Appendix A

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APPENDIX A
FAA POLICIES, GUIDANCE, AND REGULATIONS

A.1 NOISE CONTROL POLICIES AND GUIDANCE

This section presents information regarding noise and land use criteria that may be useful in the evaluation of noise impacts. With respect to airports, the Federal Aviation Administration (FAA) has a long history of publishing noise and use assessment criteria. These laws and regulations provide the basis for local development of airport plans, analyses of airport impacts, and the enactment of Compatibility policies. Other agencies, including the U.S. Environmental Protection Agency (USEPA) and the Department of Defense, have developed noise and use criteria. A summary of some of the more pertinent regulations and guidelines is presented in the following paragraphs.

A.1.1 NOISE CONTROL ACT

Congress passed the Noise Control Act (42 U.S.C. §4901 et seq.) in 1972, which established a national policy to promote an environment for all Americans free from noise that jeopardizes their health and welfare. The act set forth the foundation for conducting research and setting guidelines to restrict noise pollution.

A.1.2 U.S. ENVIRONMENTAL PROTECTION AGENCY NOISE ASSESSMENT GUIDELINES

In response to the Noise Control Act, the USEPA published *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety.* This document identifies safe levels of environmental noise exposure without consideration for economic cost for achieving these levels. In this document, 55 decibel (dB) Day-Night Average Sound Level (DNL) is identified as the requisite level with an adequate margin of safety for residential and recreational uses. This document does not constitute USEPA regulations or standards; rather, it is intended to "provide state and local governments as well as the Federal government and the private sector with an informational point of departure for the purpose of decision-making."

A.1.3 FEDERAL AVIATION NOISE ABATEMENT POLICY

On November 18, 1976, the U.S. Department of Transportation and FAA jointly issued the Federal Aviation Noise Abatement Policy. This policy recognized aircraft noise as a major constraint on the further development of the commercial aviation established key responsibilities for addressing aircraft noise. The policy stated that the Federal Government has the authority and responsibility to regulate noise at the source by designing and managing flight procedures to limit the impact of aircraft noise on local communities; and by providing funding to airports for noise abatement planning.

A.1.4 AVIATION SAFETY AND NOISE ABATEMENT ACT OF 1979

The Aviation Safety and Noise Abatement Act of 1979 (ASNA), which is codified as 49 U.S.C. 47501-47510, set forth the foundation for the airport noise compatibility planning program outlined in 14 Code of Federal Regulations (CFR) Part 150 (see Section A.1.6). The act established the requirements for conducting noise compatibility planning and provided assistance to and funding for which airport operators could apply to undertake such planning.

A.1.5 AIRPORT NOISE AND CAPACITY ACT OF 1990

The Airport Noise and Capacity Act (ANCA) of 1990 established two broad directives for the FAA: 1) to establish a method by which to review airport noise and access/use restrictions imposed by airport proprietors, and 2) to institute a program to phase out Stage 2 aircraft over 75,000 pounds by December 31, 1999.

A.1.6 FEDERAL REGULATIONS RELATED TO AIRPORT NOISE

The FAA has promulgated a series of regulations based on directions from Congress as provided in a series of authorizing statutes. Four separate Federal Regulations have been developed to specifically address permissible aircraft noise levels, operating procedures, and studies of aircraft noise levels. These regulations apply to activity within the U.S. Additionally, the International Civil Aviation Organization (ICAO) has developed and accepted similar regulations, which control the noise levels generated by aircraft operating in international airspace.

14 CFR Part 36

Title 14, Part 36 of the CFR sets forth noise levels that are permitted for aircraft of various weights, engine number, and date of certification. Originally released in 1974 as a result of Congress' modification of the Federal Aviation Act of 1958 through the Noise Control Act of 1972, aircraft were divided into three classes, based on the amount of noise they produced at three specific noise measurement locations during certification testing. These classes (or stages) were:

<u>Stage 1</u> – the oldest and loudest aircraft, typically of the first generation of jets, designed before 1974, and having measured noise levels that exceed the standards set for the other classes of aircraft. This group included many of the first generation of jet aircraft used in passenger and cargo service, including the B-707, early B-727 and B-737 aircraft, and early DC-8s. Under 14 CFR Part 91, all such aircraft weighing more than 75,000 pounds were removed from the U.S. operating fleet by 1985, unless modified to meet Stage 2 noise standards.

<u>Stage 2</u> – aircraft that were type certified before November 15, 1975 that met noise levels defined by the FAA at takeoff, sideline, and approach measurement locations. The permissible amount of noise increased with the weight of the aircraft above 75,000 pounds and the number of engines. This category included many of the second-generation jet aircraft such as the B-727, B-737-200, and DC-9 that

were extensively used in passenger and cargo service. Under 14 CFR Part 91, all such aircraft weighing more than 75,000 pounds were removed from the U.S. operating fleet by 2000, unless modified to meet Stage 3 noise standards.

Stage 3 – aircraft that meet the most stringent noise level requirements at takeoff, sideline, and approach measurement locations for their weight and engine number. This category includes the great majority of active business jet aircraft and all aircraft in passenger and cargo service that weigh more than 75,000 pounds.

The Committee on Aviation Environmental Protection, an International Civil Aviation Organization subcommittee, of which the U.S. is an active participant, has been debating the merits of adopting a more stringent standard for new aircraft type designs. In July 2005, the FAA, through notice in the *Federal Register*, adopted a Final Rule for Stage 4 Aircraft Noise Standards. No action had been taken by August 2013 to establish a phase out schedule for Stage 3 aircraft.

Stage 4 – all jet and transport-category airplanes with a maximum take-off weight of 12,500 pounds or more for which application of a new type design is submitted on or after January 1, 2006. The FAA's final Part 36 Stage 4 noise levels are a cumulative 10 EPNdB (effective perceived noise level in decibels) less than the current Stage 3 limits. They are based on the work of the International Civil Aviation Organization's committee on aviation environmental protection, in which the FAA and the International Business Aviation Council are active members.

All business jets are currently manufactured meet Stage 3 limits (by law), and nearly all would qualify to be recertified to meet Stage 4. Although the proposal doesn't contain a Stage 4 retrofit requirement and the FAA said it has no plans to impose such a requirement.

14 CFR Part 91

Title 14, Part 91 of the CFR as applied to noise, established schedules for phasing louder equipment out of the operating fleet of aircraft weighing more than 75,000 pounds. The schedules called for all Stage 1 aircraft over 75,000 pounds to be removed from the fleet by 1982, with the exception of two engine aircraft in small city service, which were allowed to continue in service until 1985. The schedule for the retirement of Stage 2 aircraft called for the removal of all such aircraft by the end of 1999, with interim retirement dates of 1994, 1996, and 1998 for the removal of portions of the Stage 2 fleet.

On July 2, 2013, the FAA issued a Final Rule which prohibits the operation in the contiguous United States of jet airplanes weighing 75,000 pounds or less that do not meet Stage 3 noise levels after December 31, 2015.

As of August 2013, no retirement schedules have been imposed for aircraft weighing less than 75,000 pounds nor has there been any indication of the imposition of a phase-out of Stage 3 aircraft.

14 CFR Part 150

Title 14, Part 150 of the CFR sets forth the standards under which a Part 150 Noise Compatibility Study is conducted. The background and requirements for such studies are presented in **Section One** of this document. Notably, the preparation of a Noise Compatibility Program (NCP) under 14 CFR Part 150 is a voluntary action by an airport proprietor. The process of preparing the plan is intended to open/enhance lines of communication between the airport, its neighbors, and users. It is the only mechanism to provide for the mitigation of aircraft noise impacts on noise-sensitive surrounding areas that is not directly tied to airfield development or airspace utilization conducted subject to the rules for preparation of an Environmental Impact Statement (EIS) or Environmental Assessment (EA).

The Part 150 Program allows airport operators to voluntarily submit noise exposure maps (NEMs) and NCPs to the FAA for review and approval. An NCP sets forth the measures that an airport operator "has taken" or "has proposed" for the reduction of existing incompatible land uses and the prevention of additional incompatible land uses within the area covered by NEMs.

14 CFR Part 161

Title 14, Part 161 of the CFR was published in 1991, subsequent to passage of the ANCA. That act established the requirement and schedule for the phase out of Stage 2 aircraft over 75,000 pounds. In return for that action, Congress restricted the ability of local communities to impose actions that would restrict aircraft access to any airport. Different levels of requirements were established for voluntary restrictions, restrictions on Stage 2 aircraft, and restrictions on Stage 3 aircraft. These requirements are applicable to all aircraft except propeller-driven aircraft weighing less than 12,500 pounds, supersonic aircraft, and Stage 1 aircraft.

Restrictive Agreements

Subpart B of 14 CFR Part 161 sets notification requirements for the implementation of Stage 3 restrictions through agreements between airport operators and all affected airport users. (Presumably, this same procedure would be followed for implementing agreements for Stage 2 restrictions.) Before going into effect, notice of these proposed agreements must be published in local newspapers of area wide circulation, posted prominently at the airport, and sent directly to all regular airport users; the FAA; Federal, state, and local agencies with land use control authority; community groups and business organizations; and any aircraft operators that are known to be interested in providing service to the airport (new entrants). After this notification period, the agreement can be implemented if all current users and any new entrants proposing to serve the airport within 180 days sign on to the proposed restriction.

Stage 2 Restrictions

Subpart C of 14 CFR Part 161 sets forth the requirements for establishing restrictions on Stage 2 aircraft operations. It requires a study of the proposed restriction that must include:

1. an analysis of the costs and benefits of the proposed restriction;
2. a description of the alternative restrictions;
3. a description of the non-restrictive alternatives that were considered and a comparison of the costs and benefits of those alternatives to the costs and benefits of the proposed restriction.

It further requires that the study use the noise methodology and land use compatibility criteria established in 14 CFR Part 150.[1] The study must also use currently accepted economic methodology. Where restrictions on Stage 2 aircraft weighing less than 75,000 pounds are involved, the study must include separate detail on how the restriction would apply to aircraft in this class.

After completing the study, the airport operator must publish a notice of the proposed restriction and an opportunity for public comment in a newspaper of general circulation in the area, post a notice prominently in the airport; and notify the FAA, local governments, all airport tenants whose operations might be affected by the proposed restrictions, and community groups and business organizations.[2] The FAA must publish an announcement of the proposed restriction in the *Federal Register*.[3]

The required study and public notice must be completed at least 180 days before the airport operator implements the proposed restriction.[4] There is no specific provision in ANCA or Part 161 for FAA action on the airport's proposed Stage 2 restriction. In practice, the FAA has reviewed Stage 2 Part 161 Studies for completeness. No specific deadlines for this review process are established in Part 161.

Stage 3 Restrictions

Subpart D of 14 CFR Part 161 establishes the requirements that an airport operator must follow in order to implement a noise or access restriction on Stage 3 aircraft. The required analysis must include the same elements required for a proposed restriction on Stage 2 aircraft. In addition, the required Part 161 Study must demonstrate "by substantial evidence that the statutory conditions are met." These six conditions, specified in ANCA are:

- Condition 1: The restriction is reasonable, non-arbitrary, and non-discriminatory.

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1 14 CFR Part 161, Sec. 161.9, 161.11, and Sec. 161.205(b).
2 14 CFR Part 161, Sec. 161.203(b).
3 14 CFR Part 161, Sec. 161.203(e).
4 14 CFR Part 161, Sec. 161.203(a).

- Condition 2: The restriction does not create an undue burden on interstate or foreign commerce.
- Condition 3: The proposed restriction maintains safe and efficient use of the navigable airspace.
- Condition 4: The proposed restriction does not conflict with any existing Federal statute or regulation.
- Condition 5: The applicant has provided adequate opportunity for public comment on the proposed restriction.
- Condition 6: The proposed restriction does not create an undue burden on the national aviation system.[5]

The applicant must also prepare an EA or documentation supporting a categorical exclusion.[6]

After submission by an airport operator of a complete Part 161 application package, the FAA has 30 days to review it for completeness. Notice of the proposed restriction must be published by the FAA in the *Federal Register*. After reviewing the application and public comments, the FAA must issue a decision approving or disapproving the proposed restriction within 180 days after receipt of a complete application. This decision is a final decision of the FAA Administrator for purposes of judicial review.[7]

Consequences of Failing to Comply with Part 161

Subpart F of 14 CFR Part 161 describes the consequences of an airport operator's failure to comply with Part 161. The sanction provided for in Subpart F is the termination of the airport's eligibility to receive airport grant funds and to collect PFCs.[8] Most of Subpart F describes the process for notifying airport operators of apparent violations, dispute resolution, and implementation of the required sanctions.

A.1.7 FEDERAL INTERAGENCY COMMITTEE ON NOISE

FICON was formed in 1990 to review specific elements of the assessment of airport noise impacts and to make recommendations regarding potential improvements. The FICON review focused primarily on the manner in which noise impacts are determined, including:

- whether aircraft noise impacts are fundamentally different from other transportation noise impacts;
- the manner in which noise impacts are described;
- the extent of impacts outside of DNL 65 dB that should be reviewed in a National Environmental Policy Act (NEPA) document;

5 14 CFR Part 161, Sec. 161.305(e).
6 14 CRF Part 161, Sec. 161.305(c).
7 14 CFR Part 161, Sec. 161.313(b)(2).
8 14 CFR Part 161, Sec. 161.501.

- the range of FAA-controlled mitigation options (noise abatement and flight track procedures) analyzed; and,
- the relationship of the 14 CFR Part 150 process to the NEPA process; including ramifications to the NEPA process if they are separate, and exploration of the means by which the two processes can be handled to maximize benefits.

The committee determined that there are no new descriptors or metrics of sufficient scientific standing to substitute for the present DNL cumulative noise exposure metric. The methodology employing DNL as the noise exposure metric and appropriate dose-response relationships to determine noise impact is considered the proper one for civil and military aviation scenarios in the general vicinity of airports.

The recommended the continued use of DNL as the principle means of assessing noise impacts and encouraged agency discretion in the use of supplemental noise analysis. FICON also recommended continued research on the impact of aircraft noise, and recommended that "a standing federal interagency committee should be established to assist agencies in providing adequate forums for discussion of public and private sector proposals, identifying needed research, and in encouraging the conduct of research and development in these areas."

Federal Interagency Committee on Aviation Noise

The FICAN was formed in 1993 to fulfill the FICON recommendation. The following Federal agencies concerned with aviation noise, including those with policy roles, are represented on the Committee:

- Department of Defense
    - U.S. Air Force
    - U.S. Army
    - U.S. Navy
- Department of Interior
    - National Park Service
- Department of Transportation
    - Federal Aviation Administration
- Environmental Protection Agency
- National Aeronautics and Space Administration (NASA)
- Department of Housing and Urban Development

A.1.8 FEDERAL REQUIREMENTS TO USE DNL IN ENVIRONMENTAL NOISE STUDIES

DNL is the standard metric used for environmental noise analysis in the U.S. This practice originated with the USEPA's effort to comply with the Noise Control Act of 1972. The USEPA designated a task group to "consider the characterization of the impact of airport community noise and develop a community noise exposure measure."[9] The task group recommended using the DNL metric. The USEPA accepted the recommendation in 1974, based on the following considerations:

- The measure is applicable to the evaluation of pervasive, long-term noise in various defined areas and under various conditions over long periods of time.
- The measure correlates well with known effects of the noise environment on individuals and the public.
- The measure is simple, practical, and accurate.
- Measurement equipment is commercially available.
- The metric at a given location is predictable, within an acceptable tolerance, from knowledge of the physical events producing the noise.[10]

In 1980, the Federal Interagency Committee on Urban Noise (FICUN) met to consolidate Federal guidance on incorporating noise considerations in local land use planning. The committee selected DNL as the best noise metric for the purpose, thus endorsing the USEPA's earlier work and making it applicable to all Federal agencies.[11]

In response to the requirements of the ASNA Act of 1979 and the recommendations of FICUN and USEPA, the FAA established DNL in 1981 as the single metric for use in airport noise and land use compatibility planning. This decision was incorporated into the final rule implementing ASNA, 14 CFR Part 150, in 1985. Part 150 established the DNL as the noise metric for determining the exposure of individuals to aircraft noise and identified residential land uses as being normally compatible with noise levels below DNL 65 dBA.

In the early 1990s, Congress authorized the creation of a new interagency committee to study airport noise issues. The FICON was formed with membership from the USEPA, the FAA, the U.S. Air Force, the U.S. Navy, HUD, the Department of Veterans Affairs, and others. FICON concluded in its 1992 report that Federal agencies should "continue the use of the DNL metric as the principal means for describing long term noise exposure of civil and military aircraft operations."[12]

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9 *Information on Levels of Environmental Noise Requisite to Protect Health and Welfare with an Adequate Margin of Safety.* U.S. Environmental Protection Agency, Office of Noise Abatement and Control. 1974, P. A-10.

10 *Information on Levels of Environmental Noise Requisite to Protect Health and Welfare with an Adequate Margin of Safety*. U.S. Environmental Protection Agency, Office of Noise Abatement and Control. 1974, Pp. A-1–A-23.

11 *Guidelines for Considering Noise in Land Use Planning and Control*. Federal Interagency Committee on Urban Noise (FICUN). 1980.

12 *Federal Agency Review of Selected Airport Noise Analysis Issues*. Federal Interagency Committee on Noise (FICON). August 1992, Pp. 3-1.

FICON further concluded that there were no new sound descriptors of sufficient scientific standing to substitute for the DNL cumulative noise exposure metric.[13]

In 1993, the FAA issued its *Report to Congress on Effects of Airport Noise*. Regarding DNL, the FAA stated, "Overall, the best measure of the social, economic, and health effects of airport noise on communities is the Day-Night Average Sound Level (DNL)."[14] According to this report, DNL 65 dBA "…as a criterion of significance, and of the land use compatibility guidelines in in Part 150 is reasonable."[15]

A.1.9 REQUIRED NOISE MODEL

To meet the requirements to assess airport noise impacts per 14 CFR Part 150, the FAA developed the Integrated Noise Model (INM). The INM has been the preferred aircraft noise contour software approved by FAA to prepared Noise Exposure Maps and other environmental studies. Effective May 29, 2015, the Aviation Environmental Design Tool (AEDT), Version 2b, replaced the INM as the required tool for noise modeling as part of an NEM Update. Per FAA policy and practice, the use of AEDT 2b is not required for projects whose analysis began before the effective date of this policy and those projects may continue with use of the INM.

A.2 FEDERAL LAWS AND POLICIES RELATED TO NOISE/LAND USE COMPATIBILITY

The FAA adopted land use compatibility guidelines relating types of land use to airport sound levels in 1985. These guidelines were promulgated in Title 14 of the Code of Federal Regulations (14 CFR) Part 150. These guidelines, reproduced here as **Table A-1**, show the compatibility parameters for the following land use types: residential, noise-sensitive public facilities that include schools, places of worship (churches), nursing homes, hospitals, and libraries, commercial, manufacturing and production, and recreation.

The Part 150 guidelines are the basis for defining areas potentially eligible for Federal funding through the Airport Improvement Program (AIP). The *Airport Improvement Handbook* states, "Noise compatibility projects usually must be located in areas where noise measured in day-night average sound level (DNL) is 65 decibel (dB) or greater."[16] Federal funding is available at noise levels below 65 DNL if the airport operator (Sponsor) determines that incompatible land uses exist below 65 DNL and the FAA concurs with the Sponsor's determination.

As shown in Table A-1, all land uses within areas below 65 DNL are considered to be compatible with airport operations. Residential land uses are generally incompatible with noise levels above 65 DNL. In some areas, residential land use may be permitted in the 65 to 70 DNL with appropriate sound insulation measures implemented. This is done at the discretion of local communities. Schools and

[13] *Federal Agency Review of Selected Airport Noise Analysis Issues, Technical Report, Volume 2.* Federal Interagency Committee on Noise (Technical). August 1992, Pp. 2-3.
[14] *Report to Congress on Effects of Airport Noise.* Federal Aviation Administration. 1993, P. 1.
[15] *Report to Congress on Effects of Airport Noise.* Federal Aviation Administration. 1993, P. 13.
[16] FAA Order 5300.38C, Chapter 7, paragraph 706.

other public use facilities located between 65 and 75 DNL are generally incompatible without sound insulation. Above 75 DNL, schools, hospitals, nursing homes, and places of worship (churches) are considered incompatible land uses. The information presented in Table A-1 is meant to act as a guideline. According to 14 CFR Part 150, "Adjustments or modifications of the descriptions of the land-use categories may be desirable after consideration of specific local conditions."[17]

Table A-1
LAND USE COMPATIBILITY GUIDELINES - 14 CFR PART 150

	YEARLY DAY-NIGHT AVERAGE SOUND LEVEL (DNL) IN DECIBELS					
LAND USE	**BELOW 65**	**65-70**	**70-75**	**75-80**	**80-85**	**OVER 85**
RESIDENTIAL						
Residential, other than mobile homes and transient lodgings	Y	N[1]	N[1]	N	N	N
Mobile home parks	Y	N	N	N	N	N
Transient lodgings	Y	N[1]	N[1]	N[1]	N	N
PUBLIC USE						
Schools, hospitals, 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]	N[4]
Parking	Y	Y	Y[2]	Y[3]	Y[4]	N
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	Y[5]	N[5]	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

[17] 14 CFR Part 150, Part B Noise Exposure Map Development, Section A150.101 Noise contours and land usages, paragraph (c).

Table A-1, *Continued*
LAND USE COMPATIBILITY GUIDELINES - 14 CFR PART 150

Note: The designations contained in this table do not constitute a Federal determination that any use of land covered by the program is acceptable 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 federally 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.

Key to Table A-1

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

Notes for Table A-1

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 five, 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 a NLR of 25 dB.
7. Residential buildings require a NLR of 30 dB.
8. Residential buildings not permitted.

Source: 14 CFR Part 150 *Airport Noise Compatibility Planning*, Appendix A, Table 1.

A.2.1 LAND USE MITIGATION TECHNIQUES

Land use management measures used for Part 150 purposes include both preventive and corrective techniques. Preventive land use management techniques seek to prevent the introduction of additional noise-sensitive land uses within existing and future airport noise contours.

Corrective land use management techniques seek to remedy existing and projected future unavoidable noise impacts in existing areas of incompatible land use. Corrective land use management techniques can be classified in one of two general categories: modify use and maintain use. Typical corrective measures include sound insulation, which maintains the existing use by improving the ability of the structure to reduce interior noise levels, and acquisition, which is used to relocate users of the noise-sensitive property and modify the use to one compatible with aircraft noise.

