0.3386	0.0122	0.3508
MP	C130	3.9479	0.0356	3.9835	3.8027	0.1808	3.9835	7.7506	0.2164	7.9670
	DHC6	0.1068	0.0027	0.1095	0.1040	0.0055	0.1095	0.2108	0.0082	0.2190
MP Total		4.0547	0.0383	4.0930	3.9067	0.1863	4.0930	7.9614	0.2246	8.1860
Total Operations		622.2403	53.1883	675.4286	626.1203	49.3083	675.4286	1,248.3606	102.4966	1,350.8572

Source: Chapter Three

Table C.2

Modeled 2007 Average Daily Flight Operations

Operational Category	Aircraft Type	Departures			Arrivals			Total		
		Day	Night	Total	Day	Night	Total	Day	Night	Total
NW/PJ	A318	3.1014	-	3.1014	2.5845	0.5169	3.1014	5.6859	0.5169	6.2028
	A319	74.3725	2.1282	76.5007	74.7301	1.7706	76.5007	149.1026	3.8988	153.0014
	A320	88.2725	6.6658	94.9383	85.1401	9.7982	94.9383	173.4126	16.4640	189.8766
	B712	3.9371	0.1981	4.1352	3.3713	0.7639	4.1352	7.3084	0.9620	8.2704
	B72Q	2.9105	0.8237	3.7342	2.0878	1.6464	3.7342	4.9983	2.4701	7.4684
	B733	24.9600	0.8959	25.8559	23.2384	2.6175	25.8559	48.1984	3.5134	51.7118
	B734	0.0592	0.0148	0.0740	0.0456	0.0284	0.0740	0.1048	0.0432	0.1480
	B735	2.8113	0.2901	3.1014	2.8536	0.2478	3.1014	5.6649	0.5379	6.2028
	B737	3.9310	0.2042	4.1352	3.8799	0.2553	4.1352	7.8109	0.4595	8.2704
	B738	34.8344	4.1967	39.0311	30.6488	8.3823	39.0311	65.4832	12.5790	78.0622
	B739	3.1014	-	3.1014	2.5845	0.5169	3.1014	5.6859	0.5169	6.2028
	B73Q	0.1259	0.0275	0.1534	0.1140	0.0394	0.1534	0.2399	0.0669	0.3068
	B752	45.2037	3.1262	48.3299	43.0711	5.2588	48.3299	88.2748	8.3850	96.6598
	B753	17.3202	0.2543	17.5745	16.7564	0.8181	17.5745	34.0766	1.0724	35.1490
	D93Q	97.7475	7.8283	105.5758	102.4173	3.1585	105.5758	200.1648	10.9868	211.1516
	D95Q	22.0168	1.7604	23.7772	23.0676	0.7096	23.7772	45.0844	2.4700	47.5544
	MD81	0.2575	0.0274	0.2849	0.2673	0.0176	0.2849	0.5248	0.0450	0.5698
	MD83	8.0228	1.2813	9.3041	8.9433	0.3608	9.3041	16.9661	1.6421	18.6082
NW/PJ Total		432.9857	29.7229	462.7086	425.8016	36.9070	462.7086	858.7873	66.6299	925.4172
NH/PH	A330	3.1014	-	3.1014	3.1014	-	3.1014	6.2028	-	6.2028
	A340	1.0338	-	1.0338	1.0338	-	1.0338	2.0676	-	2.0676
	B744	1.0071	0.0267	1.0338	0.8858	0.1480	1.0338	1.8929	0.1747	2.0676
	DC10	3.1080	0.3267	3.4347	2.9500	0.4847	3.4347	6.0580	0.8114	6.8694
	L101	0.3319	0.0572	0.3891	0.2751	0.1140	0.3891	0.6070	0.1712	0.7782
	MD11	0.0014	0.0014	0.0028	0.0028	-	0.0028	0.0042	0.0014	0.0056
NH/PH Total		8.5836	0.4120	8.9956	8.2489	0.7467	8.9956	16.8325	1.1587	17.9912
RJ	BA46/RJ85	36.5358	1.7146	38.2504	37.7865	0.4639	38.2504	74.3223	2.1785	76.5008
	CARJ	129.4071	8.0876	137.4947	131.2273	6.2674	137.4947	260.6344	14.3550	274.9894
	E145	22.7230	0.0205	22.7435	22.6104	0.1331	22.7435	45.3334	0.1536	45.4870
RJ Total		188.6659	9.8227	198.4886	191.6242	6.8644	198.4886	380.2901	16.6871	396.9772
RP	DHC6	4.9119	0.2570	5.1689	4.8733	0.2956	5.1689	9.7852	0.5526	10.3378
	SF34	46.4400	3.1821	49.6221	46.8792	2.7429	49.6221	93.3192	5.9250	99.2442
RP Total		51.3519	3.4391	54.7910	51.7525	3.0385	54.7910	103.1044	6.4776	109.5820
CH	A306	2.5532	1.9810	4.5342	2.2883	2.2459	4.5342	4.8415	4.2269	9.0684
	A310	0.6404	0.7185	1.3589	0.7651	0.5938	1.3589	1.4055	1.3123	2.7178
	B742	0.0076	0.0115	0.0191	0.0128	0.0063	0.0191	0.0204	0.0178	0.0382
	B762	0.8206	0.0342	0.8548	0.4103	0.4445	0.8548	1.2309	0.4787	1.7096
	DC10	1.6661	1.5941	3.2602	1.8342	1.4260	3.2602	3.5003	3.0201	6.5204
	DC87	-	0.7123	0.7123	-	0.7123	0.7123	-	1.4246	1.4246
	MD11	0.0796	0.2437	0.3233	0.1774	0.1459	0.3233	0.2570	0.3896	0.6466
CH Total		5.7675	5.2953	11.0628	5.4881	5.5747	11.0628	11.2556	10.8700	22.1256
CJ	B72Q	1.6715	1.6601	3.3316	1.0882	2.2434	3.3316	2.7597	3.9035	6.6632
	B752	0.0828	0.1227	0.2055	0.0678	0.1377	0.2055	0.1506	0.2604	0.4110
	D93Q	0.0134	0.9071	0.9205	0.0258	0.8947	0.9205	0.0392	1.8018	1.8410
	FA20	0.5416	0.2666	0.8082	0.4520	0.3562	0.8082	0.9936	0.6228	1.6164
	LJ25	0.2687	0.0929	0.3616	0.2351	0.1265	0.3616	0.5038	0.2194	0.7232
	LJ35	0.1261	0.0383	0.1644	0.0975	0.0669	0.1644	0.2236	0.1052	0.3288
CJ Total		2.7041	3.0877	5.7918	1.9664	3.8254	5.7918	4.6705	6.9131	11.5836
CP	BE58	3.3788	3.1035	6.4823	6.1753	0.3070	6.4823	9.5541	3.4105	12.9646
	C206	0.0144	0.0048	0.0192	0.0154	0.0038	0.0192	0.0298	0.0086	0.0384
	DHC6	2.1150	2.6904	4.8054	4.2490	0.5564	4.8054	6.3640	3.2468	9.6108
	FK27	0.0274	-	0.0274	0.0274	-	0.0274	0.0548	-	0.0548
	SEPF	0.6356	0.1589	0.7945	0.6698	0.1247	0.7945	1.3054	0.2836	1.5890
CP Total		6.1712	5.9576	12.1288	11.1369	0.9919	12.1288	17.3081	6.9495	24.2576
GJ	ASTR	1.1592	0.0787	1.2379	1.1320	0.1059	1.2379	2.2912	0.1846	2.4758
	C500	0.6803	0.0342	0.7145	0.6775	0.0370	0.7145	1.3578	0.0712	1.4290
	C650	2.3601	0.3891	2.7492	2.5547	0.1945	2.7492	4.9148	0.5836	5.4984
	C750	2.2551	0.1846	2.4397	2.2981	0.1416	2.4397	4.5532	0.3262	4.8794
	CL60	1.6201	0.1117	1.7318	1.6116	0.1202	1.7318	3.2317	0.2319	3.4636
	CL61	0.1844	0.0132	0.1976	0.0847	0.1129	0.1976	0.2691	0.1261	0.3952
	FA20	0.0169	0.0127	0.0296	0.0127	0.0169	0.0296	0.0296	0.0296	0.0592
	GLF2	1.0651	0.0708	1.1359	0.9914	0.1445	1.1359	2.0565	0.2153	2.2718
	GLF4	1.3253	0.0608	1.3861	1.2906	0.0955	1.3861	2.6159	0.1563	2.7722
	GLF5	0.4000	0.0379	0.4379	0.4014	0.0365	0.4379	0.8014	0.0744	0.8758
	LJ25	0.7892	0.0932	0.8824	0.8222	0.0602	0.8824	1.6114	0.1534	1.7648
	LJ35	12.8504	1.1653	14.0157	12.9685	1.0472	14.0157	25.8189	2.2125	28.0314
	MU30	3.6011	0.2806	3.8817	3.6007	0.2810	3.8817	7.2018	0.5616	7.7634
	SBR2	0.1996	0.0111	0.2107	0.1869	0.0238	0.2107	0.3865	0.0349	0.4214
GJ Total		28.5068	2.5439	31.0507	28.6330	2.4177	31.0507	57.1398	4.9616	62.1014
GP	BE58	2.7289	0.2649	2.9938	1.9714	1.0224	2.9938	4.7003	1.2873	5.9876
	DHC6	3.1029	0.2263	3.3292	3.0084	0.3208	3.3292	6.1113	0.5471	6.6584
	SEPV	1.9661	0.1759	2.1420	1.7791	0.3629	2.1420	3.7452	0.5388	4.2840
GP Total		7.7979	0.6671	8.4650	6.7589	1.7061	8.4650	14.5568	2.3732	16.9300
MJ	C17A	0.0274	-	0.0274	0.0219	0.0055	0.0274	0.0493	0.0055	0.0548
	C5	0.0274	-	0.0274	0.0274	-	0.0274	0.0548	-	0.0548
	F16	0.0466	-	0.0466	0.0466	-	0.0466	0.0932	-	0.0932
	F18	0.0137	0.0082	0.0219	0.0219	-	0.0219	0.0356	0.0082	0.0438
	T37	0.0301	-	0.0301	0.0301	-	0.0301	0.0602	-	0.0602
	T38	0.0329	-	0.0329	0.0329	-	0.0329	0.0658	-	0.0658
MJ Total		0.1781	0.0082	0.1863	0.1808	0.0055	0.1863	0.3589	0.0137	0.3726
MP	C130	3.9479	0.0356	3.9835	3.8027	0.1808	3.9835	7.7506	0.2164	7.9670
	DHC6	0.1068	0.0027	0.1095	0.1040	0.0055	0.1095	0.2108	0.0082	0.2190
MP Total		4.0547	0.0383	4.0930	3.9067	0.1863	4.0930	7.9614	0.2246	8.1860
Total Operations		736.7674	60.9948	797.7622	735.4980	62.2642	797.7622	1,472.2654	123.2590	1,595.5244

Source: Chapter Three

Table C.3

Existing 2002 Annual Average Runway Use

Operation Type	Time of Day	Operational Category	Runways						
			4	22	12L	12R	30L	30R	Total
Departures	Day	CH	-	0.37%	4.99%	32.89%	59.75%	2.01%	100%
		CJ	-	0.41%	6.54%	31.70%	57.26%	4.09%	100%
		CP	-	-	25.71%	14.29%	25.71%	34.29%	100%
		GJ	0.07%	0.70%	8.66%	29.85%	55.18%	5.54%	100%
		GP	0.65%	6.67%	15.95%	23.24%	39.15%	14.33%	100%
		MJ	-	4.00%	11.00%	22.00%	55.00%	8.00%	100%
		MP	-	4.07%	32.09%	9.34%	12.75%	41.76%	100%
		NH	1.43%	2.08%	4.12%	35.97%	54.23%	2.17%	100%
		NW	0.02%	0.47%	20.02%	19.31%	32.70%	27.48%	100%
		PH	0.27%	-	1.09%	37.06%	60.22%	1.36%	100%
		PJ	0.12%	0.68%	17.38%	21.55%	31.97%	28.30%	100%
		RJ	0.01%	0.71%	23.37%	15.09%	15.22%	45.61%	100%
		RP	0.05%	1.87%	27.08%	13.78%	9.49%	47.73%	100%
		Day Total	0.07%	0.86%	20.21%	19.14%	28.67%	31.05%	100%
	Night	CH	-	0.43%	2.85%	37.11%	58.91%	0.69%	100%
		CJ	0.49%	0.66%	11.33%	34.81%	48.44%	4.27%	100%
		CP	-	-	9.68%	26.88%	60.22%	3.23%	100%
		GJ	-	0.29%	8.43%	36.77%	49.42%	5.09%	100%
		GP	1.55%	2.59%	10.36%	26.42%	45.60%	13.47%	100%
		MJ	-	-	33.33%	33.33%	33.33%	-	100%
		MP	-	12.50%	50.00%	12.50%	12.50%	12.50%	100%
		NH	-	1.79%	7.14%	41.07%	46.43%	3.57%	100%
		NW	-	0.47%	21.93%	22.88%	31.10%	23.61%	100%
		PH	-	-	3.90%	39.61%	55.19%	1.30%	100%
		PJ	0.17%	0.21%	16.33%	23.72%	31.63%	27.94%	100%
		RJ	-	0.21%	23.24%	16.28%	9.81%	50.46%	100%
		RP	0.48%	1.73%	22.53%	15.25%	26.98%	33.04%	100%
		Night Total	0.12%	0.53%	17.13%	24.57%	36.05%	21.59%	100%
	Departure Total		0.08%	0.84%	19.97%	19.57%	29.25%	30.31%	100%
Arrivals	Day	CH	0.19%	-	2.94%	40.15%	50.38%	6.34%	100%
		CJ	-	-	6.84%	34.62%	51.28%	7.26%	100%
		CP	-	-	11.90%	26.19%	45.24%	16.67%	100%
		GJ	0.13%	0.22%	9.00%	35.48%	42.85%	12.32%	100%
		GP	0.22%	0.30%	11.35%	33.68%	39.41%	15.05%	100%
		MJ	0.74%	8.89%	9.63%	28.89%	36.30%	15.56%	100%
		MP	0.09%	0.09%	33.73%	11.27%	12.05%	42.77%	100%
		NH	0.17%	0.17%	6.81%	39.47%	44.51%	8.88%	100%
		NW	0.13%	0.11%	20.55%	25.26%	29.91%	24.04%	100%
		PH	0.53%	-	5.29%	39.15%	49.74%	5.29%	100%
		PJ	0.12%	0.18%	24.22%	20.68%	25.76%	29.04%	100%
		RJ	0.10%	0.10%	30.93%	14.62%	19.49%	34.76%	100%
		RP	0.06%	0.08%	30.59%	14.93%	19.57%	34.78%	100%
		Day Total	0.12%	0.12%	22.74%	22.67%	27.82%	26.54%	100%
	Night	CH	-	0.09%	3.79%	19.28%	52.29%	24.56%	100%
		CJ	-	0.55%	3.68%	29.60%	53.13%	13.05%	100%
		CP	0.84%	2.52%	9.24%	21.85%	38.66%	26.89%	100%
		GJ	0.30%	1.37%	5.34%	30.03%	51.07%	11.89%	100%
		GP	0.35%	2.42%	3.81%	35.64%	51.38%	6.40%	100%
		MJ	-	-	-	33.33%	66.67%	-	100%
		MP	-	-	30.19%	9.43%	9.43%	50.94%	100%
		NH	-	-	4.36%	34.01%	54.07%	7.56%	100%
		NW	-	0.59%	14.97%	27.93%	35.87%	20.65%	100%
		PH	-	-	0.99%	22.77%	66.34%	9.90%	100%
		PJ	0.09%	0.86%	19.66%	20.05%	29.25%	30.09%	100%
		RJ	0.11%	0.66%	29.26%	11.44%	14.74%	43.78%	100%
		RP	0.11%	0.27%	33.33%	10.77%	15.13%	40.39%	100%
		Night Total	0.08%	0.70%	15.87%	22.84%	35.27%	25.23%	100%
	Arrival Total		0.11%	0.16%	22.23%	22.68%	28.36%	26.44%	100%
Overall	Day		0.09%	0.49%	21.48%	20.91%	28.24%	28.79%	100%
	Night		0.10%	0.61%	16.53%	23.74%	35.68%	23.34%	100%
	Total		0.10%	0.50%	21.10%	21.12%	28.81%	28.38%	100%

Note: Totals may not equal 100% due to rounding.

Sourse: ANOMS and HNTB Analysis

Table C.4

Forecast 2007 Annual Average Unmitigated Runway Use

Operation Type	Time of Day	Operational Category	Runways								
			4	22	12L	12R	30L	30R	17	35	Total
Departures	Day	CH	-	0.02%	1.98%	27.55%	32.26%	1.42%	36.74%	0.02%	100%
		CJ	-	0.03%	2.61%	26.62%	30.99%	2.90%	36.83%	0.02%	100%
		CP	-	-	10.53%	12.32%	14.30%	25.00%	37.83%	0.02%	100%
		GJ	0.25%	0.05%	3.47%	25.21%	30.03%	3.95%	37.03%	0.02%	100%
		GP	2.43%	0.45%	6.57%	20.15%	21.88%	10.50%	38.02%	0.02%	100%
		MJ	-	0.27%	4.60%	19.36%	31.20%	5.95%	38.60%	0.02%	100%
		MP	-	0.28%	13.57%	8.32%	7.32%	31.44%	39.06%	0.02%	100%
		NH	4.91%	0.13%	1.57%	28.80%	27.99%	1.47%	35.11%	0.02%	100%
		NW	0.08%	0.03%	8.11%	16.49%	17.99%	19.83%	37.44%	0.02%	100%
		PH	0.96%	-	0.42%	30.23%	31.66%	0.94%	35.77%	0.02%	100%
		PJ	0.43%	0.04%	6.95%	18.15%	17.35%	20.14%	36.92%	0.02%	100%
		RJ	0.04%	0.05%	9.36%	12.73%	8.27%	32.53%	37.00%	0.02%	100%
		RP	0.17%	0.12%	10.96%	11.75%	5.22%	34.39%	37.38%	0.02%	100%
		Day Total	0.20%	0.20%	8.20%	15.90%	15.10%	23.10%	37.20%	0.10%	100%
	Night	CH	-	0.05%	1.92%	33.75%	26.30%	0.71%	37.26%	0.01%	100%
		CJ	1.10%	0.08%	7.35%	30.51%	20.84%	4.20%	35.92%	0.01%	100%
		CP	-	-	6.62%	24.84%	27.32%	3.34%	37.87%	0.01%	100%
		GJ	-	0.03%	5.47%	32.25%	21.28%	5.00%	35.94%	0.01%	100%
		GP	3.38%	0.30%	6.56%	22.61%	19.15%	12.92%	35.06%	0.01%	100%
		MJ	-	-	21.38%	28.90%	14.19%	-	35.52%	0.01%	100%
		MP	-	1.52%	32.93%	11.13%	5.46%	12.47%	36.48%	0.01%	100%
		NH	-	0.21%	4.62%	35.90%	19.93%	3.50%	35.82%	0.01%	100%
		NW	-	0.05%	13.31%	18.77%	12.53%	21.71%	33.62%	0.01%	100%
		PH	-	-	2.57%	35.35%	24.19%	1.30%	36.58%	0.01%	100%
		PJ	0.35%	0.02%	9.74%	19.11%	12.51%	25.24%	33.02%	0.01%	100%
		RJ	-	0.02%	12.66%	11.98%	3.54%	41.64%	30.16%	0.01%	100%
		RP	0.97%	0.19%	13.37%	12.24%	10.62%	29.72%	32.88%	0.01%	100%
		Night Total	0.20%	0.00%	10.30%	20.60%	14.50%	20.50%	33.90%	0.10%	100%
	Departure Total		0.20%	0.20%	8.50%	16.60%	15.00%	22.70%	36.80%	0.10%	100%
Arrivals	Day	CH	0.02%	-	3.00%	29.32%	42.35%	6.26%	0.01%	19.04%	100%
		CJ	-	-	6.87%	24.88%	42.44%	7.06%	0.01%	18.74%	100%
		CP	-	-	11.60%	18.25%	36.28%	15.69%	0.01%	18.17%	100%
		GJ	0.01%	0.92%	8.90%	25.08%	34.88%	11.77%	0.01%	18.44%	100%
		GP	0.02%	1.20%	11.09%	23.54%	31.71%	14.21%	0.01%	18.22%	100%
		MJ	0.05%	28.22%	7.36%	15.79%	22.84%	11.49%	0.01%	14.25%	100%
		MP	0.01%	0.32%	30.10%	7.19%	8.85%	36.88%	0.01%	16.64%	100%
		NH	0.02%	0.70%	6.83%	28.33%	36.78%	8.61%	0.01%	18.72%	100%
		NW	0.01%	0.43%	19.46%	17.11%	23.32%	22.00%	0.01%	17.66%	100%
		PH	0.05%	-	5.40%	28.55%	41.76%	5.21%	0.01%	19.02%	100%
		PJ	0.01%	0.68%	22.49%	13.74%	19.69%	26.06%	0.01%	17.32%	100%
		RJ	0.01%	0.38%	28.09%	9.49%	14.58%	30.51%	0.01%	16.94%	100%
		RP	0.01%	0.28%	27.82%	9.71%	14.65%	30.57%	0.01%	16.96%	100%
		Day Total	0.10%	0.50%	21.80%	14.80%	21.00%	24.50%	0.10%	17.40%	100%
	Night	CH	-	0.06%	3.74%	11.89%	48.81%	22.41%	0.01%	13.07%	100%
		CJ	-	0.36%	3.76%	18.85%	51.22%	12.30%	0.01%	13.50%	100%
		CP	0.80%	1.63%	9.26%	13.65%	36.55%	24.86%	0.01%	13.24%	100%
		GJ	0.30%	0.90%	5.47%	19.18%	49.37%	11.24%	0.01%	13.54%	100%
		GP	0.34%	1.63%	3.98%	23.25%	50.76%	6.18%	0.01%	13.83%	100%
		MJ	-	-	-	21.44%	64.92%	-	0.01%	13.64%	100%
		MP	-	-	28.70%	5.59%	8.46%	44.67%	0.01%	12.56%	100%
		NH	-	-	4.51%	21.90%	52.72%	7.20%	0.01%	13.65%	100%
		NW	-	0.38%	15.14%	17.61%	34.23%	19.27%	0.01%	13.37%	100%
		PH	-	-	0.99%	14.17%	62.51%	9.12%	0.01%	13.20%	100%
		PJ	0.09%	0.55%	19.39%	12.33%	27.23%	27.38%	0.01%	13.04%	100%
		RJ	0.10%	0.41%	28.02%	6.83%	13.32%	38.67%	0.01%	12.65%	100%
		RP	0.10%	0.16%	31.72%	6.39%	13.58%	35.46%	0.01%	12.58%	100%
		Night Total	0.10%	0.50%	16.30%	13.70%	32.10%	24.30%	0.10%	13.10%	100%
	Arrival Total		0.10%	0.50%	21.10%	14.60%	22.40%	24.50%	0.10%	16.90%	100%
Overall	Day		0.20%	0.30%	15.00%	15.30%	18.10%	23.80%	18.70%	8.80%	100%
	Night		0.10%	0.30%	13.30%	17.10%	23.30%	22.40%	17.00%	6.60%	100%
	Total		0.20%	0.30%	14.80%	15.60%	18.70%	23.60%	18.40%	8.50%	100%

Note: Totals may not equal 100% due to rounding.

Sourse: Dual Track FEIS, ANOMS and HNTB Analysis

Table C.5

Forecast 2007 Annual Average Mitigated Runway Use

Operation Type	Time of Day	Operational Category	Runways								
			4	22	12L	12R	30L	30R	17	35	Total
Departures	Day	CH	-	0.03%	2.18%	27.60%	31.89%	1.41%	36.88%	0.02%	100%
		CJ	-	0.03%	2.87%	26.65%	30.62%	2.87%	36.95%	0.02%	100%
		CP	-	-	11.50%	12.25%	14.02%	24.52%	37.69%	0.02%	100%
		GJ	0.25%	0.05%	3.81%	25.21%	29.64%	3.90%	37.12%	0.02%	100%
		GP	2.43%	0.48%	7.19%	20.08%	21.51%	10.32%	37.97%	0.02%	100%
		MJ	-	0.29%	5.04%	19.35%	30.77%	5.87%	38.66%	0.02%	100%
		MP	-	0.30%	14.76%	8.24%	7.15%	30.74%	38.78%	0.02%	100%
		NH	4.94%	0.14%	1.72%	28.84%	27.65%	1.45%	35.24%	0.02%	100%
		NW	0.08%	0.03%	8.88%	16.42%	17.69%	19.49%	37.38%	0.02%	100%
		PH	0.96%	-	0.46%	30.32%	31.34%	0.93%	35.96%	0.02%	100%
		PJ	0.43%	0.05%	7.61%	18.09%	17.07%	19.82%	36.90%	0.02%	100%
		RJ	0.04%	0.05%	10.23%	12.67%	8.13%	31.95%	36.91%	0.02%	100%
		RP	0.16%	0.13%	11.96%	11.67%	5.11%	33.71%	37.22%	0.02%	100%
		Day Total	0.20%	0.05%	8.93%	15.94%	14.98%	22.71%	37.16%	0.02%	100%
	Night	CH	-	0.89%	2.80%	31.45%	24.09%	0.71%	40.04%	0.02%	100%
		CJ	1.99%	1.25%	10.26%	27.22%	18.28%	4.03%	36.95%	0.02%	100%
		CP	-	-	9.47%	22.72%	24.56%	3.29%	39.93%	0.02%	100%
		GJ	-	0.57%	7.84%	29.53%	19.15%	4.93%	37.95%	0.02%	100%
		GP	5.80%	4.54%	8.68%	19.11%	15.91%	11.76%	34.17%	0.02%	100%
		MJ	-	-	28.54%	24.63%	11.89%	-	34.92%	0.02%	100%
		MP	-	17.92%	34.25%	7.39%	3.57%	8.92%	27.94%	0.02%	100%
		NH	-	3.39%	6.48%	32.17%	17.55%	3.38%	37.01%	0.02%	100%
		NW	-	0.82%	18.12%	16.32%	10.70%	20.33%	33.70%	0.02%	100%
		PH	-	-	3.77%	33.12%	22.27%	1.31%	39.51%	0.02%	100%
		PJ	0.63%	0.35%	13.48%	16.91%	10.88%	24.04%	33.68%	0.02%	100%
		RJ	-	0.33%	17.19%	10.39%	3.02%	38.89%	30.16%	0.02%	100%
		RP	1.66%	2.83%	17.61%	10.29%	8.78%	26.92%	31.89%	0.02%	100%
		Night Total	0.35%	0.77%	14.06%	18.29%	12.76%	19.18%	34.56%	0.02%	100%
	Departure Total		0.21%	0.11%	9.33%	16.12%	14.81%	22.44%	36.96%	0.02%	100%
Arrivals	Day	CH	0.02%	-	3.00%	29.27%	42.74%	6.45%	0.01%	18.51%	100%
		CJ	-	-	6.88%	24.83%	42.80%	7.27%	0.01%	18.21%	100%
		CP	-	-	11.59%	18.17%	36.51%	16.12%	0.01%	17.61%	100%
		GJ	0.01%	0.93%	8.91%	25.01%	35.14%	12.11%	0.01%	17.89%	100%
		GP	0.02%	1.21%	11.09%	23.45%	31.93%	14.61%	0.01%	17.68%	100%
		MJ	0.05%	28.44%	7.34%	15.68%	22.93%	11.78%	0.01%	13.78%	100%
		MP	0.01%	0.32%	29.93%	7.13%	8.86%	37.70%	0.01%	16.04%	100%
		NH	0.02%	0.70%	6.84%	28.28%	37.10%	8.87%	0.01%	18.18%	100%
		NW	0.01%	0.43%	19.43%	17.01%	23.44%	22.58%	0.01%	17.10%	100%
		PH	0.05%	-	5.41%	28.52%	42.15%	5.37%	0.01%	18.49%	100%
		PJ	0.01%	0.69%	22.42%	13.64%	19.77%	26.71%	0.01%	16.74%	100%
		RJ	0.01%	0.38%	27.98%	9.42%	14.62%	31.23%	0.01%	16.36%	100%
		RP	0.01%	0.29%	27.70%	9.63%	14.69%	31.30%	0.01%	16.38%	100%
		Day Total	0.01%	0.46%	21.76%	14.67%	21.08%	25.14%	0.01%	16.87%	100%
	Night	CH	-	0.34%	4.50%	11.86%	41.79%	27.46%	0.01%	14.04%	100%
		CJ	-	2.19%	4.57%	19.01%	44.33%	15.24%	0.01%	14.66%	100%
		CP	29.93%	6.17%	7.07%	8.64%	19.85%	19.32%	0.00%	9.02%	100%
		GJ	14.68%	4.54%	5.51%	16.05%	35.46%	11.55%	0.01%	12.20%	100%
		GP	16.37%	7.88%	3.87%	18.72%	35.06%	6.11%	0.01%	11.99%	100%
		MJ	-	-	-	23.35%	60.66%	-	0.01%	15.98%	100%
		MP	-	-	29.86%	4.83%	6.27%	47.36%	0.01%	11.67%	100%
		NH	-	-	5.65%	22.79%	47.06%	9.20%	0.01%	15.29%	100%
		NW	-	2.17%	17.28%	16.68%	27.82%	22.41%	0.01%	13.63%	100%
		PH	-	-	1.26%	15.01%	56.81%	11.86%	0.01%	15.04%	100%
		PJ	4.47%	2.84%	20.30%	10.71%	20.29%	29.20%	0.01%	12.19%	100%
		RJ	4.87%	2.01%	27.79%	5.62%	9.41%	39.09%	0.01%	11.21%	100%
		RP	4.73%	0.81%	31.86%	5.33%	9.71%	36.28%	0.01%	11.28%	100%
		Night Total	3.84%	2.44%	17.17%	12.40%	25.12%	26.35%	0.01%	12.68%	100%
	Arrival Total		0.31%	0.62%	21.40%	14.49%	21.40%	25.23%	0.01%	16.55%	100%
Overall	Day		0.11%	0.26%	15.34%	15.30%	18.03%	23.92%	18.60%	8.44%	100%
	Night		2.11%	1.61%	15.63%	15.32%	19.00%	22.80%	17.11%	6.41%	100%
	Total		0.26%	0.36%	15.36%	15.31%	18.10%	23.84%	18.49%	8.28%	100%

Note: Totals may not equal 100% due to rounding.

Sourse: Dual Track FEIS, ANOMS and HNTB Analysis

Table C.6

Annual Average Unmitigated Daytime Departure Flight Track Use

Runway	Track	Operational Category													Overall Use	
		CH	CJ	CP	GJ	GP	MJ	MP	NH	NW	PH	PJ	RJ	RP	2002	2007
4	A	-	-	-	-	18.75%	-	-	-	-	-	2.94%	-	8.33%	3.48%	3.75%
	B	-	-	-	-	6.25%	-	-	-	4.35%	-	17.65%	-	-	5.27%	7.01%
	C	-	-	-	20.00%	37.50%	-	-	4.35%	39.13%	-	23.53%	33.33%	33.33%	21.84%	24.83%
	D	-	-	-	40.00%	31.25%	-	-	95.65%	26.09%	-	23.53%	66.67%	41.67%	53.32%	43.52%
	E	-	-	-	40.00%	6.25%	-	-	-	30.43%	100.00%	32.35%	-	16.67%	16.10%	20.89%
4 Total		-	-	-	100%	100%	-	-	100%	100%	100%	100%	100%	100%	100%	100%
22	A	60.00%	-	-	9.80%	9.76%	-	-	5.97%	6.86%	-	9.69%	9.19%	10.22%	8.67%	8.92%
	B	-	-	-	7.84%	7.93%	-	10.81%	1.49%	7.07%	-	4.59%	8.11%	11.82%	8.30%	8.03%
	C	20.00%	50.00%	-	7.84%	12.80%	-	35.14%	-	11.64%	-	21.43%	13.51%	16.03%	14.48%	14.52%
	D	20.00%	50.00%	-	74.51%	66.46%	50.00%	40.54%	14.93%	46.99%	-	40.31%	57.30%	58.72%	52.05%	52.22%
	E	-	-	-	-	0.61%	25.00%	-	58.21%	6.03%	-	5.61%	1.08%	0.60%	5.17%	4.00%
	F	-	-	-	-	2.44%	25.00%	13.51%	19.40%	21.41%	-	18.37%	10.81%	2.61%	11.33%	12.30%
22 Total		100%	100%	-	100%	100%	100%	100%	100%	100%	-	100%	100%	100%	100%	100%
12L	A	1.49%	-	-	0.64%	17.60%	-	9.93%	-	0.20%	-	0.34%	0.28%	7.58%	1.86%	1.17%
	B	5.97%	12.50%	88.89%	9.57%	42.09%	-	16.44%	2.26%	6.43%	25.00%	2.31%	7.89%	63.80%	18.03%	13.06%
	C	13.43%	18.75%	-	12.12%	7.91%	-	12.67%	6.02%	13.85%	-	2.35%	12.77%	9.59%	11.30%	11.49%
	D	2.99%	12.50%	11.11%	12.44%	4.85%	27.27%	17.12%	17.29%	20.95%	-	4.32%	18.06%	3.47%	14.89%	15.98%
	E	2.99%	18.75%	-	8.13%	4.08%	9.09%	4.79%	28.57%	10.73%	25.00%	2.51%	9.30%	1.09%	7.58%	8.16%
	F	53.73%	6.25%	-	41.31%	15.31%	27.27%	8.22%	33.08%	38.79%	25.00%	50.10%	31.81%	2.09%	31.38%	33.80%
	G	16.42%	3.13%	-	10.53%	3.32%	18.18%	14.04%	9.02%	7.10%	-	24.06%	13.03%	0.69%	8.83%	10.33%
	H	2.99%	25.00%	-	4.15%	2.04%	18.18%	12.67%	3.01%	1.75%	25.00%	13.48%	6.72%	0.30%	3.78%	4.66%
	I	-	3.13%	-	1.12%	2.81%	-	4.11%	0.75%	0.21%	-	0.52%	0.15%	11.38%	2.35%	1.35%
12L Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
12R	A	0.23%	-	-	1.20%	14.71%	-	3.53%	0.52%	0.31%	-	0.26%	0.15%	2.26%	0.77%	0.62%
	B	9.50%	4.52%	-	18.27%	7.71%	27.27%	9.41%	39.83%	6.43%	11.76%	4.97%	3.54%	0.65%	7.21%	6.59%
	C	56.79%	27.10%	40.00%	31.04%	13.49%	31.82%	23.53%	31.12%	32.36%	25.00%	34.81%	39.49%	1.20%	30.22%	32.54%
	D	28.73%	60.00%	40.00%	37.60%	15.94%	31.82%	36.47%	24.66%	48.62%	52.21%	49.28%	47.47%	1.77%	41.82%	44.35%
	E	3.62%	7.10%	-	9.44%	5.08%	9.09%	10.59%	2.93%	10.18%	8.09%	8.75%	7.60%	0.41%	8.20%	8.52%
	F	1.13%	1.29%	20.00%	2.45%	43.08%	-	16.47%	0.95%	2.11%	2.94%	1.93%	1.74%	93.71%	11.78%	7.39%
12R Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
30L	A	2.49%	2.86%	-	0.73%	1.77%	-	1.72%	0.40%	2.27%	1.81%	1.47%	1.18%	2.21%	1.88%	1.82%
	B	66.00%	81.79%	22.22%	50.90%	42.83%	41.82%	56.03%	33.50%	70.59%	76.92%	79.17%	81.49%	74.73%	69.26%	70.73%
	C	5.48%	8.57%	11.11%	12.16%	9.36%	16.36%	8.62%	13.21%	10.81%	12.22%	11.53%	12.10%	9.41%	11.01%	11.09%
	D	2.99%	4.64%	-	5.61%	10.91%	10.91%	13.79%	20.58%	6.14%	6.79%	3.09%	1.68%	4.71%	5.77%	5.16%
	E	0.87%	0.71%	11.11%	3.93%	10.29%	7.27%	3.45%	14.47%	2.27%	0.45%	1.17%	0.33%	2.89%	2.71%	2.30%
	F	3.36%	0.36%	-	7.01%	5.61%	10.91%	3.45%	13.61%	2.12%	0.90%	0.95%	0.65%	1.70%	2.62%	2.31%
	G	18.80%	1.07%	55.56%	19.67%	19.23%	12.73%	12.93%	4.23%	5.79%	0.90%	2.62%	2.58%	4.35%	6.76%	6.59%
30L Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
30R	A	22.22%	20.00%	-	11.47%	9.38%	37.50%	19.47%	4.29%	3.94%	20.00%	27.43%	25.84%	21.96%	14.99%	16.80%
	B	7.41%	5.00%	-	2.99%	5.40%	-	4.74%	8.57%	7.15%	-	10.75%	9.39%	8.44%	8.16%	8.42%
	C	7.41%	25.00%	-	6.73%	21.31%	-	15.79%	27.14%	20.55%	20.00%	4.03%	5.00%	17.35%	14.55%	12.25%
	D	-	-	-	1.25%	2.27%	-	3.16%	2.86%	1.56%	-	0.19%	0.48%	2.78%	1.44%	1.13%
	E	3.70%	5.00%	-	14.46%	9.38%	25.00%	16.58%	8.57%	8.64%	20.00%	4.55%	5.92%	7.39%	7.39%	7.04%
	F	59.26%	45.00%	100.00%	63.09%	52.27%	37.50%	40.26%	48.57%	58.15%	40.00%	53.05%	53.37%	42.08%	53.47%	54.36%
30R Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
17	A	10.10%	10.10%	10.10%	10.10%	10.10%	10.10%	10.10%	10.10%	10.10%	10.10%	10.10%	10.10%	10.10%	-	10.10%
	B	8.00%	8.00%	8.00%	8.00%	8.00%	8.00%	8.00%	8.00%	8.00%	8.00%	8.00%	8.00%	8.00%	-	8.00%
	C	17.30%	17.30%	17.30%	17.30%	17.30%	17.30%	17.30%	17.30%	17.30%	17.30%	17.30%	17.30%	17.30%	-	17.30%
	D	8.50%	8.50%	8.50%	8.50%	8.50%	8.50%	8.50%	8.50%	8.50%	8.50%	8.50%	8.50%	8.50%	-	8.50%
	E	22.30%	22.30%	22.30%	22.30%	22.30%	22.30%	22.30%	22.30%	22.30%	22.30%	22.30%	22.30%	22.30%	-	22.30%
	F	7.90%	7.90%	7.90%	7.90%	7.90%	7.90%	7.90%	7.90%	7.90%	7.90%	7.90%	7.90%	7.90%	-	7.90%
	G	8.90%	8.90%	8.90%	8.90%	8.90%	8.90%	8.90%	8.90%	8.90%	8.90%	8.90%	8.90%	8.90%	-	8.90%
	H	5.10%	5.10%	5.10%	5.10%	5.10%	5.10%	5.10%	5.10%	5.10%	5.10%	5.10%	5.10%	5.10%	-	5.10%
	I	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%	-	4.00%
	L	7.90%	7.90%	7.90%	7.90%	7.90%	7.90%	7.90%	7.90%	7.90%	7.90%	7.90%	7.90%	7.90%	-	7.90%
17 Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	-	100%
35	A	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	-	100.00%
35 Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	-	100%

Note: Totals may not equal 100% due to rounding.

