DRAFT

Burlington International Airport
14 CFR Part 150 Update
2018 and 2023 Noise Exposure Maps

HMMH Report No. 308770.008
May 2019

Prepared for:

City of Burlington, Vermont
1200 Airport Drive, #1
Burlington, VT 05403

Prepared by:

HMMH
&
The Jones Payne Group

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City of Burlington, Vermont
1200 Airport Drive, #1
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Certification

The City of Burlington has completed a comprehensive update of the Title 14 Code of Federal Regulations (CFR) Part 150 Noise Exposure Map for the Burlington International Airport.

(1) The revised Noise Exposure Maps and associated documentation for the Burlington International Airport submitted in this volume to the Federal Aviation Administration under Federal Aviation Regulations Part 150, Subpart B, Section 150.21, are true and complete.

(2) Pursuant to Part 150, Subpart B, Section 150.21(b), all interested parties have been afforded adequate opportunity to submit their views, data, and comments concerning the correctness and adequacy of the draft noise exposure map, and of the descriptions of forecast aircraft operations.

(3) The "Existing Conditions (2018) Noise Exposure Map" (Figure 12 on page 37) accurately represents conditions for calendar year 2018.

(4) The "Five-Year Forecast Conditions (2023) Noise Exposure Map" (Figure 13 on page 39) accurately represents forecast conditions for calendar year 2023.

By: Eugene E. Richards III

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Title: Director of Aviation

____

Date: ____

Airport Name:	Burlington International Airport
Airport Owner/Operator:	The City of Burlington, Vermont
Address:	1200 Airport Drive, #1, Burlington, VT 05403

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Contents

Figures

Tables

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1 Introduction

Part 150 of the Federal Aviation Regulations "Airport Noise Compatibility Planning"[1] sets forth standards for airport operators to use in documenting noise exposure in airport environs and establishing programs to minimize noise-related land use incompatibilities. A formal submission to the Federal Aviation Administration (FAA) under Part 150 includes documentation for two principal elements: (1) Noise Exposure Maps (NEMs) and (2) a Noise Compatibility Program (NCP).

Part 150 "Airport Noise Compatibility Planning" is a voluntary program provided to airports and communities by the Federal Aviation Administration (FAA) to assess and mitigate aircraft noise around airports. One of the principal reasons for preparation of this update is the City's interest in continuing implementation of federally supported noise mitigation at BTV. The City would like to update the NEM to reflect calendar year 2018 operations, calendar year 2023 forecast operations, and current land uses. In addition, the FAA requested that the City update the NEM to continue federally supported noise mitigation.

The City of Burlington, Vermont (the City) completed the most recent Part 150 studies for the Burlington International Airport (BTV) in 2015 and 2008. The studies culminated in submission of two volumes of documentation to the Federal Aviation Administration (FAA): (1) NEM documentation,[2] and (2) a proposed Noise Compatibility Program (NCP).[3] The FAA found the NEM in compliance with Part 150 requirements on December 22, 2015 with NEM contours for 2015 and 2020 conditions. The 2015 and 2020 NEM represent the most recent aircraft noise contours used for FAA funded noise mitigation efforts at BTV. FAA provided a Record of Approval (ROA) for the NCP on June 23, 2008.[4] The ROA included approval of extending the land acquisition and relocation program to include residences between the 65 dB and 70 dB Day Night Average Sound Level (DNL) contours. Appendix A presents a copy of the 2008 ROA. BTV is currently in the process of updating the NCP with changes to transition away from acquisition to sound insulation.

The Airport is home to the Vermont Air National Guard (VTANG) 158th Fighter Wing, which operated the F-16C aircraft for over 30 years. The United States Air Force (USAF) prepared the F-35A Operational Basing Final Environmental Impact Statement (EIS) and later issued a Record of Decision (ROD).[5] According to a USAF April 2016 press release, VTANG is anticipated to start flying the F-35A in fall 2019.[6] To account for the change in the anticipated VTANG operations, the City is updating the NEM to reflect existing aircraft operations, including updated aviation forecast with VTANG F-35A aircraft, and current land uses.