The Part 150 guidelines are the basis for defining areas potentially eligible for Federal funding through the AIP. The *Airport Improvement Program (AIP) Handbook* states, "Noise compatibility projects usually must be located in areas where noise measured in day-night average sound level (DNL) is 65 decibel (dB) or greater."[18] Federal funding is available at noise levels below 65 DNL if the airport operator (Sponsor) determines that incompatible land uses exist below 65 DNL and the FAA concurs with the Sponsor's determination.

A.2.2 FAA FINAL POLICY ON PART 150 NOISE MITIGATION MEASURES

The FAA issued a final policy to establish a distinction between remedial and preventive noise mitigation measures proposed by airport operators and submitted for approval by the FAA under noise compatibility planning regulations. In the notice of final policy[19] effective October 1, 1998, the FAA stated the following:

- As of October 1, 1998, the FAA will approve under 14 C.F.R. Part 150 only remedial noise mitigation measures for existing incompatible development and only preventive noise mitigation measures in areas of potential new incompatible development.
- The FAA will not approve remedial noise mitigation measures for new incompatible development that occurs in the vicinity of airports.
- The use of AIP funds will be affected to the extent that such use depends on approval under Part 150.

Therefore, as of October 1, 1998, the FAA will approve remedial noise mitigation measures under Part 150 only for incompatible development which exists as of that date. Under this policy, land uses that were constructed within a published noise exposure contour after that data are considered ineligible for Federal funding for remedial noise mitigation.

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18 FAA Order 5300.38C, Chapter 7, paragraph 706.
19 FAA Notice of Final Policy, October 1, 1998.

Per 14 C.F.R. Part 150, a 45 dB standard has been adopted by the FAA for interior noise. This was further clarified in 1992 by the Federal Interagency Committee on Noise (FICON) findings of 45 dB to be the interior noise level that will accommodate indoor conversations or sleep. Therefore, a noise-impacted non-compatible structure must be experiencing existing interior noise levels that are 45 dB or greater with the windows closed to be considered eligible. For schools, the 45 dB measurement is based on the number of hours of the school day.[20] Therefore, noise mitigation inside the DNL 65 dB contour where the interior noise level is less than 45 dB is not eligible for Federal funding unless the ADO has concurred that the limited costs are due to neighborhood equity in cases where a neighborhood would be divided with some properties being eligible and some neighboring properties otherwise not eligible.

A.2.2 ELIGIBILITY AND JUSTIFICATION REQUIREMENTS FOR SOUND INSULATION PROJECTS

Through Program Guidance Letter (PGL) 12-09, the FAA reaffirmed the two-step process for determining eligibility for sound insulation funding as discussed in the AIP Handbook to require that a residential noise insulation project be in the existing or forecast DNL 65 dB contour and be designed to achieve target interior noise levels of 45 dB in habitable rooms to be eligible for AIP funding. Accordingly, residences and schools that already have interior noise levels of less than 45 dB are not generally eligible for AIP funding, with some equitable exceptions such as neighborhood equity. Subsequently, FAA issued guidance for conducting field noise testing to determine if land uses within a DNL 65 dB noise contour already met the 45 dB interior noise level prior to approving funding for sound insulation.

Per PGL 12-09, the policy that the FAA will consider funding eligibility for noise insulation measures under 14 CFR Part 150 only for non-compatible development which existed as of October 1, 1998, remains unchanged.

[20] FAA Order 5100.38D, Airport Improvement Program Handbook, September 30, 2104.

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APPENDIX B
PUBLIC INVOLVEMENT

This appendix presents information regarding the public involvement process, including opportunities for public review and comment, for the Noise Exposure Map (NEM) Update for Harrisburg International Airport (MDT or Airport).

B.1 PUBLIC INFORMATION MEETING

A Public Information Meeting is scheduled for Thursday, August 20, 2015 to provide the public with ample opportunity to participate in one-on-one discussions with Airport staff and the Airport consultants, and to review the maps, noise contours, flight tracks, and other study analysis. Newspaper notices for the meeting were published in the *Press and Journal*. Meeting dates and locations were also advertised on the Study website at http://www.airportsites.net/MDT-NEM/. Additional information regarding the Public Information Meeting is included later in this appendix.

At the meeting, Susquehanna Area Regional Airport Authority (SARAA) staff and the consultant team will be available to present and discuss the information regarding the NEM Update process, the draft noise exposure maps, as well as the information contained in the Draft NEM Update document. Newspaper notices, registration, handouts, and comments received are to be included in the final document.

B.2 PUBLIC HEARING

A Public Hearing is scheduled to be held concurrently with the Public Information Meeting to satisfy the requirement that the public be given an opportunity to comment on the NEMs prior to submission to the Federal Aviation Administration (FAA) as specified in 14 Code of Federal Regulation (C.F.R.) 150.21(b). Interested citizens are encouraged to attend and to testify or provide written comments at the Public Hearing on the Draft NEM Update. A court reporter will be available to record oral comments and comment forms will also be provided. A transcript of the oral testimony and the written comments received at the Public Hearing, as well as response to all comments, will be included in the Final NEM Update document. Comments will also be on file with the FAA Eastern Region.

B.3 AVAILABILITY OF THE DOCUMENT FOR PUBLIC REVIEW

The Draft NEM Update document will be available for public review from July 22, 2015 through September 4, 2015. Copies of the Draft NEM Update document are located in the locations listed below and newspaper notices were published announcing the availability of the document for review and comment prior to the Public Hearing scheduled for August 20, 2015.

LOCATIONS FOR DRAFT NEM UPDATE DOCUMENT REVIEW
Harrisburg International Airport, 1 Terminal Drive, Middletown, PA 17057
Middletown Public Library, 20 N. Catherine St, Middletown, PA
Website: http://www.airportsites.net/MDT-NEM/

Public Information Meeting/Public Hearing August 20, 2015

Newspaper Notices

Flyers/Postcards

Registration

Meeting Summary

Public Hearing Transcripts

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Appendix C

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APPENDIX C
NOISE MODELING METHODOLOGY

This appendix sets forth the background material necessary for the reader to understand the principles of noise, the preparation of noise exposure contours and the discussion of any potential noise impacts associated with the noise exposure contours. The data is derived from a variety of sources including, but not limited to, records maintained by the Susquehanna Area Regional Airport Authority (SARAA) and the Federal Aviation Administration (FAA), and mapping available from local planning agencies.

Section C.1 provides background information necessary to understand the characteristics and properties of sound and noise, including how noise levels are measured and expressed mathematically.

Section C.2 includes basic information on the noise metric and computer model used to compute noise and a statement relative to the comparability of baseline information and the years indicated on the official noise mapping for the airport.

Section C.3 provides information on how humans respond to sound in different settings.

Section C.4 presents notable research on the health effects of noise, such as potential for sleep deprivation and hearing loss.

Section C.5 presents the noise modeling methodology and input data for this NEM Update.

C.1 CHARACTERISTICS OF SOUND

Sound is created by a source that induces vibrations in the air. The vibration produces alternating bands of relatively dense and sparse particles of air, spreading outward from the source like ripples on a pond. Sound waves dissipate with increasing distance from the source. Sound waves can also be reflected, diffracted, refracted, or scattered. When the source stops vibrating, the sound waves disappear almost instantly and the sound ceases.

Sound conveys information to listeners. It can be instructional, alarming, pleasant, relaxing, or annoying. Identical sounds can be characterized by different people or even by the same person at different times, as desirable or unwanted. Unwanted sound is commonly referred to as "noise."

Sound can be defined in terms of four components:

1. Level (amplitude)
2. Pitch (frequency)
3. Duration (time pattern)
4. Propagation (transmission and dissipation)

C.1.1 SOUND LEVEL

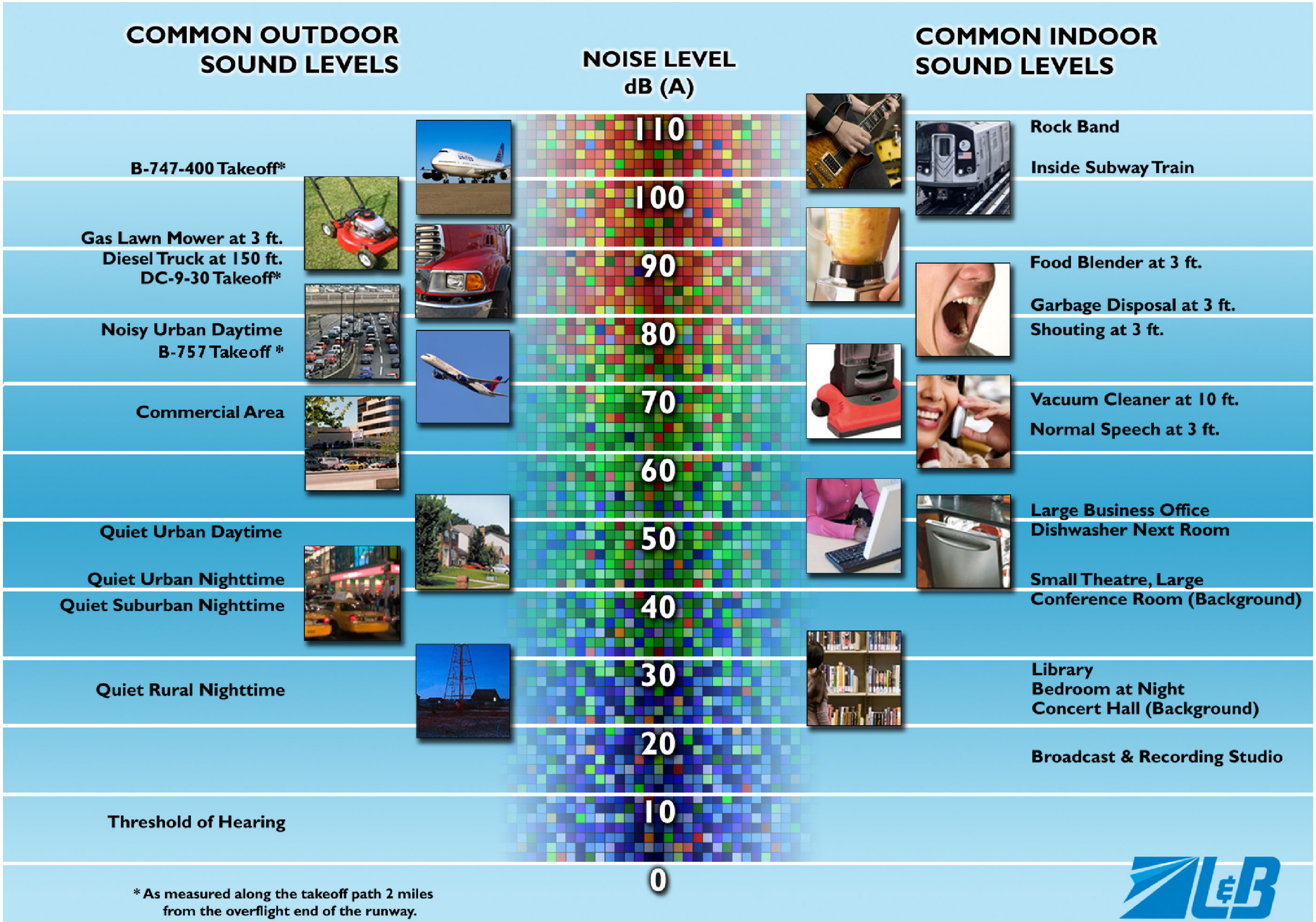
The level or amplitude of sound is measured by the difference between atmospheric pressure (without the sound) and the total pressure (with the sound). Amplitude of sound is like the relative height of the ripples caused by the stone thrown into the water. Although physicists typically measure pressure using the linear Pascal scale, sound is measured using the logarithmic decibel (dB) scale. This is because the range of sound pressures detectable by the human ear can vary from *1 to 100 trillion units*. A logarithmic scale allows us to discuss and analyze noise using more manageable numbers. The range of audible sound ranges from approximately 1 to 140 dB, although everyday sounds rarely rise above about 120 dB. The human ear is extremely sensitive to sound pressure fluctuations. A sound of 140 dB, which is sharply painful to humans, contains *100 trillion (10^{14}) times more* sound pressure than the least audible sound. **Exhibit C-1, *Comparison of Sound***, shows a comparison of common sources of indoor and outdoor sounds measured on the dB scale.

By definition, a 10 dB increase in sound is equal to a tenfold (10^1) increase in the mean square sound pressure of the reference sound. A 20 dB increase is a 100-fold (10^2) increase in the mean square sound pressure of the reference sound. A 30 dB increase is a 1,000-fold (10^3) increase in mean square sound pressure.

A logarithmic scale requires different mathematics than used with linear scales. The sound pressures of two separate sounds, expressed in dB, are not arithmetically additive. For example, if a sound of 80 dB is added to another sound of 74 dB, the total is a 1 dB increase in the louder sound (81 dB), not the arithmetic sum of 154 dB (See **Exhibit C-2, *Example of Addition of Two Decibel Levels***). If two equally loud noise events occur simultaneously, the sound pressure level from the combined events is 3 dB higher than the level produced by either event alone.

Logarithmic averaging also yields results that are quite different from simple arithmetic averaging. Consider the example shown in **Exhibit C-3, *Example of Sound Level Averaging***. Two sound levels of equal duration are averaged. One has a maximum sound level (Lmax) of 100 dB, the other 50 dB. Using conventional arithmetic, the average would be 75 dB. The true result, using logarithmic math, is 97 dB. This is because 100 dB has far more energy than 50 dB (100,000 times as much!) and is overwhelmingly dominant in computing the average of the two sounds.

Human perceptions of changes in sound pressure are less sensitive than a sound level meter. People typically perceive a tenfold increase in sound pressure, a 10 dB increase, as a doubling of loudness. Conversely, a 10 dB decrease in sound pressure is normally perceived as half as loud. In community settings, most people perceive a 3 dB increase in sound pressure (a doubling of the sound pressure or energy) as just noticeable. (In laboratory settings, people with good hearing are able to detect changes in sounds of as little as 1 dB.)



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Noise Exposure Map Update HARRISBURG INTERNATIONAL AIRPORT	**Comparison of Different Types of Sound**	EXHIBIT: **C-1**

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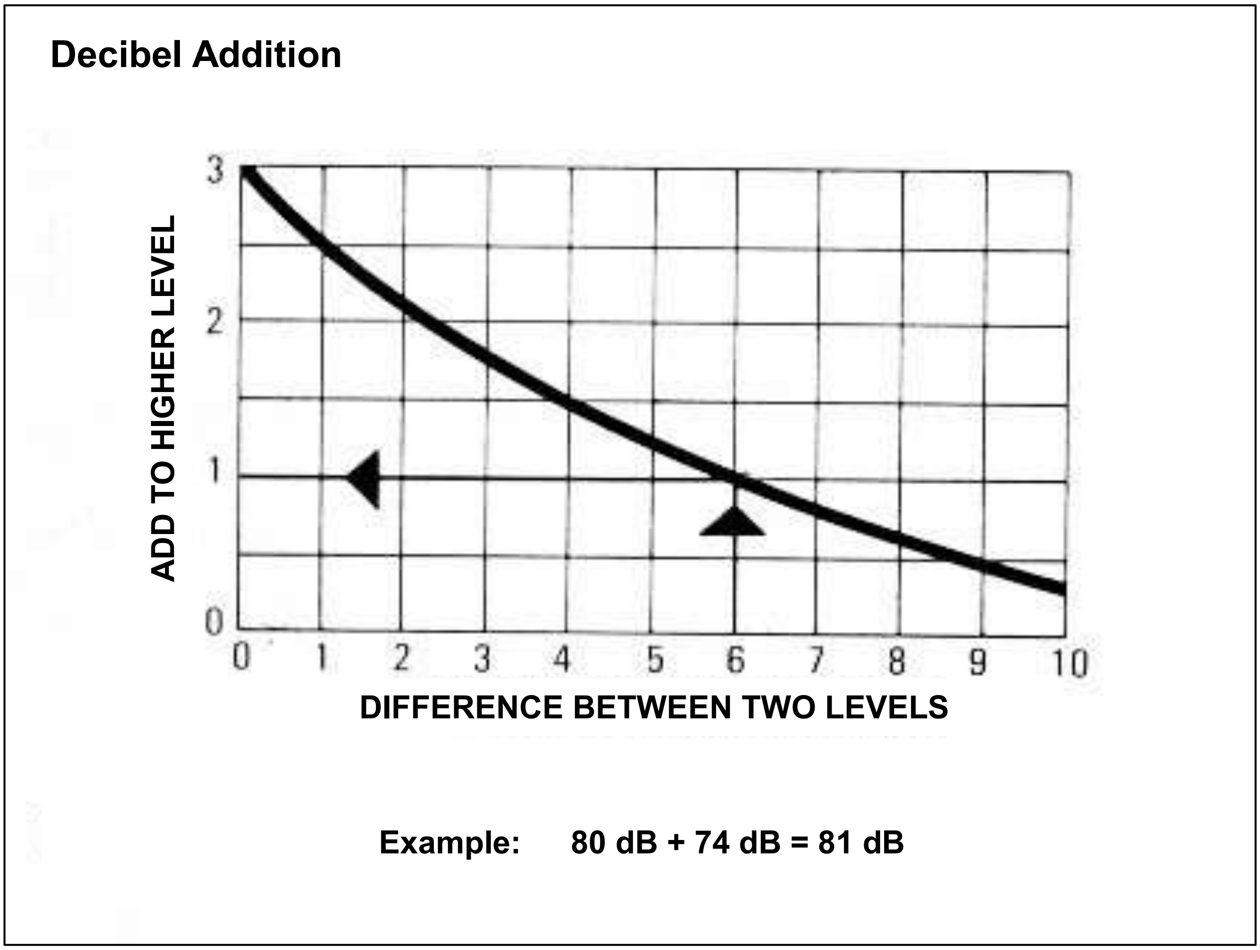
Exhibit C-2
EXAMPLE OF ADDITION OF TWO DECIBEL LEVELS



Source: *Information on Levels of Environmental Noise*. USEPA. March 1974.

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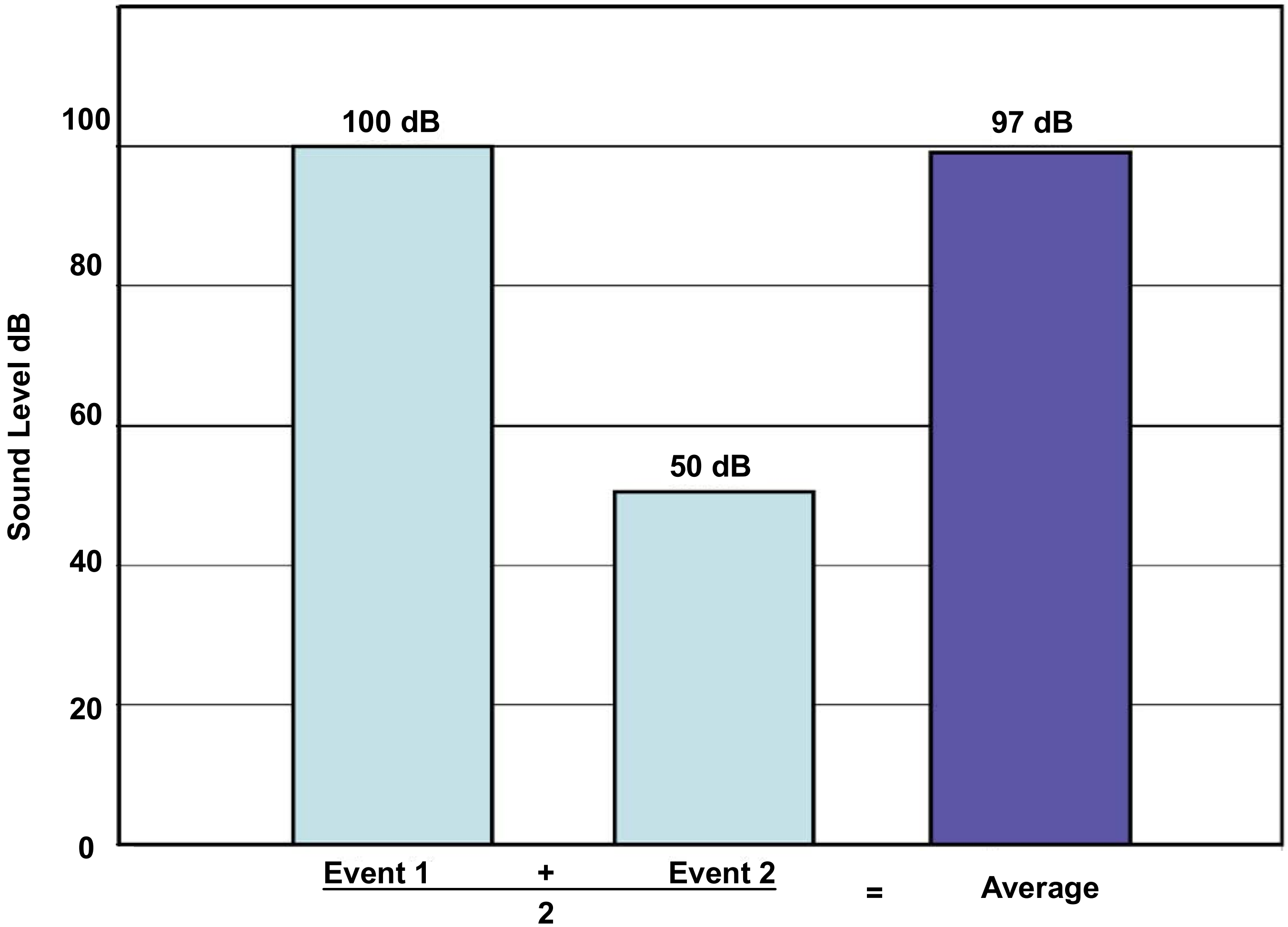
Assume two sound levels of equal duration....
What is the average level?



(100dB + 50dB) / 2 = 97dB

The decibel (dB) scale is logarithmic -
100dB is 100,000 times more energy than 50dB

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Noise Exposure Map Update HIA Harrisburg International Airport HARRISBURG INTERNATIONAL AIRPORT L&B	**Example of Sound Level Averaging**	EXHIBIT: **C-3**

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C.1.2 SOUND FREQUENCY

The pitch (or frequency) of sound can vary greatly from a low-pitched rumble to a shrill whistle. If we consider the analogy of ripples in a pond, high frequency sounds are vibrations with tightly spaced ripples, while low rumbles are vibrations with widely spaced ripples. The rate at which a source vibrates determines the frequency. The rate of vibration is measured in units called "Hertz" -- the number of cycles, or waves, per second. One's ability to hear a sound depends greatly on the frequency composition. Humans hear sounds best at frequencies between 1,000 and 6,000 Hertz. Sound at frequencies above 10,000 Hertz (high-pitched hissing) and below 100 Hertz (low rumble) are much more difficult to hear.