Source: Data for existing runways from ANOMS and HNTB analysis; Runway 17/35 data from Dual Track FEIS and November 2001 study

Table C.7

Annual Average Unmitigated Nighttime Departure Flight Track Use

Runway	Track	Operational Category													Overall Use	
		CH	CJ	CP	GJ	GP	MJ	MP	NH	NW	PH	PJ	RJ	RP	2002	2007
4	A	-	-	-	-	-	-	-	-	-	-	-	-	7.69%	3.15%	2.08%
	B	-	-	-	-	-	-	-	-	-	-	-	-	30.77%	12.78%	8.50%
	C	-	33.33%	-	-	33.33%	-	-	-	-	-	-	-	23.08%	23.03%	21.75%
	D	-	66.67%	-	-	66.67%	-	-	-	-	-	80.00%	-	38.46%	58.52%	62.67%
	E	-	-	-	-	-	-	-	-	-	-	20.00%	-	-	2.52%	5.00%
4 Total		-	100%	-	-	100%	-	-	-	-	-	100%	-	100%	100%	100%
22	A	60.00%	25.00%	-	-	-	-	-	100.00%	10.71%	-	16.67%	-	10.64%	14.79%	15.33%
	B	-	-	-	-	20.00%	-	-	-	3.57%	-	-	-	12.77%	6.78%	4.88%
	C	-	25.00%	-	50.00%	20.00%	-	-	-	3.57%	-	-	-	17.02%	10.93%	7.32%
	D	20.00%	50.00%	-	50.00%	20.00%	-	-	-	39.29%	-	66.67%	66.67%	55.32%	44.95%	48.08%
	E	-	-	-	-	-	-	-	-	10.71%	-	-	-	-	3.55%	3.48%
	F	20.00%	-	-	-	40.00%	-	100.00%	-	32.14%	-	16.67%	33.33%	4.26%	19.01%	20.91%
22 Total		100%	100%	-	100%	100%	-	100%	100%	100%	-	100%	100%	100%	100%	100%
12L	A	-	-	33.33%	1.72%	5.00%	-	-	-	3.48%	-	0.84%	0.92%	13.21%	5.61%	4.94%
	B	3.03%	1.45%	22.22%	8.62%	25.00%	-	-	-	9.89%	-	1.26%	4.89%	39.97%	12.45%	10.28%
	C	-	4.35%	11.11%	5.17%	15.00%	-	-	-	21.02%	-	1.05%	7.03%	5.87%	12.45%	12.24%
	D	3.03%	-	22.22%	3.45%	-	-	-	-	22.87%	-	1.47%	9.48%	3.10%	13.64%	13.84%
	E	3.03%	1.45%	-	5.17%	5.00%	-	-	25.00%	8.11%	-	1.26%	3.67%	1.31%	4.77%	4.77%
	F	39.39%	24.64%	11.11%	25.86%	30.00%	100.00%	25.00%	-	19.55%	-	19.08%	10.70%	3.92%	16.47%	16.80%
	G	30.30%	49.28%	-	32.76%	15.00%	-	25.00%	50.00%	8.73%	66.67%	45.07%	29.05%	0.98%	17.42%	19.38%
	H	15.15%	18.84%	-	13.79%	-	-	50.00%	25.00%	4.25%	33.33%	29.77%	31.50%	0.49%	11.46%	13.77%
	I	6.06%	-	-	3.45%	5.00%	-	-	-	2.09%	-	0.21%	2.75%	31.16%	5.72%	3.99%
12L Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
12R	A	1.63%	0.47%	44.00%	1.19%	13.73%	-	-	-	1.48%	-	0.87%	-	38.07%	8.49%	7.56%
	B	10.26%	16.04%	48.00%	28.06%	9.80%	100.00%	-	34.78%	13.63%	8.20%	19.05%	15.28%	9.40%	18.85%	19.05%
	C	56.18%	52.83%	8.00%	41.50%	11.76%	-	-	39.13%	30.74%	50.82%	39.39%	45.85%	4.34%	33.90%	35.76%
	D	25.64%	23.11%	-	22.53%	17.65%	-	100.00%	17.39%	39.48%	34.43%	35.06%	28.38%	2.65%	26.99%	27.27%
	E	4.43%	6.13%	-	5.93%	1.96%	-	-	8.70%	10.00%	4.92%	4.04%	7.42%	0.48%	5.87%	5.92%
	F	1.86%	1.42%	-	0.79%	45.10%	-	-	-	4.67%	1.64%	1.59%	3.06%	45.06%	5.90%	4.44%
12R Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
30L	A	7.93%	5.76%	-	2.65%	2.27%	-	-	-	6.54%	3.53%	2.16%	5.80%	0.68%	4.12%	4.32%
	B	80.03%	64.75%	-	50.00%	37.50%	-	-	30.77%	59.62%	83.53%	74.35%	81.88%	17.71%	50.64%	52.59%
	C	5.58%	3.39%	-	5.59%	7.95%	-	-	11.54%	7.30%	10.59%	5.41%	5.07%	5.31%	5.04%	4.93%
	D	0.15%	0.34%	-	2.94%	6.82%	100.00%	-	-	6.32%	2.35%	2.92%	0.72%	21.25%	4.35%	3.45%
	E	-	1.02%	14.29%	1.47%	9.09%	-	-	7.69%	0.98%	-	0.97%	0.72%	12.81%	4.25%	3.89%
	F	0.59%	3.39%	37.50%	12.65%	3.41%	-	-	42.31%	2.83%	-	2.81%	-	12.13%	9.93%	9.80%
	G	5.73%	21.36%	48.21%	24.71%	32.95%	-	100.00%	7.69%	16.40%	-	11.36%	5.80%	30.11%	21.68%	21.03%
30L Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
30R	A	50.00%	53.85%	-	48.57%	46.15%	-	100.00%	100.00%	6.39%	-	57.23%	57.61%	33.15%	32.55%	36.08%
	B	-	3.85%	-	2.86%	3.85%	-	-	-	10.48%	50.00%	5.15%	18.31%	8.68%	10.35%	11.52%
	C	-	3.85%	33.33%	2.86%	15.38%	-	-	-	27.21%	-	0.61%	1.69%	10.34%	13.44%	11.95%
	D	-	-	-	-	-	-	-	-	1.87%	-	-	0.42%	2.00%	1.14%	0.97%
	E	-	11.54%	-	5.71%	-	-	-	-	7.25%	50.00%	1.96%	2.54%	5.34%	4.79%	4.42%
	F	50.00%	26.92%	66.67%	40.00%	34.62%	-	-	-	46.81%	-	35.05%	19.44%	40.49%	37.74%	35.07%
30R Total		100%	100%	100%	100%	100%	-	100%	100%	100%	100%	100%	100%	100%	100%	100%
17	A	10.10%	10.10%	10.10%	10.10%	10.10%	10.10%	10.10%	10.10%	10.10%	10.10%	10.10%	10.10%	10.10%	-	10.10%
	B	8.00%	8.00%	8.00%	8.00%	8.00%	8.00%	8.00%	8.00%	8.00%	8.00%	8.00%	8.00%	8.00%	-	8.00%
	C	17.30%	17.30%	17.30%	17.30%	17.30%	17.30%	17.30%	17.30%	17.30%	17.30%	17.30%	17.30%	17.30%	-	17.30%
	D	8.50%	8.50%	8.50%	8.50%	8.50%	8.50%	8.50%	8.50%	8.50%	8.50%	8.50%	8.50%	8.50%	-	8.50%
	E	22.30%	22.30%	22.30%	22.30%	22.30%	22.30%	22.30%	22.30%	22.30%	22.30%	22.30%	22.30%	22.30%	-	22.30%
	F	7.90%	7.90%	7.90%	7.90%	7.90%	7.90%	7.90%	7.90%	7.90%	7.90%	7.90%	7.90%	7.90%	-	7.90%
	G	8.90%	8.90%	8.90%	8.90%	8.90%	8.90%	8.90%	8.90%	8.90%	8.90%	8.90%	8.90%	8.90%	-	8.90%
	H	5.10%	5.10%	5.10%	5.10%	5.10%	5.10%	5.10%	5.10%	5.10%	5.10%	5.10%	5.10%	5.10%	-	5.10%
	I	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%	-	4.00%
	L	7.90%	7.90%	7.90%	7.90%	7.90%	7.90%	7.90%	7.90%	7.90%	7.90%	7.90%	7.90%	7.90%	-	7.90%
17 Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	-	100%
35	A	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	-	100.00%
35 Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	-	100%

Note: Totals may not equal 100% due to rounding.

Source: Data for existing runways from ANOMS and HNTB analysis; Runway 17/35 data from Dual Track FEIS and November 2001 study

Table C.8

Runway 17 Annual Average Mitigated Departure Flight Track Use

Track	Operational Category													Overall Use
	CH	CJ	CP	GJ	GP	MJ	MP	NH	NW	PH	PJ	RJ	RP	
Daytime														
A	10.13%	10.13%	-	10.13%	-	10.13%	-	10.13%	10.13%	10.13%	10.13%	10.13%	-	9.17%
B	7.99%	7.99%	-	7.99%	-	7.99%	-	7.99%	7.99%	7.99%	7.99%	7.99%	-	7.23%
C	17.27%	17.27%	10.10%	17.27%	10.10%	17.27%	10.10%	17.27%	17.27%	17.27%	17.27%	17.27%	10.10%	16.59%
D	8.49%	8.49%	30.00%	8.49%	30.00%	8.49%	30.00%	8.49%	8.49%	8.49%	8.49%	8.49%	30.00%	10.53%
E	20.28%	20.28%	-	20.28%	-	20.28%	-	20.28%	20.28%	20.28%	20.28%	20.28%	-	18.36%
F	7.19%	7.19%	-	7.19%	-	7.19%	-	7.19%	7.19%	7.19%	7.19%	7.19%	-	6.51%
G	8.10%	8.10%	-	8.10%	-	8.10%	-	8.10%	8.10%	8.10%	8.10%	8.10%	-	7.33%
H	5.07%	5.07%	19.90%	5.07%	19.90%	5.07%	19.90%	5.07%	5.07%	5.07%	5.07%	5.07%	19.90%	6.48%
I	3.99%	3.99%	-	3.99%	-	3.99%	-	3.99%	3.99%	3.99%	3.99%	3.99%	-	3.61%
J	-	-	-	-	-	-	-	-	-	-	-	-	-	-
L	11.49%	11.49%	-	11.49%	-	11.49%	-	11.49%	11.49%	11.49%	11.49%	11.49%	-	10.40%
M	-	-	10.00%	-	10.00%	-	10.00%	-	-	-	-	-	10.00%	0.95%
N	-	-	30.00%	-	30.00%	-	30.00%	-	-	-	-	-	30.00%	2.85%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Nighttime														
A	10.13%	10.13%	-	10.13%	-	10.13%	-	10.13%	10.13%	10.13%	10.13%	10.13%	-	8.35%
B	7.99%	7.99%	-	7.99%	-	7.99%	-	7.99%	7.99%	7.99%	7.99%	7.99%	-	6.58%
C	17.27%	17.27%	10.10%	17.27%	10.10%	17.27%	10.10%	17.27%	17.27%	17.27%	17.27%	17.27%	10.10%	16.01%
D	8.49%	8.49%	30.00%	8.49%	30.00%	8.49%	30.00%	8.49%	8.49%	8.49%	8.49%	8.49%	30.00%	12.28%
E	17.73%	17.73%	-	17.73%	-	17.73%	-	17.73%	17.73%	17.73%	17.73%	17.73%	-	14.61%
F	6.29%	6.29%	-	6.29%	-	6.29%	-	6.29%	6.29%	6.29%	6.29%	6.29%	-	5.18%
G	7.08%	7.08%	-	7.08%	-	7.08%	-	7.08%	7.08%	7.08%	7.08%	7.08%	-	5.83%
H	5.07%	5.07%	19.90%	5.07%	19.90%	5.07%	19.90%	5.07%	5.07%	5.07%	5.07%	5.07%	19.90%	7.68%
I	3.99%	3.99%	-	3.99%	-	3.99%	-	3.99%	3.99%	3.99%	3.99%	3.99%	-	3.29%
J	0.57%	0.57%	-	0.57%	-	0.57%	-	0.57%	0.57%	0.57%	0.57%	0.57%	-	0.47%
L	15.39%	15.39%	-	15.39%	-	15.39%	-	15.39%	15.39%	15.39%	15.39%	15.39%	-	12.68%
M	-	-	10.00%	-	10.00%	-	10.00%	-	-	-	-	-	10.00%	1.76%
N	-	-	30.00%	-	30.00%	-	30.00%	-	-	-	-	-	30.00%	5.29%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Notes:

Totals may not equal 100% due to rounding.

Departure flight track use for all other runways ends for the 2007 Mitigated NEM is equivalent to the unmitigated track use shown in Tables C.6 and C.7.

Source: Table 7.37

Table C.9

Annual Average Daytime Arrival Flight Track Use

Runway	Track	Operational Category													Overall Use	
		CH	CJ	CP	GJ	GP	MJ	MP	NH	NW	PH	PJ	RJ	RP	2002	2007
4	A0	-	-	-	-	16.67%	-	100.00%	-	2.40%	-	-	-	5.56%	2.62%	2.20%
	A1	50.00%	-	-	77.78%	16.67%	100.00%	-	100.00%	86.40%	100.00%	83.33%	83.33%	77.78%	82.91%	83.88%
	A3	50.00%	-	-	-	-	-	-	-	9.60%	-	13.33%	8.33%	11.11%	9.50%	9.23%
	A5	-	-	-	-	-	-	-	-	1.60%	-	-	4.17%	5.56%	1.76%	1.65%
	A7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A8	-	-	-	11.11%	33.33%	-	-	-	-	-	-	-	-	1.17%	0.83%
	BR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	CR	-	-	-	11.11%	-	-	-	-	-	-	3.33%	-	-	0.89%	0.55%
	DR	-	-	-	-	16.67%	-	-	-	-	-	-	-	-	0.35%	0.41%
	EL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	FR	-	-	-	-	16.67%	-	-	-	-	-	-	4.17%	-	0.80%	1.24%
4 Total		100%	-	-	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
22	A0	-	-	-	-	-	33.33%	-	-	2.94%	-	4.65%	-	4.55%	3.32%	2.81%
	A1	-	-	-	-	-	-	-	-	0.98%	-	-	8.00%	-	1.36%	2.13%
	A2	-	-	-	43.75%	37.50%	50.00%	-	80.00%	65.69%	-	67.44%	64.00%	77.27%	64.18%	63.49%
	A4	-	-	-	37.50%	37.50%	-	-	20.00%	24.51%	-	20.93%	24.00%	9.09%	23.04%	23.87%
	A6	-	-	-	12.50%	-	8.33%	-	-	3.92%	-	4.65%	-	-	3.75%	3.61%
	A7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A8	-	-	-	-	-	-	-	-	0.98%	-	-	-	4.55%	0.85%	0.61%
	BR	-	-	-	-	-	-	100.00%	-	-	-	-	-	-	0.46%	0.37%
	CL	-	-	-	-	-	-	-	-	-	-	-	4.00%	-	0.44%	0.86%
	CR	-	-	-	-	12.50%	-	-	-	-	-	-	-	4.55%	0.74%	0.50%
	DL	-	-	-	-	12.50%	-	-	-	0.98%	-	-	-	-	0.81%	0.72%
	DR	-	-	-	6.25%	-	8.33%	-	-	-	-	2.33%	-	-	1.05%	1.03%
22 Total		-	-	-	100%	100%	100%	100%	100%	100%	-	100%	100%	100%	100%	100%
12L	A0	61.29%	34.38%	20.00%	44.89%	19.54%	30.77%	31.63%	50.49%	46.77%	60.00%	42.66%	42.71%	40.30%	43.77%	43.83%
	A1	6.45%	6.25%	-	4.95%	4.23%	-	8.16%	6.37%	7.01%	10.00%	5.85%	6.03%	9.59%	7.05%	6.67%
	A2	6.45%	9.38%	20.00%	4.49%	7.82%	7.69%	9.44%	5.88%	3.17%	10.00%	2.74%	3.28%	4.77%	3.70%	3.54%
	A3	-	3.13%	20.00%	3.72%	3.58%	-	6.63%	3.43%	3.46%	-	2.59%	3.09%	3.93%	3.52%	3.42%
	A4	-	-	-	0.93%	0.98%	-	1.53%	-	0.43%	5.00%	0.58%	0.53%	0.79%	0.55%	0.53%
	A5	-	-	-	1.39%	1.63%	-	3.32%	4.41%	2.32%	-	1.99%	2.06%	2.52%	2.24%	2.18%
	A6	-	-	-	0.31%	0.33%	-	0.26%	-	0.22%	-	0.36%	0.35%	0.22%	0.26%	0.28%
	A7	3.23%	-	-	1.55%	1.30%	-	2.55%	2.94%	1.94%	-	2.14%	1.54%	1.82%	1.86%	1.80%
	A8	-	-	-	0.15%	-	-	0.51%	-	0.14%	-	0.27%	0.18%	0.12%	0.16%	0.17%
	BL	-	3.13%	-	0.77%	4.89%	-	0.77%	-	0.11%	-	0.20%	0.27%	0.47%	0.27%	0.25%
	BR	-	-	-	-	-	-	0.26%	-	0.02%	-	-	0.03%	0.03%	0.02%	0.02%
	CL	-	-	-	0.46%	7.82%	-	0.51%	0.98%	0.21%	-	0.48%	0.89%	0.93%	0.55%	0.58%
	CR	-	-	-	-	-	-	0.26%	-	0.02%	-	0.07%	0.03%	0.11%	0.04%	0.04%
	DL	-	-	-	3.10%	4.89%	7.69%	1.53%	0.49%	0.69%	-	0.92%	1.50%	1.72%	1.12%	1.14%
	DR	-	-	-	-	-	-	0.51%	-	0.04%	-	0.05%	0.06%	0.15%	0.07%	0.06%
	EL	-	-	20.00%	2.48%	4.89%	-	2.04%	0.98%	1.45%	-	2.14%	2.19%	2.00%	1.97%	2.02%
	ER	-	-	-	-	-	-	1.28%	-	0.08%	-	0.09%	0.13%	0.23%	0.13%	0.12%
	FL	3.23%	3.13%	-	3.72%	4.56%	-	2.04%	1.96%	2.29%	-	3.13%	3.35%	3.41%	2.81%	2.86%
	FR	-	3.13%	-	0.15%	-	-	1.02%	-	0.13%	-	0.36%	0.19%	0.23%	0.20%	0.20%
	GL	3.23%	9.38%	-	4.18%	7.82%	-	1.53%	2.94%	3.31%	-	4.05%	4.38%	3.49%	3.64%	3.78%
	GR	-	3.13%	20.00%	0.31%	0.98%	7.69%	1.28%	-	0.14%	-	0.22%	0.25%	0.42%	0.40%	0.39%
	HL	3.23%	-	-	2.48%	3.26%	-	3.06%	2.94%	3.47%	-	3.88%	3.59%	3.46%	3.49%	3.51%
	HR	-	3.13%	-	0.15%	0.33%	-	0.77%	-	0.15%	-	0.37%	0.19%	0.38%	0.24%	0.22%
	IL	-	6.25%	-	4.49%	4.56%	23.08%	1.79%	1.47%	4.53%	-	5.12%	5.33%	4.19%	4.61%	4.77%
	IR	-	-	-	-	0.65%	-	1.53%	-	0.23%	-	0.49%	0.49%	0.40%	0.35%	0.37%
	JL	3.23%	3.13%	-	4.64%	4.89%	-	2.55%	4.41%	4.66%	-	4.70%	5.43%	3.47%	4.53%	4.76%
	JR	-	3.13%	-	-	-	7.69%	0.51%	-	0.27%	-	1.02%	0.34%	0.48%	0.42%	0.40%
	KL	9.68%	9.38%	-	10.06%	10.75%	15.38%	11.22%	10.29%	11.96%	15.00%	11.37%	10.40%	9.31%	10.96%	10.98%
	KR	-	-	-	0.62%	0.33%	-	1.53%	-	0.79%	-	2.16%	1.15%	1.04%	1.08%	1.10%
12L Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
12R	A0	47.17%	32.72%	27.27%	34.29%	21.41%	17.95%	35.88%	47.25%	49.33%	40.54%	46.20%	50.08%	41.26%	46.27%	46.66%
	A1	4.48%	8.64%	-	5.85%	6.04%	12.82%	5.34%	6.00%	3.82%	11.49%	3.81%	3.98%	4.64%	4.13%	4.10%
	A2	11.79%	12.96%	9.09%	13.59%	13.83%	15.38%	15.27%	18.85%	10.52%	16.89%	12.13%	14.63%	19.34%	12.36%	12.24%
	A3	1.65%	1.23%	18.18%	1.65%	1.43%	-	2.29%	1.69%	0.92%	0.68%	0.90%	0.58%	1.10%	1.30%	1.27%
	A4	2.59%	5.56%	-	2.71%	3.95%	2.56%	3.82%	2.20%	3.00%	2.03%	3.17%	2.74%	3.91%	3.01%	2.95%
	A5	0.47%	1.23%	-	0.75%	0.22%	-	0.76%	0.93%	0.32%	-	0.38%	0.27%	0.27%	0.36%	0.35%
	A6	2.36%	-	-	2.12%	1.65%	-	1.53%	1.94%	1.97%	3.38%	1.97%	2.20%	2.13%	1.96%	1.99%
	A7	1.18%	-	-	0.75%	0.55%	-	0.76%	0.42%	0.25%	-	0.10%	0.08%	0.18%	0.25%	0.25%
	A8	1.42%	0.62%	-	1.89%	2.31%	-	2.29%	0.93%	1.71%	1.35%	1.79%	1.73%	1.74%	1.68%	1.69%
	BL	-	-	-	0.20%	0.99%	-	-	-	0.02%	-	0.06%	0.08%	0.09%	0.06%	0.06%
	BR	-	-	-	0.31%	1.76%	-	-	-	0.03%	-	0.08%	0.08%	0.37%	0.11%	0.10%
	CL	-	-	-	0.39%	1.21%	-	-	0.08%	0.08%	-	0.08%	0.05%	0.27%	0.13%	0.12%
	CR	0.24%	-	-	0.35%	2.31%	-	0.76%	0.08%	0.03%	-	0.20%	0.19%	0.25%	0.15%	0.15%
	DL	-	-	36.36%	0.31%	0.99%	2.56%	-	-	0.15%	-	0.08%	0.14%	0.23%	0.82%	0.84%
	DR	-	2.47%	-	1.14%	2.85%	2.56%	0.76%	0.08%	0.18%	-	0.42%	0.41%	0.98%	0.41%	0.39%
	EL	-	-	9.09%	0.90%	1.43%	-	-	0.42%	0.20%	-	0.12%	0.19%	0.14%	0.41%	0.41%
	ER	0.47%	1.23%	-	1.30%	3.62%	-	1.53%	0.17%	0.57%	1.35%	0.66%	0.85%	1.17%	0.74%	0.74%
	FL	0.94%	1.23%	-	1.45%	1.32%	2.56%	-	0.68%	0.42%	0.68%	0.12%	0.19%	0.09%	0.42%	0.42%
	FR	1.18%	3.09%	-	2.12%	2.96%	7.69%	3.82%	0.34%	1.06%	-	1.61%	1.15%	2.01%	1.29%	1.26%
	GL	-	-	-	1.53%	0.66%	-	-	0.68%	0.39%	1.35%	0.20%	0.22%	0.09%	0.40%	0.40%
	GR	0.71%	4.32%	-	1.92%	3.07%	2.56%	3.82%	0.51%	1.80%	-	2.17%	1.48%	2.10%	1.81%	1.77%
	HL	-	-	-	1.37%	0.77%	-	-	0.59%	0.50%	2.03%	0.14%	0.19%	0.16%	0.45%	0.44%
	HR	3.30%	3.09%	-	3.34%	2.74%	10.26%	3.05%	1.10%	2.57%	-	3.17%	2.06%	2.45%	2.55%	2.53%
	IL	0.71%	3.70%	-	1.18%	1.32%	2.56%	-	1.52%	0.61%	-	0.18%	0.14%	0.11%	0.56%	0.52%
	IR	2.36%	1.23%	-	2.87%	2.09%	-	2.29%	0.85%	3.15%	6.76%	3.93%	3.24%	2.40%	3.01%	3.09%
	JL	0.47%	0.62%	-	1.77%	1.65%	5.13%	2.29%	1.44%	0.61%	-	0.16%	0.27%	0.07%	0.58%	0.57%
	JR	4.95%	4.32%	-	3.42%	4.39%	5.13%	6.11%	1.61%	4.46%	5.41%	4.92%	4.06%	3.79%	4.21%	4.24%
	KL	1.65%	5.56%	-	3.53%	3.40%	2.56%	0.76%	4.31%	1.56%	0.68%	0.78%	0.74%	0.30%	1.51%	1.46%
	KR	9.91%	6.17%	-	6.99%	9.11%	7.69%	6.87%	5.33%	9.79%	5.41%	10.48%	7.96%	8.37%	9.06%	9.00%
12R Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table C.9

Annual Average Daytime Arrival Flight Track Use

Runway	Track	Operational Category													Overall Use	
		CH	CJ	CP	GJ	GP	MJ	MP	NH	NW	PH	PJ	RJ	RP	2002	2007
30L	A0	33.46%	17.08%	-	24.49%	15.20%	26.53%	31.43%	24.06%	31.66%	17.55%	28.98%	39.16%	30.81%	30.13%	30.89%
	A1	2.63%	5.83%	-	4.23%	3.19%	2.04%	5.71%	3.37%	4.55%	4.79%	3.55%	3.75%	5.89%	4.29%	4.16%
	A2	4.70%	8.75%	-	6.54%	6.10%	12.24%	13.57%	5.77%	4.33%	4.26%	4.24%	5.35%	4.99%	4.63%	4.66%
	A3	1.32%	1.25%	-	2.05%	1.50%	4.08%	3.57%	1.72%	2.27%	0.53%	1.87%	2.04%	2.37%	2.10%	2.07%
	A4	0.38%	0.42%	-	1.46%	1.41%	2.04%	3.57%	1.12%	0.64%	0.53%	0.46%	0.64%	0.77%	0.69%	0.68%
	A5	1.32%	2.08%	-	1.01%	1.41%	-	3.57%	1.35%	1.72%	1.06%	1.71%	1.98%	2.02%	1.67%	1.67%
	A6	0.94%	-	-	0.75%	0.38%	2.04%	-	0.90%	0.34%	-	0.14%	0.27%	0.17%	0.33%	0.32%
	A7	1.13%	1.25%	-	1.30%	1.03%	-	0.71%	0.90%	1.53%	1.60%	1.34%	1.50%	1.88%	1.45%	1.44%
	A8	0.19%	0.42%	-	0.52%	0.47%	2.04%	-	0.45%	0.23%	-	0.14%	0.10%	0.16%	0.22%	0.21%
	BL	0.19%	-	-	0.26%	4.03%	-	-	0.07%	0.05%	-	0.06%	0.16%	0.85%	0.22%	0.18%
	BR	-	0.42%	-	0.20%	1.50%	-	-	0.07%	0.02%	-	0.06%	-	0.14%	0.07%	0.06%
	CL	0.56%	-	-	0.72%	3.56%	2.04%	0.71%	-	0.14%	-	0.22%	0.41%	1.38%	0.38%	0.34%
	CR	-	0.83%	-	0.23%	1.88%	-	0.71%	-	0.03%	-	0.02%	0.02%	0.23%	0.09%	0.08%
	DL	0.75%	1.67%	-	1.04%	5.07%	-	0.71%	0.52%	0.52%	0.53%	0.74%	0.86%	2.39%	0.86%	0.79%
	DR	-	0.42%	-	0.23%	1.03%	2.04%	-	0.07%	0.11%	-	0.06%	0.12%	0.28%	0.14%	0.13%
	EL	1.88%	2.50%	-	2.54%	4.03%	4.08%	3.57%	0.75%	1.19%	0.53%	1.33%	1.32%	3.16%	1.51%	1.44%
	ER	0.19%	0.83%	10.53%	0.72%	1.88%	-	0.71%	0.22%	0.12%	-	0.16%	0.19%	0.24%	0.48%	0.49%
	FL	2.82%	3.75%	-	3.41%	4.78%	4.08%	3.57%	2.10%	2.31%	4.26%	3.04%	2.94%	3.92%	2.67%	2.66%
	FR	-	0.83%	-	0.72%	1.03%	2.04%	0.71%	0.52%	0.23%	0.53%	0.13%	0.23%	0.30%	0.27%	0.26%
	GL	5.45%	2.50%	-	4.75%	3.47%	2.04%	3.57%	2.47%	4.33%	6.38%	5.78%	3.91%	4.50%	4.33%	4.32%
	GR	0.38%	1.25%	-	1.24%	1.31%	-	0.71%	1.27%	0.30%	0.53%	0.32%	0.29%	0.28%	0.40%	0.39%
	HL	5.26%	7.50%	-	5.56%	4.60%	-	0.71%	3.97%	6.08%	5.32%	7.73%	5.39%	4.39%	5.77%	5.80%
	HR	0.19%	2.50%	15.79%	1.63%	1.78%	4.08%	-	1.80%	0.47%	-	0.26%	0.29%	0.23%	0.93%	0.91%
	IL	7.33%	8.33%	-	5.17%	3.85%	2.04%	3.57%	4.80%	6.83%	8.51%	8.35%	5.06%	5.02%	6.31%	6.26%
	IR	0.38%	2.50%	5.26%	2.73%	1.50%	2.04%	-	2.70%	0.78%	0.53%	0.37%	0.54%	0.26%	0.95%	0.94%
	JL	4.51%	2.08%	5.26%	2.96%	2.72%	2.04%	2.86%	3.07%	4.83%	4.26%	5.12%	3.42%	3.99%	4.44%	4.38%
	JR	-	1.25%	-	1.50%	0.75%	4.08%	0.71%	2.10%	0.73%	2.13%	0.32%	0.33%	0.09%	0.65%	0.63%
	KL	5.26%	2.08%	-	2.83%	2.44%	-	2.14%	4.27%	4.51%	5.85%	4.67%	3.62%	3.23%	4.06%	4.05%
	KR	0.38%	1.67%	5.26%	1.20%	1.31%	2.04%	-	1.35%	0.49%	1.60%	0.16%	0.23%	0.14%	0.60%	0.59%
	LL	5.45%	2.92%	-	2.99%	3.10%	4.08%	1.43%	3.52%	3.90%	3.19%	3.97%	3.66%	2.88%	3.61%	3.65%
	LR	0.56%	1.25%	10.53%	0.91%	1.22%	2.04%	-	2.10%	0.48%	1.60%	0.26%	0.33%	0.17%	0.75%	0.75%
	ML	2.82%	2.92%	-	3.15%	2.72%	4.08%	2.14%	3.30%	3.52%	6.91%	3.87%	3.07%	3.23%	3.36%	3.34%
	MR	0.56%	0.83%	5.26%	1.14%	0.66%	2.04%	0.71%	3.15%	0.48%	1.60%	0.21%	0.19%	0.12%	0.63%	0.60%
	NL	3.38%	2.08%	-	2.67%	1.59%	-	0.71%	3.60%	3.35%	4.79%	3.92%	3.15%	2.96%	3.20%	3.20%
	NR	0.19%	1.25%	15.79%	0.75%	1.50%	2.04%	-	2.62%	0.48%	0.53%	0.16%	0.23%	0.12%	0.87%	0.84%
	OL	4.89%	5.00%	5.26%	4.72%	3.85%	-	7.14%	6.00%	5.55%	6.38%	5.71%	4.88%	6.09%	5.48%	5.39%
	OR	0.56%	3.75%	21.05%	1.72%	2.16%	2.04%	0.71%	3.90%	0.91%	3.72%	0.56%	0.39%	0.35%	1.45%	1.42%
30L Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
30R	A0	43.28%	11.76%	14.29%	33.82%	14.00%	9.52%	13.68%	38.72%	31.24%	50.00%	28.96%	31.48%	26.13%	29.69%	30.26%
	A1	1.49%	2.94%	-	2.04%	2.21%	-	2.82%	1.50%	1.34%	-	0.91%	1.44%	2.15%	1.46%	1.40%
	A2	7.46%	5.88%	-	12.56%	7.37%	-	9.66%	13.53%	8.92%	5.00%	7.21%	7.43%	10.31%	8.66%	8.31%
	A3	-	-	-	0.34%	0.74%	-	0.40%	0.38%	0.36%	5.00%	0.44%	0.63%	0.50%	0.44%	0.47%
	A4	2.99%	2.94%	14.29%	4.19%	2.46%	19.05%	3.42%	3.01%	3.55%	5.00%	2.40%	2.79%	3.92%	3.43%	3.29%
	A5	-	-	-	0.11%	0.49%	-	0.40%	0.38%	0.19%	-	0.33%	0.32%	0.26%	0.24%	0.26%
	A6	4.48%	-	-	2.83%	2.21%	4.76%	1.81%	1.50%	2.24%	-	2.02%	1.52%	2.66%	2.14%	2.00%
	A7	-	-	-	0.11%	-	-	0.20%	0.38%	0.17%	-	0.23%	0.28%	0.26%	0.21%	0.22%
	A8	2.99%	-	-	1.92%	2.46%	9.52%	1.21%	3.01%	1.82%	5.00%	1.49%	1.51%	1.64%	1.68%	1.65%
	BL	-	-	-	-	0.49%	-	-	0.38%	0.00%	-	-	0.05%	0.07%	0.03%	0.03%
	BR	-	-	-	0.57%	4.42%	-	1.61%	-	0.05%	-	0.07%	0.07%	0.58%	0.20%	0.15%
	CL	-	-	-	-	-	-	0.20%	-	0.01%	-	0.07%	0.07%	0.22%	0.07%	0.06%
	CR	-	-	-	0.45%	3.44%	-	2.62%	0.38%	0.06%	-	0.06%	0.23%	0.77%	0.27%	0.22%
	DL	-	-	-	-	0.25%	-	0.40%	-	0.05%	-	0.06%	0.07%	0.30%	0.10%	0.08%
	DR	-	2.94%	-	1.13%	5.65%	-	3.62%	0.38%	0.31%	-	0.47%	0.57%	1.03%	0.59%	0.55%
	EL	-	-	-	0.23%	-	-	0.20%	-	0.09%	-	0.20%	0.24%	0.40%	0.19%	0.18%
	ER	1.49%	-	14.29%	1.81%	4.91%	-	4.63%	-	0.72%	-	0.94%	1.04%	1.73%	1.20%	1.14%
	FL	-	2.94%	-	-	0.25%	-	0.40%	-	0.24%	-	0.44%	0.27%	0.38%	0.29%	0.28%
	FR	-	-	14.29%	2.04%	6.14%	-	3.62%	0.38%	1.26%	-	1.62%	1.79%	2.01%	1.72%	1.72%
	GL	-	2.94%	-	-	0.49%	-	0.60%	-	0.22%	-	0.61%	0.37%	0.50%	0.35%	0.34%
	GR	1.49%	-	14.29%	2.60%	4.67%	-	2.82%	1.13%	1.92%	5.00%	2.20%	2.45%	2.50%	2.31%	2.33%
	HL	-	-	-	0.34%	0.49%	-	1.21%	-	0.27%	-	0.79%	0.59%	0.52%	0.45%	0.47%
	HR	2.99%	5.88%	-	2.60%	5.41%	-	1.61%	2.26%	2.42%	-	3.38%	3.07%	2.87%	2.74%	2.79%
	IL	-	-	-	0.11%	0.74%	-	1.21%	-	0.36%	-	1.39%	0.77%	0.48%	0.59%	0.64%
	IR	1.49%	2.94%	14.29%	3.85%	3.44%	-	4.63%	2.63%	3.69%	5.00%	4.65%	4.55%	3.31%	4.01%	4.17%
	JL	-	5.88%	-	0.23%	-	4.76%	1.61%	0.38%	0.44%	-	1.69%	0.99%	0.92%	0.80%	0.83%
	JR	2.99%	14.71%	14.29%	2.83%	6.88%	14.29%	4.02%	5.64%	5.72%	5.00%	7.14%	5.29%	3.57%	5.49%	5.61%
	KL	-	5.88%	-	0.23%	0.25%	-	1.61%	-	0.59%	-	1.35%	0.83%	0.94%	0.80%	0.79%
	KR	2.99%	5.88%	-	3.73%	4.91%	14.29%	5.43%	3.76%	5.60%	-	4.57%	4.72%	4.31%	4.96%	4.96%
	LL	-	-	-	0.34%	-	-	1.41%	-	0.33%	-	1.08%	0.65%	0.79%	0.58%	0.58%
	LR	5.97%	11.76%	-	3.17%	1.47%	-	4.83%	3.38%	4.17%	5.00%	3.22%	3.69%	3.20%	3.72%	3.74%
	ML	1.49%	-	-	0.34%	-	-	1.21%	-	0.50%	-	1.21%	0.98%	0.97%	0.76%	0.79%
	MR	1.49%	5.88%	-	2.94%	3.93%	9.52%	1.81%	3.76%	5.28%	-	4.07%	4.35%	4.52%	4.67%	4.61%
	NL	-	2.94%	-	0.23%	-	-	1.41%	-	0.49%	-	1.45%	1.05%	0.82%	0.78%	0.82%
	NR	2.99%	2.94%	-	3.28%	3.19%	-	4.83%	3.38%	5.32%	5.00%	3.93%	4.56%	4.32%	4.69%	4.68%
	OL	-	2.94%	-	0.45%	0.98%	4.76%	2.62%	-	0.80%	-	1.73%	1.42%	1.59%	1.18%	1.19%
	OR	11.94%	-	-	8.60%	5.65%	9.52%	6.24%	9.77%	9.25%	5.00%	7.65%	7.86%	8.54%	8.50%	8.38%
30R Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
17	A0	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	-	100.00%
17 Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	-	100%