1.1 Purpose and Request for FAA Determination

With this submission, the City of Burlington, Vermont requests that the FAA review the included figures and associated documentation to determine compliance with Part 150 requirements. This document presents the updated NEM for BTV, as required by the specific provisions of 14 CFR Part 150 Subpart B, Section 150.21, and the respective Appendix A. This document includes noise contours (the 2018 NEM as Figure 12 and the 2023 NEM as Figure 13), land use, and related documentation for 2018 conditions and 2023 forecast conditions.

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[1] Title 14 of the Code of Federal Regulations (CFR) Part 150.
[2] City of Burlington, Burlington International Airport 14 CFR Part 150 Update 2015 and 2020 Noise Exposure Maps, December 2015.
[3] City of Burlington, Burlington International Airport 14 CFR Part 150 Update Noise Compatibility Program, April 2008.
[4] http://www.faa.gov/airports/environmental/airport_noise/part_150/states/?state=Vermont
[5] The Environmental Impact Statement was released September 2013. The Air Force issued a Record of Decision (ROD) December 2, 2013.
[6] The USAF made a Public Affairs Release on April 4, 2016 that included a statement that F-35A are planned to arrive at Burlington Air Guard Station, Burlington, Vermont, in fall 2019.
http://www.jsf.mil/news/docs/20160404_Selected.pdf

The City intends to use this NEM determination to continue federally supported noise mitigation in accordance with the FAA-approved NCP.

1.2 Recommendations

Based on the results of this NEM update and pending FAA's favorable determination, the BTV staff and its consultants make the following recommendations:

- The City should use the extents of the 2023 NEM contours for land use planning, as the 2018 NEM contours represent a short lived interim state of greatly reduced operations for the VTANG. The extents of the DNL contours for the 2018 NEM are reduced relative to prior NEMs and the 2023 NEM because of the following factors in CY 2018:
  - The VTANG was in the process of drawing down numbers of F-16C aircraft and operations in preparation for the arrival of the F-35A aircraft in 2019.
  - Periods of construction on Runway 15/33 resulted in reduced usage of afterburner departures by the VTANG F-16C aircraft.
- The City should continue with the implementation of the voluntary land acquisition measure for properties with noncompatible use, as approved by the FAA.[7] The voluntary land acquisition measure will be implemented for properties within the 75 dB DNL contour as[8]
  - funding becomes available from the FAA,
  - agreed upon by individual residential property owners, and
  - agreed upon by the applicable land use jurisdiction, in particular the City of South Burlington.
- For properties not included within the voluntary land acquisition area (as described above) and considered a noncompatible land use within the 65 dB DNL contour according to this updated NEM, the City should consider implementing a residential sound insulation program as stated in the BTV 2008 NCP ROA Measure 11, and allowed by Federal funding guidelines.[9]
- The City should update the NEMs if a change in the operation of the airport would establish a substantial new noncompatible use, or would significantly reduce noise over existing noncompatible uses, relative to the 2023 NEM. The City's decision to pursue an NEM update should be considered in the context of applicable state or federal laws, regulations (particularly 14 CFR Part 150) and associated funding guidelines. [10]

1.3 Organization of this Document

The balance of the document presents information required by Title 14 CFR Part 150, and supplementary information that the City believes will assist in providing a full understanding of the current and forecasted noise exposure at BTV. The organization of this document is presented below. Note that Chapter 7 and Appendix C pertain to the ongoing public consultation process for this draft document. As such, these sections are currently omitted from the document, but will be included in the Final NEM. Chapter 2 provides an overview of Part 150, including a copy of the FAA checklist utilized for review of NEM submissions.

- Chapter 3 provides an introduction to noise evaluation, terminology, and effects. This chapter also presents the Part 150 noise / land use compatibility guidelines that the City used in determining compatibility at BTV.

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[7] The reuse plan for properties that have been, or maybe purchased, by the Airport via this NCP measure will be documented separately. FAA has certain requirements for such reuse plans, though reuse planning is beyond the scope of this NEM update. However, the City of Burlington has entered into a contract with a firm to assist with a reuse plan.

[8] This is a brief summary of the 2008 NCP document and the respective FAA ROA. See also Section 4.3.1 of this document.

[9] See also Section 4.3.2 of this document.

[10] Federal Guidelines change from time to time. Currently these guidelines are primarily documented in FAA's Order 5100.38D "Airport Improvement Program (AIP) Handbook."