When attempting to measure sound in a way that approximates what our ears hear, we must give more weight to sounds at the frequencies we hear well and less weight to sounds at frequencies we do not hear well. Acousticians have developed several weighting scales for measuring sound. The A-weighted scale was developed to correlate with the judgments people make about the loudness of sounds. The A-weighted decibel scale (dBA) is used in studies where audible sound is the focus of inquiry. **Exhibit C-4, *Sound Frequency Weighting Curves***, shows the A, B, and C sound weighting scale. The U.S. Environmental Protection Agency (USEPA) has recommended the use of the A-weighted decibel scale in studies of environmental noise.[1] Its use is required by the FAA in airport noise studies.[2] For the purposes of this analysis, dBA was used as the noise metric and dB and dBA are used interchangeably in this document.

C.1.3 DURATION OF SOUNDS

The duration of sounds – their patterns of loudness and pitch over time – can vary greatly. Sounds can be classified as *continuous* like a waterfall, *impulsive* like a firecracker, or *intermittent* like aircraft overflights. Intermittent sounds are produced for relatively short periods, with the instantaneous sound level during the event roughly appearing as a bell-shaped curve. An aircraft event is characterized by the period during which it rises above the background sound level, reaches its peak, and then recedes below the background level.

C.1.4 PROPAGATION OF NOISE

Outdoor sound levels decrease (dissipate) as a function of distance from the source, and as a result of wave divergence, atmospheric absorption, and ground attenuation. If sound is radiated from a source in an homogeneous and undisturbed manner, the sound travels (is transmitted) as spherical waves. As the sound wave travels away from the source, the sound energy is distributed over a greater area, dispersing the sound energy of the wave. Spherical spreading of the sound wave reduces the noise level at a rate of 6 dB per doubling of the distance.

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1 Information on Levels of Environmental Noise Requisite to Protect Health and Welfare with an Adequate Margin of Safety. U.S. Environmental Protection Agency, Office of Noise Abatement and Control. 1974, P. A-10.

2 "Airport Noise Compatibility Planning." 14 CFR Part 150, Sec. A150.3.

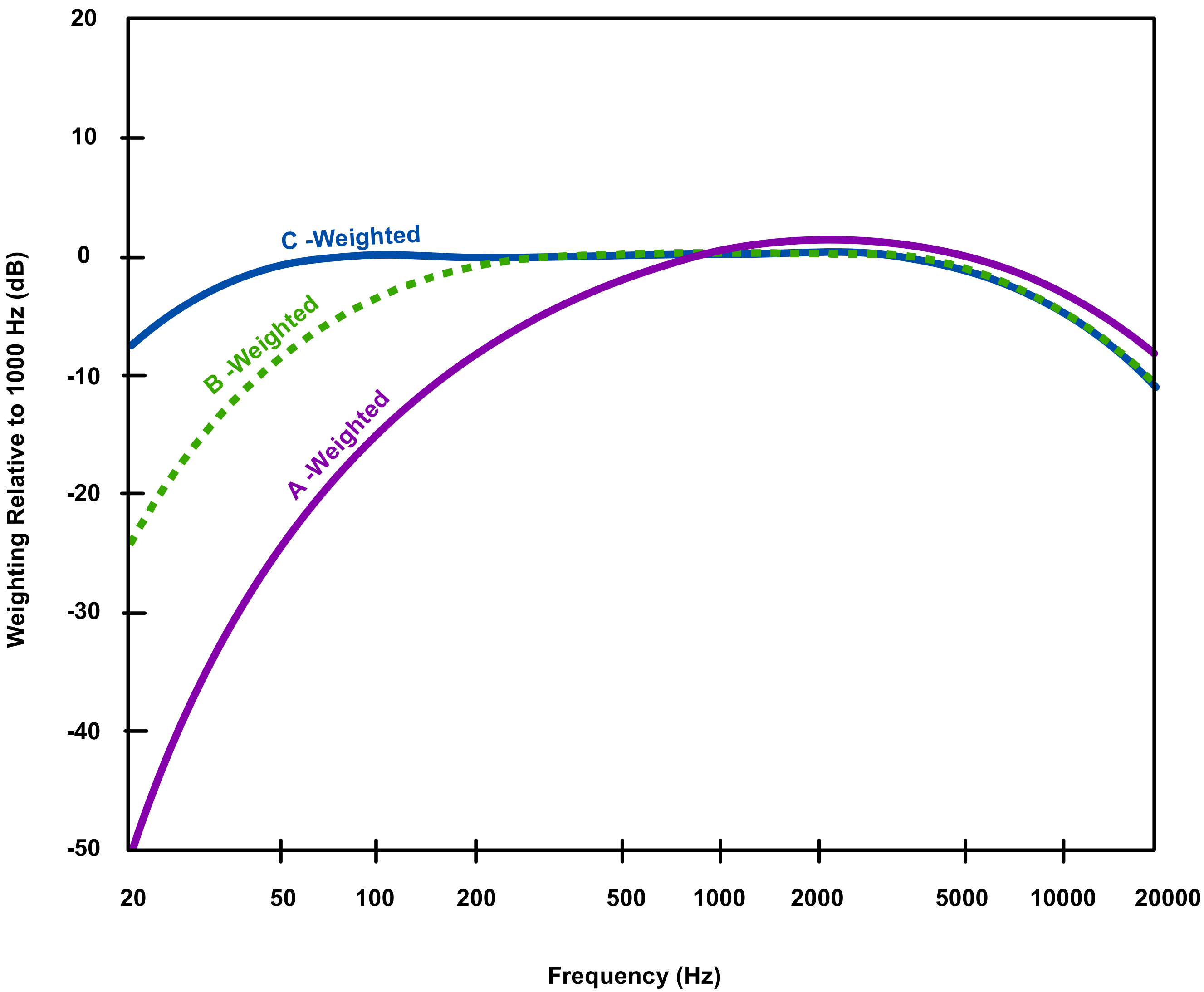
Atmospheric absorption also influences the levels that are received by the observer. The greater the distance traveled, the greater the influence of the atmosphere and the resultant fluctuations. Atmospheric absorption becomes important at distances of greater than 1,000 feet. The degree of absorption is a function of the frequency of the sound as well as the humidity and temperature of the air. For example, atmospheric absorption is lowest at high humidity and higher temperatures. Sample atmospheric attenuation graphs are presented in **Exhibit C-5, *Sound Attenuation Graphs***. The graphs show noise absorption rates based on temperature, relative humidity, and distance at five different frequency ranges. For example, sounds at a frequency of 2,000 Hz, with a relative humidity of 10 percent and a temperature of 90^{O} Fahrenheit (32^{O} Celsius), will be dissipate by 10 dB per for every 1,000 feet (305 meters) from the source.

The rate of atmospheric absorption varies with sound frequency. The higher frequencies are more readily absorbed than the lower frequencies. Over large distances, the lower frequencies become the dominant sound as the higher frequencies are attenuated.

Turbulence and gradients of wind, temperature, and humidity also play a significant role in determining the degree of attenuation. Certain conditions, such as inversions, can also result in higher noise levels than would result from spherical spreading as a result of channeling or focusing the sound waves.

The effect of ground attenuation on noise propagation is a function of the height of the source and/or receiver and the characteristics of the terrain. The closer the source of noise is to the ground, the greater the ground absorption. Terrain consisting of soft surfaces such as vegetation provide for more ground absorption than hard surfaces. Ground attenuation is important for the study of noise from airfield operations (such as, thrust reversals) and in the design of noise berms or engine run-up facilities.

These factors are an important consideration for assessing in-flight and ground noise in the area around the Airport. Atmospheric conditions will play a significant role in affecting the sound levels on a daily basis and how these sounds are perceived by the population.



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Sound Frequency Weighting Curves

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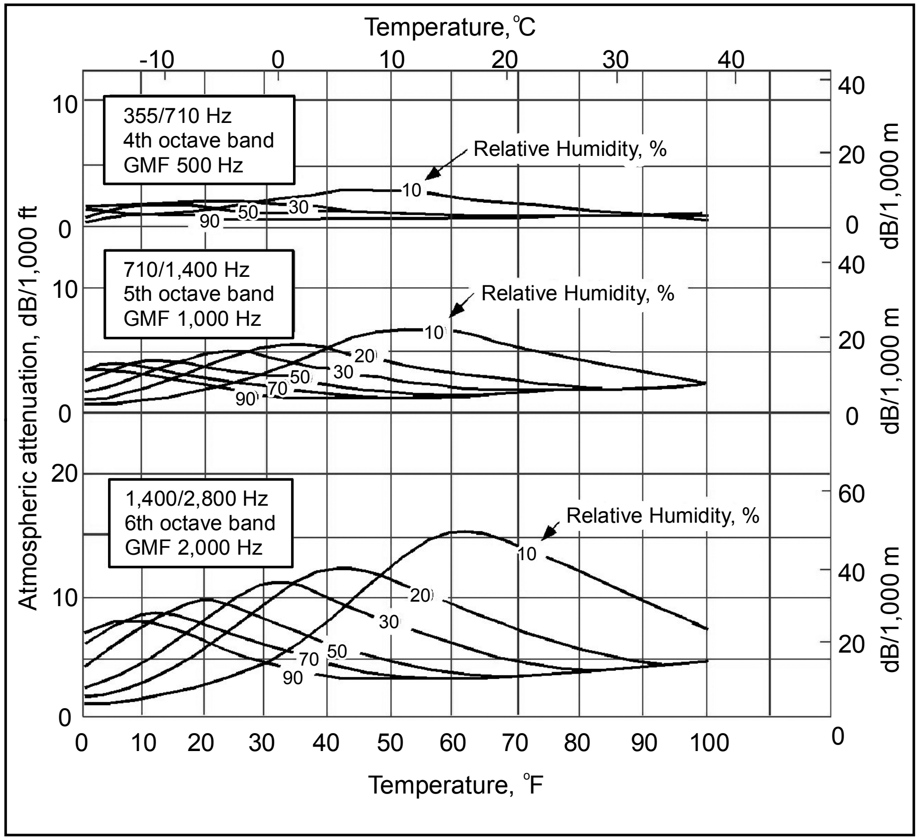

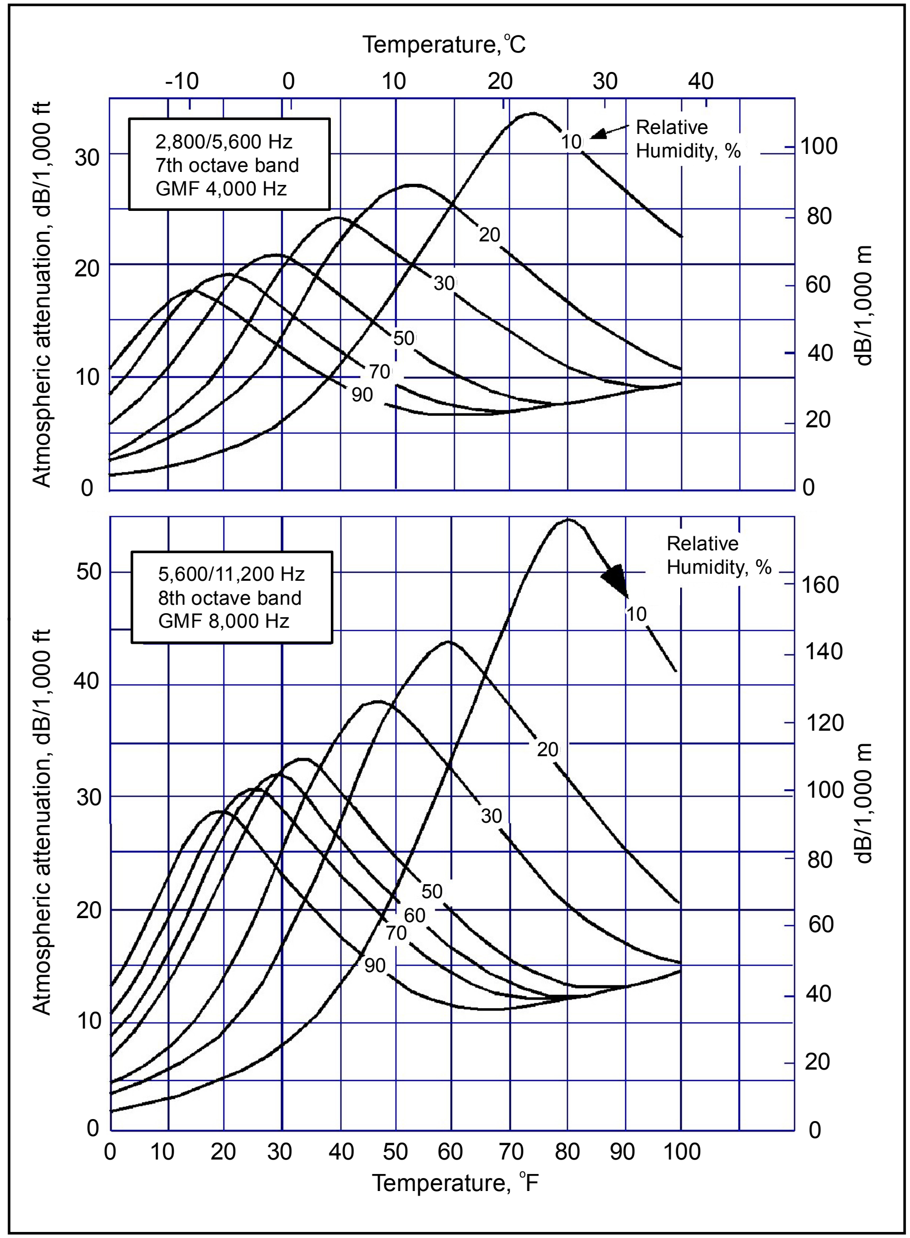

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Sound Attenuation Graphs

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C.2 STANDARD NOISE DESCRIPTORS

Given the multiple dimensions of sound, a variety of descriptors, or metrics, have been developed for describing sound and noise. Some of the most commonly used metrics are discussed in this section. They include:

1. Maximum Level (**Lmax**)
2. Time Above Level (**TA**)
3. Number of Events Above Level (**NA**)
4. Sound Exposure Level (**SEL**)
5. Equivalent Sound Level (**Leq**)
6. Day-Night Average Sound Level (**DNL**)

C.2.1 MAXIMUM LEVEL (Lmax)

Lmax is simply the highest sound level recorded during an event or over a given period of time. It provides a simple and understandable way to describe a sound event and compare it with other events. In addition to describing the peak sound level, Lmax can be reported on an appropriate weighted decibel scale (A-weighted, for example) so that it can disclose information about the frequency range of the sound event in addition to the loudness.

Lmax, however, fails to provide any information about the duration of the sound event. This can be a critical shortcoming when comparing different sounds. Even if they have identical Lmax values, sounds of greater duration contain more sound energy than sounds of shorter duration. Research has demonstrated that for many kinds of sound effects, the total sound energy, not just the peak sound level, is a critical consideration.

C.2.2 TIME ABOVE LEVEL (TA)

The “time above,” or TA, metric indicates the amount of time that sound at a particular location exceeds a given sound level threshold. TA is often expressed in terms of the total time per day that a specific threshold is exceeded. Often 65 dB is used as the threshold and the metric would be abbreviated TA65. The TA metric explicitly provides information about the duration of sound events, although it conveys no information about the peak levels during the period of observation.

C.2.3 NUMBER OF EVENTS ABOVE LEVEL (NA)

Similar to TA, the Number of Events Above (NA) metric indicates the total number of aircraft events at particular location that exceed a given sound level threshold in dB. The TA metric explicitly provides information about the number of sound events, although it conveys no information about the duration of the event(s).

C.2.4 SOUND EXPOSURE LEVEL (SEL)

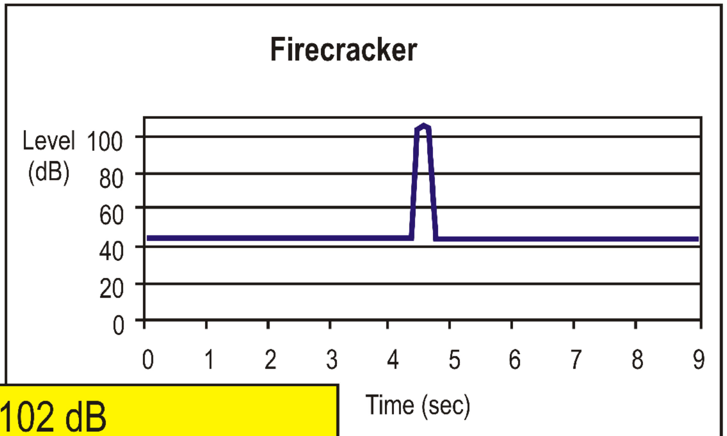
The sound exposure level, or SEL metric, provides a way of describing the total sound energy of a single event. In computing the SEL value, all sound energy occurring during the event, within 10 dB of the peak level (Lmax), is mathematically integrated over one second. (Very little information is lost by discarding the sound below the 10 dB cut-off, since the highest sound levels completely dominate the integration calculation.) Consequently, the SEL is always greater than the Lmax for events with a duration greater than one second. SELs for aircraft overflights typically range from five to 10 dB higher than the Lmax for the event.

Exhibit C-6, *Measurement of Different Types of Sound*, shows graphs of instantaneous sound levels for three different events: an aircraft flyover, steady roadway noise, and a firecracker. The Lmax and the duration of each event differ greatly. The pop of the firecracker is quite loud, 102 dB but lasts less than a second. The aircraft flyover has a considerably lower Lmax at 90 dB, but the event lasts for over a minute. The Lmax from the roadway noise is even quieter at only 72 dB, but it lasts for 15 minutes. By considering the loudness and the duration of these very different events simultaneously, the SEL metric reveals that the total sound energy of all three is identical. This can be a critical finding for studies where total noise dosage is the focus of study. As it happens, research has shown conclusively that noise dosage is crucial in understanding the effects of noise on animals and humans.

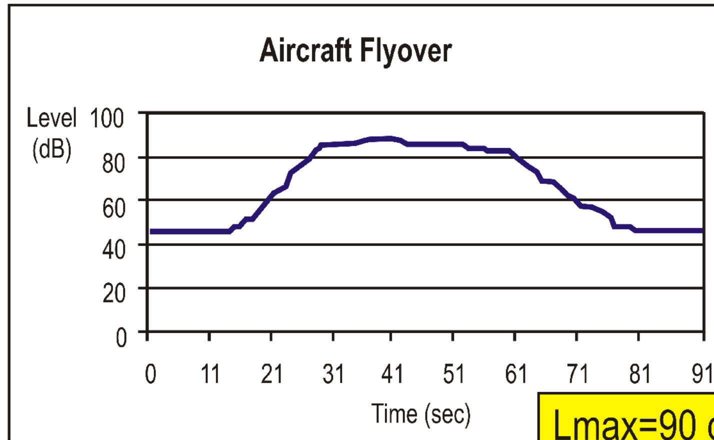
C.2.5 EQUIVALENT SOUND LEVEL (LEQ)

The equivalent sound level (Leq) metric may be used to define cumulative noise dosage, or noise exposure, over a period of time. In computing Leq, the total noise energy over a given period of time, during which numerous events may have occurred, is logarithmically averaged over the time period. The Leq represents the steady sound level that is equivalent to the varying sound levels actually occurring during the period of observation. For example, an 8-hour Leq of 67 dB indicates that the amount of sound energy in all the peaks and valleys that occurred in the 8-hour period is equivalent to the energy in a continuous sound level of 67 dB. Leq is typically computed for measurement periods of 1 hour, 8 hours, or 24 hours, although any time period can be specified.

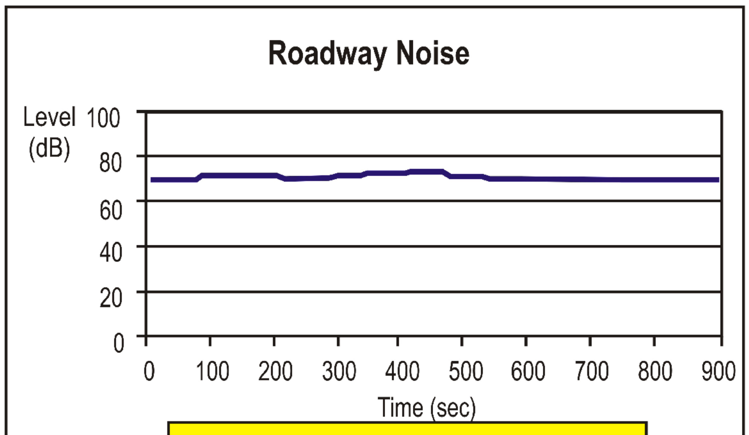
Exhibit C-7, *Relationship Among Sound Metrics*, shows the relationship of Leq to Lmax and SEL. In this example, a single aircraft event lasting 18 seconds is represented. The instantaneous noise levels for the event range from 64 to an Lmax of 101 dBA. The area under the curve represents the sound energy accumulated during the entire event. The compression of this energy into a single second results in an SEL of 105 dBA. The Leq average of the sound energy for each second during the event would be 93 dB. If this event were the only event to occur during an hour, the aircraft sound energy for the other 3,582 seconds would be considered to be zero. When converted to an hourly LEQ, the level would be nearly 70 dB of Leq. This again indicates the dominance of loud events in noise summation and averaging computations.