Table C.9

Annual Average Daytime Arrival Flight Track Use

Runway	Track	Operational Category													Overall Use	
		CH	CJ	CP	GJ	GP	MJ	MP	NH	NW	PH	PJ	RJ	RP	2002	2007
35	A0	40.34%	23.29%	11.90%	30.87%	17.56%	22.22%	24.44%	36.24%	39.06%	30.42%	35.77%	39.11%	33.61%	-	37.15%
	A1	3.50%	6.62%	-	4.68%	4.14%	5.19%	5.25%	4.60%	4.21%	7.94%	3.49%	3.77%	5.57%	-	4.07%
	A2	7.77%	10.04%	4.76%	9.67%	9.17%	14.07%	10.67%	11.75%	6.82%	9.52%	6.48%	6.84%	8.97%	-	7.13%
	A3	1.42%	1.28%	7.14%	1.84%	1.59%	1.48%	3.10%	1.70%	1.72%	0.79%	1.44%	1.66%	2.01%	-	1.78%
	A4	1.42%	2.35%	2.38%	2.27%	2.48%	4.44%	2.84%	1.67%	1.92%	1.59%	1.65%	1.69%	2.35%	-	1.88%
	A5	0.85%	1.50%	-	0.84%	0.89%	-	1.81%	1.30%	1.12%	0.53%	1.10%	1.18%	1.30%	-	1.11%
	A6	1.70%	-	-	1.48%	1.07%	2.22%	1.03%	1.30%	1.18%	1.32%	1.13%	1.01%	1.34%	-	1.14%
	A7	1.14%	0.64%	-	0.98%	0.74%	-	1.12%	0.80%	0.96%	0.79%	0.95%	0.88%	1.04%	-	0.93%
	A8	0.85%	0.43%	-	1.16%	1.40%	2.22%	0.95%	0.83%	0.97%	0.79%	0.91%	0.85%	0.90%	-	0.92%
	BL	0.09%	0.21%	-	0.25%	2.55%	-	0.26%	0.07%	0.04%	-	0.08%	0.14%	0.35%	-	0.13%
	BR	-	0.21%	-	0.26%	1.85%	-	0.86%	0.03%	0.03%	-	0.05%	0.04%	0.29%	-	0.08%
	CL	0.28%	-	-	0.49%	2.70%	0.74%	0.34%	0.10%	0.11%	-	0.21%	0.39%	0.67%	-	0.27%
	CR	0.09%	0.43%	-	0.29%	2.07%	-	1.38%	0.07%	0.04%	-	0.08%	0.12%	0.39%	-	0.12%
	DL	0.38%	0.85%	9.52%	0.84%	2.96%	1.48%	0.77%	0.27%	0.35%	0.26%	0.45%	0.68%	1.13%	-	0.69%
	DR	-	1.28%	-	0.65%	2.26%	2.22%	1.81%	0.10%	0.16%	-	0.26%	0.30%	0.60%	-	0.29%
	EL	0.95%	1.28%	4.76%	1.66%	2.62%	1.48%	1.20%	0.57%	0.73%	0.26%	0.94%	1.05%	1.39%	-	1.00%
	ER	0.38%	0.85%	7.14%	0.99%	2.70%	-	2.67%	0.17%	0.37%	0.53%	0.47%	0.56%	0.89%	-	0.63%
	FL	1.89%	2.78%	-	2.31%	2.88%	2.22%	1.29%	1.33%	1.32%	2.38%	1.69%	1.73%	1.96%	-	1.56%
	FR	0.47%	1.71%	2.38%	1.32%	2.37%	2.96%	2.41%	0.40%	0.66%	0.26%	0.92%	0.90%	1.13%	-	0.86%
	GL	2.84%	2.14%	-	2.95%	2.55%	0.74%	1.20%	1.57%	2.13%	3.70%	2.69%	2.28%	2.14%	-	2.24%
	GR	0.57%	2.35%	4.76%	1.56%	2.37%	1.48%	2.15%	0.87%	1.04%	0.53%	1.22%	1.20%	1.37%	-	1.22%
	HL	2.75%	3.85%	-	3.14%	2.51%	-	1.64%	2.20%	2.72%	3.44%	3.19%	2.40%	2.12%	-	2.62%
	HR	1.61%	2.99%	7.14%	2.22%	2.48%	4.44%	1.29%	1.43%	1.40%	-	1.79%	1.48%	1.53%	-	1.61%
	IL	3.98%	5.98%	-	3.05%	2.59%	3.70%	1.55%	2.84%	3.21%	4.23%	3.83%	2.92%	2.45%	-	3.11%
	IR	1.23%	1.92%	4.76%	2.66%	1.89%	0.74%	2.75%	1.77%	1.96%	3.17%	2.38%	2.31%	1.68%	-	2.16%
	JL	14.58%	13.03%	4.76%	11.71%	10.13%	8.89%	11.19%	13.88%	12.40%	16.67%	13.57%	11.35%	10.44%	-	12.02%
	JR	8.90%	11.97%	28.57%	9.87%	11.50%	17.04%	14.03%	12.15%	13.38%	10.85%	13.27%	13.14%	12.37%	-	13.26%
35 Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	-	100%

Note: Totals may not equal 100% due to rounding.

Source: Data for existing runways from ANOMS and HNTB analysis; Runway 17/35 data estimated from arrival track use on existing runways

Table C.10

Annual Average Nighttime Arrival Flight Track Use

Runway	Track	Operational Category													Overall Use	
		CH	CJ	CP	GJ	GP	MJ	MP	NH	NW	PH	PJ	RJ	RP	2002	2007
4	A0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	A3	-	-	-	50.00%	-	-	-	-	-	-	25.00%	100.00%	-	22.20%	30.63%
	A5	-	-	-	-	-	-	-	-	-	-	-	-	50.00%	6.34%	2.77%
	A7	-	-	100.00%	-	-	-	-	-	-	-	25.00%	-	-	28.05%	25.30%
	A8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	BR	-	-	-	-	50.00%	-	-	-	-	-	-	-	-	8.05%	5.93%
	CR	-	-	-	50.00%	-	-	-	-	-	-	-	-	-	6.83%	7.31%
	DR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	EL	-	-	-	-	-	-	-	-	-	-	-	-	50.00%	6.34%	2.77%
	FL	-	-	-	-	-	-	-	-	-	-	25.00%	-	-	7.07%	9.68%
	FR	-	-	-	-	50.00%	-	-	-	-	-	25.00%	-	-	15.12%	15.61%
4 Total		-	-	100%	100%	100%	-	-	-	-	-	100%	100%	100%	100%	100%
22	A0	-	-	-	11.11%	-	-	-	-	3.85%	-	2.70%	-	-	2.59%	2.57%
	A1	-	-	-	-	-	-	-	-	3.85%	-	-	-	-	0.95%	0.72%
	A2	-	66.67%	66.67%	77.78%	14.29%	-	-	-	61.54%	-	51.35%	66.67%	40.00%	52.98%	54.20%
	A4	100.00%	33.33%	-	11.11%	7.14%	-	-	-	26.92%	-	35.14%	16.67%	-	23.29%	25.44%
	A6	-	-	-	-	7.14%	-	-	-	-	-	2.70%	16.67%	-	2.76%	3.33%
	A7	-	-	-	-	-	-	-	-	3.85%	-	-	-	-	0.95%	0.72%
	A8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	BR	-	-	-	-	14.29%	-	-	-	-	-	-	-	20.00%	2.59%	1.68%
	CL	-	-	-	-	7.14%	-	-	-	-	-	-	-	-	0.95%	0.69%
	CR	-	-	-	-	14.29%	-	-	-	-	-	-	-	40.00%	3.28%	2.02%
	DL	-	-	-	-	7.14%	-	-	-	-	-	2.70%	-	-	1.79%	1.75%
	DR	-	-	33.33%	-	28.57%	-	-	-	-	-	5.41%	-	-	7.86%	6.89%
22 Total		100%	100%	100%	100%	100%	-	-	-	100%	-	100%	100%	100%	100%	100%
12L	A0	32.56%	25.00%	9.09%	17.14%	18.18%	-	31.25%	46.67%	40.21%	-	30.97%	39.10%	25.96%	32.91%	33.59%
	A1	-	15.00%	-	5.71%	4.55%	-	-	6.67%	6.17%	-	3.66%	9.40%	10.67%	6.54%	6.05%
	A2	2.33%	10.00%	-	2.86%	9.09%	-	12.50%	6.67%	3.01%	-	3.90%	5.26%	7.17%	4.60%	4.36%
	A3	4.65%	-	-	5.71%	-	-	-	6.67%	3.01%	-	2.25%	4.14%	4.62%	3.18%	3.02%
	A4	-	10.00%	-	5.71%	4.55%	-	-	-	1.20%	-	0.59%	1.50%	1.27%	1.24%	1.18%
	A5	-	-	-	-	-	-	6.25%	-	1.66%	-	1.06%	1.50%	2.39%	1.50%	1.36%
	A6	2.33%	-	-	-	-	-	-	-	0.60%	-	0.83%	0.75%	0.48%	0.66%	0.72%
	A7	-	-	-	-	-	-	-	-	1.66%	-	1.06%	1.13%	1.27%	1.18%	1.15%
	A8	-	-	-	-	-	-	-	-	0.60%	-	0.95%	0.38%	0.48%	0.61%	0.65%
	BL	-	10.00%	-	11.43%	22.73%	-	-	-	-	-	0.12%	-	0.64%	0.69%	0.56%
	BR	-	-	9.09%	-	4.55%	-	-	-	-	-	-	-	0.16%	0.19%	0.13%
	CL	-	10.00%	-	8.57%	4.55%	-	-	-	0.75%	-	0.35%	1.13%	1.43%	1.06%	0.95%
	CR	2.33%	-	9.09%	-	-	-	6.25%	-	-	-	-	1.13%	0.16%	0.37%	0.39%
	DL	-	-	-	8.57%	-	-	-	6.67%	1.36%	-	2.13%	0.38%	1.43%	1.54%	1.53%
	DR	-	-	9.09%	5.71%	-	-	-	-	0.45%	-	0.83%	1.88%	0.96%	0.99%	1.05%
	EL	2.33%	5.00%	-	-	9.09%	-	-	-	1.51%	-	2.60%	1.88%	4.14%	2.52%	2.36%
	ER	4.65%	5.00%	18.18%	-	-	-	-	-	0.45%	-	0.47%	4.14%	1.43%	1.45%	1.55%
	FL	-	-	-	2.86%	-	-	-	-	2.56%	-	3.78%	1.13%	3.18%	2.72%	2.72%
	FR	2.33%	-	9.09%	2.86%	-	-	-	-	0.90%	-	1.06%	2.26%	0.96%	1.24%	1.34%
	GL	-	-	-	-	-	-	12.50%	-	3.16%	-	3.31%	2.26%	2.87%	2.86%	2.87%
	GR	9.30%	-	9.09%	5.71%	-	-	-	-	0.90%	-	2.60%	1.88%	1.75%	2.04%	2.17%
	HL	4.65%	-	-	-	9.09%	-	-	-	2.41%	-	2.96%	1.88%	3.50%	2.72%	2.63%
	HR	9.30%	-	9.09%	2.86%	-	-	-	-	0.90%	100.00%	1.77%	1.50%	1.59%	1.70%	1.74%
	IL	2.33%	-	-	11.43%	-	-	-	-	3.31%	-	5.08%	3.01%	3.66%	3.83%	3.99%
	IR	4.65%	-	18.18%	-	4.55%	-	-	-	0.75%	-	3.90%	1.13%	2.39%	2.42%	2.54%
	JL	2.33%	5.00%	-	-	-	-	6.25%	-	5.27%	-	2.84%	1.50%	1.91%	3.10%	2.99%
	JR	6.98%	-	-	-	-	-	12.50%	13.33%	2.56%	-	7.21%	2.63%	1.75%	3.99%	4.50%
	KL	4.65%	5.00%	-	2.86%	4.55%	-	12.50%	-	9.94%	-	5.91%	3.01%	6.69%	6.68%	6.22%
	KR	2.33%	-	-	-	4.55%	-	-	13.33%	4.67%	-	7.80%	4.14%	5.10%	5.47%	5.69%
12L Total		100%	100%	100%	100%	100%	-	100%	100%	100%	100%	100%	100%	100%	100%	100%
12R	A0	30.59%	27.95%	11.54%	21.83%	11.17%	50.00%	20.00%	33.33%	39.23%	8.70%	26.54%	25.00%	24.14%	29.98%	29.47%
	A1	2.74%	3.73%	3.85%	4.57%	1.94%	-	-	7.69%	2.99%	8.70%	3.94%	8.65%	1.97%	3.63%	3.75%
	A2	7.31%	11.18%	7.69%	6.60%	11.17%	-	20.00%	17.09%	6.94%	26.09%	9.39%	9.62%	12.81%	9.03%	8.81%
	A3	2.28%	3.11%	-	1.52%	2.43%	-	-	2.56%	1.29%	-	1.04%	0.96%	0.99%	1.53%	1.46%
	A4	1.83%	2.48%	3.85%	2.03%	2.91%	-	-	1.71%	1.94%	-	2.78%	1.92%	4.43%	2.36%	2.36%
	A5	0.46%	0.62%	-	1.02%	-	-	-	2.56%	0.81%	-	0.93%	1.92%	0.49%	0.81%	0.82%
	A6	2.74%	1.24%	-	1.02%	0.97%	-	-	0.85%	1.21%	-	1.62%	2.88%	0.99%	1.39%	1.49%
	A7	1.37%	-	-	1.02%	0.49%	-	-	0.85%	0.40%	-	0.12%	0.96%	-	0.41%	0.40%
	A8	1.37%	0.62%	3.85%	-	1.46%	-	-	1.71%	0.56%	4.35%	1.27%	0.96%	0.49%	0.96%	0.98%
	BL	-	0.62%	-	1.52%	5.83%	-	-	-	0.24%	-	0.12%	0.96%	2.46%	0.73%	0.62%
	BR	0.46%	0.62%	3.85%	0.51%	5.34%	-	-	-	-	-	0.35%	-	1.48%	0.65%	0.57%
	CL	-	0.62%	-	2.54%	3.40%	-	20.00%	-	0.48%	-	0.46%	0.96%	0.99%	0.77%	0.74%
	CR	0.46%	1.86%	15.38%	-	5.34%	-	-	0.85%	0.48%	4.35%	0.70%	3.85%	1.97%	1.42%	1.35%
	DL	0.46%	1.86%	-	2.54%	2.91%	-	-	-	0.56%	-	0.58%	-	1.97%	0.93%	0.87%
	DR	2.74%	3.73%	15.38%	5.08%	5.34%	-	-	-	1.53%	4.35%	1.04%	3.85%	4.43%	2.56%	2.45%
	EL	0.91%	-	-	5.08%	3.40%	-	-	0.85%	1.05%	-	1.04%	-	-	1.17%	1.17%
	ER	5.94%	3.73%	3.85%	2.54%	6.80%	-	-	0.85%	1.05%	4.35%	1.97%	7.69%	6.40%	2.80%	2.85%
	FL	-	1.24%	-	1.52%	0.49%	-	20.00%	-	0.81%	-	1.62%	-	2.46%	1.02%	1.06%
	FR	5.02%	5.59%	3.85%	1.52%	4.37%	-	-	0.85%	2.42%	4.35%	3.82%	2.88%	2.96%	3.31%	3.44%
	GL	0.91%	0.62%	-	3.55%	2.91%	-	-	-	0.89%	-	2.09%	0.96%	0.99%	1.34%	1.46%
	GR	4.11%	4.97%	11.54%	4.06%	4.85%	-	-	2.56%	2.99%	4.35%	4.52%	6.73%	4.43%	4.11%	4.25%
	HL	1.83%	-	-	4.57%	2.43%	50.00%	-	0.85%	1.29%	-	1.51%	-	1.48%	1.41%	1.43%
	HR	6.85%	3.11%	3.85%	2.54%	1.94%	-	-	9.40%	2.82%	8.70%	5.10%	5.77%	4.93%	4.07%	4.14%
	IL	0.91%	0.62%	-	3.05%	0.97%	-	20.00%	-	1.05%	-	1.62%	-	0.99%	1.15%	1.22%
	IR	6.85%	3.73%	3.85%	3.05%	2.91%	-	-	4.27%	3.87%	13.04%	5.33%	2.88%	7.88%	4.54%	4.57%
	JL	1.37%	1.86%	-	3.05%	0.97%	-	-	2.56%	1.86%	-	1.85%	-	0.49%	1.68%	1.67%
	JR	3.20%	3.73%	3.85%	5.58%	1.46%	-	-	3.42%	9.85%	4.35%	7.65%	4.81%	3.94%	6.75%	6.88%
	KL	1.37%	3.11%	-	3.55%	0.49%	-	-	3.42%	3.87%	-	2.90%	-	0.49%	2.78%	2.74%
	KR	5.94%	7.45%	3.85%	4.57%	5.34%	-	-	1.71%	7.51%	4.35%	8.11%	5.77%	2.96%	6.68%	6.98%
12R Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table C.10

Annual Average Nighttime Arrival Flight Track Use

Runway	Track	Operational Category													Overall Use	
		CH	CJ	CP	GJ	GP	MJ	MP	NH	NW	PH	PJ	RJ	RP	2002	2007
30L	A0	41.92%	24.57%	15.22%	9.85%	5.39%	25.00%	-	10.75%	13.95%	2.99%	12.39%	23.13%	12.63%	17.58%	17.96%
	A1	3.03%	3.81%	-	2.09%	1.35%	-	-	3.76%	2.77%	1.49%	3.02%	3.73%	1.05%	2.76%	2.82%
	A2	13.13%	10.03%	4.35%	5.67%	2.36%	-	20.00%	3.76%	2.07%	-	2.22%	11.19%	3.51%	5.00%	5.12%
	A3	0.84%	1.38%	-	1.49%	0.67%	-	-	3.23%	1.32%	1.49%	1.27%	1.49%	0.70%	1.25%	1.22%
	A4	1.01%	1.73%	-	1.49%	0.67%	-	20.00%	1.08%	1.07%	-	0.71%	2.99%	1.40%	1.10%	1.10%
	A5	1.01%	1.04%	-	0.30%	1.68%	-	-	2.15%	0.82%	-	0.32%	1.49%	1.40%	0.83%	0.75%
	A6	0.51%	1.38%	-	1.79%	0.67%	-	-	1.08%	0.69%	-	0.71%	-	0.35%	0.76%	0.75%
	A7	1.18%	1.38%	-	0.90%	-	-	-	1.61%	0.94%	-	0.79%	1.49%	1.05%	0.94%	0.93%
	A8	0.51%	-	-	0.60%	-	-	-	0.54%	0.88%	-	0.64%	-	0.35%	0.53%	0.53%
	BL	0.17%	-	2.17%	0.60%	9.76%	-	-	-	-	-	0.16%	-	3.86%	0.83%	0.65%
	BR	-	-	-	-	4.04%	-	-	-	-	-	-	-	-	0.22%	0.18%
	CL	-	1.38%	8.70%	1.79%	5.05%	-	-	-	0.06%	1.49%	0.95%	0.75%	5.26%	1.21%	1.08%
	CR	-	0.35%	-	1.19%	5.05%	-	-	-	-	-	0.16%	-	2.46%	0.52%	0.42%
	DL	0.34%	2.08%	4.35%	1.79%	7.74%	-	-	1.08%	0.69%	2.99%	2.54%	-	5.96%	1.97%	1.88%
	DR	0.34%	-	-	0.90%	4.04%	-	-	-	0.25%	-	0.16%	-	1.05%	0.47%	0.41%
	EL	0.51%	2.77%	17.39%	2.39%	4.04%	-	-	4.30%	1.89%	5.97%	3.65%	1.49%	8.77%	3.10%	2.92%
	ER	0.17%	0.35%	2.17%	0.90%	2.69%	-	-	-	0.38%	-	0.56%	1.49%	2.46%	0.68%	0.65%
	FL	1.18%	3.46%	6.52%	4.78%	4.38%	-	-	4.30%	4.02%	4.48%	5.00%	2.99%	5.96%	3.99%	3.98%
	FR	-	0.69%	-	1.19%	3.37%	-	-	-	0.63%	-	0.87%	-	-	0.70%	0.71%
	GL	1.18%	5.88%	13.04%	5.07%	4.38%	-	-	5.38%	5.41%	10.45%	8.90%	2.24%	8.07%	5.85%	5.97%
	GR	-	0.69%	-	2.09%	2.36%	-	-	-	1.26%	-	1.03%	-	1.05%	0.96%	0.95%
	HL	2.36%	6.23%	8.70%	6.57%	4.04%	-	-	6.99%	8.36%	13.43%	7.39%	2.99%	4.21%	6.52%	6.47%
	HR	0.67%	1.04%	-	2.99%	2.69%	-	-	0.54%	1.45%	-	0.79%	1.49%	0.70%	1.20%	1.19%
	IL	3.70%	5.19%	2.17%	7.16%	1.01%	25.00%	-	10.22%	10.69%	19.40%	11.76%	8.96%	2.11%	8.21%	8.58%
	IR	0.67%	1.04%	-	6.87%	2.36%	-	-	1.61%	2.70%	2.99%	1.27%	-	1.05%	1.94%	1.85%
	JL	2.19%	3.81%	4.35%	4.48%	2.36%	25.00%	-	8.60%	5.53%	10.45%	6.83%	2.99%	2.11%	4.90%	4.97%
	JR	0.34%	0.35%	-	3.88%	1.35%	25.00%	-	1.61%	2.70%	-	1.83%	0.75%	-	1.65%	1.66%
	KL	2.19%	5.54%	2.17%	2.09%	2.36%	-	20.00%	4.84%	5.03%	7.46%	4.21%	5.22%	3.16%	4.14%	4.12%
	KR	1.01%	1.04%	-	1.79%	4.04%	-	-	0.54%	2.20%	1.49%	1.59%	1.49%	0.70%	1.67%	1.67%
	LL	3.37%	2.42%	2.17%	2.39%	1.68%	-	-	3.76%	3.39%	1.49%	2.46%	2.99%	2.81%	2.85%	2.80%
	LR	1.01%	-	-	0.90%	0.67%	-	-	-	2.20%	-	1.19%	-	-	1.12%	1.14%
	ML	2.02%	2.08%	2.17%	2.09%	1.35%	-	20.00%	4.30%	2.89%	1.49%	1.75%	2.24%	3.16%	2.34%	2.21%
	MR	0.84%	0.35%	-	2.39%	1.35%	-	20.00%	-	2.26%	-	1.27%	1.49%	1.05%	1.40%	1.41%
	NL	3.70%	3.46%	2.17%	1.79%	0.67%	-	-	5.38%	2.58%	2.99%	2.94%	3.73%	3.16%	2.89%	2.88%
	NR	0.34%	0.69%	-	1.19%	1.35%	-	-	-	1.63%	-	1.19%	-	-	1.00%	1.02%
	OL	7.24%	3.46%	2.17%	4.48%	1.68%	-	-	6.99%	4.34%	7.46%	4.53%	8.96%	5.96%	4.79%	4.86%
	OR	1.35%	0.35%	-	2.09%	1.35%	-	-	1.61%	2.95%	-	2.94%	2.24%	2.46%	2.12%	2.20%
30L Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
30R	A0	37.63%	42.25%	3.13%	20.51%	5.41%	-	11.11%	11.54%	14.30%	-	18.30%	16.08%	12.48%	18.15%	18.68%
	A1	2.87%	1.41%	-	-	-	-	-	-	3.17%	-	1.54%	3.02%	2.76%	2.28%	2.22%
	A2	12.19%	15.49%	3.13%	2.56%	2.70%	-	-	3.85%	4.04%	-	2.86%	7.04%	5.52%	5.24%	5.15%
	A3	0.72%	1.41%	-	-	-	-	-	-	0.76%	-	0.69%	1.01%	1.58%	0.86%	0.81%
	A4	1.08%	2.82%	-	2.56%	2.70%	-	3.70%	-	2.07%	-	1.24%	0.75%	2.76%	1.68%	1.48%
	A5	1.43%	-	-	1.28%	-	-	-	-	0.87%	-	0.46%	1.26%	0.53%	0.71%	0.75%
	A6	0.72%	-	-	1.28%	-	-	-	-	0.55%	-	1.08%	1.26%	2.37%	1.05%	1.01%
	A7	2.51%	-	3.13%	-	-	-	-	3.85%	0.55%	10.00%	0.23%	1.01%	0.79%	0.77%	0.72%
	A8	0.36%	-	-	-	-	-	3.70%	-	0.87%	-	0.85%	1.26%	0.92%	0.81%	0.84%
	BL	-	-	3.13%	-	-	-	-	-	-	-	0.23%	-	0.39%	0.20%	0.17%
	BR	-	-	-	1.28%	13.51%	-	33.33%	-	0.11%	-	-	-	0.66%	0.53%	0.37%
	CL	-	-	21.88%	1.28%	2.70%	-	-	-	0.11%	-	0.31%	-	0.79%	0.77%	0.60%
	CR	0.36%	-	3.13%	1.28%	8.11%	-	-	-	0.55%	-	-	-	1.58%	0.57%	0.38%
	DL	0.36%	1.41%	6.25%	1.28%	-	-	-	-	0.33%	-	1.00%	0.25%	1.58%	0.90%	0.82%
	DR	-	-	-	1.28%	8.11%	-	7.41%	-	0.44%	-	0.46%	0.25%	2.50%	0.82%	0.61%
	EL	-	-	6.25%	3.85%	2.70%	-	-	-	0.55%	10.00%	2.47%	0.50%	0.92%	1.35%	1.46%
	ER	-	-	-	-	10.81%	-	-	-	1.75%	-	0.69%	1.01%	2.63%	1.25%	1.05%
	FL	1.43%	1.41%	6.25%	2.56%	5.41%	-	-	-	1.20%	-	2.39%	1.01%	1.71%	1.81%	1.83%
	FR	-	1.41%	-	1.28%	2.70%	-	3.70%	-	3.06%	-	0.85%	1.01%	2.23%	1.58%	1.36%
	GL	1.08%	-	9.38%	1.28%	2.70%	-	-	3.85%	1.86%	10.00%	2.70%	1.26%	3.02%	2.28%	2.18%
	GR	1.08%	-	-	3.85%	-	-	-	-	3.06%	-	1.47%	0.75%	3.42%	1.95%	1.70%
	HL	1.08%	-	6.25%	2.56%	-	-	-	3.85%	1.75%	-	4.32%	2.01%	2.63%	2.68%	2.83%
	HR	1.08%	1.41%	3.13%	1.28%	-	-	11.11%	-	4.48%	-	3.17%	1.76%	2.76%	2.98%	2.89%
	IL	1.08%	1.41%	-	1.28%	-	-	11.11%	7.69%	1.86%	10.00%	5.71%	3.27%	2.63%	3.30%	3.64%
	IR	-	-	3.13%	-	2.70%	-	-	-	4.59%	-	3.71%	3.52%	2.50%	3.10%	3.21%
	JL	2.15%	-	-	7.69%	-	-	-	7.69%	3.28%	20.00%	5.56%	5.03%	4.20%	4.13%	4.40%
	JR	0.36%	2.82%	-	1.28%	5.41%	-	-	3.85%	5.68%	-	6.18%	2.01%	3.55%	4.26%	4.33%
	KL	1.08%	-	3.13%	3.85%	2.70%	-	-	11.54%	3.49%	-	4.40%	6.03%	2.37%	3.55%	3.89%
	KR	1.79%	-	3.13%	1.28%	-	-	-	-	5.02%	-	2.70%	2.26%	2.50%	2.91%	2.83%
	LL	1.08%	1.41%	3.13%	3.85%	5.41%	-	-	3.85%	1.53%	-	3.24%	4.27%	3.15%	2.68%	2.85%
	LR	1.43%	1.41%	3.13%	1.28%	2.70%	-	7.41%	-	3.38%	-	1.93%	2.51%	2.63%	2.44%	2.34%
	ML	4.66%	1.41%	-	6.41%	5.41%	-	-	3.85%	2.73%	30.00%	3.24%	6.03%	2.89%	3.49%	3.74%
	MR	1.43%	1.41%	3.13%	-	-	-	-	3.85%	5.13%	-	2.16%	1.51%	2.63%	2.73%	2.51%
	NL	5.38%	4.23%	-	2.56%	-	-	7.41%	7.69%	2.07%	-	3.17%	7.54%	4.34%	3.74%	3.96%
	NR	1.08%	2.82%	-	2.56%	-	-	-	-	4.48%	-	2.16%	2.51%	1.58%	2.50%	2.49%
	OL	8.60%	7.04%	3.13%	10.26%	2.70%	-	-	23.08%	3.71%	10.00%	4.25%	7.54%	4.60%	5.19%	5.29%
	OR	3.94%	7.04%	3.13%	6.41%	5.41%	-	-	-	6.66%	-	4.25%	3.52%	3.94%	4.73%	4.61%
30R Total		100%	100%	100%	100%	100%	-	100%	100%	100%	100%	100%	100%	100%	100%	100%
17	A0	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	-	100.00%
17 Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	-	100%

Table C.10

Annual Average Nighttime Arrival Flight Track Use

Runway	Track	Operational Category													Overall Use	
		CH	CJ	CP	GJ	GP	MJ	MP	NH	NW	PH	PJ	RJ	RP	2002	2007
35	A0	38.29%	27.76%	10.08%	15.09%	7.79%	33.33%	16.98%	20.06%	24.95%	3.96%	20.56%	24.75%	18.21%	-	23.15%
	A1	2.82%	3.86%	0.84%	2.74%	1.56%	-	-	4.94%	3.43%	2.97%	2.86%	5.61%	5.04%	-	3.37%
	A2	11.36%	11.40%	5.88%	6.40%	6.06%	-	7.55%	8.43%	4.33%	5.94%	4.60%	7.81%	6.63%	-	6.18%
	A3	1.23%	1.84%	-	1.68%	1.21%	-	-	2.91%	1.44%	0.99%	1.25%	2.09%	2.39%	-	1.47%
	A4	1.23%	2.57%	0.84%	2.13%	1.90%	-	3.77%	1.16%	1.69%	-	1.56%	1.54%	2.23%	-	1.66%
	A5	0.97%	0.74%	-	0.61%	0.87%	-	1.89%	2.03%	0.95%	-	0.63%	1.43%	1.33%	-	0.86%
	A6	1.06%	1.10%	-	1.37%	0.87%	-	-	0.87%	0.79%	-	1.05%	1.21%	1.27%	-	0.99%
	A7	1.50%	0.74%	1.68%	0.76%	0.17%	-	-	1.45%	0.83%	0.99%	0.56%	1.10%	0.90%	-	0.81%
	A8	0.62%	0.18%	0.84%	0.30%	0.52%	-	1.89%	0.87%	0.74%	0.99%	0.88%	0.77%	0.64%	-	0.72%
	BL	0.09%	0.55%	1.68%	1.37%	7.96%	-	-	-	0.07%	-	0.16%	0.11%	1.22%	-	0.50%
	BR	0.09%	0.18%	1.68%	0.30%	5.54%	-	16.98%	-	0.02%	-	0.07%	-	0.53%	-	0.32%
	CL	-	1.29%	9.24%	2.29%	4.33%	-	1.89%	-	0.29%	0.99%	0.53%	0.55%	1.70%	-	0.85%
	CR	0.26%	0.74%	5.04%	0.91%	5.36%	-	1.89%	0.29%	0.25%	0.99%	0.19%	0.77%	1.38%	-	0.62%
	DL	0.35%	1.84%	3.36%	2.29%	5.19%	-	-	0.87%	0.68%	1.98%	1.60%	0.22%	2.23%	-	1.31%
	DR	0.70%	1.10%	5.04%	2.44%	5.19%	-	3.77%	-	0.68%	0.99%	0.60%	1.10%	1.96%	-	1.06%
	EL	0.53%	1.65%	8.40%	3.20%	3.81%	-	-	2.62%	1.31%	4.95%	2.53%	0.99%	3.13%	-	2.03%
	ER	1.41%	1.47%	3.36%	1.22%	4.50%	-	-	0.29%	0.86%	0.99%	0.86%	2.75%	2.60%	-	1.39%
	FL	0.97%	2.39%	4.20%	3.35%	2.77%	-	1.89%	2.33%	2.30%	2.97%	3.28%	1.21%	2.92%	-	2.53%
	FR	1.06%	2.21%	1.68%	1.37%	3.63%	-	1.89%	0.29%	1.67%	0.99%	1.51%	1.43%	1.54%	-	1.59%
	GL	1.06%	3.31%	7.56%	3.81%	3.46%	-	3.77%	3.20%	3.04%	7.92%	4.48%	1.65%	3.50%	-	3.41%
	GR	1.41%	1.84%	3.36%	3.05%	2.94%	-	-	0.87%	2.05%	0.99%	2.16%	1.65%	2.60%	-	2.07%
	HL	2.02%	3.31%	5.04%	5.03%	3.29%	16.67%	-	4.36%	4.08%	8.91%	4.34%	1.87%	3.03%	-	3.71%
	HR	2.29%	1.65%	2.52%	2.59%	2.08%	-	5.66%	3.49%	2.37%	2.97%	2.56%	2.09%	2.28%	-	2.37%
	IL	2.46%	3.13%	0.84%	5.34%	0.87%	16.67%	7.55%	6.10%	5.00%	13.86%	6.48%	3.63%	2.71%	-	4.82%
	IR	1.85%	1.65%	3.36%	4.42%	2.60%	-	-	2.33%	3.11%	4.95%	3.32%	2.20%	2.81%	-	2.91%
	JL	17.25%	14.71%	8.40%	15.09%	6.92%	16.67%	13.21%	24.71%	15.87%	26.73%	16.50%	21.12%	14.76%	-	16.36%
	JR	7.13%	6.80%	5.04%	10.82%	8.65%	16.67%	9.43%	5.52%	17.20%	2.97%	14.87%	10.34%	10.46%	-	12.91%
35 Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	-	100%

Note: Totals may not equal 100% due to rounding.