- Chapter 4 summarizes the elements and status of the existing FAA-approved NCP.
- Chapter 5 presents the official NEM graphics for 2018 and 2023, as well as comparisons of the contours for those years. Additional comparisons of the 2018 and 2023 NEM contours to prior noise study contours from the 2015 NEM as well as the F-35A EIS are also presented. Section 5.3 identifies potentially noncompatible land uses in the noise contours and includes estimates of the residential population contained within the noise contours.
- Chapter 6 describes the development of the noise contours, including detailed information that Part 150 requires on noise modeling methodology, data sources, data reduction, and final modeling assumptions and inputs.
- Chapter 7 summarizes the public consultation process that BTV undertook in developing this NEM update. It also summarizes the changes to the Final NEM document relative to the May 2019 Draft NEM document.
- Appendix A presents the documentation of non-standard noise modeling requests submitted for FAA approval.
- Appendix B presents the documentation of airport layout and operations assumptions for noise modeling of the existing and forecast conditions submitted for FAA approval.
- Appendix C presents material related to public notice and participation for the NEM update.

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2 Part 150 Overview

Part 150 defines a process for airport proprietors to follow in developing and obtaining FAA approval for programs to reduce or eliminate incompatibilities between aircraft noise and surrounding land uses. Part 150 prescribes specific standards and systems for:

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

2.1 Noise Exposure Maps

NEM documentation describes the airport layout and operation, aircraft-related noise exposure, land uses in the airport environs, and the resulting noise/land use compatibility. The NEM documentation must address two time frames: (1) data representing the existing condition and (2) a forecast condition that is at least five years in the future. Part 150 requires more than simple “maps” to provide the necessary information in an NEM, graphic information is too extensive to present in a single figure. Requirements also include extensive tabulated information and text discussion. Therefore, the NEM documentation includes graphic depiction of existing and future noise exposure resulting from aircraft operations and of land uses in the airport environs. It also describes the data collection and analysis undertaken in its development.

This update contains an existing condition map for calendar year 2018, and a five-year forecast condition map for calendar year 2023. Chapter 5 presents the updated existing and forecast condition NEM figures.

2.2 Noise Compatibility Program

The NCP is essentially a list of the actions that an airport proprietor proposes to undertake to minimize existing and future noise/land use incompatibilities. The NCP documentation must describe the development of the program, including a description of all measures considered, the reasons that individual measures were accepted or rejected, how measures will be implemented and funded, and the predicted effectiveness of individual measures and the overall program.

Official FAA acceptance of the Part 150 submission and approval of the NCP does not eliminate requirements for formal environmental assessment of any proposed actions pursuant to requirements of the National Environmental Policy Act (NEPA). However, acceptance of the submission is a prerequisite to the application for funding of implementation actions.

Chapter 4 presents information on the current 2008 NCP. An update to the Airport’s 2008 NCP is currently in process and is scheduled to be completed during the first half of 2020.

2.3 FAA Noise Exposure Checklist

The FAA produced Advisory Circular 150/5020-1, "Airport Noise and Land Use Compatibility Planning", that includes a checklist to aid in both the development and review of NEM and NCPs. The FAA prefers that the NEM documentation include a copy of the NEM checklist with appropriate page numbers or other references and other notes and comments (as presented in Table 1).

Table 1. Part 150 Noise Exposure Maps Checklist

Source: FAA/APP, Washington, DC, March 1989; revised June 2005; reviewed for currency 12/2007[11]