Lmax=102 dB
SEL=100 dB
Leq=105
Event Duration=0.3 seconds



Lmax=90 dB
SEL=100 dB
Leq=82
Event Duration=70 seconds



Lmax=72 dB
SEL=100 dB
Leq=71
Event Duration=900 seconds

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Measurement of Different Types of Sound

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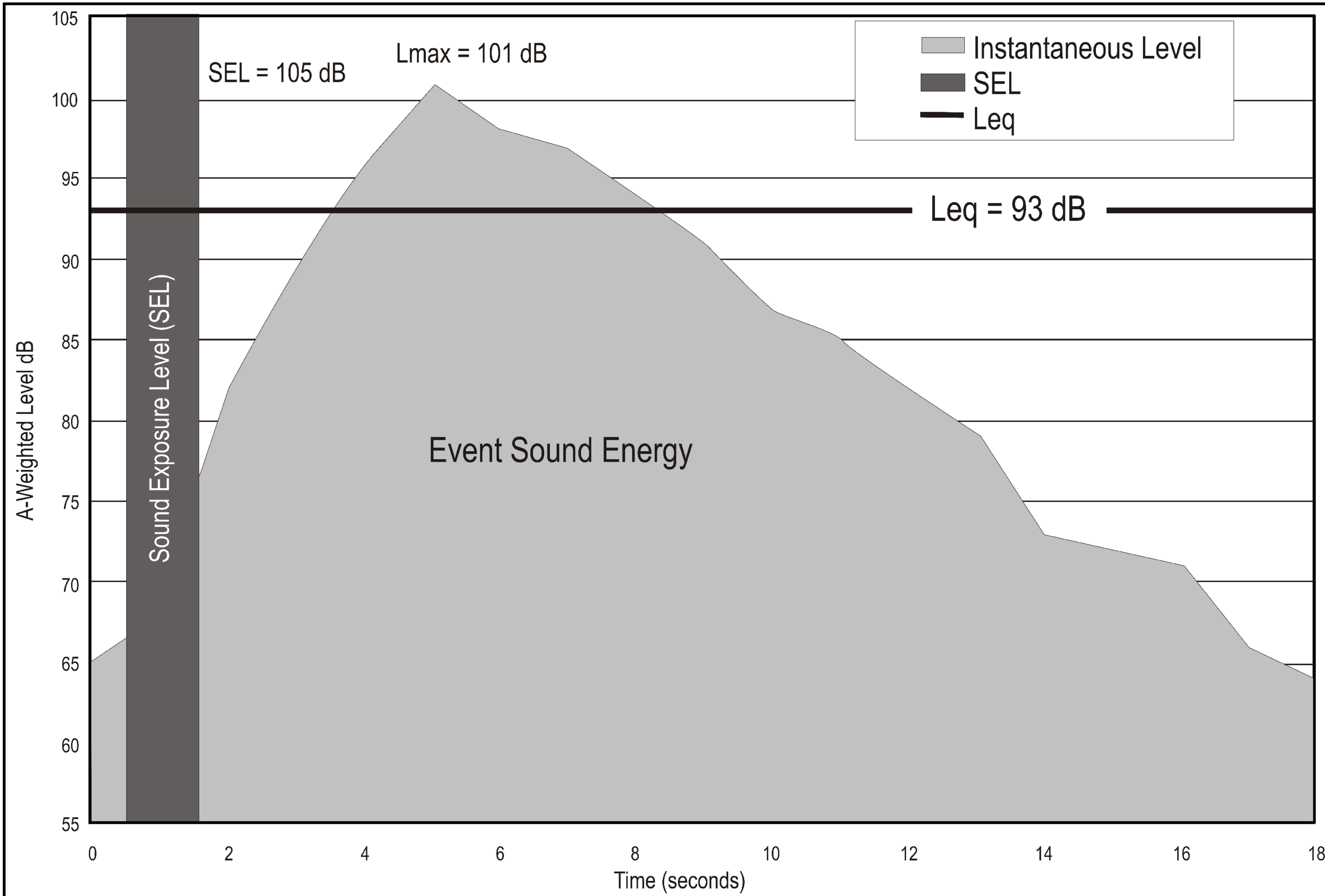

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Noise Exposure Map Update

HARRISBURG INTERNATIONAL AIRPORT

Relationship Among Sound Metrics

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Leq is a critical noise metric for many kinds of analysis where total noise dosage, or noise exposure, is under investigation. As already noted, noise dosage is important in understanding the effects of noise on both animals and people. Indeed, research has led to the formulation of the "equal energy rule." This rule states that it is the total acoustical energy to which people are exposed that explains the effects the noise will have on them. That is, a very loud noise with a short duration will have the same effect as a lesser noise with a longer duration if they have the same total sound energy.

C.2.6 DAY-NIGHT AVERAGE SOUND LEVEL (DNL)

The Day-Night Average Sound Level (DNL) metric is really a variation of the 24-hour Leq metric. Like Leq, the DNL metric describes the total noise exposure during a given period. Unlike Leq, however, DNL, by definition, can only be applied to a 24-hour period. In computing DNL, an extra weight of 10 dB is assigned to any sound levels occurring between the hours of 10:00 p.m. and 7:00 a.m. This is intended to account for the greater annoyance that nighttime noise is presumed to cause for most people. Recalling the logarithmic nature of the dB scale, this extra weight treats one nighttime noise event as equivalent to 10 daytime events of the same magnitude.

As with Leq, DNL values are strongly influenced by the loud events. For example, 30 seconds of sound of 100 dB, followed by 23 hours, 59 minutes, and 30 seconds of silence would compute to a DNL value of 65 dB. If the 30 seconds occurred at night, it would yield a DNL of 75 dB.

This example can be roughly equated to an airport noise environment. Recall that an SEL is the mathematical compression of a noise event into one second. Thus, 30 SELs of 100 dB during a 24-hour period would equal DNL 65 dB, or DNL 75 dB if they occurred at night. This situation could actually occur in places around a real airport. If the area experienced 30 overflights during the day, each of which produced an SEL of 100 dB, it would be exposed to DNL 65 dB. Recalling the relationship of SEL to the peak noise level (Lmax) of an aircraft overflight, the Lmax recorded for each of those overflights (the peak level a person would actually hear) would typically range from 90 to 95 dB.

C.3 FACTORS INFLUENCING HUMAN RESPONSE TO SOUND

Many factors influence how a sound is perceived and whether or not it is considered annoying to the listener. These factors include not only physical (acoustic) characteristics of the sound but also secondary (non-acoustic) factors, such as sociological and external factors.

Sound rating scales are developed to account for the factors that affect human response to sound. Nearly all of these factors are relevant in describing how sounds are perceived in the community. Many of the non-acoustic parameters play a prominent role in affecting individual response to noise. Background sound (ambient noise) is also important in describing sound in rural settings. Some non-acoustic factors that may influence an individual's response to aircraft noise include:

- Predictability of when the sound/noise will occur;
- How the noise affects certain activities;
- Fear of an aircraft crashing;
- Belief that aircraft noise could be prevented or reduced by aircraft designers, pilots, or authorities related to airlines or airports; and
- Sensitivity to noise in general.

Thus, it is important to recognize that non-acoustic factors such as those described above, as well as acoustic factors, contribute to human response to noise.

C.3.1 PERCEIVED NOISE LEVEL

Perceived noise level is another method of rating sound that was originally developed for the assessment of aircraft noise. Perceived noise level is the subjective measure of the degree to which noise is unwanted or causes annoyance to an individual. To determine perceived noise level, individuals are asked to judge in a laboratory setting when two sounds are equally noisy or disturbing if heard regularly in their own environment. These surveys are inherently subjective and thus subject to greater variability. For example, two separate events of equal noise energy may be perceived differently if one sound is more annoying to the listener than the other; or the same noise event may be annoying to one individual yet not another.

C.4 HEALTH EFFECTS OF NOISE

A considerable amount of research has been conducted over the last 30 years to identify, measure, and quantify the potential effects of aviation noise on health. The various methods by which noise can be measured (e.g. single dose, long-term average, number of events above a certain level, etc.), and difficulties in separating other lifestyle factors from the analysis, increases the complexity of determining the health effects of noise, and has caused considerable variability in the results of past studies. The health effects of noise are often divided into the following topics: cardiovascular effects, hearing loss, sleep disturbance, and speech/communication interference.

C.4.1 CARDIOVASCULAR EFFECTS

Several studies have suggested that increased hypertension or other cardiovascular effects, such as increased blood pressure, and change in pulse rate, may be associated with long-term exposure to high levels of environmental noise. When conducting cross-sectional studies of environmental noise exposure, it is difficult to control for other important variables. Subsequent reviews of past research has pointed out that such studies "…are notoriously difficult to interpret. They often report conflicting results, generally do not identify a cause and effect relationship, and often do not report a dose-response relationship between the cause and effect."[3] Therefore, it is not known what, if any, cardiovascular effects are caused by aircraft noise exposure.

C.4.2 HEARING LOSS

The potential for noise-induced hearing loss is commonly associated with occupational noise exposure from working in a noisy work environment or recreational noise such as listening to loud music. Recent studies have concluded that "because environmental noise does not approximate occupational noise levels or recreational noise exposures…it does not have an effect on hearing threshold levels." Furthermore, "aviation noise does not pose a risk factor for child or adolescent hearing loss, but perhaps other noise sources (personal music devices, concerts, motorcycles, or night clubs) are a main risk factor."[4] Because aviation noise levels near airports does not approach levels of occupational or recreational noise exposures associated with hearing loss, hearing impairment is likely not caused by aircraft noise for populations living near an airport.

C.4.3 SLEEP DISTURBANCE

Sleep disturbance is a common complaint from people who live in the vicinity of an airport. A large amount of research has been published on the topic of sleep disturbance caused by environmental noise. This research has produced variable results due to differing definitions of sleep disturbance, different ways for measuring sleep disturbance (behavioral awakenings or sleep interruption), and

[3] Airport Cooperative Research Program, Transportation Research Board, Effects of Aircraft Noise: Research Update on Selected Topics, 2008.
[4] Ibid.

different settings in which to measure it (laboratory setting or field setting). In-home sleep disturbance studies clearly demonstrate that it requires more noise to cause awakenings than was previously theorized based on laboratory sleep disturbance studies.

In 1992, the Federal Interagency Committee on Noise (FICON) recommended an interim dose-response curve to predict the percent of the exposed population expected to be awakened (percent awakening) as a function of the exposure to single event noise levels expressed in terms of the Sound Exposure Level (SEL). This interim curve was based on statistical adjustment of previous analysis, and included data from both laboratory and field studies. In 1997, Federal Interagency Committee on Aviation Noise (FICAN) recommended a revised sleep disturbance relationship based on data and analysis from three field studies.[5]

Exhibit C-8, *Sleep Disturbance Dose–Response Curves*, show the results of the 1992 and 1997 analyses. The top graph shows a comparison of the 1992 FICON and 1997 FICAN curves. The 1997 FICAN curve represents the upper limit of the observed field data, and should be interpreted as predicting the "maximum percent of the exposed population expected to be behaviorally awakened", or the "maximum percent awakened" for a given residential population.

In 2008, FICAN recommended the use of a revised method to predict sleep disturbance in terms of percent awakenings based on data published by the American National Standards Institute (ANSI) in 2008.[6] In contrast to the earlier FICAN recommendation, the 2008 ANSI standard indicates that the probability of awakening is lower for a single noise event in cases where the population is exposed to the given noise source for a long period of time (more than one year) compared to the probability of awakening for sound that is new to an area. In Exhibit C-8, the lower graph shows these two relationships, with Equation 1 (blue dotted line) representing percent awakenings from long-term noise and Equation B1 (pink dashed line) representing percent awakenings from a new noise source based on the 1997 FICAN results. As shown in this exhibit, at an indoor SEL of 100 dB, the probability of awakenings would be expected to exceed 15 percent for a new noise source; yet for long-term noise sources, the probability of awakening is expected to be less than 10 percent.

No definitive conclusions have been drawn on the percent of a population that is estimated to be awakened by a certain level of aircraft noise and recent studies have cautioned about the over-interpretation of the data.

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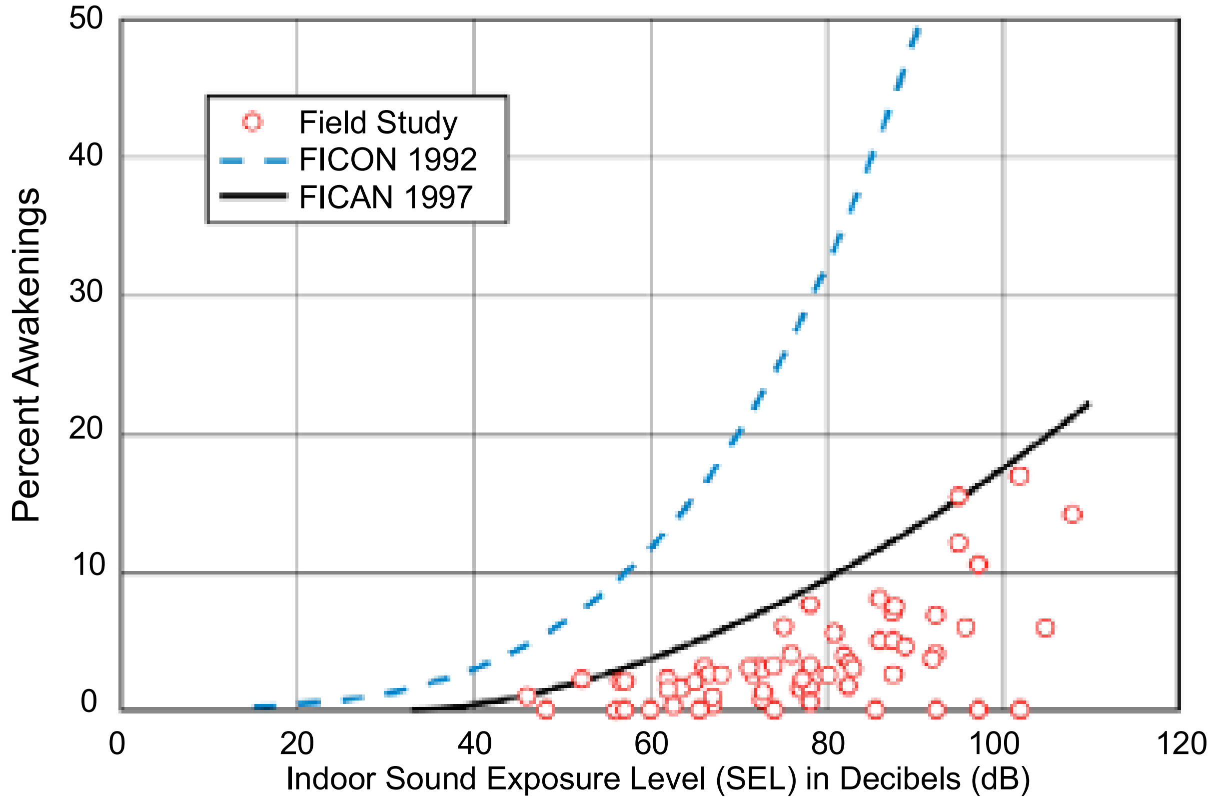
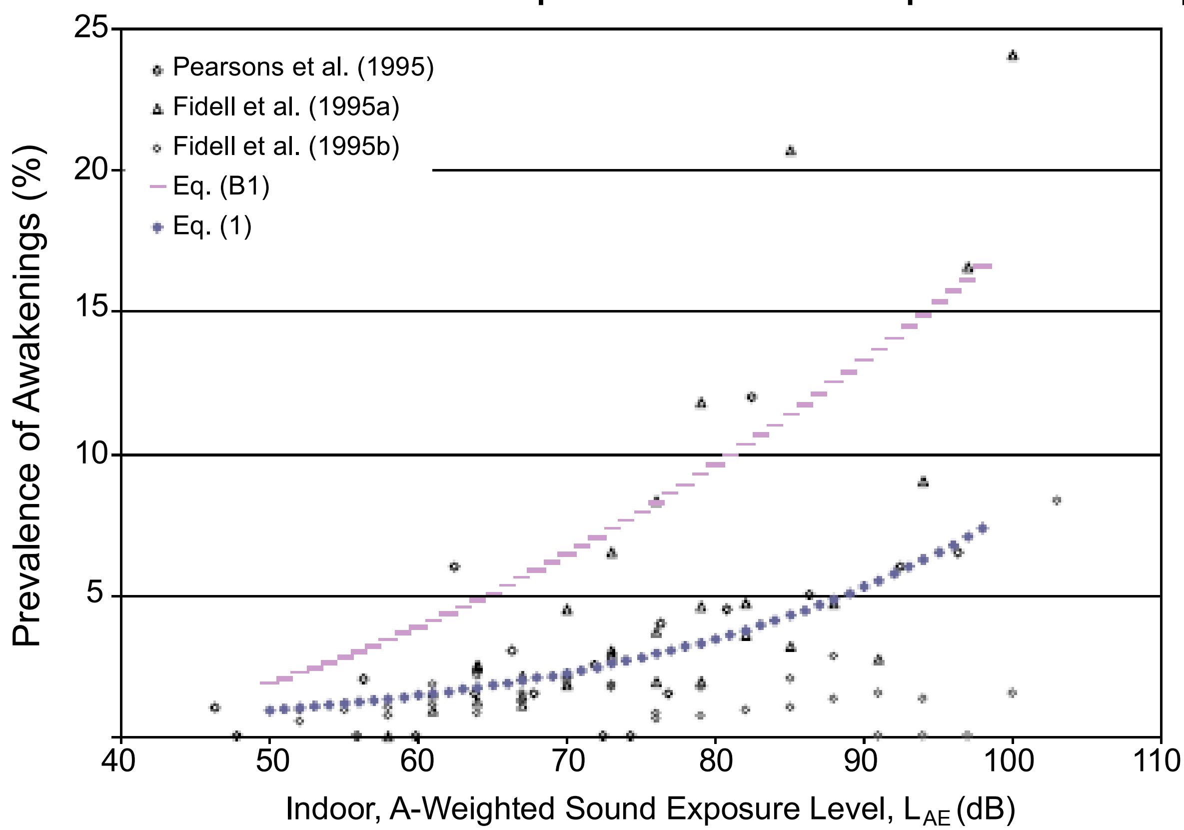
5 See Appendix C, *FAA Policies, Guidance, and Regulations,* for more information about FICON and FICAN.

6 ANSI S12.9-2008, Quantities and Procedures for Description and Measurement of Environmental Sound — Part 6: Methods for Estimation of Awakenings Associated with Outdoor Noise Events Heard in Homes, 2008.

FICAN 1997 Recommended Sleep Disturbance Dose-Response Relationship



ANSI 2008 Recommended Sleep Disturbance Dose-Response Relationship



Sources: Federal Interagency Committee on Aviation Noise (FICAN), June 1997; American National Standards Institute, 2008.

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Noise Exposure Map Update

HARRISBURG INTERNATIONAL AIRPORT

Sleep Disturbance Curves

EXHIBIT: C-8

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C.4.4 COMMUNICATION INTERFERENCE

Communication interference can impact activities such as personal conversations, classroom learning, and listening to radio and television. Most studies have focused on communication interference due to continual noise sources. In 1974, the USEPA published *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety*, which is one of the few studies to focus on intermittent noise. The study concluded that for voice communication, an indoor Leq of 45 dB allows normal conversation at distances up to 2 meters with 95 percent sentence intelligibility. **Exhibit C-9, *Noise Effects on Distance Necessary for Speech Communication***, shows the required distance between talker and listener based on the type of speech communication (normal voice, loud voice, etc.) and the environmental noise level from the 1974 USEPA report.

Noise can also impact communication between student and teacher necessary for learning in a classroom setting. It is usually accepted that noise levels above a certain Leq may affect a child's learning experiences. Research has shown a "decline in reading when outdoor noise levels equal or exceed Leq of 65 dBA."[7] Furthermore, a study conducted by FICAN in 2007 found: "(1) a substantial association between noise reduction and decreased failure (worst-score) rates for high-school students, and (2) significant association between noise reduction and increased average test scores for student/test subgroups. In general, the study found little dependence upon student group and upon test type."[8]

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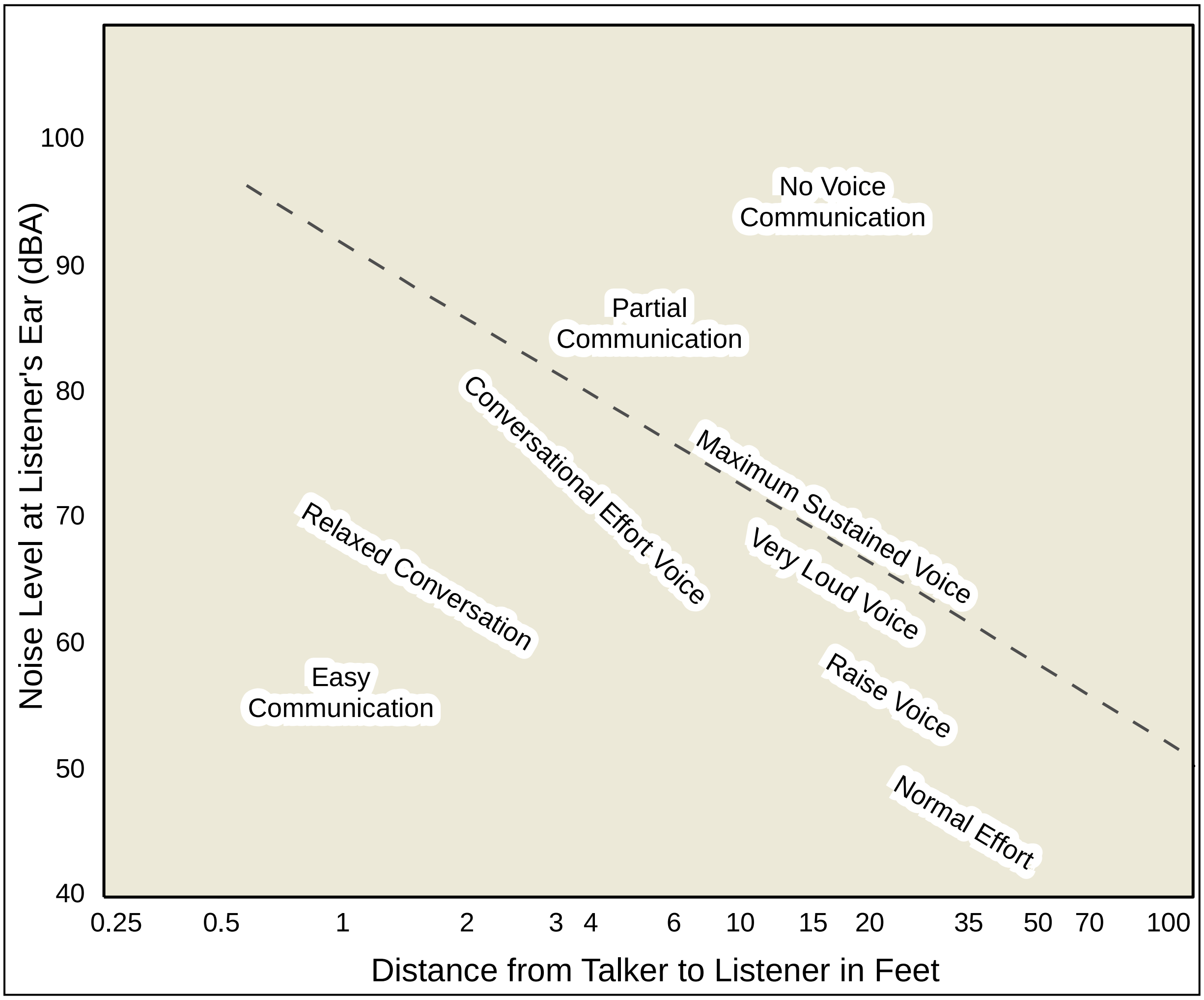
[7] Airport Cooperative Research Program, Transportation Research Board, Effects of Aircraft Noise: Research Update on Selected Topics, 2008.