Source: Data for existing runways from ANOMS and HNTB analysis; Runway 17/35 data estimated from arrival track use on existing runways

APPENDIX D

NOISE ABATEMENT DEPARTURE PROFILES

FAA Advisory Circular (AC) 91-53A, published in 1993, establishes guidelines for Noise Abatement Departure Profiles (NADP). The AC is general, and defines guidelines and minimum operating parameters for airlines to use in developing operating procedures. It does not detail exact, aircraft type-specific procedures due to their complexity.

The AC establishes the following distinct NADPs:

Close-In NADP

The Close-In NADP reduces noise slightly for communities within the immediate vicinity of the runway end - approximately 3.5 miles from the start of takeoff roll.

A generic example of Close-In NADP:

- Takeoff using takeoff power and flaps. This may include derate thrust takeoffs.
- At 1,000 feet, reduce power to climb thrust. Maintain takeoff flaps. Slight acceleration.
- At 3,000 feet, reduce rate of climb by half and accelerate.
- As airplane accelerates, retract flaps and then slats.
- Accelerate to 250 knots and continue climb.

Distant NADP

This is the normal takeoff procedure. The Distant NADP reduces noise slightly for other communities that are not within the immediate vicinity of the runway end - beyond approximately 3.5 miles from the start of takeoff roll.

A generic example of Distant NADP:

- Takeoff using takeoff power and flaps. This may derate thrust takeoffs.
- At 1,000 feet, reduce rate of climb and accelerate.
- As airplane accelerates, retract flaps and slats.
- After flaps are retracted, reduce power to climb thrust.
- At 3,000 feet, lower nose to accelerate. Continue climb at 250 knots.

When using a Close-In NADP, the aircraft reduces thrust sooner, and maintains takeoff flaps longer, than in a Distant NADP. This results in a quick climb, and allows the aircraft to "pop" up over communities close to the airport and reduce noise exposure. This slightly reduces noise exposure for homes within the immediate vicinity of the airport.

After reaching 3,000 feet, however, the Close-In NADP aircraft must substantially reduce its rate of climb and accelerate to a sufficient airspeed to retract flaps and slats. Although the aircraft is slightly higher, it is also slower and at a higher thrust setting than aircraft using a Distant NADP. Beyond the immediate vicinity of the airport, this results in a slight increase in noise exposure.

Generally, the Close-In NADP slightly reduces impacted population within the 65 DNL contour. The Distant NADP, however, reduces impacted population within the 60-65 DNL contour. For

modern, high-performance jet aircraft (such as the A320, B757, and B717) the difference in noise between a Close-In and Distant NADP is minimal.

The AC does not allow airports to develop their own, unique procedures due to safety issues. The AC establishes a standardized system so that an aircraft will use the same operating procedures throughout the world. Each airline develops specific procedures for flying NADPs that are approved by the FAA and that must comply with the provisions of the AC. Airports are permitted to decide the appropriate NADP to use on each runway end. Unless otherwise instructed, airlines will typically use the Distant NADP.

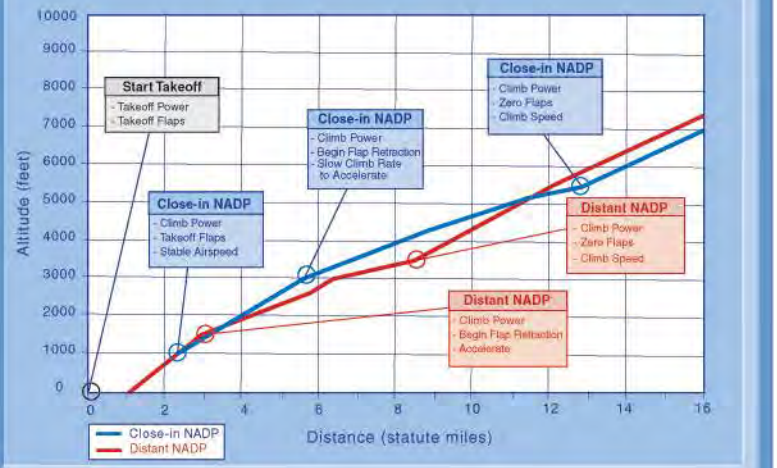
Figures D-1 through D-3 show typical NADP operating procedures for A320- and DC9-type aircraft, along with a depiction of the areas that benefit from either the Close-In or Distant NADPs.

Figures D-4 through D-7 show the correlation between actual radar takeoff profiles and INM-generated takeoff profiles for typical aircraft operating at MSP. The radar takeoff profiles are composed of small boxes that mark points along the profile. The INM-generated takeoff profile is shown as a single, continuous line.

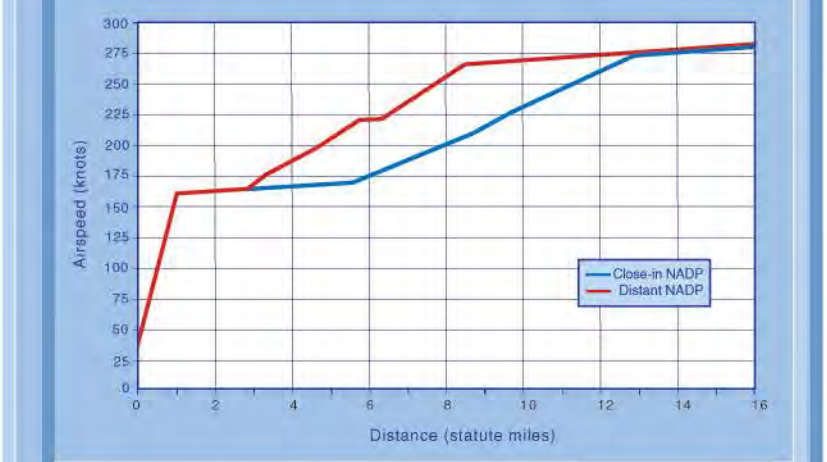
A320 Noise Abatement Departure Profiles

Figure D-1

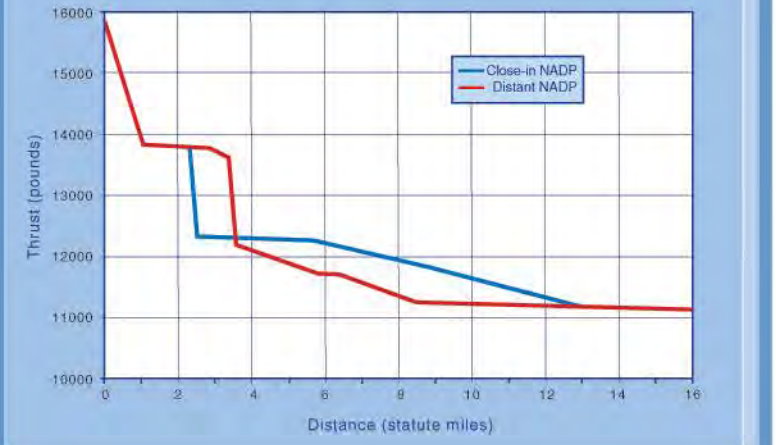
A320 Takeoff Profiles



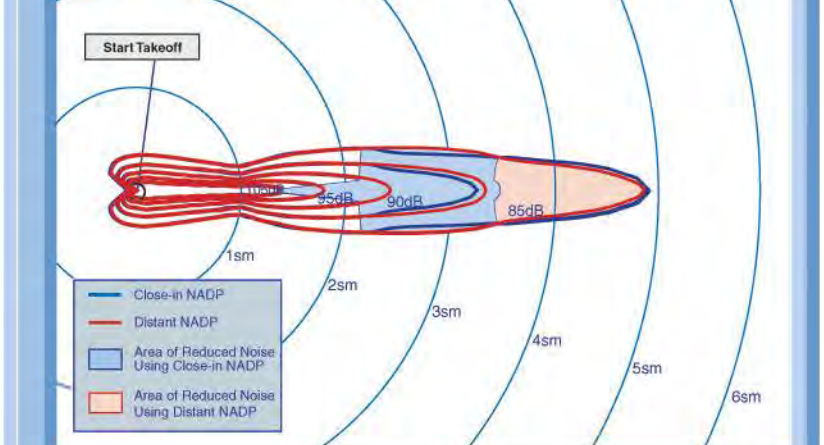
A320 Airspeed



A320 - Engine Thrust

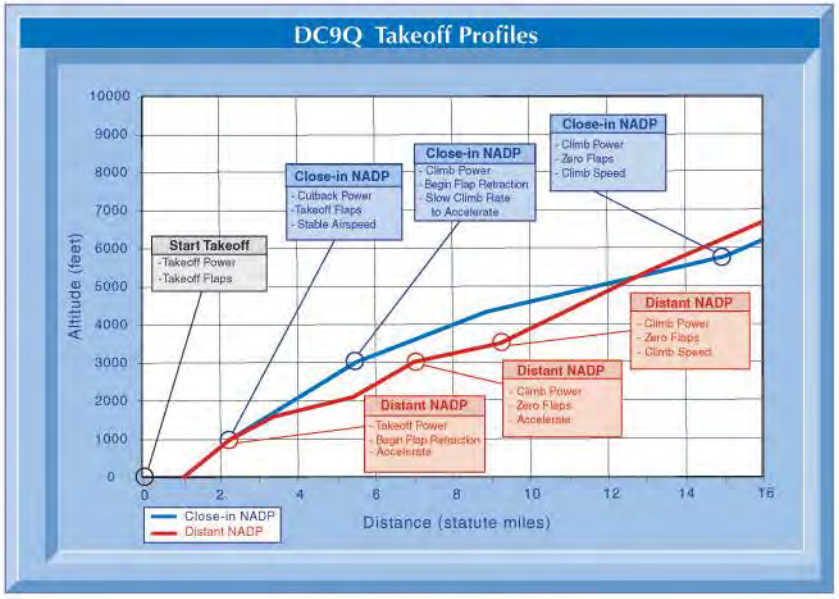


A320 SEL NADP Comparison for SEL ≥85dB



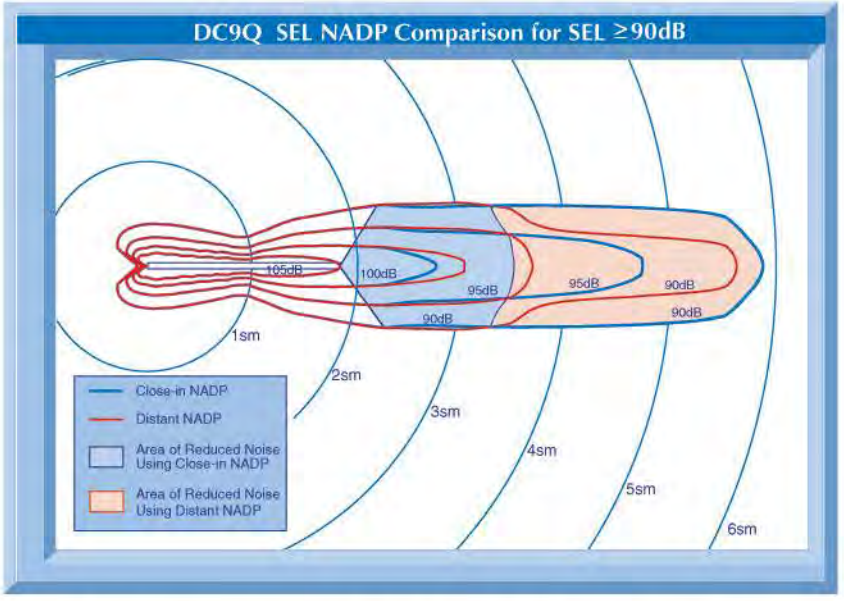
DC9Q Noise Abatement Departure Profiles

Figure D-2









Comparison of DNL Contours for Noise Abatement Departure Profiles

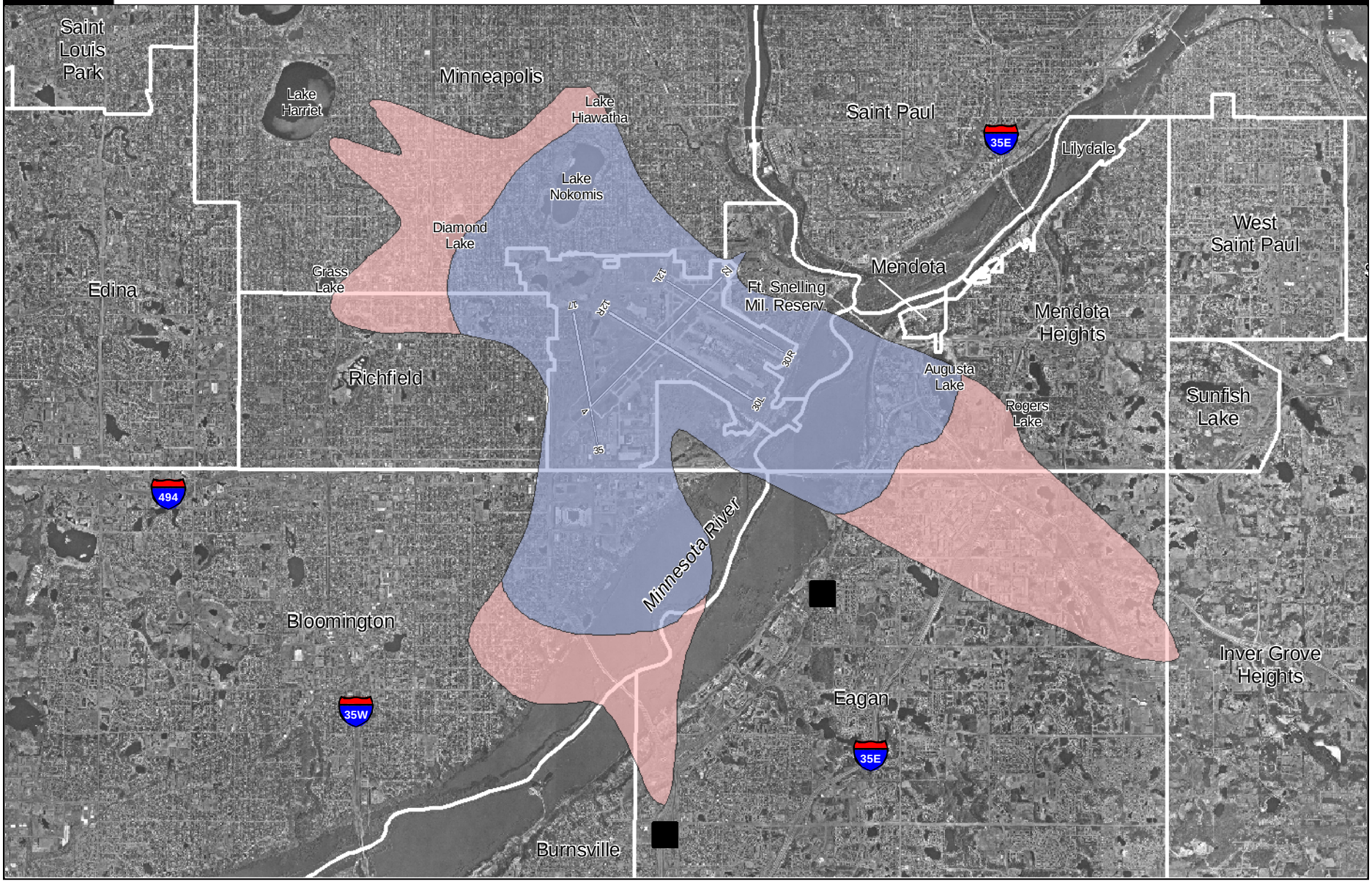
Area of Reduced Noise Using Distant NAPD

Area of Reduced Noise Using Close-In NADP

0 1 2 Miles

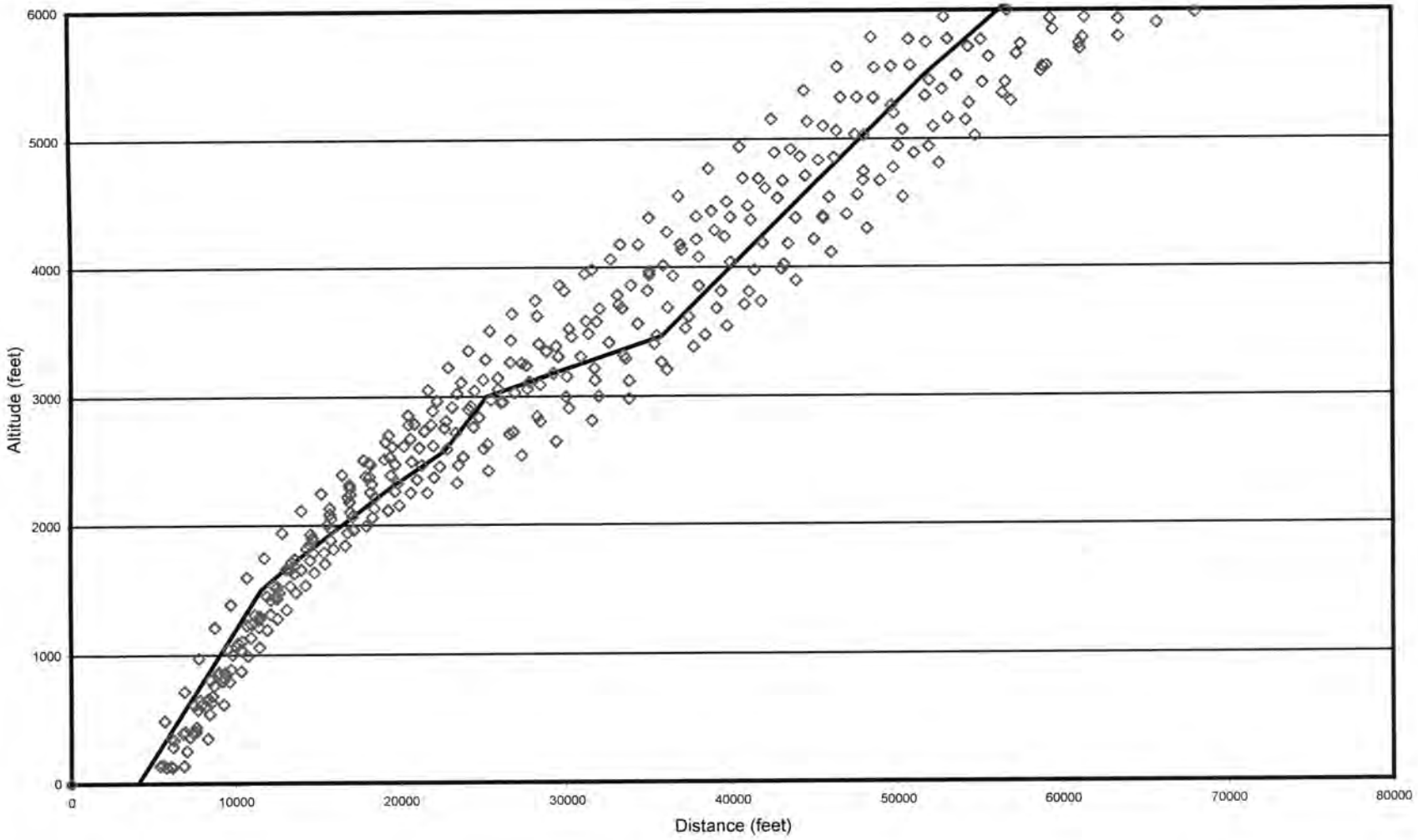
N

Figure D-3



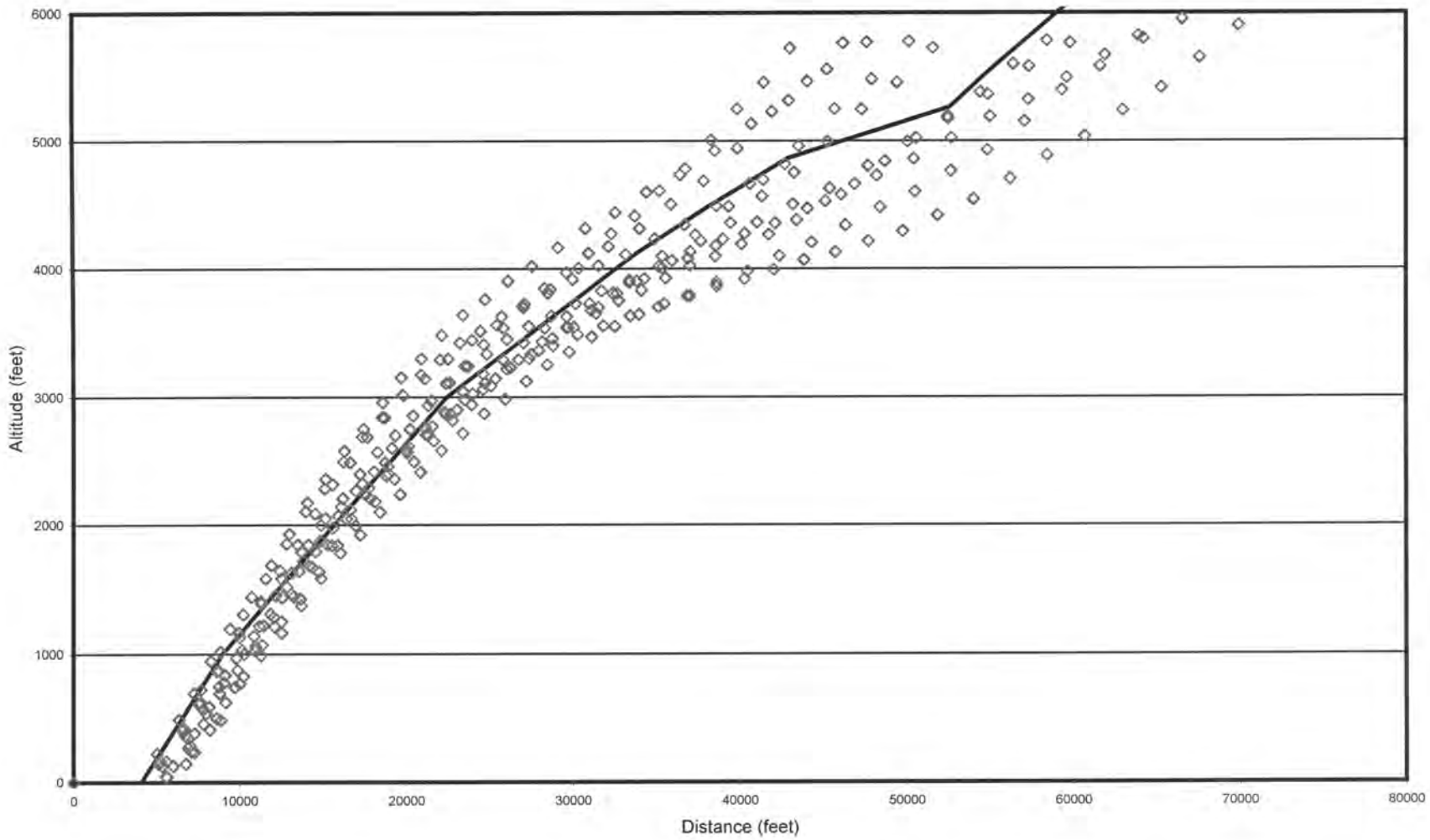
Comparison of Modeled and Actual Takeoff Profiles for A320 Using Distant NADP

Figure D-4



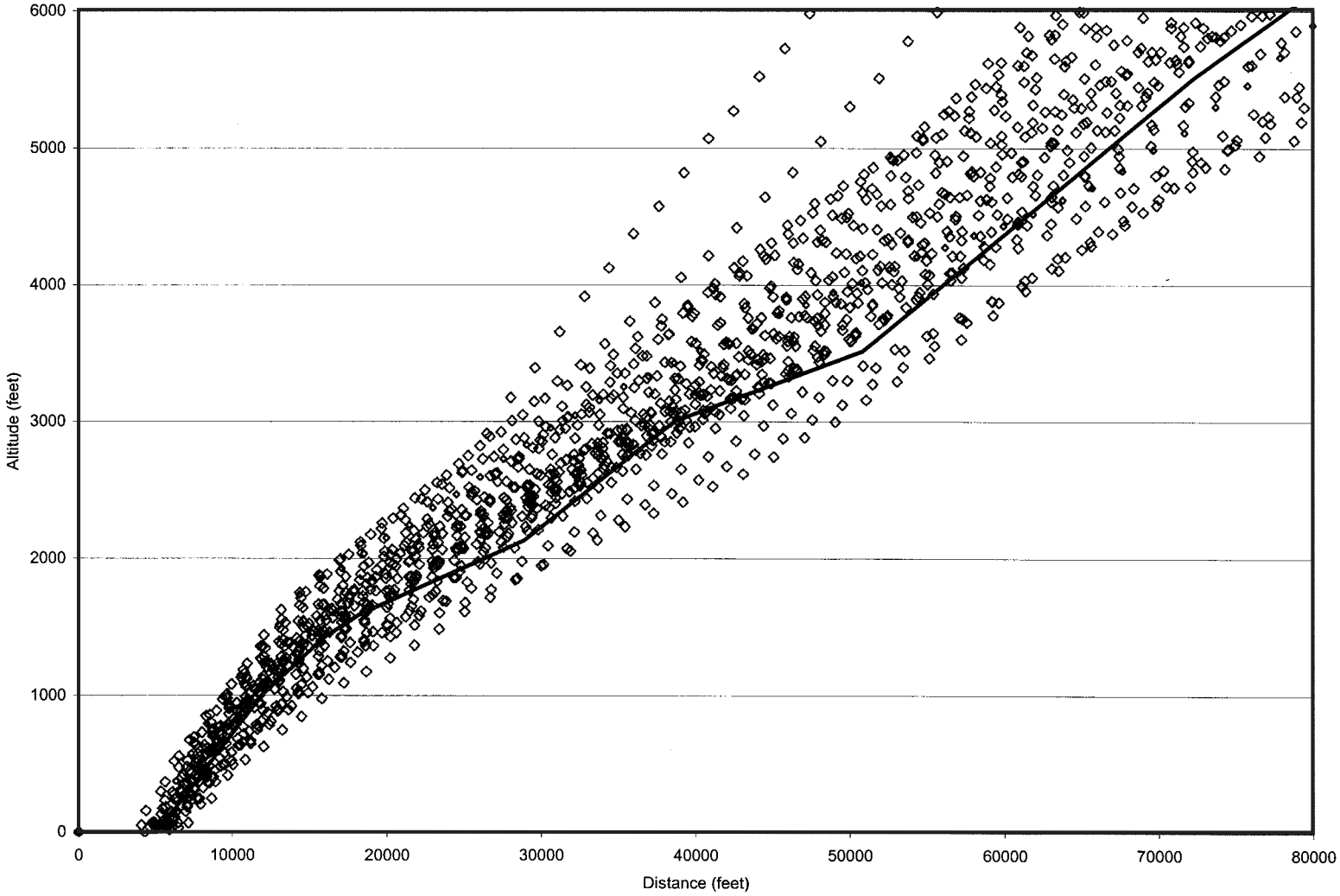
Comparison of Modeled and Actual Takeoff Profiles for A320 Using Close-In NADP

Figure D-5



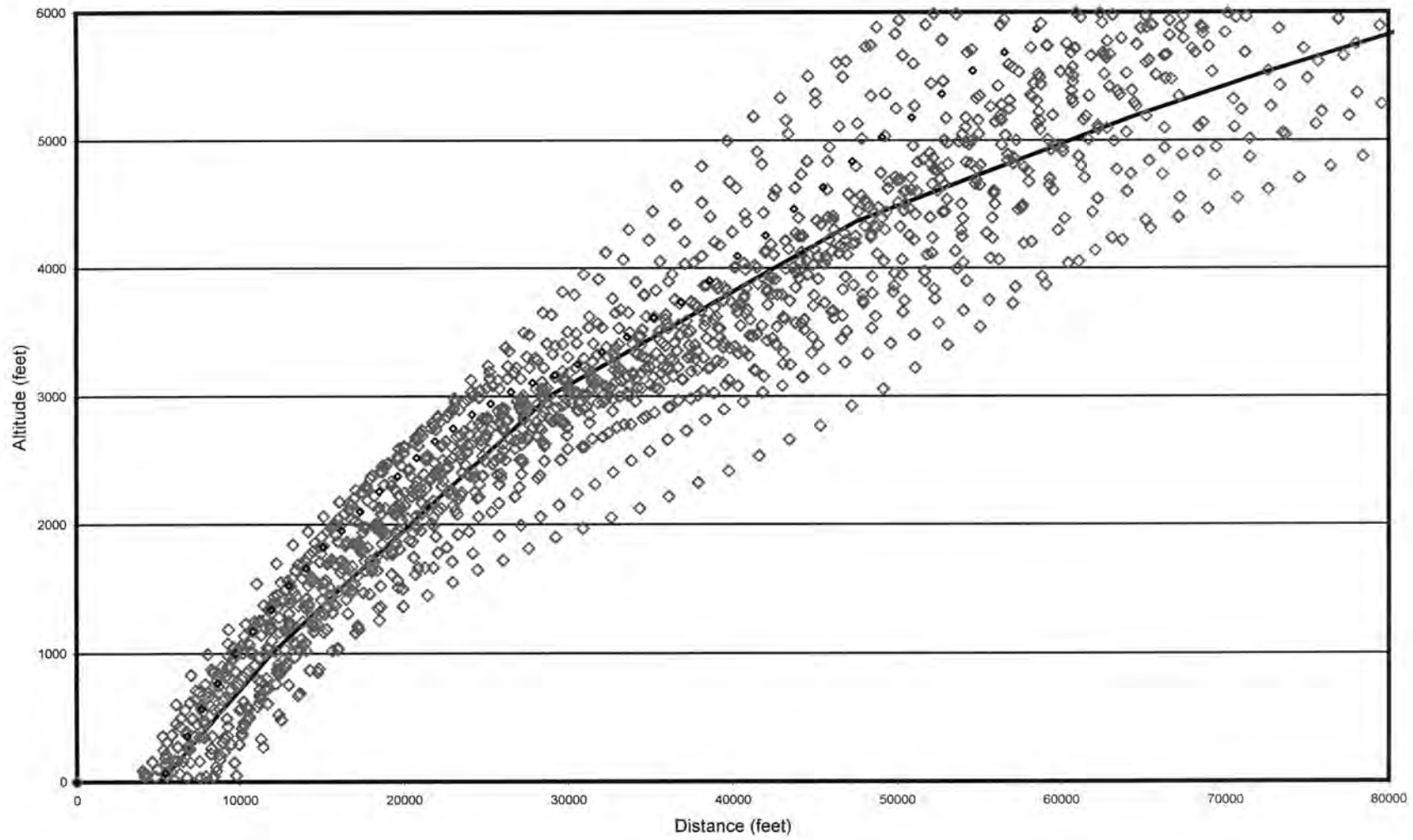
Comparison of Modeled and Actual Takeoff Profiles for DC9Q Using Distant NADP

Figure D-6



Comparison of Modeled and Actual Takeoff Profiles for DC9Q Using Close-In NADP

Figure D-7



APPENDIX E

2007 NO-BUILD RUNWAY 17/35 SENSITIVITY ANALYSIS

A sensitivity analysis was completed to assess the impact of Runway 17/35 on the size and shape of the 2007 Unmitigated 60 DNL contour.

The "no-build" scenario used the following assumptions:

- Runway use would be equivalent to the 2002 existing average annual runway use, as shown in Table 4.7.

- Growth in forecast air traffic would not be constrained by capacity shortcomings that would occur without Runway 17/35.

- Approximately seven-percent of daytime operations would be pushed into nighttime, due to capacity constraints and increased delays that would occur without Runway 17/35 (based on SIMMOD analysis).

Figure E-1 shows the 2007 No-Build Runway 17/35 DNL contour as compared to the 2007 Unmitigated DNL contour.

The 2007 No-Build Runway 17/35 Case contains 65,886 people and 27,472 dwellings within the 60 DNL contour, as shown in **Table E.1**. This is an increase of 25,455 people and 10,355 dwellings relative to the 2007 Unmitigated NEM. Because operations from Runway 17/35 will predominantly overfly the Minnesota River Valley area, use of Runway 17/35 will reduce the total noise-impacted population and dwellings.