[8] Federal Interagency Committee on Aviation Noise (FICAN), Findings of the FICAN Pilot Study on the Relationship between Aircraft Noise Reduction and Changes in Standardized Test Scores, July 2007.

Exhibit C-9
NOISE EFFECTS ON DISTANCE NECESSARY FOR SPEECH COMMUNICATION



Source: FICON, 1992; from USEPA, 1974.

C.5 NOISE MODELING METHODOLOGY

The following sections summarize the methodology, assumptions, and input data for the noise contour modeling for this NEM Update.

C.5.1 NOISE MODEL

The analysis of noise exposure around MDT was prepared using the latest version of the *Integrated Noise Model (INM)*, Version 7.0d.[9] Inputs to the INM include runway definition, number of aircraft operations during the time period evaluated, the types of aircraft flown, the time of day when they are flown, how frequently each runway is used for arriving and departing aircraft, the routes of flight used when arriving to and departing from the runways, and ground run-up activity. The INM calculates noise exposure for the area around the airport and outputs contours of equal noise exposure using the DNL metric. For this NEM Update, equal noise exposure contours for the levels of 65, 70, and 75 DNL were calculated and represent average-annual day conditions. Noise exposure contours were developed for Existing (2015) conditions and Future (2020) conditions.

C.5.2 EXISTING (2015) NOISE CONTOUR MODELING INPUT DATA

Runway Definition

The Airport currently has a single runway (designated Runway 13/31). The runway is 10,001 feet in length by 200 feet in width and there is a displaced arrival threshold of 993 feet at both ends. **Exhibit C-10, *Existing Airport Layout***, shows the existing airfield layout at MDT.

[9] Effective May 29, 2015, the Aviation Environmental Design Tool (AEDT), Version 2b, replaced the INM as the required tool for noise modeling as part of an NEM Update. Consistent with current FAA policy and practice, the use of AEDT 2b is not required for projects whose analysis began before the effective date of this policy. Noise analysis for this NEM Update began before May 29, 2015, therefore use of INM was continued for this Study (80 FR 27853).

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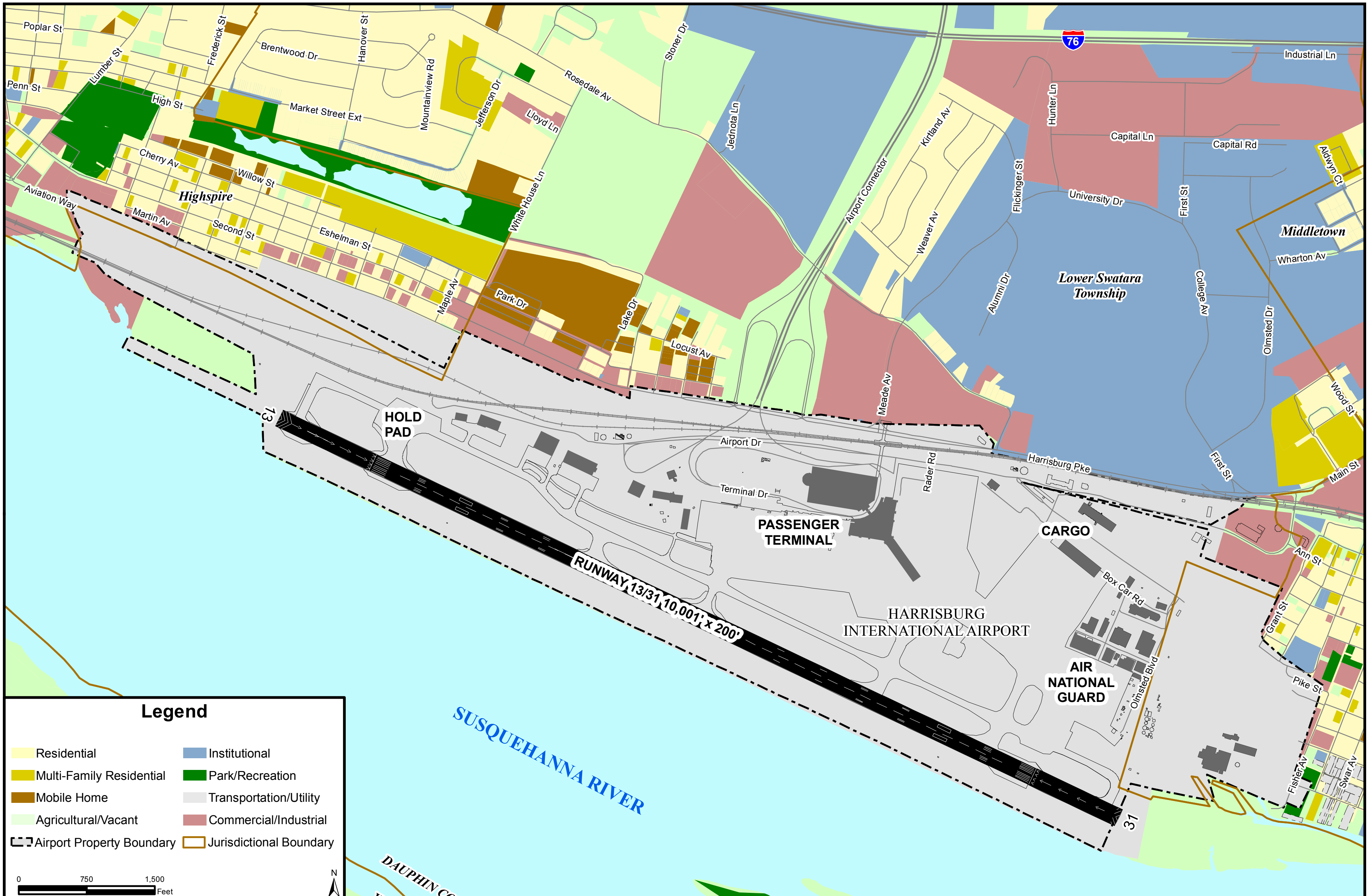

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Prepared by Landrum & Brown - 5/22/2015
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Noise Exposure Map Update

HARRISBURG INTERNATIONAL AIRPORT

Existing Airport Layout

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Number of Operations and Fleet Mix

The number of annual operations modeled for the Existing (2015) Noise Exposure Contour at MDT was based on Air Traffic Control Tower (ATCT) counts for the period from January 2014 through December 2014, which was the most recent twelve months of data available when the noise modeling began. During that twelve-month period, 50,855 operations occurred at MDT, which results in 140 average-annual day operations. Specific aircraft types and times of operation for commercial aircraft were developed from Official Airline Guide (OAG) data and FAA Traffic Flow Management System Counts (TFMSC) from MDT for the period from January 2014 through December 2014. **Table C-1** provides a summary of the average daily operations and fleet mix at MDT, organized by aircraft type, operation type, and time of day.

Table C-1
DISTRIBUTION OF AVERAGE DAILY OPERATIONS BY AIRCRAFT CATEGORY
EXISTING (2015) CONDITIONS
Harrisburg International Airport

AIRCRAFT DESCRIPTION	INM ID	ARRIVALS		DEPARTURES		TOTAL
		DAY	NIGHT	DAY	NIGHT	
Large Passenger Jets						
Boeing 717-200	717200	1	0	1	0	2
Airbus A319-100	A319-131	2	0	1	1	4
Airbus A320-200	A320-232	0	1	1	0	2
Bombardier Regional Jet CRJ-700	CRJ701	2	0	2	0	4
Bombardier Regional Jet CRJ-900	CRJ9-ER	3	1	3	1	8
Embraer EMB-170	EMB170	1	1	2	0	4
McDonnell Douglas MD-83	MD83	1	0	1	0	2
McDonnell Douglas MD-88	MD88	0	1	0	1	2
Subtotal		*10*	*4*	*11*	*3*	*28*
Large Cargo Jets						
Boeing 757-200	757RR	0	1	0	1	2
Boeing 767-200	767CF6	0	1	0	1	2
Airbus A300-600	A300-622R	0	1	0	1	2
Subtotal		*0*	*3*	*0*	*3*	*6*

Table C-1, *(continued)*
DISTRIBUTION OF AVERAGE DAILY OPERATIONS BY AIRCRAFT CATEGORY
EXISTING (2015) CONDITIONS
Harrisburg International Airport

AIRCRAFT DESCRIPTION	INM ID	ARRIVALS		DEPARTURES		TOTAL
		DAY	NIGHT	DAY	NIGHT	
Regional / General Aviation Jets						
Twin Engine Business Jet	BEC400	1	0	1	0	2
Twin Engine Business Jet	CL600	2	0	2	0	4
Bombardier Regional Jet CRJ-200	CLREGJ	4	1	4	1	10
Twin Engine Business Jet	CNA525C	1	0	1	0	2
Twin Engine Business Jet	CNA560U	1	0	1	0	2
Twin Engine Business Jet	CNA560XL	1	0	1	0	2
Twin Engine Business Jet	CNA750	1	0	1	0	2
Embraer EMB-145	EMB145	5	1	5	1	12
Twin Engine Business Jet	G200	1	0	1	0	2
Twin Engine Business Jet	GIV	1	0	1	0	2
Twin Engine Business Jet	HS1258	2	0	2	0	4
Twin Engine Business Jet	LEAR35	1	0	1	0	2
Subtotal		*21*	*2*	*21*	*2*	*46*
Commuter / General Aviation Props						
Twin Engine Turbo Prop	1900D	2	0	2	0	4
Twin Engine Turboprop	BEC200	2	0	2	0	4
Single Engine Prop	CNA172	1	0	1	0	2
Single Engine Turboprop	CNA208	3	0	3	0	6
Twin Engine Turboprop	DHC8	7	1	6	2	16
Twin Engine Turboprop	DHC830	1	0	1	0	2
Twin Engine Turboprop	SD360	1	0	1	0	2
Subtotal		*17*	*1*	*16*	*2*	*36*
Military Jets						
Boeing KC-135 Stratotanker	KC-135	1	0	1	0	2
Boeing C-17 Globemaster	C17	0.75	0	0.75	0	1.5
Lockheed C-5 Galaxy	C5A	0.25	0	0.25	0	0.5
Subtotal		*2*	*0*	*2*	*0*	*5*
Military Props						
Lockheed C-130 Hercules	C130E	9	0	9	0	18
Subtotal		*9*	*0*	*9*	*0*	*18*
Helicopters						
UH-60 Black Hawk	S70	1	0	1	0	2
Subtotal		*1*	*0*	*1*	*0*	*2*
Grand Total		**60**	**10**	**60**	**10**	**140**

Notes: Day = 7:00 a.m. to 9:59 p.m., Night = 10:00 p.m. to 6:59 a.m.

Source: FAA Operations Network (OPSNET) data, FAA Traffic Flow Management System Counts (TFMSC), Official Airline Guide (OAG) flight schedules; Landrum & Brown analysis, 2015.

Runway End Utilization

The proportional use of the two runway ends at MDT is influenced by the proximity of Capital City Airport (CXY) to MDT, the relative position between the runway ends and the terminal and other aircraft parking positions at MDT, as well as typical wind conditions. Average-annual day runway end utilization was derived primarily from analysis of FAA radar data and a review of historic weather data. Based on this data, it was determined that during an average year, MDT operates in west flow (arriving to and departing from Runway 31) approximately 72 percent of the time; and in east flow (arriving to and departing from Runway 13) approximately 28 percent of the time.

Flight Tracks

There are two components to modeling flight tracks in the INM: flight track location, and percentage of distribution. FAA radar data was analyzed to verify the location of and distribution of aircraft along existing flight corridors. Consolidated flight tracks were developed from this radar data and used in the INM to model the flight corridors present around the Airport. The INM flight tracks modeled for the Existing (2015) Noise Exposure Contour are shown on **Exhibit C-11** and **Exhibit C-12**. **Table C-2** shows arrival flight track distribution percentages and **Table C-3** shows departure flight track distribution percentages for the 2015 conditions. Each flight track is identified by a track ID that corresponds to the label in the flight track exhibits.

Table C-2
ARRIVAL FLIGHT TRACK UTILIZATION PERCENTAGES – EXISTING (2015) CONDITIONS
Harrisburg International Airport

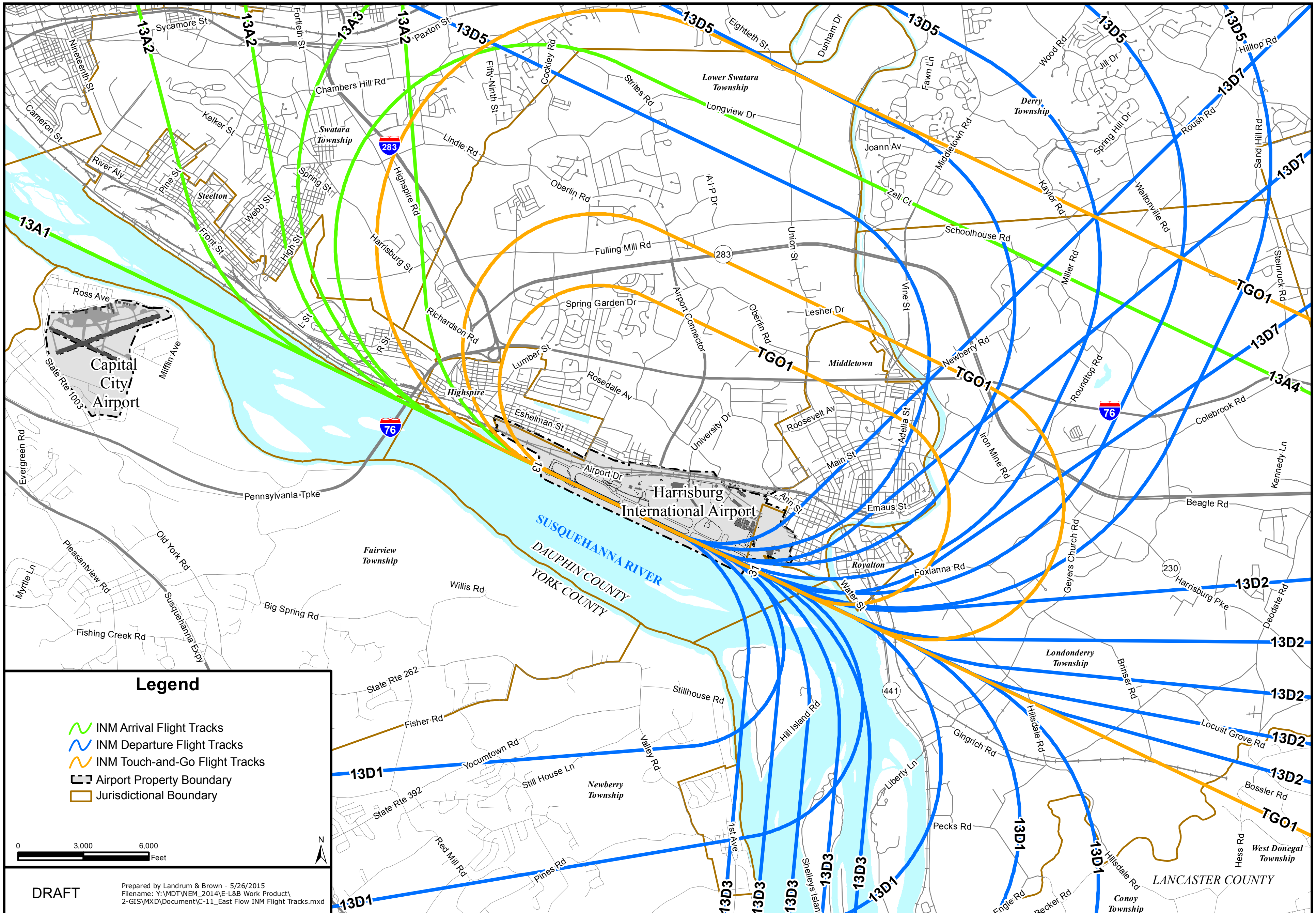
RUNWAY	TRACK ID	JET	PROP	MILITARY
13	13A1	12.3%	4.8%	4.0%
	13A2	3.6%	3.2%	6.6%
	13A3	0.0%	14.5%	5.3%
	13A4	4.4%	1.6%	0.0%
	13A5	8.7%	0.0%	0.0%
	TGO1	0.0%	4.8%	10.5%
	TGO2	0.0%	0.0%	2.6%
31	31A1	28.4%	3.9%	0.0%
	31A2	23.1%	0.0%	0.0%
	31A3	10.7%	35.5%	19.3%
	31A4	0.0%	7.5%	0.0%
	31A5	8.9%	4.3%	12.8%
	31A6	0.0%	7.9%	6.6%
	TGO1	0.0%	7.9%	32.3%
	TGO2	0.0%	3.9%	0.0%
TOTAL		**100.0%**	**100.0%**	**100.0%**

Source: FAA radar data, Landrum & Brown analysis, 2015.

Table C-3
DEPARTURE FLIGHT TRACK UTILIZATION PERCENTAGES – EXISTING (2015) CONDITIONS
Harrisburg International Airport

RUNWAY	TRACK ID	JET	PROP	MILITARY
13	13D1	2.6%	0.6%	0.0%
	13D2	3.7%	3.5%	3.0%
	13D3	11.2%	10.4%	8.9%
	13D5	8.5%	2.9%	0.0%
	13D7	0.0%	4.3%	2.4%
	TGO1	0.0%	4.8%	10.5%
	TGO2	0.0%	0.0%	2.6%
31	31D1	13.0%	0.0%	6.7%
	31D1A	0.0%	45.2%	20.2%
	31D3	0.0%	2.5%	6.9%
	31D4	15.7%	7.8%	6.7%
	31D5	29.6%	0.0%	0.0%
	31D5A	0.0%	4.1%	0.0%
	31D7	15.7%	2.1%	0.0%
	TGO1	0.0%	7.9%	32.3%
	TGO2	0.0%	3.9%	0.0%
TOTAL		**100.0%**	**100.0%**	**100.0%**

Source: FAA radar data, Landrum & Brown analysis, 2015.



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Noise Exposure Map Update

HIA Harrisburg International Airport

HARRISBURG INTERNATIONAL AIRPORT

L&B

East Flow INM Flight Tracks

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C-11

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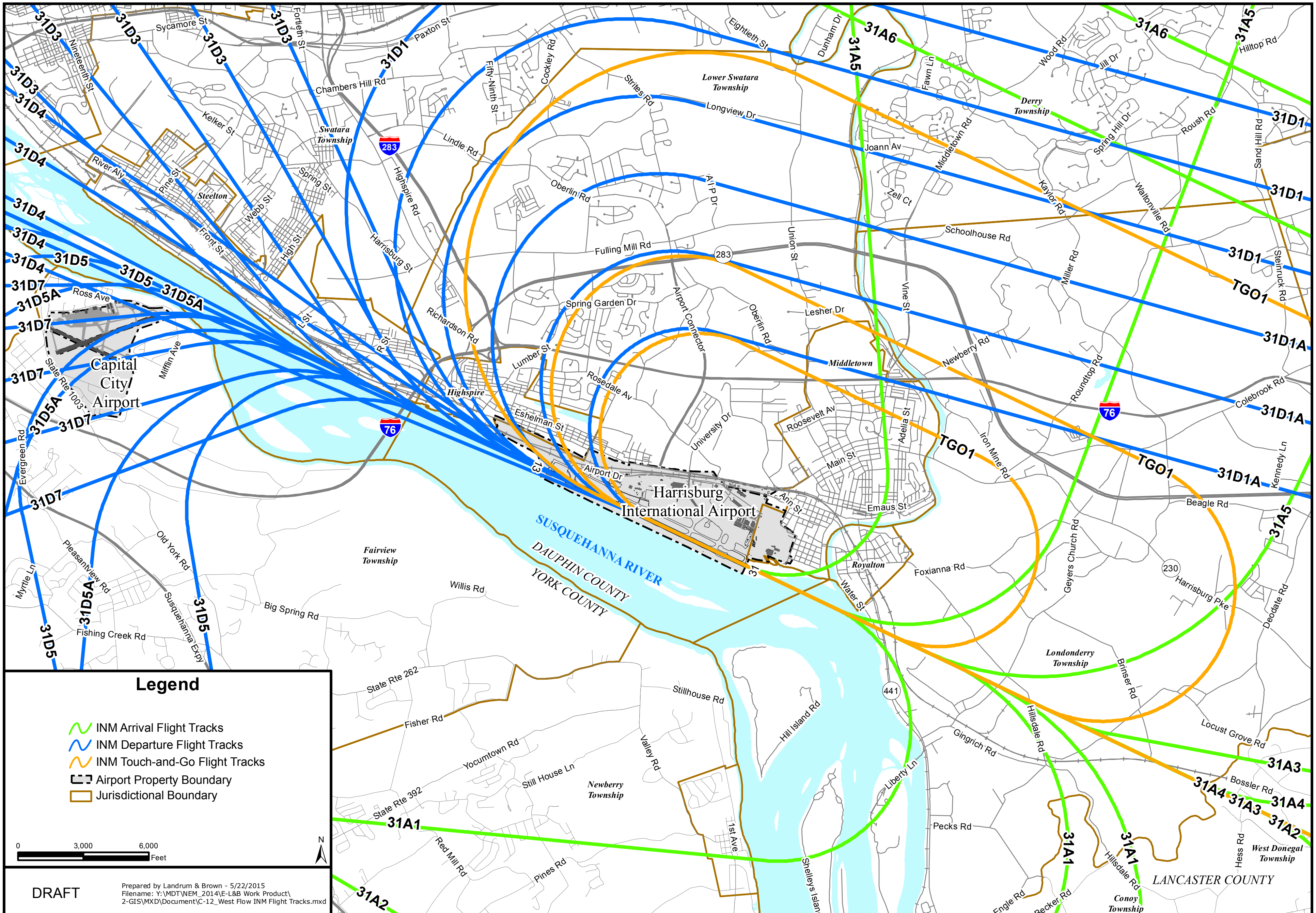

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Noise Exposure Map Update

HIA Harrisburg International Airport
HARRISBURG INTERNATIONAL AIRPORT
L&B

West Flow INM Flight Tracks

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C-12

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Aircraft Weight and Trip Length

Aircraft weight upon departure is a factor in the dispersion of noise because it impacts the rate at which an aircraft is able to climb. Generally, heavier aircraft have a slower rate of climb and a wider dispersion of noise along their flight routes. Where specific aircraft weights are unknown, the INM uses the distance flown to the first stop as a surrogate for the weight, by assuming that the weight has a direct relationship with the fuel load necessary to reach the first destination. The INM groups trip lengths into nine stage categories and assigns standard aircraft weights to each stage category. These categories are:

Stage Category	Stage Length
1	0-500 nautical miles
2	500-1000 nautical miles
3	1000-1500 nautical miles
4	1500-2500 nautical miles
5	2500-3500 nautical miles
6	3500-4500 nautical miles
7	4500-5500 nautical miles
8	5500-6500 nautical miles
9	6500+ nautical miles

The trip lengths modeled for the Existing (2015) Noise Exposure Contour at MDT are based upon a review of OAG data showing destinations of scheduled departures. **Table 4** indicates the proportion of the operations that fell within each of the nine trip length categories. For the 2015 conditions, 71 percent of all large passenger jet departures, 83 percent of all cargo jet departures, 93 percent of all regional jet departures, and 100 percent of all propeller and military aircraft departures operated to destinations with a stage length of one (0 to 500 nautical miles). Destinations within this range include Boston, Charlotte, Detroit, Philadelphia, Pittsburgh, and Washington DC. An additional 25 percent of large passenger jets, 17 percent of cargo jets, and 7 percent of regional jets operated to destinations with a stage length of two (500-1,000 nautical miles). Destinations within this range include Atlanta, Chicago, Louisville, and Memphis. A small percentage (4 percent) of large passenger jets operated to destinations with a stage length of three (1,000 to 1,500 nautical miles).

Table C-4
DEPARTURE TRIP LENGTH DISTRIBUTION –
EXISTING (2015) CONDITIONS
Harrisburg International Airport

STAGE LENGTH CATEGORY	LARGE PASSENGER JET	LARGE CARGO JET	REGIONAL/ GENERAL AVIATION JET	COMMUTER/ GENERAL AVIATION PROP	MILITARY JET	MILITARY
1	71%	83%	93%	100%	100%	100%
2	25%	17%	7%	0%	0%	0%
3	4%	0%	0%	0%	0%	0%
4	0%	0%	0%	0%	0%	0%
5	0%	0%	0%	0%	0%	0%
6	0%	0%	0%	0%	0%	0%
7	0%	0%	0%	0%	0%	0%
8	0%	0%	0%	0%	0%	0%
9	0%	0%	0%	0%	0%	0%
Total	100%	100%	100%	100%	100%	100%

Source: FAA radar data, Landrum & Brown analysis, 2015.

Ground Run-up Noise

Engine run-ups are occasionally conducted at MDT for maintenance purposes on civil and military aircraft. Civil engine run-ups are conducted on the airfield at the hold area on Taxiway Alpha near Taxiway Bravo. Military run-ups are conducted at the Pennsylvania Air National Guard ramp. Engine run-up activity was modeled based on estimates of run-up activity provided by SARAA staff. On average, it is estimated that approximately one civil run-up and one military run-up occurs per day at MDT (14 total run-ups per week). It was assumed that each civil run-up is conducted at low power (50% thrust) for up to 15 minutes, and at high power (100% thrust) for up to three additional minutes, for a total duration of 18 minutes per run-up (252 minutes or 4 hours and 12 minutes per week). In addition, it was estimated that military run-ups occur at high power for three minutes per run-up. It was assumed that approximately 90 percent of all civil run-ups and 100 percent of all military run-ups occur during the daytime (7:00 am to 9:59 pm). **Table C-5** shows the number, types, durations and times of day of engine run-ups that were modeled for the Existing (2015) Noise Exposure Contour.

Table C-5
AIRCRAFT ENGINE RUN-UPS - EXISTING (2015) CONDITIONS
Harrisburg International Airport

AIRCRAFT TYPE	MODELED RUN-UPS PER WEEK			
	DAYTIME	NIGHTTIME	TOTAL	RUN-UP DURATION PER WEEK (HOURS : MINUTES)
Civil Run-Ups				
DHC8	4.7	0.5	5.3	1:35
EMB145	1.6	0.2	1.8	0:32
Subtotal	*6.3*	*0.7*	*7.0*	2:06
Military Run-Ups				
C-130E	7.0	0.0	7.0	2:06
Subtotal	*7.0*	*0.0*	*7.0*	2:06
Grand Total	**13.3**	**0.7**	**14.0**	4:12

Source: Discussion with SARAA staff, and Landrum & Brown analysis, 2015.

C.5.3 FUTURE (2020) NOISE CONTOUR MODELING INPUT DATA

Runway Definition

No changes to runway configuration are expected at MDT by 2020; therefore the runway layout discussed for the 2015 condition was also used to model the Future (2020) Noise Exposure Contour.

Number of Operations and Fleet Mix

The Future (2020) Noise Exposure Contour operating levels are based upon the FAA's Terminal Area Forecast (TAF) issued in January 2015. The Future (2020) conditions include 59,741 annual operations or 164 average-annual day operations, an increase of 17 percent from the Existing (2015) Noise Exposure Contour operating levels. Future fleet mix data was derived from the TAF and the demand-capacity assumptions from the Aviation Demand Forecast prepared for the 2014 Master Plan for MDT. **Table C-6** provides a summary of the average daily operations and fleet mix at MDT, organized by aircraft category, operation type, and time of day.

Runway End Utilization: Average-annual day runway end utilization in 2020 is expected to remain similar to 2015 conditions. Therefore, runway end utilization percentages modeled for the Future (2020) conditions are the same as the Existing (2015) conditions.

Flight Tracks

No substantial changes to flight track locations or utilization percentages are expected to occur by 2020, therefore flight track locations modeled for the Existing (2015) Noise Exposure Contour, and shown in Exhibits C-11 and C-12, remain the same for the Future (2020) Noise Exposure Contour modeling. Minor variations in flight track percentages were modeled for the Future (2020) Noise Exposure Contour due to changes in operating levels, fleet mix, and the ratio of origins/destinations served. Flight track percentages that were modeled for the Future (2020) Noise Exposure Contour are shown in **Table C-7** and **Table C-8**.

Table C-6
DISTRIBUTION OF AVERAGE DAILY OPERATIONS BY AIRCRAFT TYPE – FUTURE (2020) CONDITIONS
Harrisburg International Airport

AIRCRAFT DESCRIPTION	INM ID	ARRIVALS		DEPARTURES		TOTAL
		DAY	NIGHT	DAY	NIGHT	
Large Passenger Jet						
Boeing 717-200	717200	2	0	2	0	4
Boeing 737-800	737800	1	0	1	0	2
Airbus A319-100	A319-131	3	0	2	1	6
Airbus A320-200	A320-232	1	0	1	0	2
Bombardier Regional Jet CRJ-700	CRJ701	8	0	6	2	16
Bombardier Regional Jet CRJ-900	CRJ9-ER	7	2	8	1	18
Embraer EMB-170	EMB170	3	2	5	0	10
McDonnell Douglas MD-83	MD83	1	0	1	0	2
McDonnell Douglas MD-88	MD88	0	1	0	1	2
Subtotal		*26*	*5*	*26*	*5*	*62*
Large Cargo Jet						
Boeing 757-200	757RR	1	1	1	1	4
Boeing 767-200	767CF6	1	1	1	1	4
Airbus A300-600	A300-622R	1	1	1	1	4
Subtotal		*3*	*3*	*3*	*3*	*12*
Regional / General Aviation Jet						
Twin Engine Business Jet	BEC400	1	0	1	0	2
Twin Engine Business Jet	CL600	1	0	1	0	2
Bombardier Regional Jet CRJ-200	CLREGJ	2	1	2	1	6
Twin Engine Business Jet	CNA525C	1	0	1	0	2
Twin Engine Business Jet	CNA560U	1	0	1	0	2
Twin Engine Business Jet	CNA560XL	1	0	1	0	2
Twin Engine Business Jet	CNA750	2	0	2	0	4
Embraer EMB-145	EMB145	2	1	2	1	6
Twin Engine Business Jet	G200	1	0	1	0	2
Twin Engine Business Jet	GIV	2	0	2	0	4
Twin Engine Business Jet	HS1258	2	0	2	0	4
Twin Engine Business Jet	LEAR35	2	0	2	0	4
Subtotal		*18*	*2*	*18*	*2*	*40*
Commuter / General Aviation Prop						
Twin Engine Turbo Prop	1900D	2	0	2	0	4
Twin Engine Turboprop	BEC200	1	0	1	0	2
Single Engine Prop	CNA172	1	0	1	0	2
Single Engine Turboprop	CNA208	1	0	1	0	2
Twin Engine Turboprop	DHC8	5	1	5	1	12
Twin Engine Turboprop	DHC830	1	0	1	0	2
Twin Engine Turboprop	SD360	1	0	1	0	2
Subtotal		*12*	*1*	*12*	*1*	*26*

Table C-6 *(continued)*
DISTRIBUTION OF AVERAGE DAILY OPERATIONS BY AIRCRAFT TYPE – FUTURE (2020) CONDITIONS
Harrisburg International Airport

AIRCRAFT DESCRIPTION	INM ID	ARRIVALS		DEPARTURES		TOTAL
		DAY	NIGHT	DAY	NIGHT	
Military Jets						
Boeing KC-135 Stratotanker	KC-135	1	0	1	0	2
Boeing C-17 Globemaster	C17	0.75	0	0.75	0	1.5
Lockheed C-5 Galaxy	C5A	0.25	0	0.25	0	0.5
Subtotal		*2*	*0*	*2*	*0*	*4*
Military Prop						
Lockheed C-130 Hercules	C130E	9	0	9	0	18
Subtotal		*9*	*0*	*9*	*0*	*18*
Helicopter						
UH-60 Black Hawk	S70	1	0	1	0	2
Subtotal		*1*	*0*	*1*	*0*	*2*
Grand Total		**70**	**12**	**71**	**11**	**164**

Notes: Day = 7:00 a.m. to 9:59 p.m., Night = 10:00 p.m. to 6:59 a.m.

Source: FAA Operations Network (OPSNET) data, FAA Traffic Flow Management System Counts (TFMSC), Official Airline Guide (OAG) flight schedules; FAA Terminal Area Forecast (TAF); MDT 2014 Airport Master Plan Aviation Demand Forecast; Landrum & Brown analysis, 2015.

Table C-7
ARRIVAL FLIGHT TRACK UTILIZATION PERCENTAGES –
FUTURE (2020) CONDITIONS
Harrisburg International Airport

RUNWAY	TRACK ID	JET	PROP	MILITARY
13	13A1	10.2%	6.7%	2.6%
	13A2	3.6%	0.0%	6.0%
	13A3	1.5%	15.6%	6.8%
	13A4	4.1%	2.2%	0.0%
	13A5	9.2%	0.0%	0.0%
	TGO1	0.5%	4.5%	10.5%
	TGO2	0.0%	0.0%	2.6%
31	31A1	27.4%	5.5%	0.0%
	31A2	19.9%	0.0%	0.0%
	31A3	11.2%	43.7%	21.7%
	31A4	1.2%	0.0%	0.0%
	31A5	10.0%	0.0%	13.0%
	31A6	0.0%	10.9%	4.4%
	TGO1	0.0%	5.5%	0.0%
	TGO2	1.2%	5.5%	32.3%
TOTAL		100.0%	100.0%	100.0%

Source: FAA radar data, Landrum & Brown analysis, 2015.

Table C-8
DEPARTURE FLIGHT TRACK UTILIZATION PERCENTAGES –
FUTURE (2020) CONDITIONS
Harrisburg International Airport

RUNWAY	TRACK ID	JET	PROP	MILITARY
13	13D1	2.5%	0.8%	0.0%
	13D2	3.8%	4.3%	2.8%
	13D3	11.5%	12.9%	8.3%
	13D5	7.8%	4.0%	0.0%
	13D7	0.0%	0.0%	3.2%
	TGO1	0.5%	4.5%	10.5%
	TGO2	0.0%	0.0%	2.6%
31	31D1	15.6%	0.0%	4.4%
	31D1A	0.0%	39.8%	26.9%
	31D3	0.0%	3.4%	4.6%
	31D4	13.6%	10.8%	4.4%
	31D5	29.9%	0.0%	0.0%
	31D5A	0.0%	5.7%	0.0%
	31D7	13.6%	2.8%	0.0%
	TGO1	0.0%	5.5%	0.0%
	TGO2	1.2%	5.5%	32.3%
TOTAL		100.0%	100.0%	100.0%

Source: FAA radar data, Landrum & Brown analysis, 2015.

Aircraft Weight and Trip Length

The trip lengths flown from MDT are based upon projected operations for the future conditions. There are expected to be no significant changes in the destinations served by airlines from MDT, however changes in the number of operations and fleet mix results in small variations in the departure trip length distributions for the 2020 conditions as shown in **Table C-9**. For the 2020 conditions, 74 percent of all large passenger jet departures, 83 percent of all cargo jet departures, 97 percent of all regional jet departures, and 100 percent of all propeller and military aircraft departures operated to destinations with a stage length of one (0 to 500 nautical miles).

Table C-9
DEPARTURE TRIP LENGTH DISTRIBUTION – FUTURE (2020) CONDITIONS
Harrisburg International Airport

STAGE LENGTH CATEGORY	LARGE PASSENGER JET	LARGE CARGO JET	REGIONAL/ GENERAL AVIATION JET	COMMUTER/ GENERAL AVIATION PROP	MILITARY JET	MILITARY
1	74%	83%	97%	100%	100%	100%
2	24%	17%	3%	0%	0%	0%
3	2%	0%	0%	0%	0%	0%
4	0%	0%	0%	0%	0%	0%
5	0%	0%	0%	0%	0%	0%
6	0%	0%	0%	0%	0%	0%
7	0%	0%	0%	0%	0%	0%
8	0%	0%	0%	0%	0%	0%
9	0%	0%	0%	0%	0%	0%
Total	100%	100%	100%	100%	100%	100%

Source: Official Airline Guide, Landrum & Brown, 2015.

Ground Run-up Noise

Engine run-up activity was projected for the 2020 conditions based upon the forecasted increase in operations of civil and military aircraft at MDT. On average, approximately 15.3 run-ups are expected to occur per week at MDT in 2020, (approximately 2.18 per day). Estimates of run-up times, durations and locations remain the same as described for the 2015 conditions. The number, types, durations and times of day of engine run-ups that were modeled for the Future (2020) Noise Exposure Contour are shown in **Table C-10**.

Table C-10
GROUND RUN-UP OPERATIONS – FUTURE (2020) CONDITIONS
Harrisburg International Airport

AIRCRAFT TYPE	MODELED RUN-UPS PER WEEK			
	DAYTIME	NIGHTTIME	TOTAL	RUN-UP DURATION PER WEEK (HOURS : MINUTES)
Civil Run-ups				
DHC8	5.6	0.6	6.2	1:52
EMB145	1.9	0.2	2.1	0:37
Subtotal	*7.4*	*0.8*	*8.3*	2:29
Military Run-ups				
C-130E	7.0	0.0	7.0	2:06
Subtotal	*7.0*	*0.0*	*7.0*	2:06
Grand Total	**14.4**	**0.8**	**15.3**	4:35

Source Discussion with SARAA staff, and Landrum & Brown analysis, 2015.

C.6 COMPARABILITY OF CONDITIONS

Total operations used for modeling the Existing (2015) Noise Exposure Contour was based on ATCT counts for the period from January 2014 through December 2014, which was the latest twelve months of data available when the noise modeling began. During that time period, 50,855 total operations occurred at MDT. In comparison, from May 2014 through April 2015, 50,348 operations occurred at MDT for a difference of one percent. No significant changes in fleet mix, the ratio of daytime to nighttime operations, runway use patterns, or flight corridors have occurred at MDT from calendar year 2014 to May 2015. The Future (2020) Noise Exposure Contour is based on the most recent FAA TAF. Therefore, the conditions modeled for the Existing (2015) and Future (2020) Noise Exposure Contours are representative of existing and future five-year conditions.

Appendix D

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APPENDIX D
LAND USE ASSESSMENT METHODOLOGY

Identifying and evaluating land uses within the Airport Environs is an important step in the Noise Exposure Map (NEM) Update process. This evaluation is necessary to identify residential and other noise-sensitive land uses within the Airport Environs. The land use assessment includes examining land use classifications, zoning codes, and development trends within the Airport Environs; and applying the Federal Aviation Administration (FAA) Part 150 guidelines for land use compatibility. A Geographic Information System (GIS) land use database was developed to facilitate the identification and noise compatibility analysis of land uses within the Airport Environs.

D.1 AIRPORT ENVIRONS

The Airport Environs refers to the regional area that may experience broader effects from the noise of aircraft operations. The Airport Environs for MDT is shown in Exhibit 2-1, *Airport Environs* in Chapter Two. The Airport Environs includes portions of Dauphin County and York County, including the boroughs of Highspire, Middletown, Royalton, and Steelton; Fairview Township, Londonderry Township, Newberry Township, Swatara Township, and Lower Swatara Township. These jurisdictions generally share both the benefits and the potentially negative impacts of airport operations at MDT, and therefore, are the subject of the land use evaluation in this study. The Airport Environs, shown on Exhibit 2-1, encompasses an area of approximately 23 square miles. The map includes jurisdictional boundaries, local roads and major highways, the Airport property line, and significant geographical features. The Airport Environs was delineated based upon previous noise exposure contours as well as radar data showing existing flight tracks. The Airport Environs map extends to the east by approximately 2.2 miles from Runway 13/31, to the west by approximately 2.1 miles west of Runway 13/31, and to the north and south by approximately 1.5 to 2.5 miles from the centerline of Runway 13/31.

D.1.1 LAND USE MAPPING

Land use data was collected and incorporated into a GIS database that includes jurisdictional boundaries, roads, bodies of water, and other physical features. The database was used to identify existing land use conditions within the Airport Environs and to identify areas impacted by noise per FAA guidelines. This section describes the methodology for collecting and analyzing land use data.

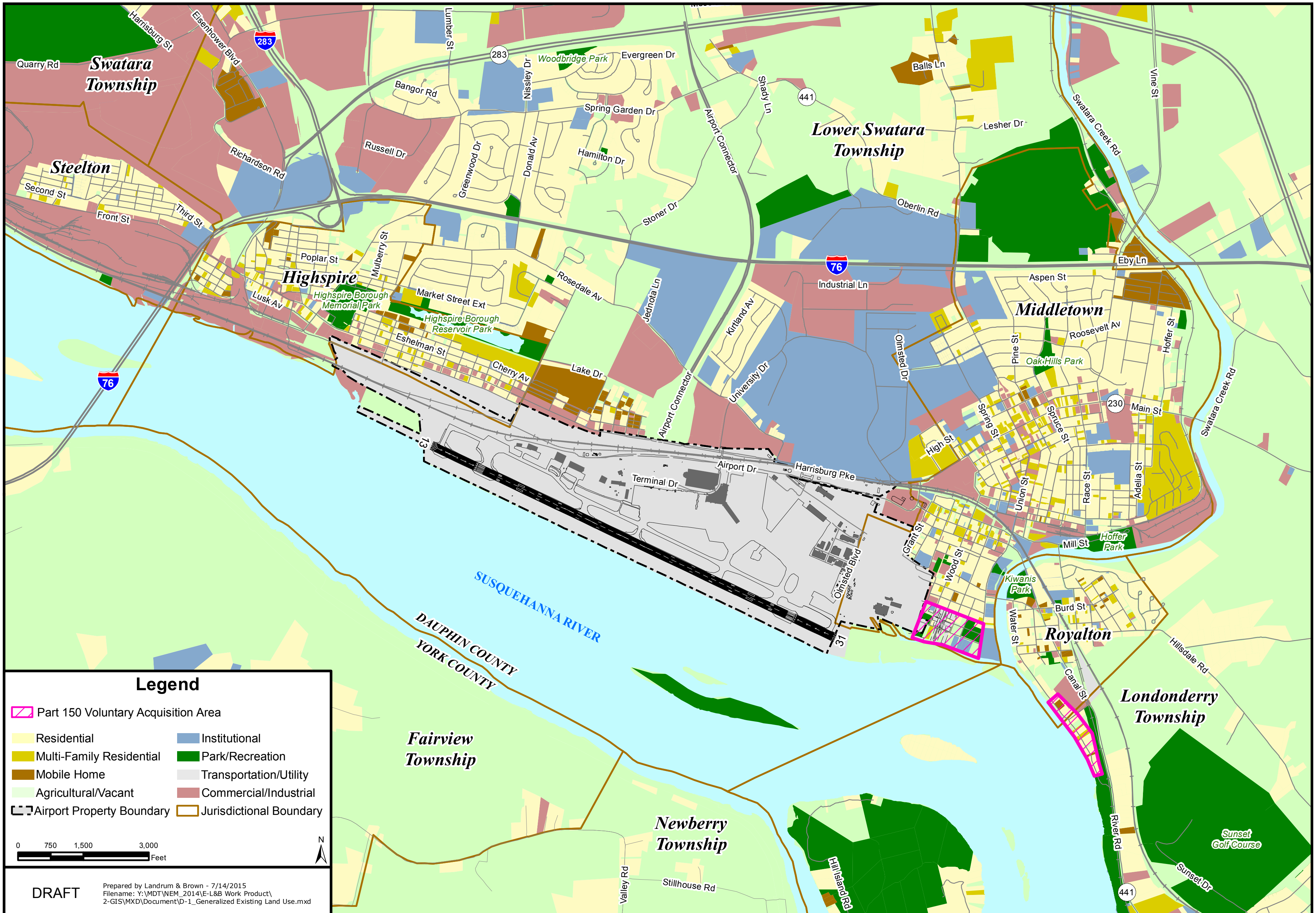
D.1.2 LAND USE CLASSIFICATIONS

Existing land use data was collected from the local government agencies within the Airport Environs, including the Dauphin County Department of Information Technology. Land uses in the vicinity of MDT were categorized in terms of the general land use classifications presented in 14 CFR Part 150, which include residential (single and multi-family), commercial, public/institutional, and agricultural/recreational/open space. These land uses were identified based on Dauphin County's GIS database and supplemented by aerial photography and field verification. **Table D-1** shows the generalized land use categories and examples of specific land uses that were grouped into these general land use categories. The existing land use patterns within the *Airport Environs* is shown in **Exhibit D-1, *Generalized Existing Land Use***.

Table D-1
GENERALIZED LAND USE CLASSIFICATIONS
Harrisburg International Airport

GENERALIZED LAND USE	SPECIFIC LAND USE
Agriculture / Vacant	Farm Land Unimproved, Farm Land With Buildings, Uninhabitable Lot, Vacant
Commercial / Industrial	Carwash, Commercial Garage/Auto Dealer, Commercial Land, Condominium Office, Diner, Fast Food Restaurant, Financial Institution, Funeral Home, Gas Station, Laundromat, Lodging Facility, Marina, Medical Office, Office, Parking Lot/Garage, Quarry/Mineral Lands, Restaurant/Tavern, Shopping Center, Store/Retail, Wholesale
Institutional	Cemetery, Church, Educational, Fire House, Library, Municipal, State/Govt Bldgs, Legion/VFW/Club, Extended Care, Group Residence
Mobile Home	Mobile Home Park, Mobile Home Site, Mobile Home
Multi-Family	Apartments 4 or Less Units, Apartments Over 10 Units, Multiple Dwellings, Apartments 4 to 10 Units
Park / Recreation	Swim Clubs, Mountainland/Timberland, Park/Recreation Exempt
Residential	1-Story Residence, 1.5-Story Residence, 2-Story Residence, 3-Story Residence, Bi Level Residence
Transportation	Airport, Right Of Way, Railroad

Source: Dauphin County, Landrum & Brown, 2015.