Table E.1

Population and Dwelling Impacts - 2007 No-Build Runway 17/35 Sensitivity Analysis

	60-64 DNL		65-69 DNL		70-74 DNL		75+ DNL		Total	
City	**Population**	**Dwellings**	**Population**	**Dwellings**	**Population**	**Dwellings**	**Population**	**Dwellings**	**Population**	**Dwellings**
Bloomington	-	-	-	-	-	-	-	-	-	-
Burnsville	-	-	-	-	-	-	-	-	-	-
Eagan	2,587	957	345	106	-	-	-	-	2,932	1,063
Edina	-	-	-	-	-	-	-	-	-	-
Inver Grove Heights	1,016	420	-	-	-	-	-	-	1,016	420
Mendota	54	23	-	-	-	-	-	-	54	23
Mendota Heights	1,356	561	189	74	3	1	-	-	1,548	636
Minneapolis	32,368	13,322	11,786	4,786	4,543	1,901	6	3	48,703	20,012
Richfield	9,857	4,542	1,592	657	184	74	-	-	11,633	5,273
Total	47,238	19,825	13,912	5,623	4,730	1,976	6	3	65,886	27,427

Source: HNTB analysis

2007 No-Build Runway 17/35 Sensitivity Analysis

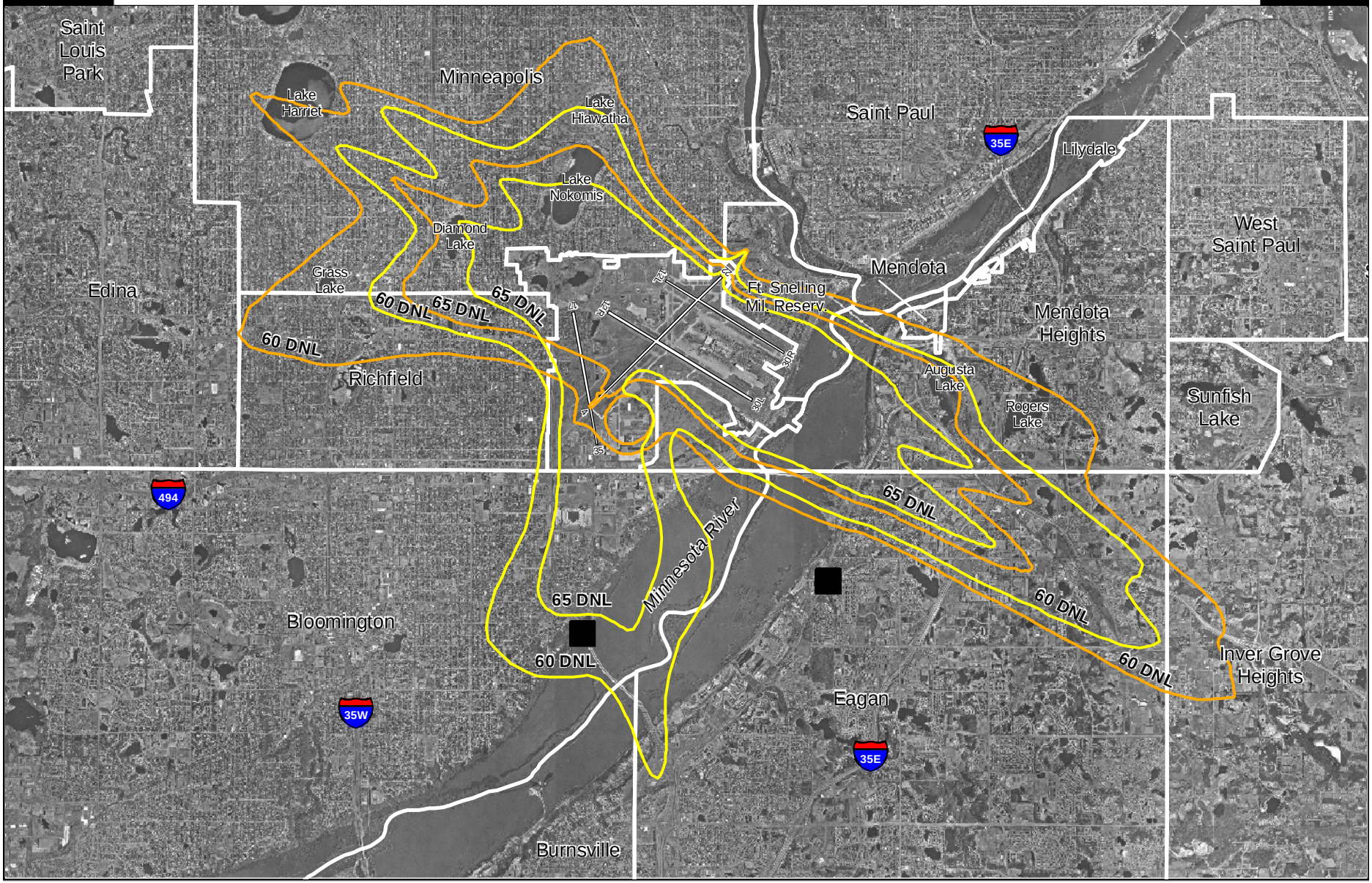
2007 Unmitigated NEM

2007 No-Build Runway 17-35 DNL Contour

0 1 2 Miles

N

Figure E-1



APPENDIX F

DETAILED LAND USE COMPATIBILITY DATA

Table F.1

Estimated Acreage within DNL Contour Intervals for 2002 NEM

Land Use	Acreage Within DNL Contour Interval (dB)				
	60-64 dB	65-69 dB	70-74 dB	75+ dB	Total
Bloomington					
Single-Family Residential	-	-	-	-	-
Multi-Family Residential	-	-	-	-	-
Mobile Home Residential	-	-	-	-	-
Nursing Home	-	-	-	-	-
Place of Worship	-	-	-	-	-
School	-	-	-	-	-
Recreation/Open Space	312	-	-	-	312
Government/Public	-	-	-	-	-
Commercial/Office	-	-	-	-	-
Industrial	-	-	-	-	-
Agriculture	-	-	-	-	-
Vacant	-	-	-	-	-
Unclassified	-	-	-	-	-
Total	312	-	-	-	312
Burnsville	**No acreage within 60 DNL contour**				
Eagan					
Single-Family Residential	379	44	-	-	423
Multi-Family Residential	20	-	-	-	20
Mobile Home Residential	-	-	-	-	-
Nursing Home	-	-	-	-	-
Place of Worship	10	-	-	-	10
School	-	-	-	-	-
Recreation/Open Space	539	85	69	-	693
Government/Public	186	3	-	-	189
Commercial/Office	700	205	18	-	923
Industrial	553	182	-	-	735
Agriculture	17	-	-	-	17
Vacant	75	1	-	-	76
Unclassified	51	-	1	-	52
Total	2,530	520	88	-	3,138
Edina					
Single-Family Residential	7	-	-	-	7
Multi-Family Residential	50	-	-	-	50
Mobile Home Residential	-	-	-	-	-
Nursing Home	2	-	-	-	2
Place of Worship	-	-	-	-	-
School	-	-	-	-	-
Recreation/Open Space	1	-	-	-	1
Government/Public	-	-	-	-	-
Commercial/Office	187	-	-	-	187
Industrial	-	-	-	-	-
Agriculture	-	-	-	-	-
Vacant	-	-	-	-	-
Unclassified	-	-	-	-	-
Total	247	-	-	-	247
Inver Grove Heights					
Single-Family Residential	56	-	-	-	56
Multi-Family Residential	-	-	-	-	-
Mobile Home Residential	76	-	-	-	76
Nursing Home	-	-	-	-	-
Place of Worship	35	-	-	-	35
School	-	-	-	-	-
Recreation/Open Space	-	-	-	-	-
Government/Public	1	-	-	-	1
Commercial/Office	4	-	-	-	4
Industrial	-	-	-	-	-
Agriculture	-	-	-	-	-
Vacant	-	-	-	-	-
Unclassified	1	-	-	-	1
Total	173	-	-	-	173

Table F.1

Estimated Acreage within DNL Contour Intervals for 2002 NEM

Land Use	Acreage Within DNL Contour Interval (dB)				
	60-64 dB	65-69 dB	70-74 dB	75+ dB	Total
Mendota					
Single-Family Residential	7	-	-	-	7
Multi-Family Residential	-	-	-	-	-
Mobile Home Residential	-	-	-	-	-
Nursing Home	-	-	-	-	-
Place of Worship	4	-	-	-	4
School	-	-	-	-	-
Recreation/Open Space	-	-	-	-	-
Government/Public	4	-	-	-	4
Commercial/Office	-	-	-	-	-
Industrial	-	-	-	-	-
Agriculture	-	-	-	-	-
Vacant	1	-	-	-	1
Unclassified	32	-	-	-	32
Total	48	-	-	-	48
Mendota Heights					
Single-Family Residential	101	40	-	-	141
Multi-Family Residential	24	21	-	-	45
Mobile Home Residential	-	-	-	-	-
Nursing Home	-	-	-	-	-
Place of Worship	25	-	-	-	25
School	152	-	-	-	152
Recreation/Open Space	152	85	-	-	237
Government/Public	44	363	34	-	441
Commercial/Office	72	88	29	-	189
Industrial	11	212	3	-	226
Agriculture	-	-	-	-	-
Vacant	5	16	394	-	415
Unclassified	6	30	1	-	37
Total	592	855	461	-	1,908
Minneapolis					
Single-Family Residential	2,007	624	106	-	2,737
Multi-Family Residential	148	66	17	-	231
Mobile Home Residential	-	-	-	-	-
Nursing Home	6	2	-	-	8
Place of Worship	37	12	1	-	50
School	63	10	4	-	77
Recreation/Open Space	291	182	64	-	537
Government/Public	81	23	-	-	104
Commercial/Office	65	46	1	62	174
Industrial	1	28	-	-	29
Agriculture	1	-	-	-	1
Vacant	48	21	3	-	72
Unclassified	1	1	-	-	2
Total	2,749	1,015	196	62	4,022
Richfield					
Single-Family Residential	691	187	4	-	882
Multi-Family Residential	64	14	-	-	78
Mobile Home Residential	-	-	-	-	-
Nursing Home	-	-	-	-	-
Place of Worship	11	-	-	-	11
School	38	1	-	-	39
Recreation/Open Space	216	125	14	-	355
Government/Public	1	-	-	-	1
Commercial/Office	113	9	4	-	126
Industrial	2	-	-	-	2
Agriculture	-	-	-	-	-
Vacant	14	10	2	-	26
Unclassified	1	-	-	-	1
Total	1,151	346	24	-	1,521
St. Paul	**No acreage within 60 DNL contour**				
Sunfish Lake	**No acreage within 60 DNL contour**				

Source: HNTB analysis

Table F.2

Estimated Noise-Sensitive Structures within DNL Contour Intervals for 2002 NEM

Schools	**Number Within DNL Interval (dB)**				
CITY	**60-64**	**65-69**	**70-74**	**Within 75**	**Total**
Bloomington	-	-	-	-	-
Eagan	-	-	-	-	-
Edina	1	-	-	-	1
Inver Grove Heights	-	-	-	-	-
Mendota	-	-	-	-	-
Mendota Hgts	3	-	-	-	3
Minneapolis	14	4	1	-	19
Richfield	5	-	-	-	5
St. Paul	-	-	-	-	-
Sunfish Lake	-	-	-	-	-
Total	23	4	1	-	28
Places of Worship	**Number Within DNL Interval (dB)**				
CITY	**60-64**	**65-69**	**70-74**	**Within 75**	**Total**
Bloomington	-	-	-		-
Eagan	1	-	-	-	1
Edina	-	-	-	-	-
Inver Grove Heights	1	-	-	-	1
Mendota	1	-	-	-	1
Mendota Hgts	2	-	-	-	2
Minneapolis	31	13	-	-	44
Richfield	6	-	-	-	6
St. Paul	-	-	-	-	-
Sunfish Lake	-	-	-	-	-
Total	42	13	-	-	55
Nursing Homes	**Number Within DNL Interval (dB)**				
CITY	**60-64**	**65-69**	**70-74**	**Within 75**	**Total**
Bloomington	-	-	-	-	-
Eagan	-	-	-	-	-
Edina	1	-	-	-	1
Inver Grove Heights	-	-	-	-	-
Mendota	-	-	-	-	-
Mendota Hgts	-	-	-	-	-
Minneapolis	2	1	-	-	3
Richfield	-	-	-	-	-
St. Paul	-	-	-	-	-
Sunfish Lake	-	-	-	-	-
Total	3	1	-	-	4
Pre-schools	**Number Within DNL Interval (dB)**				
CITY	**60-64**	**65-69**	**70-74**	**Within 75**	**Total**
Bloomington	-	-	-	-	-
Eagan	2	-	-	-	2
Edina	-	-	-	-	-
Inver Grove Heights	-	-	-	-	-
Mendota	-	-	-	-	-
Mendota Hgts	1	-	-	-	1
Minneapolis	8	5	-	-	13
Richfield	3	-	-	-	3
St. Paul	-	-	-	-	-
Sunfish Lake	-	-	-	-	-
Total	14	5	-	-	19
Historical Structures	**Number Within DNL Interval (dB)**				
CITY	**60-64**	**65-69**	**70-74**	**Within 75**	**Total**
Bloomington	-	-	-	-	-
Eagan	-	-	-	-	-
Edina	-	-	-	-	-
Inver Grove Heights	-	-	-	-	-
Mendota	-	-	-	-	-
Mendota Hgts	1	1	-	-	2
Minneapolis	24	92	-	-	116
Richfield	2	-	-	-	2
St. Paul	-	-	-	-	-
Sunfish Lake	-	-	-	-	-
Total	27	93	-	-	120

Source: HNTB Analysis

Table F.3

Estimated Acreage within DNL Contour Intervals for the 2007 Unmitigated NEM

Land Use	Acreage Within DNL Contour Interval (dB)				
	60-64 dB	65-69 dB	70-74 dB	75+ dB	Total
Bloomington					
Single-Family Residential	397	111	64	-	572
Multi-Family Residential	39	63	6	-	108
Mobile Home Residential	-	-	-	-	-
Nursing Home	1	-	-	-	1
Place of Worship	36	13	-	-	49
School	2	-	-	-	2
Recreation/Open Space	751	818	212	-	1,781
Government/Public	-	1	-	1	2
Commercial/Office	63	93	172	10	338
Industrial	14	16	8	13	51
Agriculture	1	1	58	-	60
Vacant	2	3	1	-	6
Unclassified	-	1	-	-	1
Total	1,306	1,120	521	24	2,971
Burnsville					
Single-Family Residential	-	-	-	-	-
Multi-Family Residential	-	-	-	-	-
Mobile Home Residential	-	-	-	-	-
Nursing Home	-	-	-	-	-
Place of Worship	-	-	-	-	-
School	-	-	-	-	-
Recreation/Open Space	247	-	-	-	247
Government/Public	-	-	-	-	-
Commercial/Office	-	-	-	-	-
Industrial	-	-	-	-	-
Agriculture	-	-	-	-	-
Vacant	-	-	-	-	-
Unclassified	1	-	-	-	1
Total	248	-	-	-	248
Eagan					
Single-Family Residential	283	13	-	-	296
Multi-Family Residential	20	-	-	-	20
Mobile Home Residential	-	-	-	-	-
Nursing Home	-	-	-	-	-
Place of Worship	10	-	-	-	10
School	-	-	-	-	-
Recreation/Open Space	873	142	-	-	1,015
Government/Public	206	-	-	-	206
Commercial/Office	618	145	-	-	763
Industrial	566	136	-	-	702
Agriculture	17	-	-	-	17
Vacant	65	1	-	-	66
Unclassified	41	1	-	-	42
Total	2,699	438	-	-	3,137
Edina	**No acreage within 60 DNL contour**				
Inver Grove Heights	**No acreage within 60 DNL contour**				
Mendota	**No acreage within 60 DNL contour**				
Mendota Heights					
Single-Family Residential	40	3	-	-	43
Multi-Family Residential	27	-	-	-	27
Mobile Home Residential	-	-	-	-	-
Nursing Home	-	-	-	-	-
Place of Worship	-	-	-	-	-
School	26	-	-	-	26
Recreation/Open Space	78	85	329	-	492
Government/Public	309	99	-	-	408
Commercial/Office	76	61	-	-	137
Industrial	51	176	-	-	227
Agriculture	-	-	-	-	-
Vacant	3	14	-	-	17
Unclassified	3	28	-	-	31
Total	613	466	329	-	1,408

Table F.3

Estimated Acreage within DNL Contour Intervals for the 2007 Unmitigated NEM

Land Use	Acreage Within DNL Contour Interval (dB)				
	60-64 dB	65-69 dB	70-74 dB	75+ dB	Total
Minneapolis					
Single-Family Residential	880	379	41	-	1,300
Multi-Family Residential	95	34	3	-	132
Mobile Home Residential	-	-	-	-	-
Nursing Home	1	-	-	-	1
Place of Worship	12	3	-	-	15
School	23	4	4	-	31
Recreation/Open Space	257	163	37	-	457
Government/Public	24	-	-	-	24
Commercial/Office	40	3	62	-	105
Industrial	28	-	-	-	28
Agriculture	-	-	-	-	-
Vacant	16	12	1	-	29
Unclassified	1	1	-	-	2
Total	1,377	599	148	-	2,124
Richfield					
Single-Family Residential	207	59	-	-	266
Multi-Family Residential	29	2	1	-	32
Mobile Home Residential	-	-	-	-	-
Nursing Home	-	-	-	-	-
Place of Worship	1	-	-	-	1
School	2	-	-	-	2
Recreation/Open Space	23	111	12	-	146
Government/Public	-	-	-	-	-
Commercial/Office	24	4	4	-	32
Industrial	-	-	-	-	-
Agriculture	-	-	-	-	-
Vacant	6	10	4	-	20
Unclassified	-	-	-	-	-
Total	292	186	21	-	499
St. Paul	**No acreage within 60 DNL contour**				
Sunfish Lake	**No acreage within 60 DNL contour**				

Source: HNTB analysis

Table F.4

Estimated Noise-Sensitive Structures within DNL Contour Intervals for the 2007 Unmitigated NEM

Schools	**Number Within DNL Interval (dB)**				
CITY	**60-64**	**65-69**	**70-74**	**Within 75**	**Total**
Bloomington	1	1	-	-	2
Eagan	-	-	-	-	-
Edina	-	-	-	-	-
Inver Grove Heights	-	-	-	-	-
Mendota	-	-	-	-	-
Mendota Hgts	1	-	-	-	1
Minneapolis	5	-	1	-	6
Richfield	2	-	-	-	2
St. Paul	-	-	-	-	-
Sunfish Lake	-	-	-	-	-
Total	9	1	1	-	11
Places of Worship	**Number Within DNL Interval (dB)**				
CITY	**60-64**	**65-69**	**70-74**	**Within 75**	**Total**
Bloomington	2	2	-		4
Eagan	1	-	-	-	1
Edina	-	-	-	-	-
Inver Grove Heights	-	-	-	-	-
Mendota	-	-	-	-	-
Mendota Hgts	-	-	-	-	-
Minneapolis	14	6	-	-	20
Richfield	2	-	-	-	2
St. Paul	-	-	-	-	-
Sunfish Lake	-	-	-	-	-
Total	19	8	-	-	27
Nursing Homes	**Number Within DNL Interval (dB)**				
CITY	**60-64**	**65-69**	**70-74**	**Within 75**	**Total**
Bloomington	1	-	-	-	1
Eagan	-	-	-	-	-
Edina	-	-	-	-	-
Inver Grove Heights	-	-	-	-	-
Mendota	-	-	-	-	-
Mendota Hgts	-	-	-	-	-
Minneapolis	-	-	-	-	-
Richfield	-	-	-	-	-
St. Paul	-	-	-	-	-
Sunfish Lake	-	-	-	-	-
Total	1	-	-	-	1
Pre-schools	**Number Within DNL Interval (dB)**				
CITY	**60-64**	**65-69**	**70-74**	**Within 75**	**Total**
Bloomington	1	2	-	-	3
Eagan	2	-	-	-	2
Edina	-	-	-	-	-
Inver Grove Heights	-	-	-	-	-
Mendota	-	-	-	-	-
Mendota Hgts	-	-	-	-	-
Minneapolis	5	2	-	-	7
Richfield	1	-	-	-	1
St. Paul	-	-	-	-	-
Sunfish Lake	-	-	-	-	-
Total	9	4	-	-	13
Historical Structures	**Number Within DNL Interval (dB)**				
CITY	**60-64**	**65-69**	**70-74**	**Within 75**	**Total**
Bloomington	1	-	-	-	1
Eagan	-	-	-	-	-
Edina	-	-	-	-	-
Inver Grove Heights	-	-	-	-	-
Mendota	-	-	-	-	-
Mendota Hgts	1	-	-	-	1
Minneapolis	47	60	-	-	107
Richfield	-	-	-	-	-
St. Paul	-	-	-	-	-
Sunfish Lake	-	-	-	-	-
Total	49	60	-	-	109

Source: HNTB Analysis

Table F.5

Estimated Acreage within DNL Contour Intervals for the 2007 Mitigated NEM

Land Use	Acreage Within DNL Contour Interval (dB)				
	60-64 dB	65-69 dB	70-74 dB	75+ dB	Total
Bloomington					
Single-Family Residential	85	38	68	-	191
Multi-Family Residential	40	15	6	-	61
Mobile Home Residential	-	-	-	-	-
Nursing Home	-	-	-	-	-
Place of Worship	-	10	-	-	10
School	2	-	-	-	2
Recreation/Open Space	731	894	226	-	1,851
Government/Public	1	-	-	1	2
Commercial/Office	66	64	173	21	324
Industrial	10	7	16	13	46
Agriculture	1	-	59	-	60
Vacant	2	1	2	-	5
Unclassified	-	1	-	-	1
Total	938	1,030	550	35	2,553
Burnsville					
Single-Family Residential	-	-	-	-	-
Multi-Family Residential	-	-	-	-	-
Mobile Home Residential	-	-	-	-	-
Nursing Home	-	-	-	-	-
Place of Worship	-	-	-	-	-
School	-	-	-	-	-
Recreation/Open Space	457	-	-	-	457
Government/Public	95	-	-	-	95
Commercial/Office	-	-	-	-	-
Industrial	-	-	-	-	-
Agriculture	-	-	-	-	-
Vacant	-	-	-	-	-
Unclassified	17	-	-	-	17
Total	569	-	-	-	569
Eagan					
Single-Family Residential	282	9	-	-	291
Multi-Family Residential	5	-	-	-	5
Mobile Home Residential	-	-	-	-	-
Nursing Home	-	-	-	-	-
Place of Worship	10	-	-	-	10
School	-	-	-	-	-
Recreation/Open Space	1,035	123	-	-	1,158
Government/Public	205	-	-	-	205
Commercial/Office	649	120	-	-	769
Industrial	498	124	-	-	622
Agriculture	17	-	-	-	17
Vacant	66	1	-	-	67
Unclassified	41	1	-	-	42
Total	2,808	378	-	-	3,186
Edina	**No acreage within 60 DNL contour**				
Inver Grove Heights	**No acreage within 60 DNL contour**				
Mendota	**No acreage within 60 DNL contour**				

Table F.5

Estimated Acreage within DNL Contour Intervals for the 2007 Mitigated NEM

Mendota Heights					
Single-Family Residential	37	5	-	-	42
Multi-Family Residential	45	-	-	-	45
Mobile Home Residential	-	-	-	-	-
Nursing Home	-	-	-	-	-
Place of Worship	18	-	-	-	18
School	26	-	-	-	26
Recreation/Open Space	82	114	309	-	505
Government/Public	292	138	1	-	431
Commercial/Office	75	70	-	-	145
Industrial	30	197	-	-	227
Agriculture	-	-	-	-	-
Vacant	3	14	-	-	17
Unclassified	6	29	-	-	35
Total	614	567	310	-	1,491
Minneapolis					
Single-Family Residential	871	361	38	-	1,270
Multi-Family Residential	90	34	2	-	126
Mobile Home Residential	-	-	-	-	-
Nursing Home	-	-	-	-	-
Place of Worship	12	3	-	-	15
School	23	4	4	-	31
Recreation/Open Space	253	163	37	-	453
Government/Public	19	-	-	-	19
Commercial/Office	38	3	62	-	103
Industrial	27	-	-	-	27
Agriculture	-	-	-	-	-
Vacant	15	12	1	-	28
Unclassified	1	1	-	-	2
Total	1,349	581	144	-	2,074
Richfield					
Single-Family Residential	200	55	-	-	255
Multi-Family Residential	25	2	-	-	27
Mobile Home Residential	-	-	-	-	-
Nursing Home	-	-	-	-	-
Place of Worship	1	-	-	-	1
School	2	-	-	-	2
Recreation/Open Space	24	111	12	-	147
Government/Public	-	-	-	-	-
Commercial/Office	25	5	4	-	34
Industrial	-	-	-	-	-
Agriculture	-	-	-	-	-
Vacant	7	9	3	-	19
Unclassified	-	-	-	-	-
Total	284	182	19	-	485
St. Paul	**No acreage within 60 DNL contour**				
Sunfish Lake	**No acreage within 60 DNL contour**				

Source: HNTB analysis

Table F.6

Estimated Noise-Sensitive Structures within DNL Contour Intervals for the 2007 Mitigated NEM

Schools	**Number Within DNL Interval (dB)**				
CITY	**60-64**	**65-69**	**70-74**	**Within 75**	**Total**
Bloomington	1	1	-	-	2
Eagan	-	-	-	-	-
Edina	-	-	-	-	-
Inver Grove Heights	-	-	-	-	-
Mendota	-	-	-	-	-
Mendota Hgts	1	-	-	-	1
Minneapolis	5	-	1	-	6
Richfield	2	-	-	-	2
St. Paul	-	-	-	-	-
Sunfish Lake	-	-	-	-	-
Total	9	1	1	-	11
Places of Worship	**Number Within DNL Interval (dB)**				
CITY	**60-64**	**65-69**	**70-74**	**Within 75**	**Total**
Bloomington	-	1	-		1
Eagan	1	-	-	-	1
Edina	-	-	-	-	-
Inver Grove Heights	-	-	-	-	-
Mendota	-	-	-	-	-
Mendota Hgts	-	-	-	-	-
Minneapolis	13	6	-	-	19
Richfield	2	-	-	-	2
St. Paul	-	-	-	-	-
Sunfish Lake	-	-	-	-	-
Total	16	7	-	-	23
Nursing Homes	**Number Within DNL Interval (dB)**				
CITY	**60-64**	**65-69**	**70-74**	**Within 75**	**Total**
Bloomington	-	-	-	-	-
Eagan	-	-	-	-	-
Edina	-	-	-	-	-
Inver Grove Heights	-	-	-	-	-
Mendota	-	-	-	-	-
Mendota Hgts	-	-	-	-	-
Minneapolis	-	-	-	-	-
Richfield	-	-	-	-	-
St. Paul	-	-	-	-	-
Sunfish Lake	-	-	-	-	-
Total	-	-	-	-	-
Pre-schools	**Number Within DNL Interval (dB)**				
CITY	**60-64**	**65-69**	**70-74**	**Within 75**	**Total**
Bloomington	1	-	-	-	1
Eagan	2	-	-	-	2
Edina	-	-	-	-	-
Inver Grove Heights	-	-	-	-	-
Mendota	-	-	-	-	-
Mendota Hgts	-	-	-	-	-
Minneapolis	5	2	-	-	7
Richfield	1	-	-	-	1
St. Paul	-	-	-	-	-
Sunfish Lake	-	-	-	-	-
Total	9	2	-	-	11
Historical Structures	**Number Within DNL Interval (dB)**				
CITY	**60-64**	**65-69**	**70-74**	**Within 75**	**Total**
Bloomington	1	-	-	-	1
Eagan	-	-	-	-	-
Edina	-	-	-	-	-
Inver Grove Heights	-	-	-	-	-
Mendota	-	-	-	-	-
Mendota Hgts	2	-	-	-	2
Minneapolis	52	54	-	-	106
Richfield	-	-	-	-	-
St. Paul	-	-	-	-	-
Sunfish Lake	-	-	-	-	-
Total	55	54	-	-	109

Source: HNTB analysis

Table F.7

Single Family and Multi-Family Dwelling Units by Block DNL Noise Level w/Part 150 Method (Single Family = 1 Units) for the 2007 Mitigated NEM

Block DNL	Single Family Eligible	Single Family Additional 2007	Multi-Family Eligible	Multi-Family Additional 2007	Total
60	220	2,495	6	1,393	4,114
61	379	1,416	281	688	2,764
62	522	886	123	239	1,770
63	1,071	319	143	141	1,674
64	1,077	73	112	57	1,319
65	959	21	98	14	1,092
66	925	44	100	45	1,114
67	747	11	34	-	792
68	349	15	91	-	455
69	175	37	10	402	624
70	204	33	310	-	547
71	176	-	107	-	283
72	64	4	-	-	68
73	28	-	4	-	32
74	-	-	-	-	-
75+	-	-	-	-	-
Total	6,896	5,354	1,419	2,979	16,648

Notes:

"Eligible Dwellings" refers to those dwelling initially eligible within the 65 dB DNL contour of the 1996 NEM.

"Additional Dwellings" refers to additional dwelling units eligible to the 60 dB DNL contour of the 2007 Mitigated NEM using the block intersect boundary method.

Excludes 29 single-family and 136 multi-family units within the 65 DNL of the 2007 Mitigated NEM scheduled for purchase and demolition by the MAC by 2007.

Excludes 46 new housing units in Mendota Heights built since 2000 (ineligibile for Sound Mitigation Program)

Source: MAC

APPENDIX G

GPS INITIATIVES

Note: This document was prepared with the November 2001 Study and is unchanged in this edition of the Study. The status of ongoing GPS development and implementation efforts have been changing rapidly, and some of the references in this document are therefore dated. However, the document does provide a review of the potential of GPS technologies.

In conjunction with the Minneapolis-St. Paul International Airport Part 150 Noise Compatibility Program, the Metropolitan Airports Commission (MAC) has undertaken a feasibility study to investigate the potential benefits of applying Global Positioning System (GPS) technology to the arrival and departure routes currently in use at the airport. Results of that preliminary work suggest that the new GPS technology, when more fully operational and prevalent within the aircraft fleet, can offer worthwhile improvements to the noise exposure environment around MSP. However, further detailed planning, design and testing of specific GPS-based procedures is needed along each prospective flight corridor of concern before final recommendations can be offered for formal FAA review.

As a result of these findings, MAC requests that FAA approve a proposed mitigation measure to conduct further detailed analyses of new GPS-coupled Flight Management System (FMS) and Area Navigation (RNAV) procedures for MSP, with the objective of improving traffic flow in and out of the airport while also reducing the number of people experiencing significant noise exposure levels.

The balance of this appendix summarizes the work conducted during the feasibility study. It sets the context for the analysis by introducing a discussion of GPS technology and the steps MAC has taken to date to advance the state-of-the-art technology. It also includes a critical discussion of the limitations on designing and flying a GPS procedure and how those factors may negate some of the apparent benefits of the technology. The appendix concludes with several comparative noise analyses that point to the need for precise positioning of a flight corridor in order to achieve meaningful reductions in exposure.

BACKGROUND

In the early 1990s, the FAA began to implement a major new strategy to provide nationwide air traffic control services through a satellite-based navigation system known as the Global Positioning System, or GPS. Initially accepted for use as an input to multi-sensor receivers operating in enroute airspace environments, the technology was subsequently approved by FAA in June 1993 for supplemental use on non-precision approaches as well. Eight months later, FAA certified the first on-board GPS receiver for use in a multi-sensor navigational system – the aircraft's Flight Management System, or FMS. And in late 1994, GPS was approved as a sole-means of navigation on transoceanic flights.

Ultimately, when this new technology becomes fully accepted and implemented throughout all phases of flight, it will offer significant enhancements to the National Airspace System including improved safety, greater accommodation of user-defined flight profiles and routings, and augmented airport and airspace capacity in both VMC and IMC. All of these factors are essential to the safe and efficient movement of increasing numbers of aircraft to serve the flying public. In addition, GPS will require fewer onboard navigational systems, thus lowering long-term equipment costs both for the aircraft operator as well as for the FAA. Eventually, however, GPS will allow the phaseout of older ground-based navigation systems including Very High Frequency Omnidirectional Range (VOR) stations, Distance Measuring Equipment (DME) signals, and Instrument Landing System (ILS) and Non-Directional Beacon (NDB)

instrumentation. Decommissioning of these navigational aids (NAVAIDs) is currently scheduled to begin in 2005.

From an environmental perspective, GPS will offer airports, even now, the chance to develop new, narrower, arrival and departure routes, where appropriate, to help minimize noise and other impacts in airport vicinity.

The transition to GPS navigation is underway in several important, if limited, areas, but the benefits of this technology are already starting to be realized. GPS-based FMS or RNAV procedures are being utilized at major airports such as Chicago-O'Hare, Seattle, Anchorage, and Boston-Logan, with onboard hardware a nearly standard requirement for new production aircraft such as the 757, 767, and A-320. As more and more types become equipped with GPS receivers and eventually the transmitters, larger and larger percentages of the fleet at any given airport will be capable of flying GPS/FMS routings with greater precision. A 10-year transition period leading to final decommissioning of older navigational systems will assure that all aircraft are eventually operating with the new satellite environment.

An Overview of GPS Technology

The satellites providing GPS signals are operated and maintained by the U.S. Department of Defense. Twenty-four orbiting satellites continuously transmit precisely timed signals back to the surface of the earth. A receiver on or near the earth's surface can use these signals to determine distance from the satellite as well as the satellite's position. By simultaneously receiving such signals from four or more satellites, the receiver can determine its own location and time.

Initially, two levels of service were provided by the GPS satellites: a Precise Positioning Service (PPS) previously available only to Defense Department and other authorized users (often referred to as "selective availability (SA)"), and a Standard Positioning Service (SPS) available free of charge to other users worldwide. SPS provided a lower level of positional accuracy, designed to protect U.S. national security interests. Location could be determined within 100 meters horizontally and 150 meters vertically at least 95 percent of the time, and within 300 meters horizontally and 450 meters vertically 99.99 percent of the time. For many applications, this would have been perfectly adequate, but FAA requires more stringent standards if the system is to be used for controlling aircraft. For example, enroute position accuracy must be better than 100 meters horizontally at least 99.999 percent of the time. The criteria for Category (CAT) I landing guidance and CAT II/III precision approaches are even more stringent -- CAT I approaches have performance criteria of 7.6 meters both horizontally *and* vertically and the signal must be available at least 99.9 percent of the time. Although SA was turned off on May 1, 2000, and GPS now provides higher levels of accuracy, improved accuracy is still needed.

To meet these operational requirements, FAA undertook development of two supplemental systems that augment GPS; each uses ground-based antennas whose precisely known locations are used to correct the satellite signals and provide greater positional accuracy as well as integrity of service to aircraft in the air. These supplemental stations are known as the Wide

Area Augmentation System (WAAS) and the Local Area Augmentation System (LAAS), respectively.

Though currently facing serious technical challenges and behind schedule in its development, WAAS is designed to enable aircraft to use GPS as the primary means of navigation in all phases of flight, including CAT I precision approaches with ceilings as low as 200 feet and visibilities down to ½ mile. This would be satisfactory performance for most general aviation needs if it can be achieved; however, it appears more likely that at best, by 2002 the system will only be capable of use down to ceilings of 400 feet and visibilities of 1 mile. Furthermore, airlines demand CAT II and CAT III performance to operate effectively in poorer weather and are therefore unsupportive of continued WAAS development. Whether WAAS can ever be cost-effective without their backing remains to be proven.

More promising and of much greater interest to airlines as well as to MSP and other airports are LAAS's capabilities. Its range of service typically extends some 25 to 30 nautical miles from a facility - far enough to encompass most local airspace operations and environmental noise issues. It can also provide terminal navigation, airport surface navigation, departure procedures, and guided missed approaches. Furthermore, as part of the LAAS effort, FAA has been working with U.S. electronics firms and universities in a Government Industry Partnership (GIP) to demonstrate phase differential techniques to meet the further accuracy requirements of CAT III autoland approaches. These efforts are also being coordinated with local area differential GPS (DGPS) technologies which are being developed, tested, and certified for Special Category I (SCAT I) precision approaches. Finally, given the current difficulties with WAAS, LAAS now has higher priority for implementation, with some 160 antennas expected to be installed at airports across the continental U.S. between now and the end of 2001.