Noise Exposure Map Update

HIA Harrisburg International Airport

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L&B

Generalized Existing Land Use

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D-1

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D.1.2.1 Land Use Data Compilation

Base mapping information; including roads, county and municipal boundaries, and land parcel data including existing land use; were obtained from Dauphin County GIS data and compiled using ArcMap, version 10.1. ArcMap is an analytical software program that allows manipulation and analysis of spatial data from a variety of sources. The base map information was then compared to flight tracks and noise contours generated by the Integrated Noise Model (INM), version 7.0d.

Land parcel data obtained from Dauphin County was used to identify any land uses that would be considered noise-sensitive land per FAA guidelines. The noise exposure contours were overlaid onto the parcel data using GIS software to determine if any noise-sensitive land uses were impacted by noise per FAA guidelines. A discussion of the FAA's guidelines regarding land use compatibility with aircraft noise is included in Appendix A.

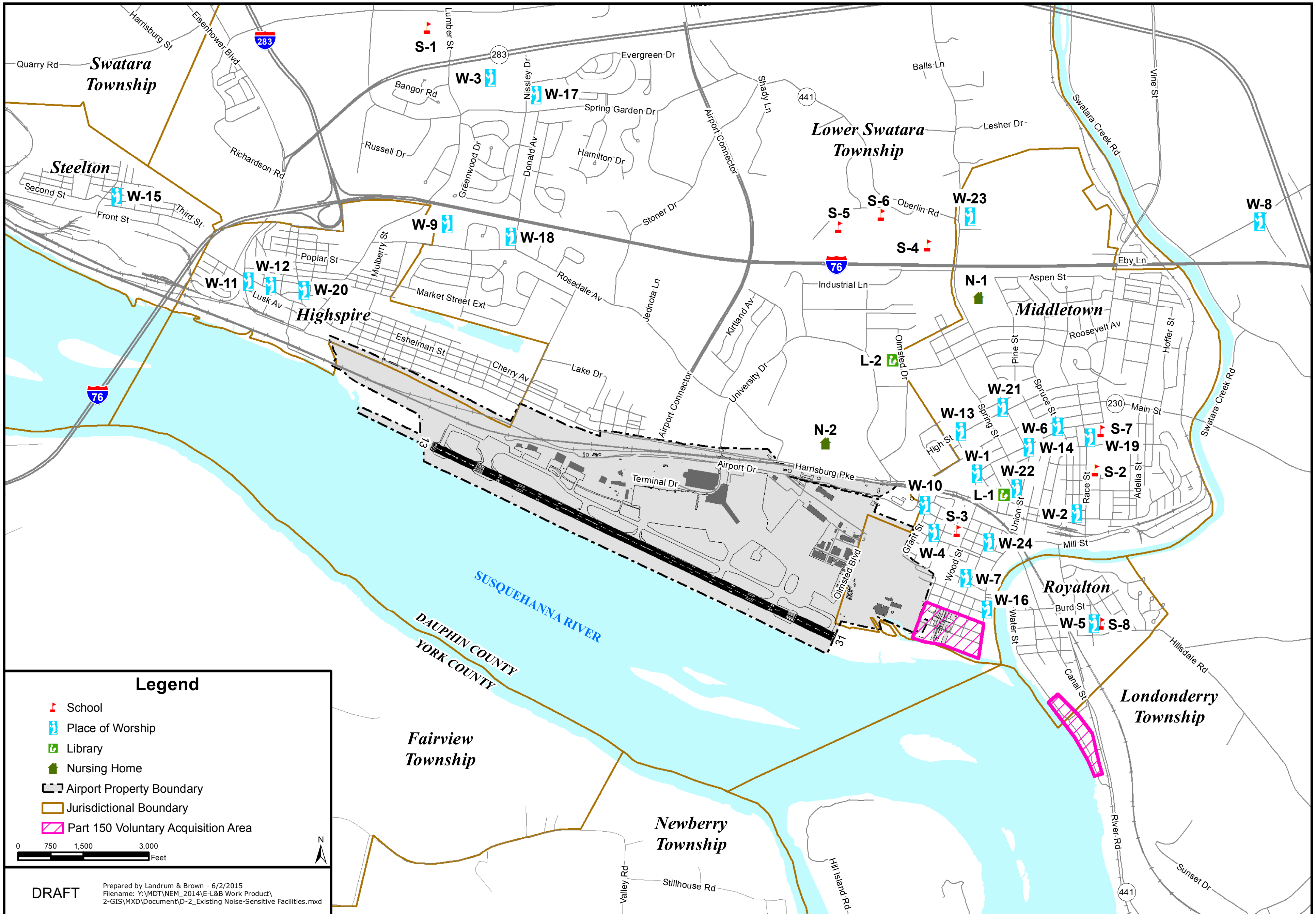
D.1.2.2 Noise-Sensitive Public Facilities

Land uses that could be considered incompatible with airport operations include more than just residential uses. FAA guidelines define certain public facilities as noise-sensitive: places of worship, schools (and daycare facilities at which licensed education occurs), nursing homes, libraries, and hospitals. Detailed information on noise-sensitive facilities was collected within the vicinity of MDT. Within this area there are 8 schools, 2 libraries, 2 nursing homes, and 24 places of worship as shown on **Exhibit D-2, *Existing Noise-Sensitive Public Facilities*** and listed in **Table D-2**.

Table D-2
NOISE-SENSITIVE PUBLIC FACILITIES
Harrisburg International Airport

MAP ID	NAME
Schools	
S-1	John Kunkel Elementary School
S-2	Lyall J. Fink Elementary School
S-3	Mansberger Elementary School
S-4	Middletown Area High School
S-5	Middletown Area Middle School
S-6	Robert Reid Elementary School
S-7	Seven Sorrows BVM School
S-8	Sonshine Academy
Libraries	
L-1	Middletown Public Library
L-2	Penn State Harrisburg
Nursing Homes	
N-1	Middletown Home
N-2	Frey Village
Places of Worship	
W-1	B'Nai Jacob Synagogue
W-2	Calvary Orthodox Presbyterian Church
W-3	Dayspring Ministries
W-4	Ebenezer A.M.E. Church
W-5	Emmanuel United Methodist Church
W-6	Evangelical United Methodist Church
W-7	First Zion Baptist
W-8	Fountain of Life Church
W-9	Garden Chapel
W-10	Grace and Mercy Church
W-11	Highspire First Church of God
W-12	Highspire United Methodist Church
W-13	Middletown First Church of God
W-14	Middletown Presbyterian Church
W-15	Mt Zion United Methodist Church
W-16	New Beginnings Church
W-17	Open Door Bible Church
W-18	Rosedale Church of the Nazarene
W-19	Seven Sorrows of the Blessed Virgin Mary Catholic Church
W-20	St. Peter’s Lutheran Church
W-21	St. Peter’s Evangelical Lutheran Church (historic church)
W-22	St. Peter’s Evangelical Lutheran Church (new church)
W-23	Valley Baptist Church
W-24	Wesley United Methodist

Source: Landrum & Brown, 2015.



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Noise Exposure Map Update

HARRISBURG INTERNATIONAL AIRPORT

Existing Noise-Sensitive Public Facilities

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D-2

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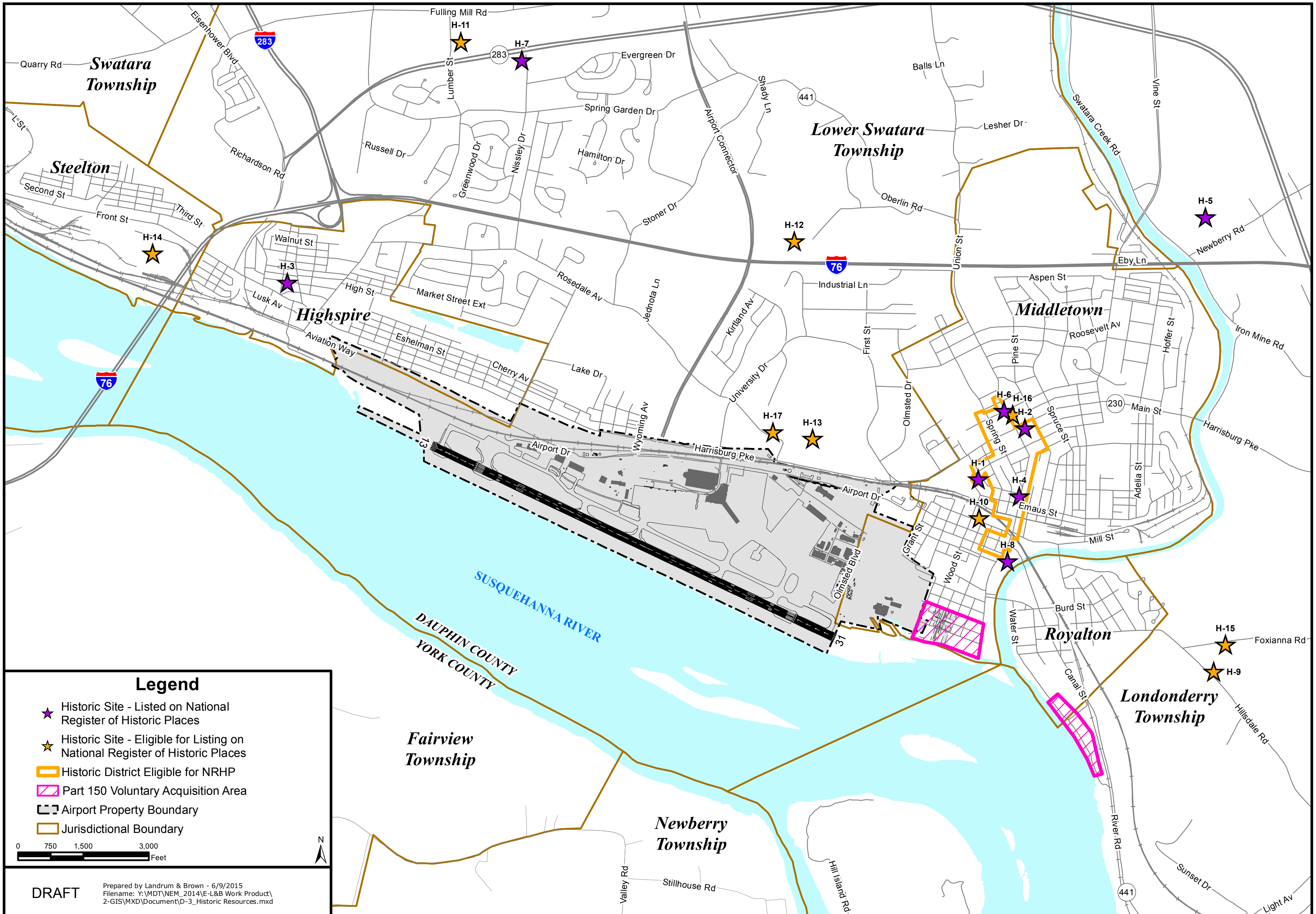
D.1.2.3 Existing Historic Properties

Per FAA guidance, historic properties in the vicinity of MDT have been identified and displayed on the NEMs. Historic properties include those properties that are listed on the National Register of Historic Places (NRHP) or properties that have been surveyed and determined eligible for listing on the NRHP. The NRHP is the official list of historic places worthy of preservation. The NRHP was created in accordance with the National Historic Preservation Act of 1966 and is maintained by the U.S. the National Park Service to coordinate and support public and private efforts to identify, evaluate, and protect historic and archeological resources. There are eight properties which are listed on the NRHP within the Airport Environs as shown on **Exhibit D-3, *Historic Resources*** and listed in **Table D-3**. There are an additional ten sites that have been determined eligible for the NRHP but have not been nominated or accepted for listing on the NRHP. These eligible sites include the Middletown Historic District, which was identified through a site survey conducted by the Pennsylvania Historical Museum Commission. The district has not been nominated for inclusion on the NRHP; although, it includes several individual structures that are listed on or eligible for the NRHP.

Table D-3
HISTORIC RESOURCES
Harrisburg International Airport

MAP ID	NAME
Listed on National Register of Historic Places	
H-1	B'Nai Jacob Synagogue
H-2	Cameron, Simon, House and Bank
H-3	Highspire High School
H-4	Raymond, Charles and Joseph, Houses
H-5	Smith, Henry, Farm
H-6	St. Peter's Kierch
H-7	Star Barn Complex
H-8	Swatara Ferry House
Eligible for National Register of Historic Places	
H-9	Gingrich, Dr. Rife Farm
H-10	Kreider Shoe Factory
H-11	Motter, John Farm
H-12	Mumma Farm
H-13	Odd Fellows Home of Pennsylvania
H-14	Pennsylvania Steele Company
H-15	Rife, Jacob & Fanny, Farmstead
H-16	Smuller, George House
H-17	Zimmerman House
n/a	Middletown Historic District

Source: U.S. National Parks Service and Pennsylvania's Cultural Resources Geographic Information System (CRGIS), 2015.



Noise Exposure Map Update

HARRISBURG INTERNATIONAL AIRPORT

Historic Resources

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D.1.3 FUTURE LAND USE AND DEVELOPMENT TRENDS

Identifying development trends and potential future land use is an important step in a noise compatibility assessment to determine the potential for new incompatible development that may occur. As discussed in Chapter Three and Chapter Four, there are currently no noise-sensitive land uses within the 65+ Day Night Average Sound Level (DNL) of the Existing or Future noise exposure contours.

Zoning is one of the primary tools available to local communities to ensure land use compatibility. Zoning ordinances and regulations are intended to promote public health, safety, and welfare by regulating the use of the land within a jurisdiction based on factors such as land use compatibility and existing and expected socioeconomic conditions. Zoning designations are legal requirements, which determine how parcels of land may be used and are often a key part of implementing future land use plans. The individual jurisdictions within the Airport Environs have the responsibility for enacting zoning codes to regulate development. **Exhibit D-4, *Current Zoning***, depicts the generalized zoning within the Airport Environs based on available data from local government agencies. Exhibit D-4 shows the general type of use primarily permitted in each zone (residential, commercial, industrial, etc.); however, specific uses and intensities permitted within each zone are determined by the local governments.

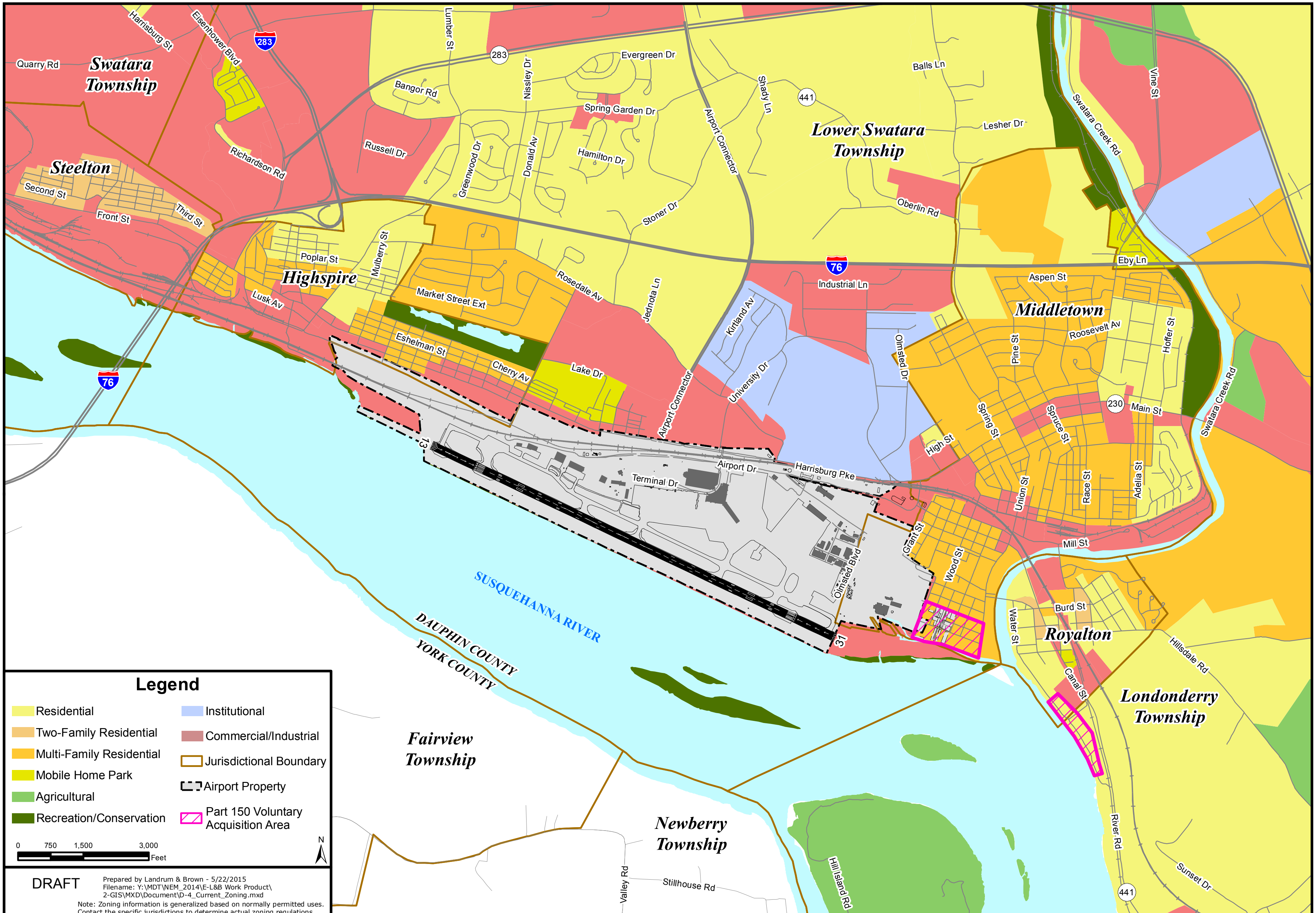
Zoning is one element of determining potential development trends, although, market conditions and population growth also play a role. **Table D-4** shows the population in 2000 and 2010 for the jurisdictions within or partially within the Airport Environs. While overall these areas have seen moderate population growth, the Borough of Middletown, which is immediately southeast of MDT has seen a decline in population.

As described in Chapter One and Chapter Two, Susquehanna Area Regional Airport Authority (SARAA) implemented a voluntary acquisition program to improve land use compatibility in the vicinity of MDT. To date, 26 residential parcels in Middletown have been acquired under that program. Following the acquisition, residents were relocated and all residential structures were removed to convert the property to vacant land that is compatible with airport operations. It is the intention of SARAA to seek redevelopment options for these properties to convert them to non-residential, tax-generating uses that are compatible with aircraft noise and operations. Until that time, these properties are expected to remain vacant, undeveloped lots. No new residential or other incompatible uses are expected to be developed in areas impacted by significant noise in the vicinity of MDT.

Table D-4
AREA POPULATION
Harrisburg International Airport

JURISDICTION	POPULATION		
	2000	2010	PERCENT CHANGE
Dauphin County	251,798	264,823	5%
City of Harrisburg	48,950	49,332	1%
Borough of Highspire	2,720	2,712	0%
Borough of Middletown	9,242	8,970	-3%
Borough of Royalton	963	1,123	17%
Borough of Steelton	5,858	5,994	2%
Londonderry Township	5,224	5,222	0%
Lower Swatara Township	8,149	8,211	1%
Swatara Township	22,611	23,157	2%
York County	381,751	428,175	12%
Fairview Township	14,321	16,339	14%
Newberry Township	14,332	15,215	6%

Source: U.S. Census Bureau, 2015.



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Note: Zoning information is generalized based on normally permitted uses. Contact the specific jurisdictions to determine actual zoning regulations.

Noise Exposure Map Update

HARRISBURG INTERNATIONAL AIRPORT

Generalized Current Zoning

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Appendix E

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APPENDIX E
SUPPLEMENTAL GRID POINT ANALYSIS

This Appendix provides maps and output grid reports detailing the results of a supplemental grid point analysis that was conducted for this Noise Exposure Map (NEM) Update. The Integrated Noise Model (INM) was used to calculate noise levels at specific grid points in the vicinity of the Harrisburg International Airport (MDT) using the following noise metrics:

- Day-Night Average Sound Level (DNL),
- Sound Exposure Level (SEL),
- Maximum Level (LMAX), and
- Time Above Level-65 (TA65) decibels (dB) reported in minutes and seconds (MM:SS) per day.

Grid point locations were created in the INM at the noise-sensitive facilities, and at regularly-spaced grid points. **Exhibit E-1, *INM Grid Point Locations***, shows the locations of the INM grid points. **Table E-1** provides a key for the INM grid point locations. **Table E-2** provides the noise levels at each of the grid points for the Existing (2015) Noise Exposure Contour and the Future (2020) Noise Exposure Contour.

The noise levels at each of the grid points are reported using the DNL, LMAX, SEL and TA65, metrics. More information about these metrics is included in Appendix C. Note that the SEL and LMAX metrics are always higher than the DNL as the DNL is the average noise for an average annual day. The LMAX represents the instantaneous noise level single highest aircraft noise event. For the SEL metric all sound energy occurring during the event, within 10 dB of the peak level (Lmax), is mathematically integrated over one second. Per FAA guidelines, there are no thresholds of significance for the LMAX and SEL.

The DNL levels at each grid point is higher for the Future (2020) Noise Exposure Contour than the Existing (2015) Noise Exposure Contour due to the forecasted increase in total operations expected to occur by 2020. At most locations the TA65 increases from the 2015 to 2020 conditions although at some grid points these values decrease from the 2015 to 2020 conditions. This decrease occurs in locations under lesser used flight corridors which are more influenced by small variations in the percentage of modeled operations on these flight tracks. The LMAX levels remain the same as they represent the single loudest event at that location cause by one aircraft. The same type of aircraft is expected to continue to operate in 2020.

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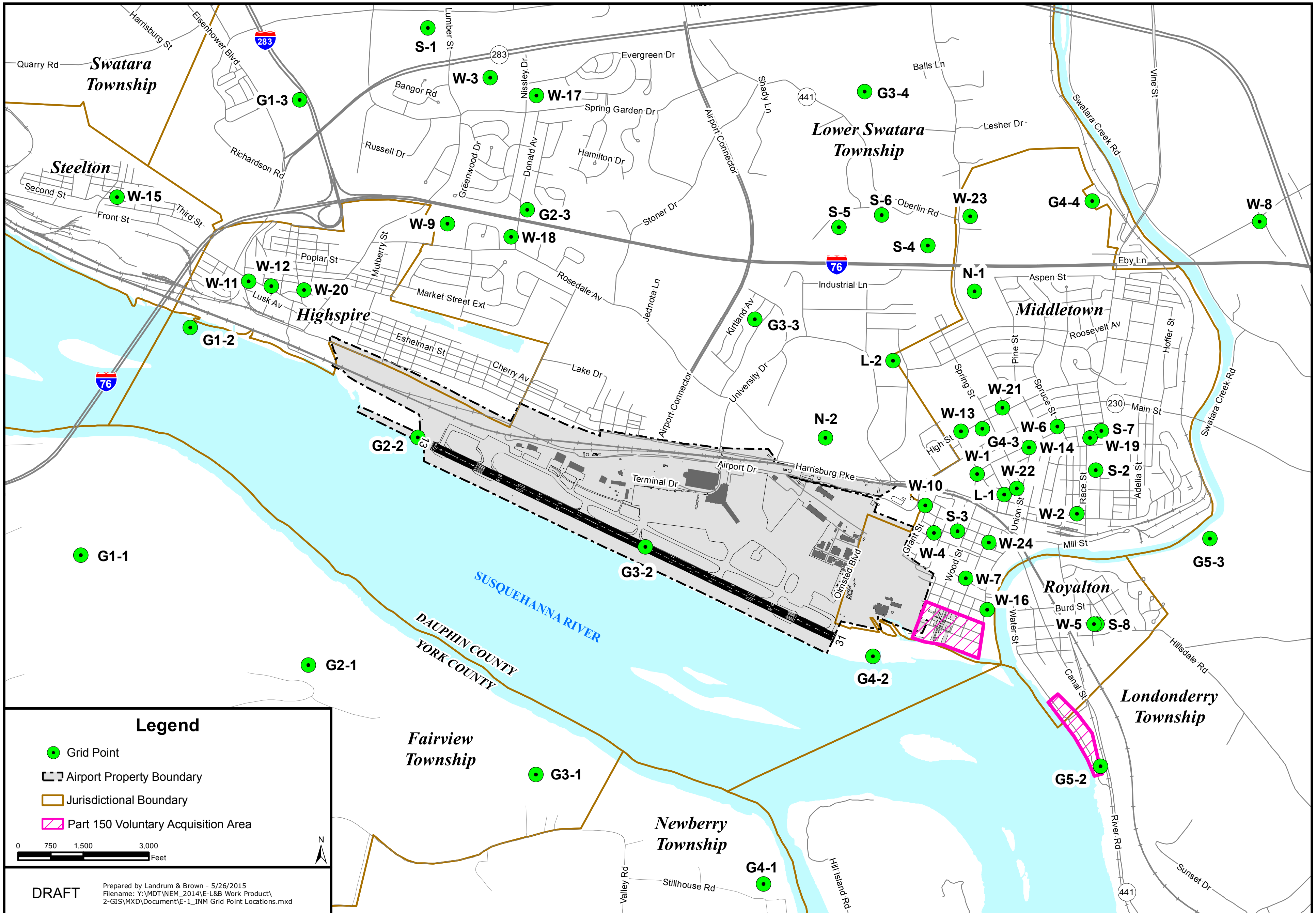

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HARRISBURG INTERNATIONAL AIRPORT

INM Grid Point Locations

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E-1

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Table E-1
INM GRID POINT LOCATIONS
Harrisburg International Airport

GRID ID	LOCATION	LATITUDE	LONGITUDE
L-1	Middletown Public Library	40.195671	-76.732354
L-2	Penn State Harrisburg	40.204246	-76.741214
S-1	John Kunkel Elementary School	40.225758	-76.778631
S-2	Lyall J. Fink Elementary School	40.197066	-76.72483
S-3	Mansberger Elementary School	40.193462	-76.736239
S-4	Middletown Area High School	40.211402	-76.738123
S-5	Middletown Area Middle School	40.212686	-76.745364
S-6	Robert Reid Elementary School	40.213379	-76.741868
S-7	Seven Sorrows BVM School	40.199526	-76.724271
S-8	Sonshine Academy	40.187439	-76.725003
W-1	B'Nai Jacob Synagogue	40.197012	-76.734513
W-2	Calvary Orthodox Presbyterian Church	40.194381	-76.726445
W-3	Dayspring Ministries	40.222539	-76.773611
W-4	Ebenezer A.M.E. Church	40.193381	-76.738168
W-5	Emmanuel United Methodist Church	40.187433	-76.725237
W-6	Evangelical United Methodist Church	40.199856	-76.72786
W-7	First Zion Bapist	40.190488	-76.735658
W-8	Fountain of Life Church	40.212435	-76.710948
W-9	Garden Chapel	40.213442	-76.777402
W-10	Grace and Mercy Church	40.19511	-76.738838
W-11	Highspire First Church of God	40.210107	-76.79376
W-12	Highspire United Methodist Church	40.209797	-76.791898
W-13	Middletown First Church of God	40.199696	-76.735754
W-14	Middletown Presbyterian Church	40.198607	-76.730221
W-15	Mt Zion United Methodist Church	40.215591	-76.804393
W-16	New Beginnings Church	40.188483	-76.73396
W-17	Open Door Bible Church	40.221369	-76.769888
W-18	Rosedale Church of the Nazarene	40.212547	-76.772198
W-19	Seven Sorrows of the Blessed Virgin Mary Catholic Church	40.199106	-76.725224
W-20	St. Peter’s Lutheran Church (historic church)	40.209482	-76.789231
W-21	St. Peter’s Lutheran Church (new church)	40.201131	-76.732316
W-22	St. Peter's Evangelical Lutheran Church	40.196037	-76.731297
W-23	Valley Baptist Church	40.213168	-76.734619
W-24	Wesley United Methodist	40.192691	-76.733693
N-1	Frey Village	40.208471	-76.734399
N-2	Middletown Home	40.19948	-76.74686

Table E-1, *(continued)*
INM GRID POINT LOCATIONS
Harrisburg International Airport

GRID ID	LOCATION	LATITUDE	LONGITUDE
G1-1	Regularly-Spaced Grid 1-1	40.1932	-76.808
G1-2	Regularly-Spaced Grid 1-2	40.2073	-76.7986
G1-3	Regularly-Spaced Grid 1-3	40.2214	-76.7892
G2-1	Regularly-Spaced Grid 2-1	40.186	-76.7896
G2-2	Regularly-Spaced Grid 2-2	40.2001	-76.7802
G2-3	Regularly-Spaced Grid 2-3	40.2142	-76.7708
G3-1	Regularly-Spaced Grid 3-1	40.1788	-76.7712
G3-2	Regularly-Spaced Grid 3-2	40.1929	-76.7618
G3-3	Regularly-Spaced Grid 3-3	40.207	-76.7524
G3-4	Regularly-Spaced Grid 3-4	40.2211	-76.743
G4-1	Regularly-Spaced Grid 4-1	40.1716	-76.7528
G4-2	Regularly-Spaced Grid 4-2	40.1857	-76.7434
G4-3	Regularly-Spaced Grid 4-3	40.1998	-76.734
G4-4	Regularly-Spaced Grid 4-4	40.2139	-76.7246
G5-2	Regularly-Spaced Grid 5-2	40.1785	-76.725
G5-3	Regularly-Spaced Grid 5-3	40.1926	-76.7156

Table E-2
SUPPLEMENTAL GRID POINT ANALYSIS
Harrisburg International Airport

GRID ID	DNL			LMAX			SEL			TA65		
	2015	**2020**	**Change**	**2015**	**2020**	**Change**	**2015**	**2020**	**Change**	**2015**	**2020**	**Change**
L1	46.7	47.1	0.4	91.1	91.1	0.0	92.5	93.3	0.8	0:54	1:06	0:12
L2	44.4	44.8	0.4	77.2	77.2	0.0	89.6	90.5	0.9	0:18	0:18	0:00
S1	44.7	44.9	0.2	83.1	83.1	0.0	92.8	93.0	0.2	1:42	1:36	-0:06
S2	45.7	46.0	0.3	108.2	108.2	0.0	93.7	94.0	0.3	0:24	0:36	0:12
S3	50.2	50.6	0.4	88.8	88.8	0.0	95.6	96.5	0.9	2:36	3:18	0:42
S4	42.6	42.8	0.2	82.7	82.7	0.0	90.3	90.5	0.2	0:48	0:48	0:00
S5	42.9	43.1	0.2	77.9	77.9	0.0	90.2	90.5	0.3	0:24	0:24	0:00
S6	42.7	42.9	0.2	78.7	78.7	0.0	90.5	90.7	0.2	0:48	0:48	0:00
S7	45.5	45.7	0.2	108.9	108.9	0.0	93.8	94.1	0.3	0:30	0:36	0:06
S8	48.9	49.5	0.6	103.7	103.7	0.0	95.8	96.6	0.8	2:18	2:54	0:36
W1	46.8	47.2	0.4	86.3	86.3	0.0	92.5	93.3	0.8	0:48	1:00	0:12
W2	46.2	46.6	0.4	106.5	106.5	0.0	93.6	94.1	0.5	0:48	1:00	0:12
W3	45.3	45.5	0.2	84.0	84.0	0.0	93.4	93.6	0.2	1:42	1:48	0:06
W4	51.4	51.9	0.5	87.6	87.6	0.0	96.8	97.6	0.8	3:30	4:42	1:12
W5	49.1	49.6	0.5	104.2	104.2	0.0	95.9	96.8	0.9	2:24	2:54	0:30
W6	43.9	44.2	0.3	99.4	99.4	0.0	91.0	91.4	0.4	0:24	0:24	0:00
W7	52.0	52.4	0.4	97.3	97.3	0.0	97.8	98.7	0.9	4:00	5:18	1:18
W8	43.2	43.3	0.1	84.6	84.6	0.0	92.2	92.3	0.1	1:12	1:18	0:06
W9	50.4	50.7	0.3	83.8	83.8	0.0	97.6	98.0	0.4	3:36	4:06	0:30
W10	50.4	50.8	0.4	84.8	84.8	0.0	95.5	96.4	0.9	2:36	3:30	0:54
W11	59.6	60.0	0.4	115.4	115.4	0.0	107.3	107.6	0.3	11:42	15:30	3:48
W12	59.3	59.6	0.3	111.4	111.4	0.0	107.0	107.3	0.3	11:30	15:06	3:36
W13	45.6	46.0	0.4	84.5	84.5	0.0	91.0	91.8	0.8	0:24	0:30	0:06
W14	44.6	45.0	0.4	94.1	94.1	0.0	91.0	91.6	0.6	0:24	0:24	0:00
W15	56.6	56.9	0.3	106.3	106.3	0.0	104.0	104.3	0.3	7:30	10:48	3:18
W16	52.9	53.3	0.4	107.4	107.4	0.0	99.6	100.2	0.6	5:12	6:30	1:18
W17	45.5	45.7	0.2	81.9	81.9	0.0	93.6	93.8	0.2	1:30	1:36	0:06
W18	49.7	50.0	0.3	82.0	82.0	0.0	96.4	96.9	0.5	3:24	3:48	0:24

Table E-2, *(continued)*
SUPPLEMENTAL GRID POINT ANALYSIS
Harrisburg International Airport

GRID ID	DNL			LMAX			SEL			TA65		
	2015	2020	CHANGE	2015	2020	CHANGE	2015	2020	CHANGE	2015	2020	CHANGE
W19	44.9	45.2	0.3	106.5	106.5	0.0	92.9	93.2	0.3	0:24	0:30	0:06
W20	58.1	58.5	0.4	108.3	108.3	0.0	105.5	105.9	0.4	11:18	14:36	3:18
W21	43.9	44.2	0.3	90.2	90.2	0.0	90.1	90.7	0.6	0:18	0:18	0:00
W22	46.1	46.5	0.4	92.8	92.8	0.0	92.1	92.8	0.7	0:48	0:54	0:06
W23	42.5	42.6	0.1	87.9	87.9	0.0	90.6	90.8	0.2	1:12	1:12	0:00
W24	49.1	49.6	0.5	94.0	94.0	0.0	94.9	95.7	0.8	2:06	2:36	0:30
N1	42.5	42.7	0.2	87.7	87.7	0.0	89.9	90.2	0.3	0:24	0:24	0:00
N2	49.5	49.9	0.4	80.0	80.0	0.0	93.9	95.0	1.1	1:36	2:00	0:24
G1-1	44.6	45.0	0.4	79.3	79.3	0.0	88.6	89.9	1.3	0:18	0:24	0:06
G1-2	64.1	64.4	0.3	114.8	114.8	0.0	111.4	111.8	0.4	14:30	19:12	4:42
G1-3	49.1	49.6	0.5	97.6	97.6	0.0	97.2	97.5	0.3	2:48	2:54	0:06
G2-1	46.1	46.6	0.5	75.9	75.9	0.0	89.8	91.2	1.4	0:30	0:42	0:12
G2-2	71.5	71.8	0.3	125.8	125.8	0.0	119.5	119.8	0.3	20:30	26:42	6:12
G2-3	48.5	48.8	0.3	81.6	81.6	0.0	95.6	96.0	0.4	2:36	2:48	0:12
G3-3	45.7	46.1	0.4	71.1	71.1	0.0	91.0	91.8	0.8	0:30	0:30	0:00
G3-4	43.4	43.5	0.1	77.0	77.0	0.0	92.1	92.2	0.1	1:18	1:18	0:00
G4-1	47.1	47.5	0.4	98.3	98.3	0.0	92.3	93.1	0.8	0:48	0:54	0:06
G4-2	71.0	71.4	0.4	123.2	123.2	0.0	118.5	118.9	0.4	19:18	23:36	4:18
G4-3	45.0	45.3	0.3	87.1	87.1	0.0	90.8	91.5	0.7	0:24	0:24	0:00
G4-4	45.1	45.3	0.2	106.3	106.3	0.0	94.2	94.3	0.1	1:24	1:36	0:12
G5-2	64.0	64.5	0.5	113.7	113.7	0.0	111.4	111.8	0.4	14:12	18:06	3:54
G5-3	42.9	43.6	0.7	91.8	91.8	0.0	89.9	91.0	1.1	0:48	1:06	0:18

Source: Landrum & Brown, 2015.

Appendix F

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APPENDIX F
FORECAST OF AVIATION ACTIVITY

This appendix presents information regarding the forecast of aviation activity that was used to develop the Future (2020) noise exposure contour.

F.1 TERMINAL AREA FORECAST

Total aircraft operations modeled for the Future (2020) noise exposure contour is based on the Federal Aviation Administration's (FAA's) 2014 Terminal Area Forecast (TAF), which was published in January 2015. This is the most recently approved FAA forecast of aviation activity at Harrisburg International Airport (MDT). The TAF shows the forecast of aircraft operations by user group (air carrier, air taxi, general aviation, and military). The 2014 FAA TAF is reproduced in **Table F-1**.

Additional information related to aircraft type forecast for 2020 was obtained from the MDT Master Plan Aviation Demand Forecast which provides a forecast of aircraft by Aircraft Approach Category (AAC) designation. Although this forecast precedes the 2014 TAF, it provides additional fleet mix information not provided by the TAF. The Master Plan Forecast included fleet mix information by percent of total fleet for the years 2018 and 2023. For this Noise Exposure Map Update (NEM) Update, data was interpolated between these two planning years to derive fleet mix percentages for 2020. This fleet mix forecast is included in **Table F-2** and **Table F-3**.

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Table F-1
FEDERAL AVIATION ADMINISTRATION TERMINAL AREA FORECAST
Harrisburg International Airport

FISCAL YEAR	ENPLANEMENTS			AIRCRAFT OPERATIONS								
				ITINERANT OPERATIONS					LOCAL OPERATIONS			TOTAL OPERATIONS
	AIR CARRIER	COMMUTER	TOTAL	AIR CARRIER	AIR TAXI & COMMUTER	GENERAL AVIATION	MILITARY	TOTAL	CIVIL	MILITARY	TOTAL	
2014	198,695	456,024	654,719	10,782	21,723	8,616	4,884	46,005	2,413	3,582	5,995	52,000
2015	335,173	350,735	685,908	16,470	15,253	8,462	4,884	45,069	2,658	3,582	6,240	51,309
2016	342,993	351,802	694,795	17,810	15,081	8,521	4,884	46,296	2,667	3,582	6,249	52,545
2017	350,985	358,035	709,020	19,409	14,797	8,580	4,884	47,670	2,676	3,582	6,258	53,928
2018	358,363	361,742	720,105	21,639	14,236	8,639	4,884	49,398	2,685	3,582	6,267	55,665
2019	365,849	365,397	731,246	24,223	13,594	8,699	4,884	51,400	2,694	3,582	6,276	57,676
2020	372,907	371,603	744,510	26,917	12,896	8,759	4,884	53,456	2,703	3,582	6,285	59,741

Notes: FAA defines air carrier operations as aircraft with seating capacity of more than 60 seats or a maximum payload capacity of more than 18,000 pounds carrying passengers or cargo for hire or compensation. Conversely, air taxi operations include 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. General aviation (GA) includes takeoffs and landings of all civil aircraft, except those classified as air carriers or air taxis. GA and military operations can be either local operations, meaning they operate in the local traffic pattern or takeoff and land at airports within a 20-mile radius of each other, or itinerant (non-local) operations.

Source: Federal Aviation Administration, APO Terminal Area Forecast Detail Report, Issued January 2015

Table F-2
MASTER PLAN FLEET MIX FORECAST BY AIRCRAFT APPROACH CATEGORY
Harrisburg International Airport

AIRCRAFT APPROACH CATEGORY	DESCRIPTION	2013	2018	2020 (interpolated)	2023
A/B	Small Single or Multi Engine Aircraft	26.4%	23.4%	22.2%	20.5%
C	Large Aircraft	69.4%	71.9%	72.9%	74.5%
D	Heavy Aircraft or Boeing 757	4.2%	4.7%	4.8%	5.0%
Total		**100.0%**	**100.0%**	**100.0%**	**100.0%**

Source: Harrisburg International Airport (MDT) Master Plan Aviation Demand Forecast, Interim Report #2, dated March 2014; and Landrum & Brown analysis

Table F-3
MASTER PLAN FLEET MIX FORECAST BY AIRCRAFT TYPE
Harrisburg International Airport

		Historical		Forecast		
	Seats	2013	2018	2023	2028	2033
PASSENGER AIRLINES						
Narrowbody						
A319	124	3.0%	3.0%	3.0%	3.1%	3.2%
A320 / A320neo	145	0.2	0.2	0.2	0.2	0.2
B737-800 / B737 MAX	157	0.4	0.4	0.4	0.4	0.4
MD-80	149	0.1	0.1	0.1	0.1	0.1
MD-83	166	0.7	0.7	0.8	0.8	0.8
MD-88	166	0.6	0.6	0.6	0.6	0.6
Subtotal-narrowbody		5.0%	5.0%	5.1%	5.3%	5.4%
Regional jets						
More than 60 seats						
CRJ-700	70	0.6%	3.8%	8.1%	12.4%	17.0%
CRJ-900	76	3.7	5.5	5.6	5.6	5.4
CS300	130	0	0.1	0.3	0.5	0.6
ERJ-175	78	0	0	0	0	0
ERJ-190	99	0	0.1	0.1	0.1	0.2
Subtotal		4.4%	9.5%	14.1%	18.6%	23.2%
60 seats or less						
CRJ-100/200	50	12.5%	10.6%	8.6%	6.7%	4.8%
ERJ-145	50	13.8	11.1	9	6.9	4.8
Subtotal		26.3%	21.7%	17.6%	13.6%	9.6%
Subtotal-regional jets		30.7%	31.2%	31.8%	32.3%	32.9%
Turboprop						
Beech 1900	18	2.1%	2.0%	1.9%	1.8%	1.7%
Q400	74	0	1	1.9	2.8	3.6
DH8-100/DH8-200	37	13.3	10.2	7.2	4.4	1.7
DH8-300	50	1.5	2.9	4.3	5.5	6.7
Subtotal-- turboprop		16.9%	16.1%	15.3%	14.4%	13.7%
Subtotal-passenger airlines		52.6%	52.4%	52.2%	52.0%	52.0%

Table F-3, Continued
MASTER PLAN FLEET MIX FORECAST
Harrisburg International Airport

	Historical	Forecast			
	2013	2018	2023	2028	2033
CARGO AIRLINES					
Air carrier					
A300	3.3%	3.7%	4.0%	4.1%	4.5%
A310	0.80	1.00	1.00	1.10	1.10
	4.2%	4.7%	5.0%	5.2%	5.6%
Air taxi (regional feeders)					
C208 Caravan	3.6%	4.1%	4.4%	4.5%	4.6%
Short 330 (SD3-60)	1.0	0.7	0.6	0.8	0.6
	4.6%	4.9%	5.0%	5.3%	5.2%
Subtotal-cargo airlines	8.8%	9.6%	10.0%	10.5%	10.8%
GENERAL AVIATION					
Business Jet multi-engine heavy	5.7%	5.7%	5.8%	5.8%	5.9%
Business Jet multi-engine light plus	6.3	6.3	6.3	6.3	6.3
Multi-engine piston	1.4	1.4	1.4	1.4	1.4
Multi-engine turboprop	2.2	2.2	2.2	2.2	2.2
Single engine	2.9	2.8	2.8	2.8	2.7
Helicopter	0.1	0.1	0.1	0.1	0.1
	18.6%	18.5%	18.6%	18.6%	18.6%
MILITARY					
Military fighter jet	0.2%	0.2%	0.2%	0.2%	0.2%
Military refueling aircraft	0.3	0.3	0.3	0.3	0.3
Military trainer	0.1	0.1	0.1	0.1	0.1
Military transport aircraft	8.0	8.0	7.9	7.8	7.7
Military transport aircraft	6.8	6.5	6.3	6.2	6.1
Military transport aircraft	0.2	0.2	0.2	0.2	0.2
	15.5%	15.2%	14.9%	14.7%	14.5%
Other (unclassified operations)					
Air carrier	1.1%	1.1%	1.1%	1.1%	1.0%
Air taxi/commuter	3.4	3.3	3.3	3.2	3.1
	4.5%	4.4%	4.3%	4.2%	4.2%
Total Airport	100.0%	100.0%	100.0%	100.0%	100.0%

Note: Totals may not add due to rounding.

Source: Harrisburg International Airport (MDT) Master Plan Aviation Demand Forecast, Interim Report #2, dated March 2014.