Equipment changes must also take place onboard aircraft for LAAS to be fully effective. AIRINC 755, a technical committee comprised of industry representatives, is developing performance specifications for the airborne instrumentation, which are expected to be issued in early 2002. These will standardize vendors' hardware so that the new multi-modal receivers can capture the DGPS signal along with those of other NAVAIDs and integrate them into the aircraft's Flight Management System. One major manufacturer of such equipment has already installed some 3,000 multi-modal receivers in existing aircraft and is acknowledged to have an additional 8,000 units on order, all capable of simple upgrades to capture the GPS signal as soon as the final standard is issued. Whether aircraft owners will install the upgrades when they become available, is still, however, unknown; there appears to be no move by FAA to require retrofitting aircraft to accommodate new GPS receivers (though decommissioning of older NAVAIDs, if carried out on schedule, will expedite some conversions).

GPS Technology and its Implementation at MSP

The MAC noise office has pursued the advancement of GPS as an innovative tool to reduce noise exposure in the communities surrounding MSP almost from its beginning. In the process, the airport has achieved many firsts: MAC installed and commissioned Honeywell's DGPS ground station – the first of its kind in the U.S. Flight testing conducted by Honeywell in November 1996 in a specially-instrumented Gulfstream IV provided vivid insight into the future

benefits of the new technology. SCAT I type acceptance for the system was granted on 6 August 1997, and the first DGPS ground station was commissioned into the National Airspace Plan in January 1998. The world's first commercial flight to utilize the system was flown on 21 September 1998. On-site demonstrations by Honeywell and NASA during November 1999 provided opportunity for other interested parties to experience the benefits of the new technologies. Now, subsequent stations have been installed or are being considered for installation at Newark, Chicago's O'Hare and Midway Airports, Memphis, Seattle, Juneau, and others.

Lastly, MSP's DGPS installation will soon be the first to be upgraded from SCAT I to full LAAS capability. Knowledge of the precise location of the aircraft will be reduced to a maximum error of 25 centimeters (about 10 inches!) while occasional but more problematic undetectable position errors will be reduced from the current 15 meters (about 50 feet) to 3.6 meters (about 12 feet).

The analysis that follows now extends the development efforts pursued by MAC to the practical issue of whether GPS can be used to reduce noise. Other potential benefits include increased capacity and more efficient overall operation of the airspace.

FAA DESIGN CRITERIA AND OTHER FACTORS AFFECTING GPS-BASED PROCEDURES

Based on the previous discussion, it is tempting to conclude that knowledge of the precise location of an aircraft within MSP's airspace must mean that airplanes will at last be able to follow fine lines in the sky, comparable to cars following a highway. Unfortunately, that is still not the case. Nor is it the case that GPS will eliminate noise problems near an airport. But in each instance GPS guidance may be able to help.

Two of the major factors still unaddressed by GPS include pilot technique and aircraft performance. The first refers to the variation with which individuals implement procedures as they are flying the aircraft. The second refers to the variation that occurs because of wind, temperature, thrust, takeoff weight, use of flaps, and so on.

To illustrate the effects of these, reference is made to **Figure G-1** which compares the performance of one air carrier against all others flying an FMS departure procedure off of Runway 27 at Logan International Airport in Boston. The procedure utilizes "flyby" and "fly over" waypoints defined by latitude and longitude coordinates, compatible to a GPS-only procedure. The sample covers a three month test period in which Northwest Airlines pilots were requested to engage the lateral navigation feature on the Flight Management System (FMS) of their aircraft before they started their takeoff roll, and to utilize the instrument's flight director which has "command bars" that show the pilot when and how much to turn in order to follow a predefined track. The other carriers were given no special requests and used whatever techniques they were normally comfortable flying.

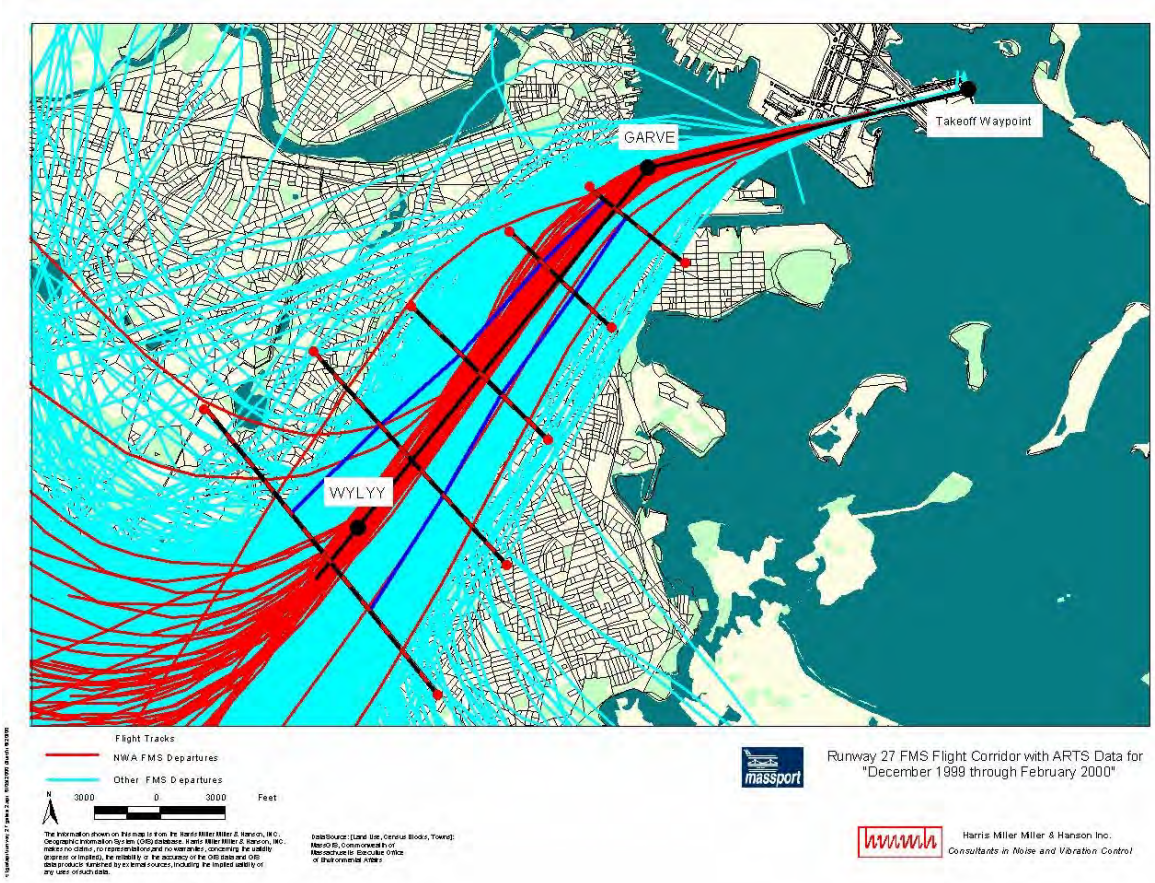


FIGURE G-1

A Comparison of GPS-Based Dispersion Patterns Affected by Pilot Technique

Note that the dispersion of Northwest's tracks is significantly less than that of the other carriers, yet all of the aircraft were assigned a procedure which was designed to guide them along the black line down the center of the desired corridor. GPS alone will not solve this wide dispersion pattern; pilot technique has a clear bearing on the results. Note that in a GPS environment, the ability to know the precise location of the aircraft means only that one can tell with a high degree of precision exactly how far away the plane is from its "supposed" location. GPS can also provide guidance to the aircraft so that it travels on desired flight tracks with a high degree of precision.

A second set of factors affecting the potential benefits of GPS-based procedures are the FAA's design criteria contained in documents such as FAA Order 8260.40A (Flight Management System (FMS) Instrument Procedures Development) or Order 8260.48 (Area Navigation (RNAV) Approach Construction Criteria). These set very strict design requirements used by Flight Standards when defining waypoints that are eventually published as a Terminal Instrument Procedures (TERPS) plate. **Figure G-2** illustrates a deceptively simple example of the criteria used in locating the first waypoint for an FMS/GPS procedure. The first segment

ends at a waypoint located on the extended centerline of the runway, and should be at least two nautical miles past the departure end of the runway. If the segment ends at a flyby waypoint, however, then a minimum turn distance that depends on the speed of the aircraft must be added to the first segment.

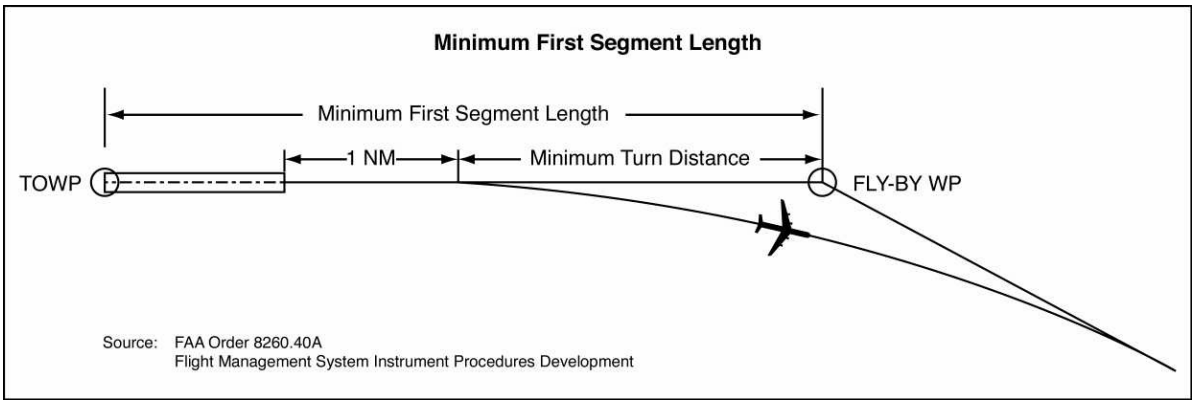


FIGURE G-2

Example of FAA Design Criteria Used in Developing Waypoints

The implication of such criteria when applied to, say, the river departure off of runway 17 at MSP, is that an aircraft may be kept from turning too early so as to avoid overflying parts of Burnsville or Eagan. Such criteria must be examined in detail and reviewed by FAA before committing to a new procedure that may create greater impact than benefit.

Now that various constraints on implementing GPS procedures have been identified, it is appropriate to identify whether there are any potential noise benefits to be derived from such procedures.

NOISE IMPLICATIONS OF NEW GPS PROCEDURES

There are three basic factors that influence the noise exposure resulting from an arrival or departure procedure that accommodates GPS technology – the mix of aircraft that can use the procedure (fleet mix), the position of the desired track over the ground, and the distribution of flights about the desired track (dispersion).

Fleet Mix

Any of the newer aircraft types that operate in today's air carrier fleets, such as the Boeing 757 and 767, and Airbus 320, are nearly always equipped with a Flight Management System capable of integrating signals from a variety of navigational aids such as VORs and ILSs. FMS-equipped airplanes are also capable of incorporating waypoints in their guidance systems, and they provide steering information to the pilot. Some aircraft also have inertial navigation

systems, usually operating with laser gyros. Each aircraft's position is not known quite as precisely as if it were also receiving a GPS signal, nevertheless, the pilot can fly an FMS or RNAV arrival or departure procedure quite closely, like the Northwest flights out of Logan in Figure G-1. The older hushkit airplanes and those that barely meet Stage 3 noise emission levels cause another problem - they are the loudest in the fleet, they do not have FMS capability, and they are incapable of following a new GPS, FMS, or RNAV flight procedure. It seems that the only practical way that these older aircraft will be upgraded is if their operations are mandated to re-instrument their cockpits. Such a mandate is unlikely, as there appears to be no effort in that direction by the FAA. Mandate notwithstanding, the older aircraft will most likely continue to fly according to present procedures until they are retired. From a noise perspective, that most likely means little change to existing conditions.

This problem is illustrated in the set of three DNL contours in **Figure G-3**. Figure G-3 depicts the varying exposure from the projected baseline fleet to two other fleets – one representing 70 percent of the aircraft equipped with FMS instrumentation, and the second representing 100 percent of the aircraft so equipped. The FMS-equipped aircraft were assigned to less dispersed flight tracks as if they were given clearances and flew a GPS-based procedure. A clear narrowing of the 65 dB DNL contour is seen off to the north, west and southwest where much broader dispersion occurs under the present set of departure procedures. This illustrates a potential benefit from FMS/GPS and RNAV/GPS procedures as long as the narrower contour lobes can be focused over more noise compatible land use.

Position of a Desired Track Over the Ground

Depending on how much a track is moved and what other operations are left to influence the noise environment after the track is moved, this condition can provide significant change. The single greatest benefit from the introduction of GPS-based technology is apt to be the possibility of curved approach paths. At MSP where arrivals to runways 30L and 30R dominate the noise exposure contours to the southeast, a curved approach to that runway might bend the contours over more compatible land to the extent it exists at the extremities of the contours in that area. Note, however, that the FAA design criteria mentioned earlier will most assuredly control the proximity of curved paths to the airport, for aircraft must be lined up on the runway centerline 1-2 nm prior to touchdown to assure safe landings.

Reduction of Unwanted Dispersion

This final example of the manner in which GPS technology might affect noise exposure addresses those factors that affect aircraft dispersion along desired paths. For example, wind easily affects an aircraft's position when it is simply following a vectored heading, like many of the departure routes from MSP. Aircraft following the same ideal path in a GPS environment would instead be given steering guidance by the flight director that will adjust aircraft heading for wind drift and improve the plane's ability to follow the desired track.

Similar effects can occur along an ILS approach path. Eight to twelve or more miles out from touchdown, the signal has spread so that there is not only inherently greater inaccuracy in the pilot's localizer and glide slope indicators, but wind drift can also be more pronounced without

GPS Analysis

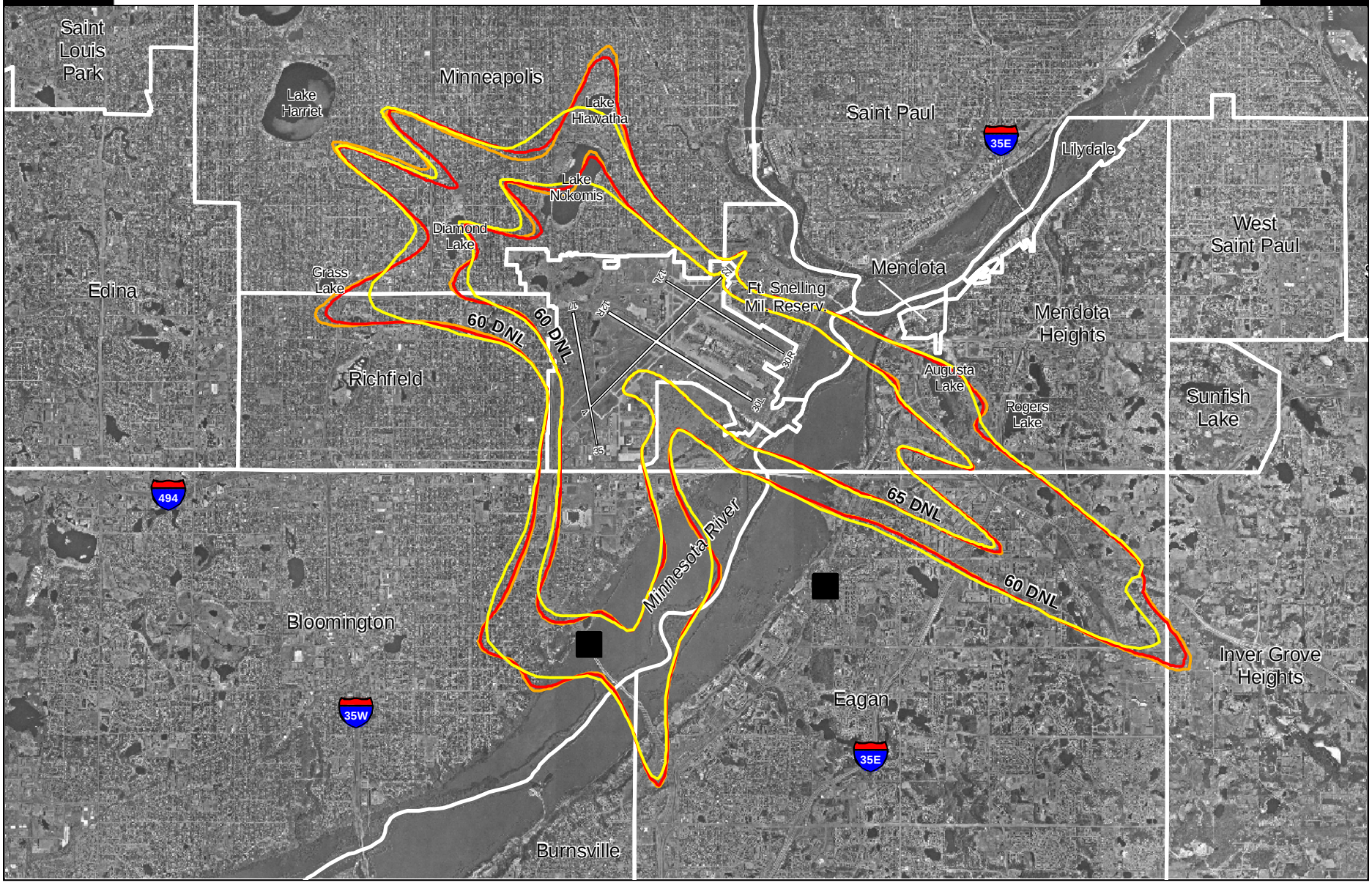


Figure G-3

causing movement in the pilot's localizer indicator to move. A GPS-based approach procedure will correct for both of these effects – the signal is just as precise at 12 miles from the runway as it is at 1 mile from the runway and heading guidance will be adjusted for wind.

The effect of wind on a standard ILS approach is illustrated in the bar charts of **Figure G-4**. The bar charts portray the dispersion of flights 3 miles from MSP on an ILS approach to land on Runway 12L. The runway centerline is in the center of each graph. The left-hand plot shows how aircraft have been blown left of center by strong right crosswinds (60 to 90 degrees to the side at speeds of greater than 15 knots). The right-hand plot shows the spread of aircraft blown less dramatically to the right of center by strong left crosswinds. Together, they show the kind of unwanted dispersion that occurs even with a relatively highly accurate navigational aid such as an ILS.

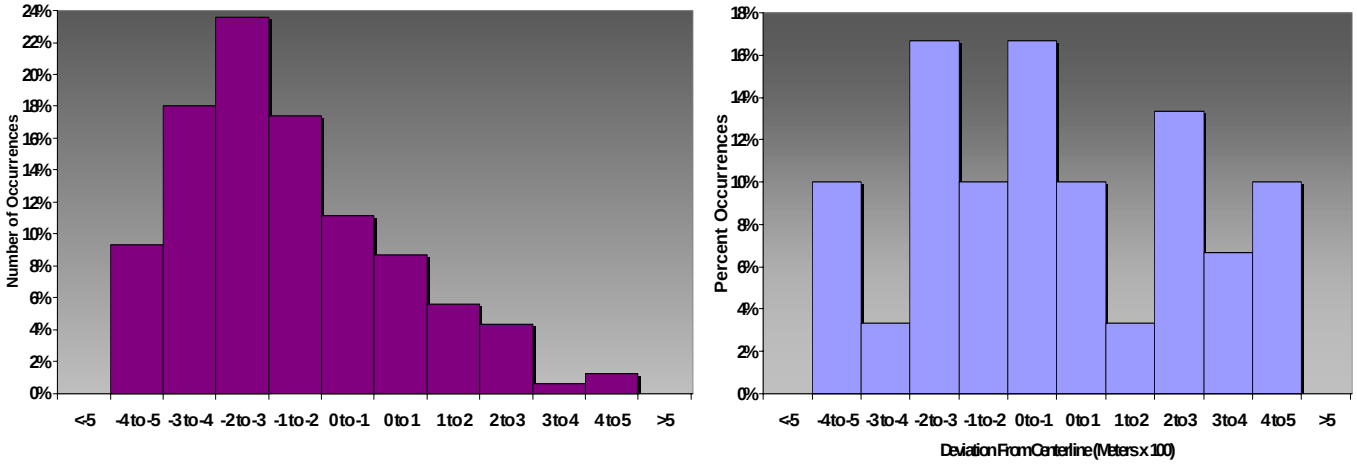


FIGURE G-4

Dispersion of Aircraft Approaching to Land on Runway 12L in Right and Left Crosswind Conditions, Respectively

Recommendation to Pursue More Detailed Analyses of Benefits from GPS-Based Flight Procedures

While results of these noise analyses are inconclusive as to the true improvement in noise exposure resulting from GPS-type procedures, they illustrate potential benefits in an air traffic control environment that depends heavily on vectoring of traffic. MAC believes it is appropriate to pursue more detailed analyses of possible FMS/GPS and RNAV procedures and their applicability to the control of aircraft in the vicinity of MSP. MAC recommends that FAA approve the further exploration of GPS technology as future step towards the development and refinement of true noise mitigating flight corridors.

APPENDIX H

RECOMMENDATIONS OF THE LOW-FREQUENCY NOISE POLICY COMMITTEE

Note: This appendix is identical in content to the document endorsed by the Low-Frequency Noise Policy Committee. It refers to two appendices (A and B), which are contained in the full report that is available from MAC. This document was not altered for consistency with the remainder of the Part 150 Update (figure and table numbering, and terminology). However, the table of contents, list of figures, and list of tables was deleted.

INTRODUCTION

The Low Frequency Noise Policy Committee was formed as a part of a December 18, 1998 agreement between the City of Richfield and the Metropolitan Airports Commission.

The agreement between the City and the MAC arose out of the City's concern regarding the potential impact of low frequency noise from the new North/South (17/35) Runway on established residential neighborhoods in east Richfield. The North/South Runway is part of MAC's 2010 expansion plan. The new runway is currently under construction and is scheduled to be completed and operational in December, 2003. When complete, the runway will be 8000 feet long and will carry up to 300 to 400 daily operations.

The Agreement charged the Low Frequency Noise Policy Committee with completion of the following tasks:

A. Review all existing information pertaining to SFO, BOS, BWI and LAX and any other published studies of the audibility and impact of Low Frequency Noise, not excluding impacts outside of residential settings.

B. Conduct such studies as, in the opinion of the Low Frequency Noise Policy Committee, are necessary to address issues related to low frequency noise.

C. Convene an Expert Panel consisting of Sandford Fidell, Andrew Harris, and a third member to be named by these two (Louis Sutherland), to provide technical input and information to the Policy Committee for consideration.

D. Present recommendations regarding the appropriate noise metric, compatibility standards, and recommended mitigation programs, measures or techniques.

E. Prepare a report or reports documenting the Policy Committee's deliberations and conclusions.

The Committee began meeting in February, 1999, and held 15 meetings. At the final meeting, the Policy Committee adopted the Summary Report. Appendices A and B contain information regarding membership and activities of the Policy Committee.

POLICY COMMITTEE REVIEW OF THE EXPERT PANEL WORK

This section of the Report presents the Policy Committee's interpretation and review of the information prepared and presented by members of the Expert Panel.

Methodology

The Committee instructed the Expert Panel, convened pursuant to the Agreement, to undertake the following tasks:

Task 1. Review the literature on audibility, noticeability and the effects of low-frequency noise on individuals and communities.

Task 2. Identify relevant noise effects and descriptors.

Task 3. Determine existing and predicted low-frequency noise levels in the vicinity of MSP runways, based on field measurements in areas adjacent to MSP.

Task 4. Identify criteria for acceptability of low-frequency noise in residences, including a laboratory study of annoyance of a set of sounds under controlled listening conditions and a social survey in neighborhoods adjacent to MSP.

Task 5. Determine low-frequency noise reduction provided by typical residential construction in the vicinity of MSP, based on field measurements of typical homes in the area.

Task 6. Determine low-frequency noise reduction provided by residences subsequent to treatment in the MSP Residential Sound Insulation Program.

Task 7. Evaluate the acceptability of low-frequency noise environments in residences without and with treatment from the MSP Residential Sound Insulation Program.

Task 8. Determine the types of treatment required to improve the noise reduction and achieve compatibility of the low-frequency noise environment, including a laboratory analysis of low frequency transmission loss of typical wall, window and door construction.

Task 9. Prepare reports for the Policy Committee documenting the work of the Expert Panel.

Task 10. Measure noise in the vicinity of MSP for comparison with calculated C-weighted values from Integrated Noise Model 6.0 (INM 6.0)[1].

Effects of Low Frequency Aircraft Noise

The primary effect of existing or forecast low frequency aircraft noise on the residents of neighborhoods near MSP is rattle-related annoyance. The low frequency aircraft noise poses no known risk of adverse public health consequences, nor a risk of structural damage. Under the expected circumstances of

[1] This task was added at the request of the FAA's Office of Environment and Energy.

residential exposure, low frequency aircraft noise will not interfere with indoor speech, nor is this low frequency noise likely to awaken people.

Annoyance is not a trivial effect of aircraft noise exposure. The Federal Interagency Committee on Noise (FICON) recognizes annoyance as the best indication of adverse community reaction to aircraft noise. It is the highly annoyed portion of the population that is usually identified. The prevalence of annoyance also provides much of the rationale for federal and state policies concerning mitigation of aircraft noise impacts in residential areas.

Additional information about the effects of low frequency aircraft noise on individuals and communities may be found in the technical reports.

A laboratory study in which test subjects judged the annoyance of recorded samples of low frequency aircraft noise confirmed the following facts:

- Low frequency noise is more annoying than aircraft overflight noise heard at the same A-weighted sound level.

- The addition of even minor amounts of rattle to low frequency noise increased its judged annoyance by about 5 dB in this study.

- Reductions in the low frequency content of this noise proportionally decreases the annoyance of non-rattling test sounds.

Descriptors of Low Frequency Aircraft Noise and Low Frequency Noise Dose

The Expert Panel recommended that the Policy Committee adopt the sum of the maximum sound levels in the 25-80 Hz one-third octave bands (the low frequency sound level, abbreviated LFSL) during individual aircraft noise events as the preferred descriptor of low frequency aircraft noise in the vicinity of MSP. This recommendation was accepted on May 19, 1999. Further review identified the arithmetic average of the maximum low frequency sound levels for those events as the best measure of low frequency aircraft noise dose. The Expert Panel did not agree on whether the lower bound for the dose analysis should be 60 or 70 dB.

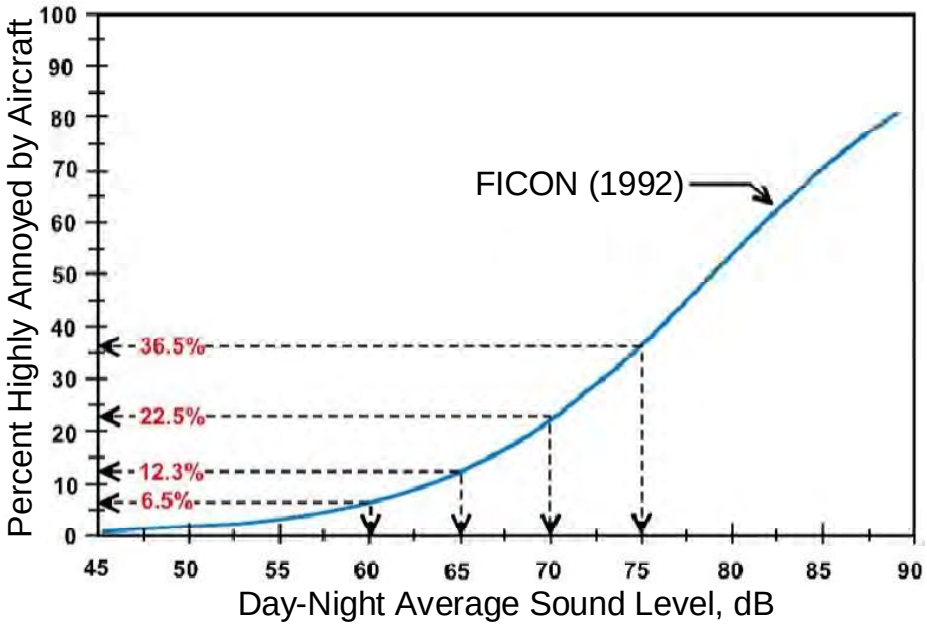
Criteria for Acceptability of Low Frequency Noise in Residences

FICON and its constituent federal agencies have adopted the relationship between overall noise exposure and the percentage of the population that is annoyed by the noise exposure for guidance in setting policy.[2] The descriptor for overall noise is Day-night Average Sound Level (DNL). Figure 1 shows the FICON relationship. Table 1 shows the FICON levels and also levels identified by various bodies for specific purposes.

HUD, the Federal Aviation Administration (FAA), the Federal Railroad Administration (FRA) and the Urban Mass Transit Administration (UMTA) have adopted criterion levels for noise and vibration compatibility where the percentage of persons highly annoyed was selected to correspond to the percentages reflected in the FICON relationship for DNL 65, DNL 70 and DNL 75. The Expert Panel recommended, and the Policy Committee has used, the same approach in basing its recommendations on the percentages of the population that is highly annoyed.

[2] The U.S. Department of Housing and Urban Development (HUD) sponsored the initial research that showed this relationship.

FICON ANNOYANCE CURVE



*Note: The above graphic depicts the relationship of noise exposure to the prevalence of high annoyance, per the dosage-response relationship by the Federal Interagency Committee on Noise (1992).

Figure 1

Table 1

Levels Identified by Government Entities for Various Purposes with Associated Percentages of Highly Annoyed Population (from FICON)

Entity	Purpose	Identified Level DNL	Percentage Highly Annoyed
U.S. E.P.A.	Level identified as Requisite to Protect Health and Welfare with Margin of Safety (Not policy, standard or regulation)	55	4
Minnesota Legislature	Identify Area to Study Treatment	60	7
Minnesota Legislature	Identify Area for Sound Insulation	65	12
Metropolitan Airports Commission	Lower Limit of Residential Sound Insulation	60	6
HUD FAA	Level below which Untreated Residential Use Compatible (Regulation)	<65	12
HUD FAA	Range of Levels where Improved Noise Reduction is Required (Regulation)	65-75	37
HUD FAA	Level above which Residential Use not Compatible (Regulation)	>75	>37

During this study a social survey of the annoyance of low frequency aircraft noise and noise-induced rattle was conducted in a Minneapolis neighborhood north of the intersection of Runways 12L/30R and 4/22 at MSP. The results of the MSP survey are consistent with those observed within the comparable range of LFSL (low frequency sound level) values in a survey conducted in a neighborhood near Runways 25 L/R at Los Angeles International Airport.

Annoyance due to low frequency aircraft noise was strongly related to LFSL values. The most common frequency of awareness of noise-induced rattle was "a few times a day". Windows were the most cited sources of rattling noises.

Figure 2 summarizes the relationship between low frequency aircraft noise levels in the MSP and LAX survey areas and annoyance.

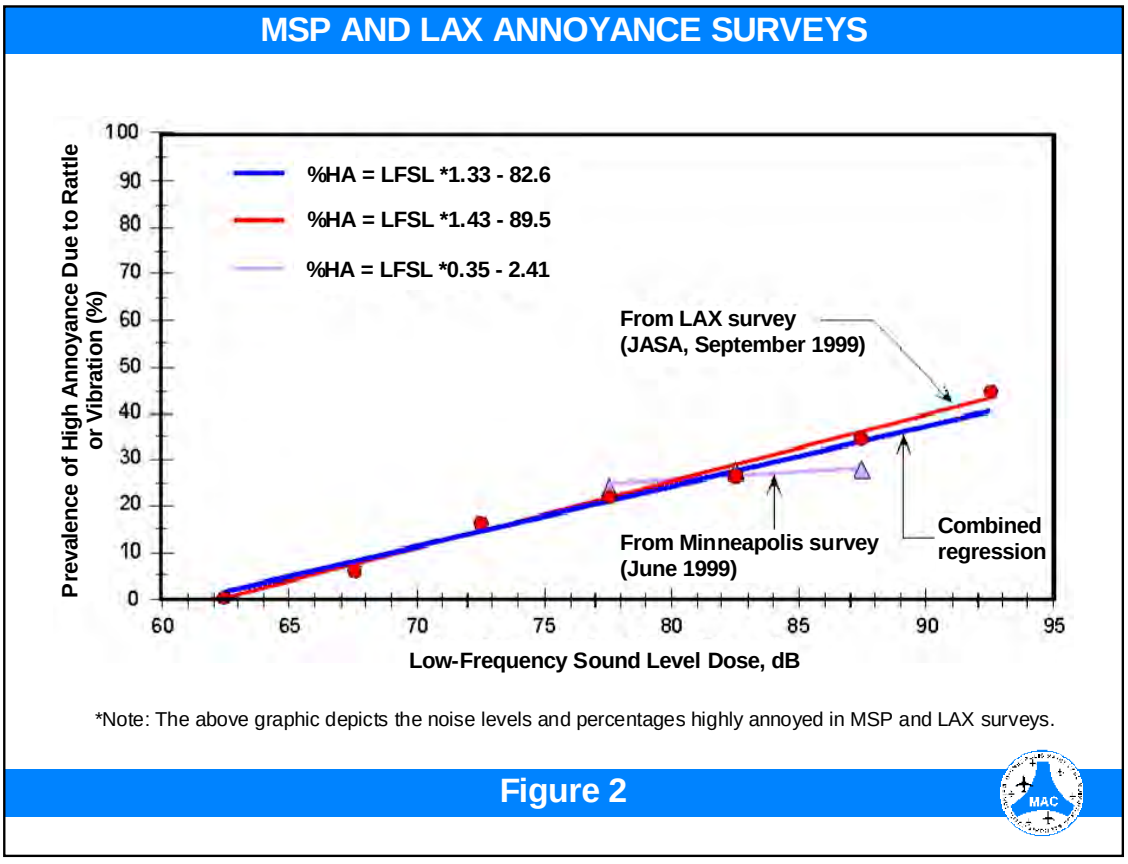
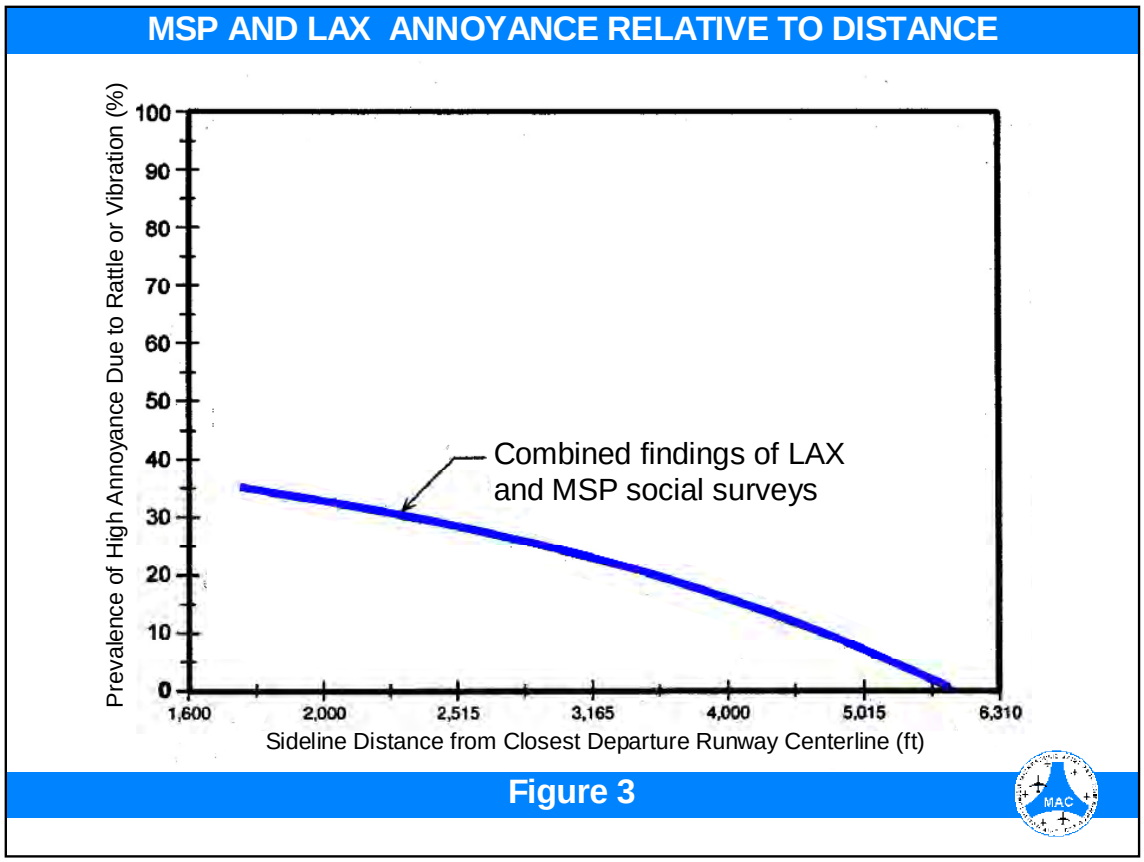


Figure 3 indicates the relationship between the percentage of respondents in the LAX and MSP social survey who were highly annoyed by rattle and vibration from aircraft and the distance from their homes to the nearest runway. The prevalence of annoyance to vibration increased in degree the closer in proximity the home was to the runway. This relationship is variable depending on a number of other factors.

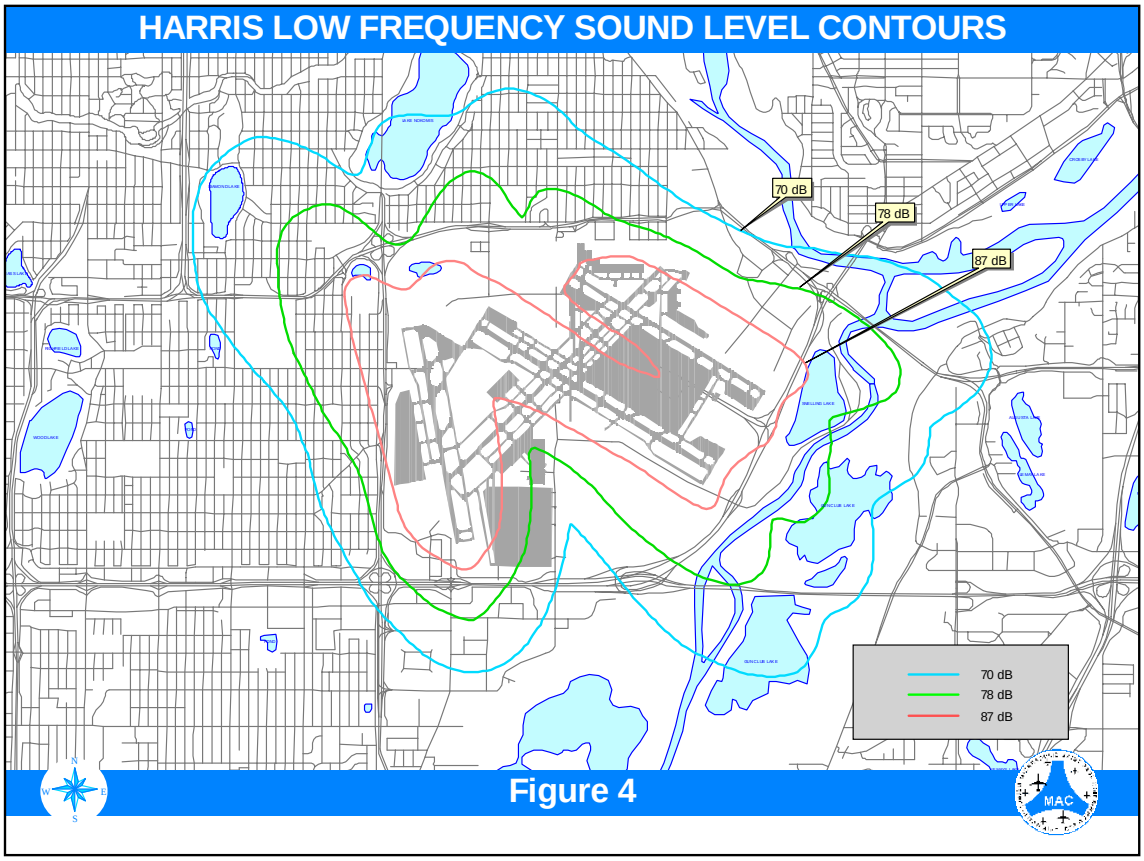


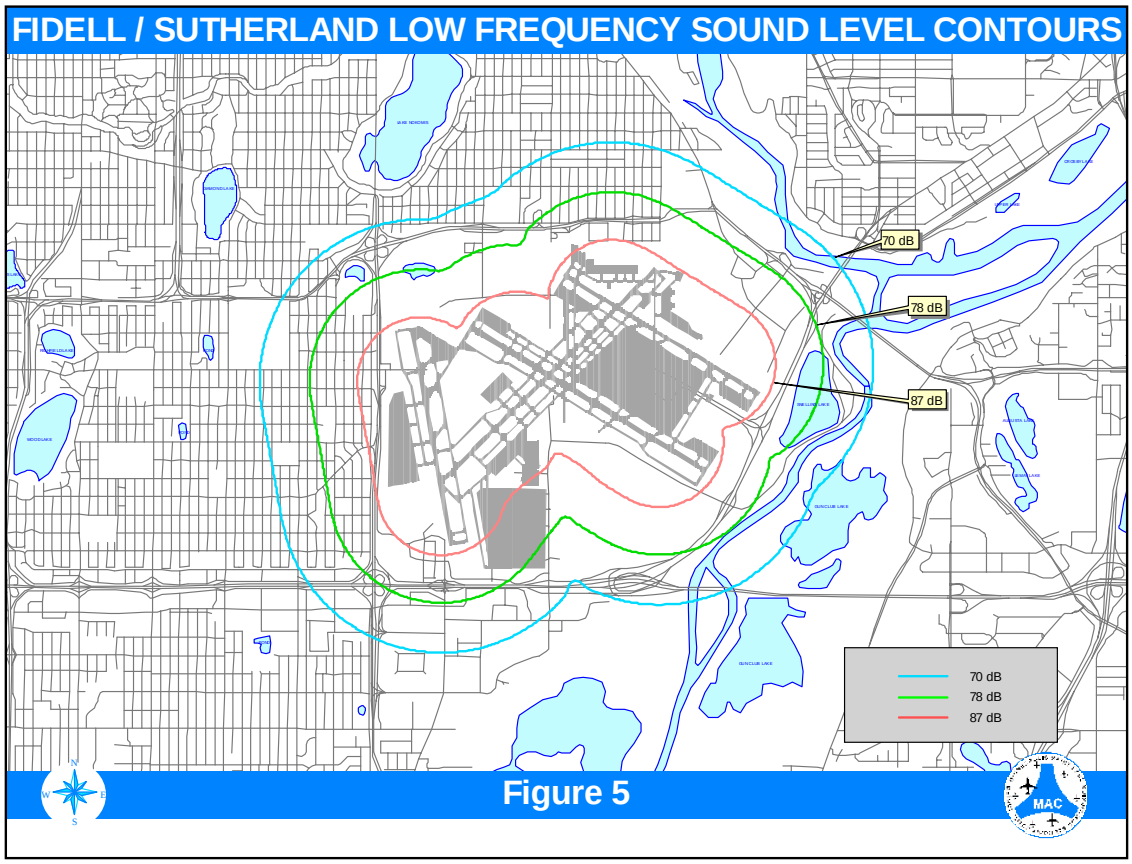
Based on the relationships shown in Figures 1, 2, and 3 the actions by federal agencies and the Minnesota Legislature, the Expert Panel and Policy Committee recommendations are based on the percentages of highly annoyed persons that correspond to DNL 65 (12%), DNL 70 (22%) and DNL 75 (37%). From Figure 2, the equivalent levels of low frequency sound dose are 70 dB, 78 dB, and 87 dB.

Predicted Low Frequency Noise Levels in the Vicinity of MSP

Daytime ambient sound levels in low frequency one-third octave bands in residential areas of Minneapolis, Richfield, and Bloomington near MSP are currently on the order of 55 dB ± 5 dB. Nighttime ambient sound levels in Richfield are roughly 10 dB lower. These findings are consistent with previous surveys that identified typical levels of environmental noise in developed areas and approximately a 10 dB difference between daytime levels and nighttime levels.

Figures 4 and 5 show projected low frequency sound level contours with Runway 17-35 in use. Two approaches were taken toward contour development, one which determined that takeoff noise impacts were more significant and one which determined that reverse thrust impacts were more significant. The two contours were the result of different approaches taken by the consultants toward interpretation of the data collected during the monitoring program completed as part of this work effort. The takeoff-dominated contour (Figure 4) has more impact at the northern end of the runway whereas the reverse thrust dominated contour (Figure 5) incorporates additional areas toward the midpoint of the runway. No consensus was reached by the Expert Panel that one contour or the other was a better representation of low frequency noise impacts.


HARRIS LOW FREQUENCY SOUND LEVEL CONTOURS
70 dB
78 dB
87 dB
70 dB
78 dB
87 dB
Figure 4
MAC


FIDELL / SUTHERLAND LOW FREQUENCY SOUND LEVEL CONTOURS
70 dB
78 dB
87 dB
70 dB
78 dB
87 dB
Figure 5
MAC

Existing and Potential Low Frequency Noise Reduction of Residences near MSP

Field measurements of single family detached residences near MSP provide roughly 15 dB of noise reduction at frequencies between 25-100 Hz regardless of construction type. No meaningful differences were observed in the reduction of LFSL values of homes that had MSP's standard acoustic insulation treatments and homes that had not been so treated.

However, the social survey indicates a decrease in persons highly annoyed by aircraft noise in homes that have received the treatment. The decrease is equivalent to a 5 dB decrease in sound dose or a 5 dB increase in noise reduction. The reasons for this change in attitude are not known, although they may be associated with changes such as a reduction in rattling windows or with the difference in noise levels at frequencies above 80 Hz.

Modifying the structure can increase the low frequency noise reduction provided by residences. An improvement of approximately 5 dB can be achieved by adding a heavy layer to the outside or inside (e.g., the equivalent of a 1" heavy-weight plaster/stucco skin resiliently supported from the standard construction or a double layer of ½" gypsum board added to all interior wall surfaces and ceiling).

The upper limit of improvement is approximately 10 dB. This low frequency noise reduction would require use of a complex structure (e.g., a brick wall with minimal openings toward the noise source with separately supported interior skins and multi-pane windows of limited size).

The interior levels of low frequency noise can be reduced by a number of methods. These include increasing the noise reduction of the structure, decreasing the outdoor noise levels or a combination of the two.

Level of Noise Reduction Required to Achieve Compatibility with the Low Frequency Aircraft Noise Environment

Table 2 identifies the level of treatment recommended to achieve compatibility for existing residences. Table 3 identifies the level of treatment recommended to achieve compatibility for new construction.

Table 2

Recommended Treatment to Reduce Interior LFSL in Existing Residential Areas

Average Exterior LFSL in dB	Treatment to Reduce Rattle	Interior LFSL Reduction
<70	None Required	None Required
70-77	Treat Rattle Directly	Decrease interior LFSL by 5 dB*
78-86	Treat Rattle Directly May not be fully adequate	Decrease Interior LFSL by 5 dB and Consider Reducing by more than 5 dB
>87	Treat Rattle Directly Probably not fully Adequate	Decrease Interior LFSL by at least 10 dB. Probably not Economically Feasible

*Based on findings of the social survey, the existing Part 150 Residential Sound Insulation Program provides the equivalent of 5 db reduction, therefore no further reduction is necessary.

Table 3

Recommended Rattle Prevention and Limits for Interior LFSL for New Construction

Average Exterior LFSL in dB	Rattle Prevention Treatment	Interior LFSL Reduction
<70	None Required	No Special Requirement
70-77	Rattle Prevention	15 dB
78-86	Rattle Prevention	20 dB
>87	Do not develop for residential use	

FINDINGS

The following represent the Findings of the Low Frequency Noise Policy Committee. The findings are based on information developed by the Expert Panel and Committee discussion.

1. Effects on People: The primary effect of low frequency aircraft noise on the residents of neighborhoods near MSP is rattle-related annoyance. Low frequency aircraft noise poses no known risk of adverse public health consequences, nor a risk of structural damage. Under the expected circumstances of residential exposure, low frequency aircraft noise will not interfere with indoor speech, nor are the levels of low frequency noise likely to awaken people.

2. Noise Descriptors: The preferred descriptor of low frequency aircraft noise is the sum of the maximum sound levels in the 25-80 Hz one-third octave bands during individual aircraft noise events. This measure is called the low frequency sound level (LFSL). The best available predictor of the prevalence of annoyance due to multiple aircraft events is the arithmetic average of low frequency sound levels above a selected threshold. This measure is called the low frequency sound level dose (LFSL Dose).

3. Information on Compatibility: Many bodies have identified levels of general aircraft noise in terms of their compatibility with a range of land uses. These levels are typically expressed relative to the Day-night Average Sound Level (DNL). HUD and the FAA have established regulations that place no restrictions on residential development where the exterior DNL is less than 65 dB. They also do not allow new residential development where the exterior DNL exceeds 75 dB, except under special circumstances. In the range of exterior levels from a DNL of 65 dB to a DNL of 75 dB, residential development is allowed if the noise reduction provided by the building structure prevents interior noise levels from exceeding a DNL of 45 dB.

4. Community Response to Noise: Annoyance related to environmental noise is typically described in terms of the percentage of the community that reports a high level of annoyance to the noise.

5. FICON Relationship: Figure 1 shows the relationship of noise exposure (DNL) to the prevalence of high annoyance as adopted by the Federal Interagency Committee on Noise (FICON). Table 1 shows the percentages of the population highly annoyed, from FICON, associated with levels of overall environmental noise identified by various bodies.

6. Low Frequency Survey Responses: Responses to low frequency noise obtained by a social survey conducted in Minneapolis showed results consistent with a social survey conducted adjacent to LAX in the range of LFSL Dose from about 75 dB to 88 dB. Figure 2 shows the results of the individual surveys and the combined results.

7. Relationship between sideline distance of households to runway: A relationship exists between the distance of homes from the runways and the prevalence of high annoyance. Figure 3 indicates the percentage of respondents in the LAX and MSP social survey who were highly annoyed by rattle and vibration from aircraft and the distance from their homes to the nearest runway. This relationship is variable depending on a number of factors.

8. LFSL Dose Relationships: The exterior LFSL Doses corresponding to various levels of the population highly annoyed are 12.3% HA (70 dB), 22.5% HA (78 dB) and 36.5% HA (87 dB). Exterior LFSL Doses below 70 dB are considered fully compatible with residential use without any special treatment. Exterior LFSL Doses at or above 87 dB are considered incompatible with residential use. Exterior

LFSL Doses at or above 78 dB and below 87 dB require structures that provide higher than normal low frequency noise reduction.

9. Low Frequency Noise Reduction Provided by Existing Residences: Existing residences in the vicinity of MSP, whether or not treated under the MSP Residential Sound Insulation Program, provide approximately 15 dB of low frequency noise reduction. However, residents in structures that have been treated report levels of annoyance to low frequency noise that would be expected only if the residence provided a 20 dB low frequency noise reduction.

10. Forecast Exterior LFSL Dose near MSP: The Expert Panel did not reach consensus on a LFSL contour representing conditions with Runway 17-35 in operation. Two contours have been presented to the Policy Committee. The Policy Committee has indicated uncertainty about certain aspects of both contours: 1) the reverse thrust dominated contour potentially understates impacts at the north end of the runway, and 2) the takeoff dominated contour potentially understates impacts toward the midpoint of the runway and potentially overstates impacts at the north end of the runway. A policy contour has been developed which takes these concerns into consideration (Figure 6). This policy contour is appropriate for use in determining land use compatibility.

11. Treatment of Existing Single-Family Residences: Table 2 shows the treatment that is appropriate for existing single-family residences exposed to low frequency noise.

12. Noise Reduction Requirements for New Single-Family Residences: Table 3 shows the noise reduction requirements that are appropriate for new single-family residences exposed to low frequency noise.

RECOMMENDATIONS

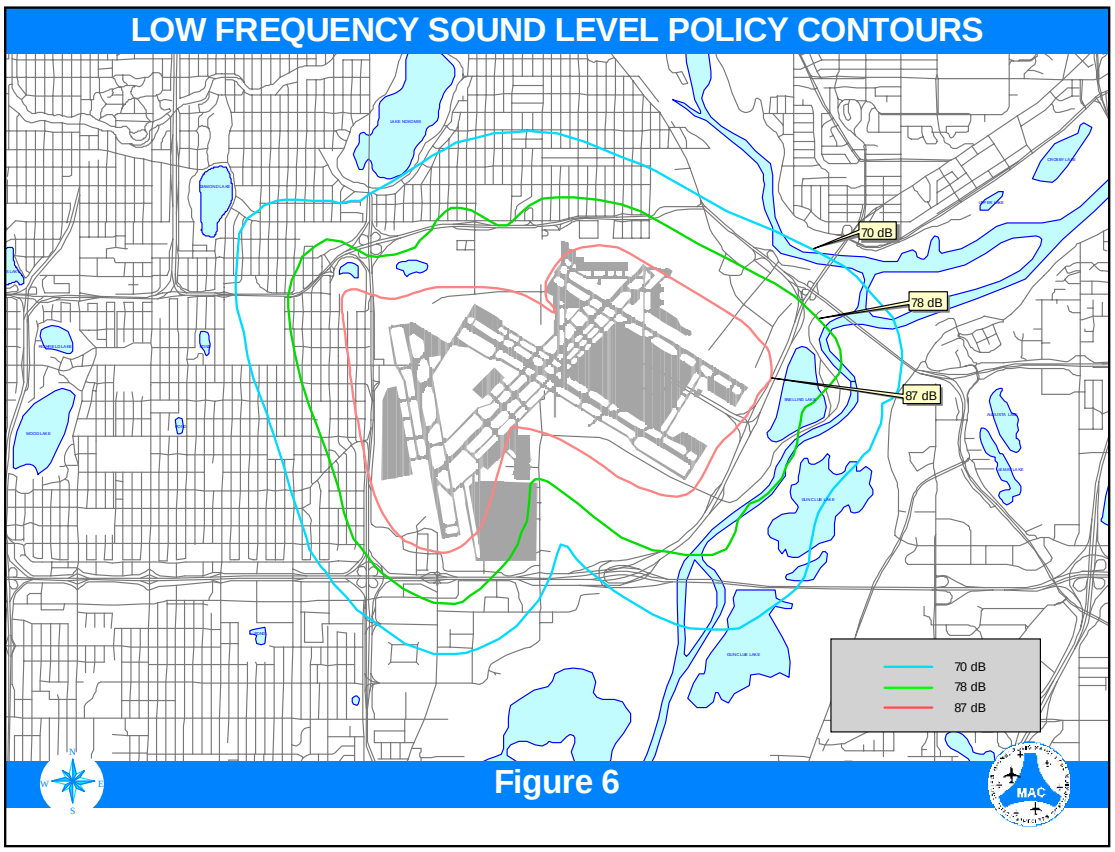


Figure 6

The Low Frequency Noise Policy Committee recommends that:

1. The recommendations of the Low Frequency Policy Committee be adopted by MAC, incorporated into the Part 150 Noise Mitigation Program Update, and submitted to FAA for review and approval as soon as possible.

2. The FAA be urged to act expeditiously in review and approval of the Part 150 Update since Runway 17-35 is currently under construction.

3. The best descriptor of low frequency aircraft noise is the sum of the maximum sound levels in the 25-80 Hz octave bands, and the best descriptor of low frequency aircraft noise dose is the arithmetic average of low frequency sound levels above a selected dB threshold.

4. The mitigation measures identified in Table 2 be used as the basis for determining appropriate low frequency noise mitigation for existing areas, including single-family residential conversion at levels above 87 dB LFSL.

5. The mitigation measures identified in Table 3 are to be used as the basis for future residential development.

6. Blocks intersected by low frequency noise contours be treated as if the whole block is included within the contour.

7. Land use conversion be used as the preferred method of mitigation in residential neighborhoods inside of the 87 db contour.

8. The low frequency sound level contours shown on Figure 6 (LFSL Policy Contour with Runway 17-35 in use) be adopted as the best representation of areas potentially affected by low frequency sound.

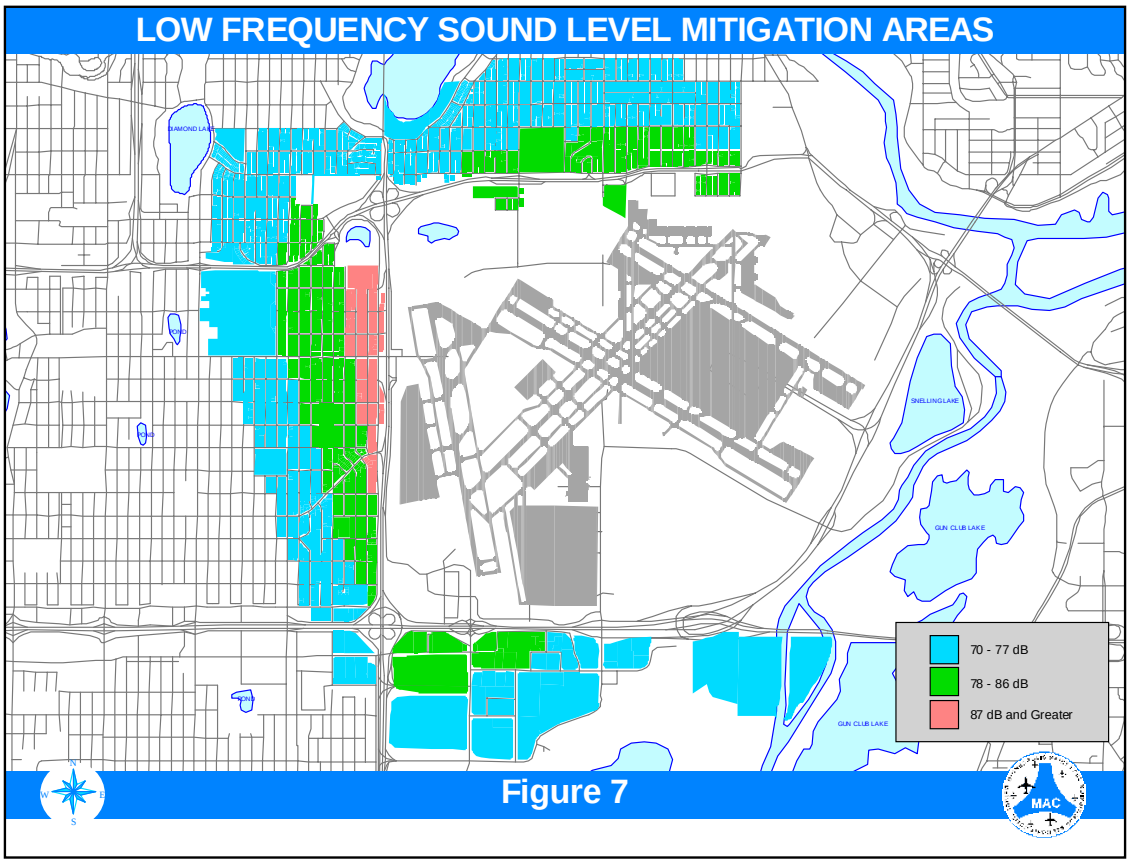
9. Figure 7, identifying the blocks impacted by the 87 dB, 78 dB, and 70 dB LFSL, be adopted for application of the mitigation measures indicated in Tables 2 and 3.

10. Homes previously insulated under the MSP residential insulation program, and now included within the low frequency impact area, receive additional low frequency mitigation as appropriate.

11. Homes included within both the DNL (for overall noise) and LFSL (low frequency noise) contours receive appropriate treatment for both types of noise concurrently.

12. FAA move forward expeditiously with development of national standards for determining both the impacts of low frequency aircraft noise as well as appropriate mitigation measures.

13. Information developed by the Expert Panel be forwarded to FAA for use in development of national standards for low frequency noise.


LOW FREQUENCY SOUND LEVEL MITIGATION AREAS
DIAMOND LAKE
SNELLING LAKE
GUN CLUB LAKE
GUN CLUB LAKE
70 - 77 dB
78 - 86 dB
87 dB and Greater
Figure 7
MAC

APPENDIX I

IMPACTS OF LOW-FREQUENCY AIRCRAFT NOISE ON RESIDENTIAL LAND USE

Use of Policy Committee Contour and Block Identification

The impacts of low-frequency aircraft noise for future operation of MSP were assessed on the basis of the "Low-Frequency Sound Level Policy Contours" of Figure 6 of Appendix H as interpreted on a block-by-block basis in the "Low-Frequency Sound Level Mitigation Areas" of Figure 7 of Appendix H. The blocks shown in Figure 7 were selected in accordance with the current practices of the MSP Residential Sound Insulation Program. That is, blocks intersected by low-frequency noise contours are treated as though the whole block were within the contour.

Impacts on Residential Land Use

Table I.1 shows the numbers of residential units in the three low-frequency noise zones. Single-family units and multi-family units are shown separately. The numbers of single-family units that have received treatment in the MSP Residential Sound Insulation Program are also shown.

Table I.1

Numbers of Residential Units in Low-frequency Noise Zones
(Zones by LFSL Dose in dB)

	Numbers of Units in Zone				Numbers of Units in Zone with Treatment(a)			
City and Type of Unit	**70 - 77**	**78 - 86**	**≥ 87**	**Total**	**70 - 77**	**78 - 86**	**≥ 87**	**Total**
City of Minneapolis								
Multi-family	280	409	0	689	0	0	0	0
Single-family	3,357	944	0	4,301	2,485	815	0	3,300
City of Richfield								
Multi-family	147	251	231	629	0	0	0	0
Single-family	845	1,003	206	2,054	63	506	102	671
City of Bloomington								
Multi-family	32	0	0	32	0	0	0	0
Single-family	0	0	0	0	0	0	0	0
All Cities								
Multi-family	459	660	231	1,350	0	0	0	0
Single-family	4,202	1,947	206	6,355	2,548	1,321	102	3,971
Total	**4,661**	**2,607**	**437**	**7,705**	**2,548**	**1,321**	**102**	**3,971**

(a) Does not include treatment for low-frequency sound levels.

Source: MAC

APPENDIX J

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Rev. 5/13/04

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Airport User Chair: Kathleen Nelson, Scheduled Airline (Northwest Airlines)

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APPENDIX K

REVISED MODELED ARRIVAL FLIGHT TRACKS EVALUATION REPORT

METROPOLITAN AIRPORTS COMMISSION
Minneapolis-Saint Paul International Airport
6040 - 28th Avenue South • Minneapolis, MN 55450-2799
Phone (612) 726-8100 • Fax (612) 726-5296

October 11, 2001

TO: Whom It May Concern

RE: **Executive Summary – MSP 2000 Part 150 Update – Arrival Flight Track Analysis**

On July 25, 2001 the Planning and Environment Committee of the Metropolitan Airports Commission (MAC) held a meeting to hear public comments relating to the proposed expansion of the Residential Sound Insulation Program at Minneapolis St. Paul International Airport (MSP). At this meeting a representative from a newly formed public group, known as the '5100 POP Group', spoke disputing the accuracy of the noise contours generated by the Integrated Noise Model (INM).

The location of the 5100 POP Group homes can best be described as located between Portland Avenue and Park Avenue situated in the area located between the 1996 65 DNL contour *"arrival paths."* The residents living in this area stated that the actual arrival flight tracks were not being adequately and/or accurately considered in the INM contour generation process. Claims were based on their own observations and the perceived noise levels in the area.

As a result, the MAC committed to an evaluation of the Airport Noise and Operations Monitoring System (ANOMS) flight track data accuracy, actual flight path observations, and the resultant INM flight tracks that were used to generate the Part 150 Update contours for MSP.

Pursuant to this commitment, MAC staff conducted actual observations of aircraft over flights and compared that information to the radar data that is used to generate the INM modeled flight tracks. The result of this evaluation was the determination of an extremely high degree of flight track data positional accuracy relative to observed aircraft over flight locations.

In addition, the single arrival track INM contour modeling process was evaluated. Extensive analysis of aircraft over flight observations and radar data determined that more consideration should be given to dispersing aircraft arrival operations around a main straight-in arrival flight track as part of the contour development process. As a result, an extensive INM arrival flight track development method was established, based on actual radar data, to reflect the aircraft dispersion around the main arrival path, as well as to consider the impact from aircraft turning on to the final approach even within the limits of the contour extent. These changes are being applied to the final contours generated for the 2000 Part 150 Update.

A complete technical report documenting the arrival analysis method responsive to this request is available upon request by contacting Melissa Scovronski at 612-726-8141. The report will also be incorporated into the Part 150 Update document as an appendix.

Sincerely,

Chad E. Leqve
Manager - MAC Aviation Noise & Satellite programs

The Metropolitan Airports Commission – Aviation Noise & Satellite Programs

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Evaluation of Minneapolis-St. Paul International Airport (MSP) Arrival Track Impacts Relative to Integrated Noise Model (INM) Contour Generation Criteria

October 11, 2001

METROPOLITAN AIRPORTS COMMISSION
Minneapolis-Saint Paul International Airport
6040 - 28th Avenue South • Minneapolis, MN 55450-2799
Phone (612) 726-8100 • Fax (612) 726-5296

October 10, 2001

Dear Reader,

The Metropolitan Airports Commission (MAC) is a world-renowned organization known for a superior reputation of excellent airport development/planning, airport services and safety. A trademark of the MAC system of airports is the environmentally sound manner in which the mentioned functions of the organization are achieved.

The MAC has long been considered at the forefront of responsible airport practices with respect to the mitigating the impact of airport noise on the environment. This document provides a comprehensive evaluation of the Minneapolis-St. Paul International Airport (MSP) 2000 Part 150 Update Integrated Noise Model (INM) contour generation process. The focus of this analysis is on the accurate representation of actual arrival flight track locations relative to the development of INM modeled flight tracks. The catalyst for this evaluation stems from concerns on behalf of residents in the 5100 POP Group located in the South Minneapolis area.

I would like to take this opportunity to thank the following members of the MAC Aviation Noise and Satellite Programs staff for their contributions and commitment to this analysis.

- Jason Giesen, Noise Monitoring Specialist
- Clinton Ind, ANOMS Specialist
- Eric Swenson, GIS Intern

In addition, I would like to thank Mr. Brian Timerson of the Minnesota Pollution Control Agency for his participation in this evaluation.

I hope the following information is helpful and addresses any questions relative to the accuracy of the INM arrival flight track development methodology. If further information is required regarding this topic, please feel free to contact me at 612-725-6326 or via e-mail at cleqve@macavsat.org.

Respectfully Submitted,

Chad E. Leqve
Manager,
Aviation Noise & Satellite Programs

The Metropolitan Airports Commission is an affirmative action employer.

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Section 1 - Introduction

The issue of airport noise continues to be of paramount importance to the Metropolitan Airports Commission (MAC). Realizing the noise impacts the Minneapolis-St. Paul International Airport (MSP) imposes on surrounding communities, the MAC has pursued multiple noise reduction programs around MSP. A significant part of this effort has been the establishment of a 14 CFR Part 150 Program at MSP.

A Part 150-developed Noise Compatibility Program (NCP) has been in place at MSP since the late 1980s and has provided an overall plan for noise reduction initiatives including the home insulation program, which was approved in the 1991 MSP Part 150 Update. As of August 17, 2001 the MAC has sound insulated or awarded contracts for the insulation of a total of 6,702 homes at a cost of $186.7 million. It is important to note that all of the funding is provided from aviation generated revenue sources; none of the money is derived from local tax bases. The ability of an airport authority to use Part 150 funds or any aviation generated funds for the purpose of noise mitigation hinges upon completion and federal acceptance of approved noise mitigation measures proposed in a Part 150 study.

At MSP the Part 150 program underwent an update in 1991 and to address significant changes planned by the construction and operation of Runway 17-35, MAC is sponsoring another Part 150 Update. With Metropolitan Aircraft Sound Abatement Council (MASAC was an organization comprised of equal airport user and community representatives) involvement, HNTB Corporation (MAC's environmental noise consultant) and MAC prepared a Part 150 update based on the forecasted 2005 airport configuration/use, airline fleet mix, airspace use and proposed mitigation measures (measures include operational procedures and land use tactics). In addition, the document proposes the expansion of the sound mitigation area from the present 65 DNL noise contour area to the 60 DNL noise contour area. These efforts represent measures beyond what has long been considered federal guidelines for areas and impacts eligible for mitigation.

The update process, which began in February 1999 with input from MASAC and local city representatives, included three series of public workshops and two public hearings held on November 8 and 9, 2000.

It is important to note the realities of Federal policy that dictate the manner in which noise is quantified and addressed at our nation's public use airports via Part 150. In 1979 the Aviation Safety and Noise Abatement Act established a congressional directive to the Federal Aviation Administration (FAA) calling for the implementation of a mechanism for the development of noise mitigation programs at U.S. airports. The result of this congressional direction was the development of 14 CFR Part 150. Through the development of Part 150, the FAA endorsed the use of the Day-Night Average Sound Level (DNL) metric as the appropriate metric for quantifying noise impacts around airports. The endorsement of DNL as an appropriate metric for quantifying impact is shared by the Department of Defense (DoD) and the Department of Housing and Urban

Development (HUD). DNL has been extensively evaluated over the years by the Environmental Protection Agency (EPA), FAA and the Federal Interagency Committee On Noise (FICON).

The DNL metric is calculated by adding all the sound exposure during the daytime plus a 10-decibel penalty for each aircraft noise event during the nighttime (10:00 P.M. to 7:00 A.M.). The night sound exposures are increased by 10 decibels because nighttime noise is more intrusive.

1.1 - Integrated Noise Model (INM)

The Federally established mechanism for quantifying airport DNL noise impacts is the Integrated Noise Model (INM). The availability of federal or aviation generated funds for the purpose of noise mitigation efforts (sound insulation) is contingent upon the development of a noise exposure map (typically referred to as contours) that is consistent with the federal criteria for doing so (i.e. INM and DNL). Having said that, it is imperative to understand the inputs and function of the federally required INM DNL contour generation process.

The Integrated Noise Model (INM) is used to specifically assess the noise impact of aircraft operations. INM utilizes input files to generate a noise exposure map. INM Input files consist of information relative to:

- Runway use
- Flight track use
- Aircraft fleet mix
- Aircraft performance/thrust settings
- Topography information
- Atmospheric conditions

The computer model generates contours (typically represented in five DNL increments) that depict an annualized average day of aircraft noise impacts. The DNL contours generated are the focal point of any noise mitigation measure proposed in a Part 150 program. The method for quantifying aircraft specific noise characteristics in INM is accomplished through the use of a comprehensive noise database which has been developed under the auspices of Federal Aviation Regulation (FAR) Part 36. As part of the airworthiness certification process, aircraft manufacturers are required to subject the aircraft to a battery of noise tests. Through the use of federally adopted and endorsed algorithms, this aircraft specific noise information is used to generate the INM DNL contours.

The Part 150 process provides airport operators with the procedures, standards and methodology governing the development, submission and review of airport Noise Exposure Maps and airport Noise Compatibility Programs.

1.2 – INM Flight Track Development Considerations

The geometry of a noise contour developed using the Integrated Noise Model (INM) is a function of the above mentioned INM input file variables. One of the more significant variables is the representation of flight track locations and the allocation of aircraft fleet mixes and total operations numbers to the respective flight tracks. For the purposes of INM contour development at MSP, core and sub flight tracks are developed for each runway with respect to the density of operations along any one given departure/arrival path or heading.

At most airports around the country the location and shape of these flight tracks are predicated on remote visual observations made by either airport staff or consultants performing the analysis. Furthermore, the determination of aircraft fleet mixes and the total number of operations on the various core and sub flight tracks are typically determined by estimations made relative to considering typical FAA heading allocations relative to published departure destinations for the various operations at the airport. The arrival flight tracks are typically developed as a single core flight track, which is a function of the extended runway centerline.

The above INM flight track development process is the prevailing method for determining INM flight tracks and associated operations information at the majority of our nations airports. The Metropolitan Airports Commission (MAC) has gone above and beyond traditional methodologies for this Part 150 Update at Minneapolis-St. Paul International Airport (MSP) by incorporating actual flight track data collected from the Federal Aviation Administration's (FAAs) radar located at the airport through the use of the Airport Noise and Operations Monitoring System (ANOMS).

By way of background, ANOMS at MSP provides an objective tool for the purpose of assessing airport and airspace utilization and the resultant impacts. ANOMS utilizes two data sets, aircraft flight track data and monitored noise information. The noise information is collected via 29 permanently located noise monitoring poles located in communities around MSP. These monitors collect noise data 24-hours a day seven days a week. The flight track information is collected via a flight track data acquisition system that interfaces directly with the FAAs radar equipment located at MSP. ANOMS provides further analytical capabilities by correlating the noise events to aircraft over flights.

Realizing the data available, MAC staff and consultants developed a method to incorporate actual flight tracks and operations information into the development of INM flight tracks. Through the use of flight track positional information out of ANOMS, INM flight tracks were developed consistent with the actual FAA radar-derived locations.

Furthermore, aircraft fleet mix information based on ANOMS spatial analysis capabilities, was applied to INM core and sub flight track distributions.

This INM flight track development process represents unprecedented use of actual flight track information and ANOMS analytical capabilities, ensuring the greatest degree of accuracy in the development of forecasted noise impact contours for MSP.

1.3 – Community Inquiry Regarding MSP INM Arrival Flight Track Locations

On July 25, 2001 the Planning and Environment Committee of the Metropolitan Airports Commission (MAC) held a meeting to hear public comments relating to the proposed expansion of the Residential Sound Insulation Program at Minneapolis St. Paul International Airport (MSP). At this meeting a representative from a newly formed public group, known as the '5100 POP Group', spoke questioning the accuracy of the noise contours generated by the Integrated Noise Model (INM).

The location of the 5100 POP Group homes can best be described as located between Portland Avenue and Park Avenue situated in the area located between the 1996 65 DNL contour *"arrival spikes."* The residents living in this area stated that the actual arrival flight tracks were not being adequately and/or accurately considered in the INM contour generation process. Claims were based on their own observations and the perceived noise levels in the area.

Due to the statements presented at the public meeting, on the evening of August 20, 2001 Jeff Hamiel, MAC Executive Director, gave a presentation highlighting the contour generation process and associated considerations. The presentation was provided to members of the 5100 POP Group at the home of one of the members. During the course of this meeting the residents stated that the tracks used in the generation of the INM contours did not accurately reflect the actual flight paths of the aircraft. Due to the concerns raised by the residents, Mr. Hamiel committed MAC staff to an analysis that would determine any discrepancy relative to the accuracy of the INM flight tracks used as part of the future contour generation process.

1.4 – Framework for Follow-On Arrival Flight Track Evaluations

In an effort to evaluate the concerns expressed by the 5100 POP Group, MAC staff conducted an analysis in conjunction with the Minnesota Pollution Control Agency to physically determine the position of aircraft relative to the radar flight track information and associated INM flight tracks used to generate the MSP Part 150 Update contours. The determined course of action was twofold in scope, 1) an assessment of the integrity of the flight track location information received from the FAA Airport Surveillance Radar (ASR-9) via ANOMS and 2) consideration of possible methods to more adequately represent dispersion along arrival tracks if the actual flight track information dictates justification for such representation in the INM contour generation process.

The following information provides specific information relative to the above-mentioned analysis, the associated conclusions and resultant enhancements to the contour generation process.

Section 2 – Accuracy of FAA Airport Surveillance Radar (ASR-9) – Airport Noise and Operations Monitoring System (ANOMS) Flight Track Data Source

Before discussing the analysis process and the associated findings relative to the INM flight track location accuracy it is imperative to understand the data source and/or the primary mechanism/equipment used to gather the aircraft flight track positional information that ultimately determines the location and geometry of the INM flight tracks.

2.1 – Purpose/Function of the FAA ASR-9 Radar at MSP

In addition to providing data to the MAC ANOMS program, the primary function of the FAA Airport Surveillance Radar (ASR-9) at MSP is for air traffic control purposes ensuring the safe and expedient flow of air traffic in and out of MSP. Considering the aircraft separation function and safety of flight contributions that are expected/provided by the ASR-9 radar, the flight track positional accuracy and integrity of the system is paramount.

By way of background, the ASR-9 radar is based on the principles of active radar surveillance. The radar transmits interrogations utilizing a rotating antenna (please refer to Figure 2.1). As the transmitted beam passes a given aircraft, it triggers the aircraft's transponder, causing the aircraft to transmit a reply. This aircraft positional information, altitude and associated operations information is what the FAA uses to control aircraft in the Terminal Area around MSP as they arrive and depart the airport.

The FAA stores the ASR-9 data temporarily and, in addition, via a Memorandum of Agreement (MOA's), allows MAC to use the radar information in the ANOMS program at MSP.

2.2 – ASR-9 Radar as Peripheral ANOMS Flight Track Data Acquisition Element

In the rare event of a radar failure, the FAA records all radar data using an Optical Disc Subsystem (ODS), which records each flight operation. Using specialized software, FAA personnel process and filter the radar data available from the ODS for use by the ANOMS program. As a result of the processing, two files are created. A text file containing all of the inter-facility data (typically referred to as operational data) for each flight and a point file containing all of the radar points for each flight track. The information within the two files is symbolically linked via a unique operation number, which is critical to further ANOMS processing. Once the mentioned processing and filtering is complete, the files are released to the MAC Noise Department.

The inter-facility/operational data contains unique information for each operation such as aircraft type, airline, arrival/departure, etc. This information is correlated to the

Figure 2.1

Airport Surveillance Radar (ASR)



appropriate flight track point set via a unique number. FAA flight track radar points consists of coordinates for each radar contact point along the flight track.

2.3 – Accuracy of the FAA ASR-9 Radar

Given the magnitude of the safety functions that are demanded of the FAAs ASR-9 radar, it is not surprising that the radar is extremely accurate/reliable relative to the positional information that it provides.

It is documented in the Federal Aviation Technical Instruction Manual (TI 6310.24) that the MSP ASR-9 radar provides a range accuracy of 1/32 Nautical Miles and the azimuth accuracy is within .088 degrees (please refer to Figure 2.2).

Section 3 – Validation of Flight Track Positional Accuracy

In an effort to address the concerns of the residents regarding appropriate INM flight track locations, an evaluation of the radar flight track data was conducted. The following documentation provides specific information regarding this effort.

3.1 – Assessment Methodology Considerations

Consistent with the concerns expressed by the 5100 POP Group, a commitment was made to evaluate the flight tracks used to develop the MSP Part 150 Update contours. In an effort to provide a thorough evaluation of this contour development variable, MAC staff commenced an evaluation of the data used to develop the INM flight tracks. Thus, an evaluation of flight track location information was conducted relative to the location of observed aircraft over flights. It was determined that the most effective way to verify the radar flight track data was to determine the location of an over flight in the area of concern and compare it to the available flight track location data.

Several methods of identifying observed over flight locations were considered. The goal of the location assessment methodology was to determine a point on the ground where the aircraft was observed passing directly over. Triangulation of the aircraft altitude and distance from a measured point was contemplated, but no accurate measurement of distance from the ground to the passing aircraft was identified. Consequently, the method employed to determine ground location was a direct observation of the over flight location by one MAC staff member and one Minnesota Pollution Control Agency (MPCA) representative. Although this method seems simplistic, the theory was that with fewer measurements being made there would be less total error compounded during the procedure. This observation method is consistent with the method used by the 5100 POP representatives.

3.2 – Flight Track Monitoring Process

MAC and Minnesota Pollution Control Agency (MPCA) staff visually observed the arrival flight path of aircraft over flights and used a Global Positioning System (GPS)

Figure 2.2

U.S. Department of Transportation
Federal Aviation Administration

Memorandum

Subject: Information: **Minneapolis ASR-9 Accuracy** **Date:** April 11, 2000

From: Gregory M. Ingraham
Minneapolis Facility Manager, DMS SMO

Reply To:

To: Cindy Greene
Minneapolis Air Traffic Support Manager

As specified in the Federal Aviation Technical Instruction Manual (TI 6310.24), the Minneapolis Airport Surveillance Radar (MSP ASR) provides a range accuracy of 1/32 Nautical Miles and the azimuth accuracy is within .088 degrees. If you have any further questions on this matter, please contact Curt Wynkoop at (612)713-4113.

Gregory M. Ingraham

receiver to identify the location perceived to be directly underneath the aircraft as it passed overhead. Staff positioned themselves at locations on Portland Avenue and Chicago Avenue to allow for adjustment North or South for each specific aircraft over flight approaching runway 12L (please refer to Figure 3.1). When the location of the aircraft was identified, the aircraft type and time were noted to link that event to its associated radar flight track location information. The geographic location of the over flight was also referenced and measured from street intersections. The location of the observed arrival over flight was then compared to the flight track data to ascertain the accuracy of the flight track data.

The corner of Chicago Avenue and 51st Street East was used as a reference point to compare the exact geographic location of the observed over flight to the location of the flight track. Obviously, any observation of aircraft over flights will have an element of inaccuracy associated with it, but the observations were all performed by the same staff personnel and there was a high degree of consistency in the procedure employed to identify the over flight locations. This consistency minimized, to the greatest degree possible, the inherent perceptual inaccuracies associated with the manual observation process. Additionally, the MPCA representative verified the observation data as part of this process.

3.3 - Flight Track Monitoring Findings

The processes outlined above resulted in the determination of the distance between physically monitored tracks, and depicted tracks in ANOMS. By doing this, staff was able to determine the accuracy of the depicted flight tracks in ANOMS, with respect to the physically monitored flights. The results of the analysis showed the average deviation of flights depicted in ANOMS from the physically monitored tracks to be approximately 28 feet.

Considering the multifaceted elements of error introduced in such an aircraft positional evaluation, the above findings are extremely favorable with regard to the unprecedented aircraft positional accuracy considerations that have been part of the INM contour generation process at MSP.

When looking at the results of the analysis presented above, consideration should be given to certain factors that inadvertently impacted the results of the analysis. While these factors, individually are insignificant, the compounding effect of them can account for a limited degree of discrepancy in the findings of the analysis.

The greatest introduction of error relative to the monitoring procedure is a result of the difficulty associated with the exact determination of a point directly beneath the spot on the aircraft where the transmitting transponder antenna is located. For the purpose of this evaluation this point was arbitrarily determined relative to a point below what was perceived to be a direct over flight.

Monitered Aircraft GPS Point Location

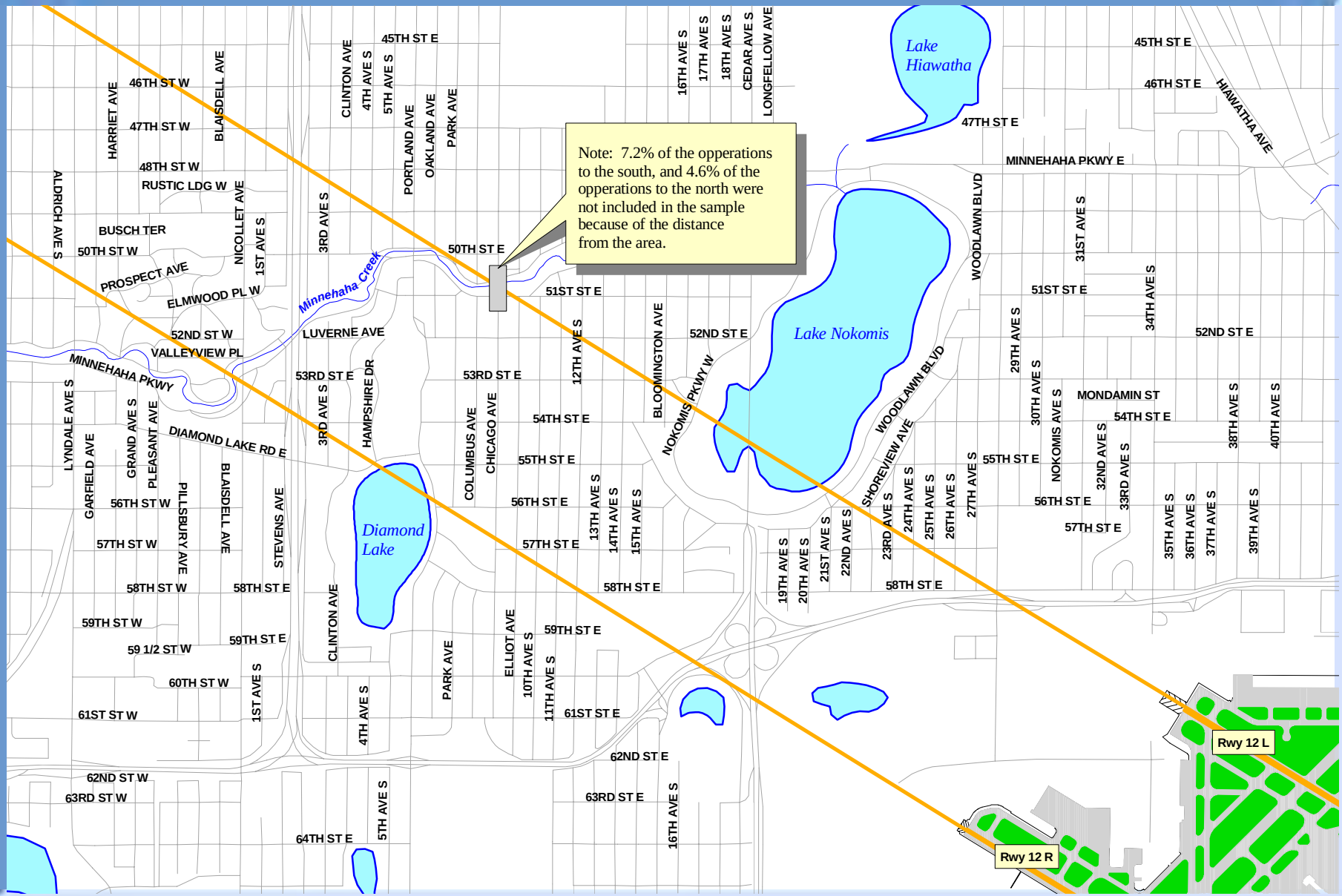
Runway Centerline

GPS Point Location

0.25 0 0.25 0.5 Miles

N W E S

Figure 3.1



When considering the favorable findings of this analysis, it is helpful to consider the varying widths of aircraft wingspans that can range from 70' 4" for a SABB 340, to 165' 4" for a DC10.

Considering the above information, the coordinated effort between MAC staff and the MPCA assured the highest level of accuracy. The positional accuracy of the flight track information that has contributed to the development of INM flight tracks is well within the width of all predominate aircraft wingspans at MSP. The findings of this analysis validate the high degree of accuracy ANOMS has in depicting actual flight paths of aircraft.

3.4 - Independent ANOMS Accuracy Evaluation Findings

The question of accuracy relative to noise and operational data collected at major airports around the country is not new. Acceptance testing of systems related to flight track data acquisition and spatial analysis are predicated on stringent criteria, the loftiest of which have been at MSP.

This conclusion of high ANOMS informational accuracy is further validated by the analyses of consulting firms independent of any users, developers or owners of the ANOMS software program (please refer to Figure 3.2).

Section 4 – INM Arrival Flight Track Revision Concept

Upon establishing the above input data accuracy, revised INM modeled arrival flight tracks were developed in response to public concerns regarding the comprehensiveness of previous modeled arrival flight tracks. Specifically, the layout of the arrival flight tracks was revised to capture two predominant effects related to the arrival routes into MSP, as described below.

4.1 – Modeling Aircraft Flight Track Dispersion About Final Approach Course

Arriving aircraft may fly to the left, right, and directly on the final approach course, or extended runway centerline, for landing at MSP. The flight of aircraft to the left or right of the median track is known as dispersion, and is the result of wind, pilot technique, and/or the performance of radio navigational aids systems (i.e., ILS). Dispersion is not a violation of ATC directions or Federal Aviation Regulations. The flight tracks that model this occurrence are collectively known as dispersed straight-in flight tracks.

Aircraft on the straight-in arrival route are modeled by a set of nine sub flight tracks, spaced at 0.5-degree increments. This results in a track width of 4-degrees, extending from the runway threshold, which is wider than (and therefore encompassing of) the predominant straight-in arrival route. A gate analysis, as described below, is used to determine the proportion of aircraft on each straight-in track.

Figure 3.2

LOCHARD

September 13, 2001

Mr. Chad Leqve
Metropolitan Airports Commission
6040 28th Avenue South
Minneapolis MN 5540-2799

Subject: **Noise and Operations Monitoring System (ANOMS)**

Dear Mr. Leqve;

Lochard's Airport Noise and Operations Monitoring System (ANOMS) software has been verified to acquire, process, and report airport noise and flight track data in an accurate and reliable manner. Verification of the accuracy of noise data acquisition and processing, flight track acquisition and processing, noise event correlation, noise calculations, and runway matching has all been done by independent consulting firms. The testing and validation projects have shown ANOMS to perform within its specified parameters.

Yours Sincerely,

Nathan Higbie
Vice President Technology
Lochard Corporation

Lochard Corporation
39 Pleasant St.
Stoneham MA 02180-3829
781 438-5515

4.2 – Modeling Aircraft Intercept of Final Approach Course

Most aircraft intercept the final approach course at a point outside the 60 dB DNL contour, and are modeled using the dispersed straight-in tracks, as described above. Some aircraft, however, intercept the final approach course relatively close to MSP, and within the 60 dB DNL contour. The close-in intercepts of the final approach course can occur due to ATC directives (which result from requirements for aircraft separation and/or airspace capacity and traffic demand considerations), weather, and the use of visual approaches. Regardless of the reason, close-in intercepts are a safe and established procedure, and do not violate Federal Aviation Regulations. The flight tracks that model this occurrence are collectively known as dispersed intercept flight tracks.

A grid of flight tracks is used to model aircraft executing a close-in intercept to the final approach course. The grid includes curved modeled flight tracks spaced at 0.5 nautical mile increments on the extended runway centerline; the grid begins at 0.5 NM from the runway threshold, and extends approximately 1 NM beyond the 2000 60 dB DNL contour. Modeled flight tracks within 1.5 NM of the runway threshold have a two-turn approach course, with an initial approach course of 42.5-degrees and an intercept course of 22.5-degrees (relative to the final approach course). The two-turn course models the relatively broad approach angle used by aircraft on initial approach close to the runway threshold; the broad angle is necessitated by the aircraft's close proximity to the runway threshold, and is reflective of typical close-in visual approach procedures. Modeled flight tracks beyond 1.5 NM of the runway threshold have a single turn with an intercept course of 22.5-degrees (relative to the final approach course). The one-turn course models the narrow approach angle used by aircraft intercepting the final approach course as part of an ILS Initial Approach Procedure (IAP). The 22.5 and 42.5-degree courses used in the modeled flight tracks are representative of typical approach courses. The lateral spacing of the intercept course for each successive flight track is approximately 1,160 feet (please refer to Figure 4.1). A gate analysis, as described below, is used to determine the proportion of aircraft on each dispersed intercept flight track.

4.3 – ANOMS Flight Track Gate Analysis

For the purpose of this discussion, a gate is a line, delineated by latitude/longitude points at each end that is used to determine the proportion and mix of aircraft that use each modeled arrival flight track. Gates are arranged so that the midpoint of a gate intersects the modeled arrival flight track; when connected end-to-end, the gates form a 'U' about each runway end, and thereby capture the total distribution, and flight track use, for arrivals to that runway end (please refer to Figure 4.2).

ANOMS is then used to count the total number of actual arrival aircraft operations, by runway end, aircraft type, airline, and daytime/nighttime, that cross each gate during a 12-month composite period. The 12-month composite period of operational data is the same sample used to develop runway use and departure flight track use: January to March of 1999, April through September of 1997, and October to December of 1999. The data derived from the gate analysis establishes average annual flight track use (note that the data is separated into the 22 operational categories used in the noise model as described in Chapter 3 of the November 2001 Draft Part 150 Update).

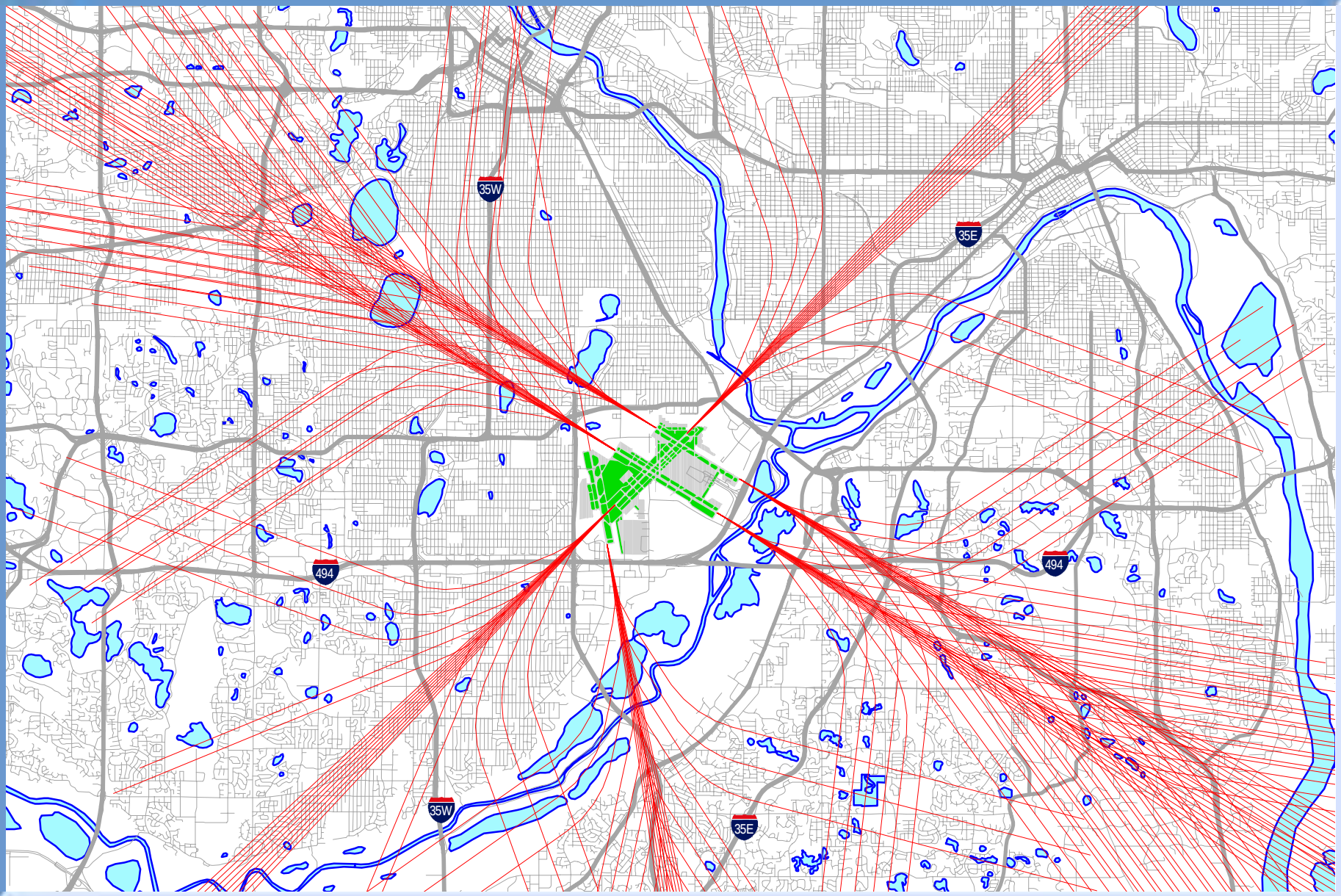
Updated Arrival INM Tracks

Arrival INM Tracks

1 0 1 2 Miles

N W E S

Figure 4.1



INM Tracks With ANOMS Gates

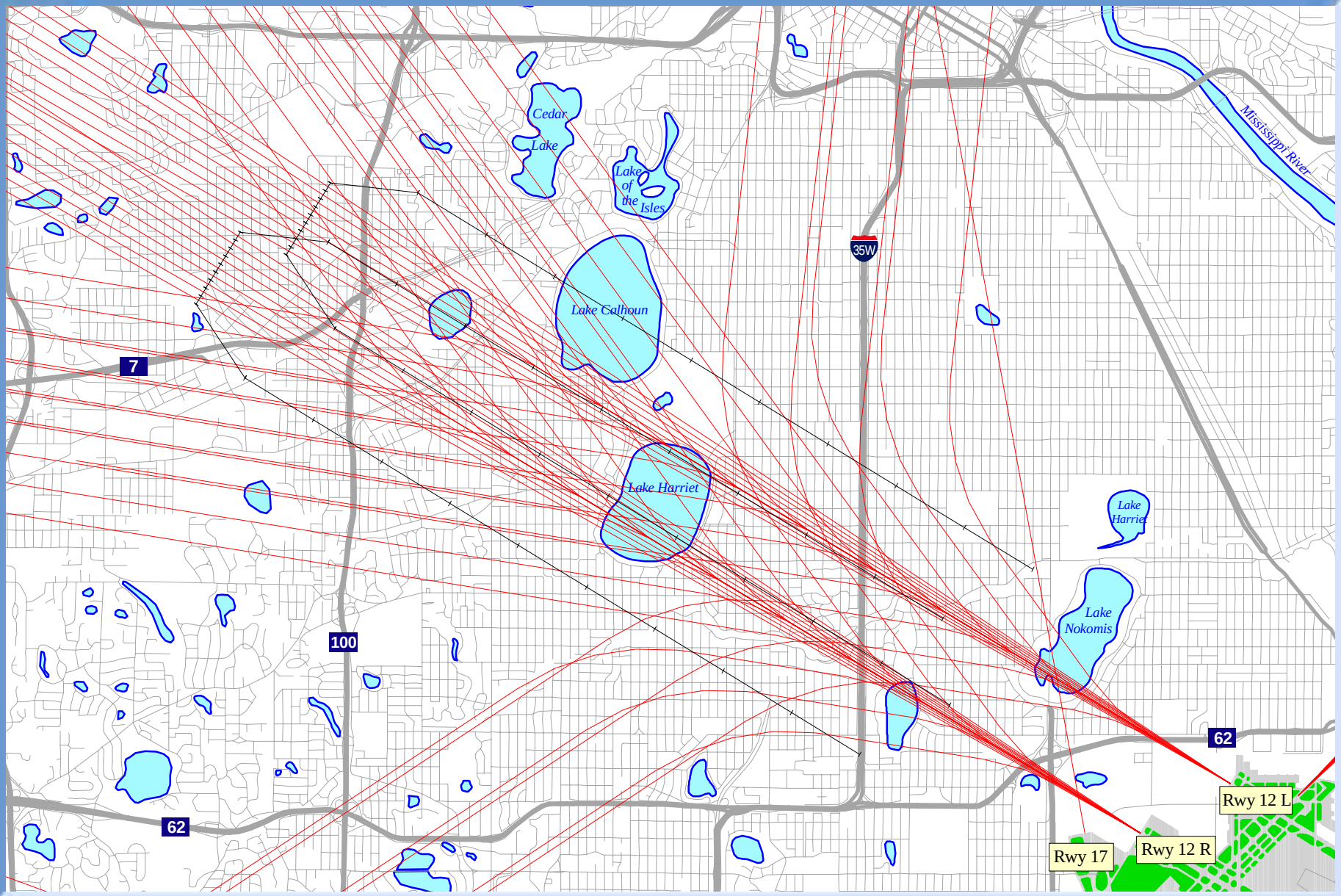
Arrival INM Tracks

Individual ANOMS Gates

0.5 0 0.5 1 Miles

N W E S

Figure 4.2



The revised modeled arrival flight tracks improve the modeling of arrival operations at MSP, especially in areas between the 60-65 dB DNL contours, where arrival dispersion can and does occur. The net effect of the revised modeled arrival flight tracks is to improve the INM data inputs and thereby improve the estimation of aircraft noise exposure as depicted in the DNL contours.

4.4 – Incorporation of Dispersed Aircraft Arrival Tracks in the MSP Part 150 Update

The above-mentioned modifications and considerations will be incorporated in the final MSP Part 150 Update contours that will be submitted to the FAA. This exercise is a true testament to the cooperative efforts that are intended to be cultivated through the public involvement processes associated with capital improvement and environmental planning at our nations airports.

Given the dispersion observed during this process, the arrival contour lobes may tend to reduce in length due to the reassignment of some straight-in arrival operations to close-in final approach turn-on tracks. Typically, any growth in the width of the arrival contour lobes as a result of the turn-on operations is negligible due to the containment of these operations within other arrival and departure areas.

APPENDIX L

COMPARISON OF 2005 AND 2007 MITIGATED NOISE EXPOSURE MAPS

This appendix provides a brief comparison of the 2005 Mitigated NEM developed for the November 2001 Study and the 2007 Mitigated NEM developed for this edition of the Study. **Figure L-1** provides a comparison of the NEMs. Also, see Section 1.3 for a discussion of the Study history. While retaining approximately the same shape as the 2005 Mitigated NEM, the 2007 Mitigated NEM is substantially smaller. There would be a reduction of about 7,301 people and 4,170 dwellings within the 2007 Mitigated NEM, as compared to the 2005 Mitigated NEM.

The 2005 and 2007 Mitigated NEMs are based upon the same recommended operational noise abatement measures as described in Chapter Seven. As shown in **Table L.1**, the 2007 Mitigated NEM contains about 20 more daily operations than the 2005 Mitigated NEM. The 2007 Mitigated NEM was run in INM version 6.1, which has some enhancements as compared to version 6.0a that was used for the 2005 Mitigated NEM as described in Chapter Four. Nonetheless, the dominant factors in the smaller size of the 2007 Mitigated NEM are the continued integration of quieter aircraft and, more importantly, a reduction in the number of forecast nighttime operations.

Table L.1

Fleet Mix Comparison of 2005 and 2007 Mitigated NEMs

Aircraft Type	2007					2005					2007 vs. 2005 Total Ops
	Day	Night	Total	Percent Day	Percent Night	Day	Night	Total	Percent Day	Percent Night	
A319/A320	322.5	20.4	342.9	94.1%	5.9%	376.4	45.2	421.5	89.3%	10.7%	-78.6
B72Q	7.8	6.4	14.1	54.9%	45.1%	16.0	6.0	22.0	72.6%	27.4%	-7.9
B757	122.5	9.7	132.2	92.7%	7.3%	96.0	17.9	113.9	84.3%	15.7%	18.3
CARJ	260.6	14.4	275.0	94.8%	5.2%	119.3	21.8	141.1	84.5%	15.5%	133.9
DC9Q	245.3	15.3	260.5	94.1%	5.9%	205.2	21.5	226.7	90.5%	9.5%	33.8
RJ85	74.3	2.2	76.5	97.2%	2.8%	68.9	4.1	73.0	94.3%	5.7%	3.5
SF34	93.3	5.9	99.2	94.0%	6.0%	138.4	13.0	151.4	91.4%	8.6%	-52.2
Other	345.9	49.1	395.0	87.6%	12.4%	342.2	83.4	425.6	80.4%	19.6%	-30.6
Total Daily	**1472.3**	**123.3**	**1595.5**	**92.3%**	**7.7%**	**1362.3**	**213.0**	**1575.3**	**86.5%**	**13.5%**	**20.2**
Total Annual			**582,366**					**575,000**			**7,366**

Note: Differences may exist due to rounding as actual INM input is to four decimal places; only one decimal place is shown in the table in the interest of conciseness.

Source: 2001 Study and Table 4.5

Comparison of DNL Contours for the 2005 Mitigated NEM and 2007 Mitigated NEM

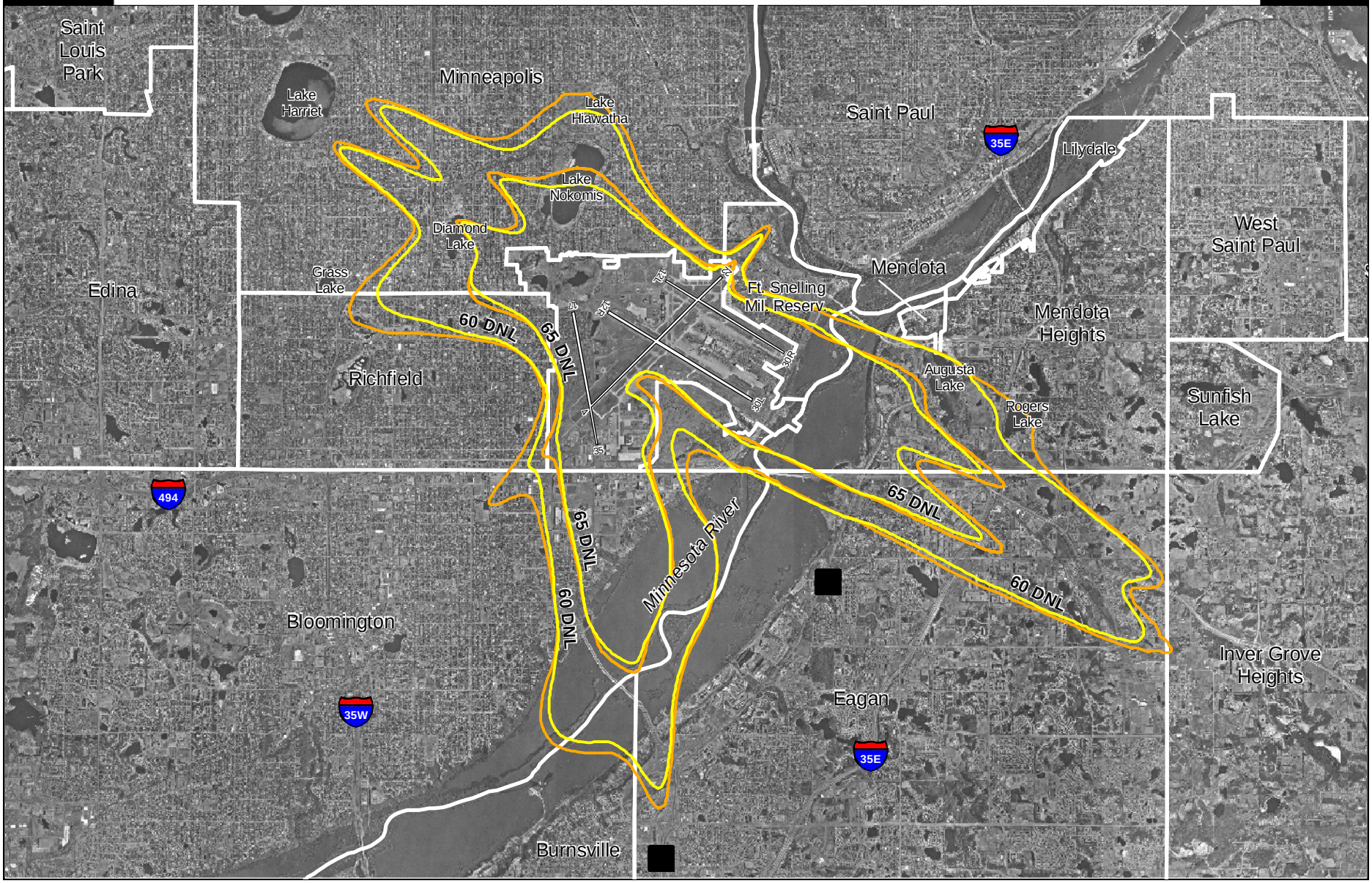


Figure L-1