PART 150 NOISE EXPOSURE MAP CHECKLIST-PART I			
Airport Name: Burlington International Airport (BTV)	**REVIEWER:**		
	Yes	**No**	**Supporting Pages/Review Comments**
I. Submitting and Identifying the NEM:			
A. Submission properly identified:			
1. 14 C.F.R. Part 150 NEM?	Yes		
2. NEM and NCP together?		No	Only NEM Update
3. Revision to NEM FAA previously determined to be in compliance with Part 150?	Yes		Chapter 1
B. Airport and Airport Operator's name are identified?	Yes		Certification
C. NCP is transmitted by operator's dated cover letter, describing it as a Part 150 submittal and requesting appropriate FAA determination?			N/A; This is a draft document.
II. Consultation: [150.21(b), A150.105(a)]			N/A; This is a draft document.
A. Is there a narrative description of the consultation accomplished, including opportunities for public review and comment during map development?			
B. Identification of consulted parties:			
1. Are the consulted parties identified?			
2. Do they include all those required by 150.21(b) and A150.105 (a)?			
3. Agencies in 2. above, correspond to those indicated on the NEM?			
C. Does the documentation include the airport operator's certification, and evidence to support it, that interested persons have been afforded adequate opportunity to submit their views, data, and comments during map development and in accordance with 150.21(b)?			
D. Does the document indicate whether written comments were received during consultation and, if there were comments that they are on file with the FAA regional airports division manager?			
III. General Requirements: [150.21]			
A. Are there two maps, each clearly labeled on the face with year (existing condition year and one that is at least 5 years into the future)?	Yes		Figure 12 and Figure 13

[11] http://www.faa.gov/airports/environmental/airport_noise/part_150/checklists/

PART 150 NOISE EXPOSURE MAP CHECKLIST-PART I			
Airport Name: Burlington International Airport (BTV)	REVIEWER: Yes	No	Supporting Pages/Review Comments
B. Map currency:			N/A; This is a draft document.
1. Does the year on the face of the existing condition map graphic match the year on the airport operator's NEM submittal letter?			
2. Is the forecast year map based on reasonable forecasts and other planning assumptions and is it for at least the fifth calendar year after the year of submission?			
3. If the answer to 1 and 2 above is no, the airport operator must verify in writing that data in the documentation are representative of existing condition and at least 5 years' forecast conditions as of the date of submission?			
C. If the NEM and NCP are submitted together:			
1. Has the airport operator indicated whether the forecast year map is based on either forecast conditions without the program or forecast conditions if the program is implemented?		N/A	This is only an NEM document. Maps reflect implementation of the previously approved NCP as discussed in Chapter 4.
2. If the forecast year map is based on program implementation:		N/A	
a. Are the specific program measures that are reflected on the map identified?		N/A	
b. Does the documentation specifically describe how these measures affect land use compatibilities depicted on the map?		N/A	
3. If the forecast year NEM does not model program implementation, the airport operator must either submit a revised forecast NEM showing program implementation conditions [B150.3 (b), 150.35 (f)] or the sponsor must demonstrate the adopted forecast year NEM with approved NCP measures would not change by plus/minus 1.5 DNL [or Community Noise Equivalent Level, CNEL]? [150.21(d)]		N/A	
IV. MAP SCALE, GRAPHICS, AND DATA REQUIREMENTS: [A150.101, A150.103, A150.105, 150.21(a)]			
A. Are the maps of sufficient scale to be clear and readable (they must not be less than 1" to 2,000'), and is the scale indicated on the maps? (Note (1) if the submittal uses separate graphics to depict flight tracks and/or noise monitoring sites, these must be of the same scale, because they are part of the documentation required for NEM.) (Note (2) supplemental graphics that are not required by the regulation do not need to be at the 1" to 2,000' scale)	Yes		Figure 12, Figure 13, Figure 18, Figure 19, Figure 20, Figure 21, Figure 22, Figure 23, Figure 24, and Figure 25 are provided at 1" to 2,000' (printing instructions provided are provided for readers of the electronic version of this document)
B. Is the quality of the graphics such that required information is clear and readable? (Refer to C. through G., below, for specific graphic depictions that must be clear and readable)	Yes		All official figures

PART 150 NOISE EXPOSURE MAP CHECKLIST-PART I			
Airport Name: Burlington International Airport (BTV)	**REVIEWER:**		
	Yes	**No**	**Supporting Pages/Review Comments**
C. Depiction of the airport and its environs.			
1. Is the following graphically depicted to scale on both the existing condition and forecast year maps:			
a. Airport boundaries	Yes		All official figures
b. Runway configurations with runway end numbers	Yes		
2. Does the depiction of the off-airport data include?			All official figures
a. A land use base map depicting streets and other identifiable geographic features	Yes		
b. The area within the DNL 65 dB (or beyond, at local discretion) [or Community Noise Equivalent Level, CNEL]	Yes		
c. Clear delineation of geographic boundaries and the names of all jurisdictions with planning and land use control authority within the DNL 65 dB (or beyond, at local discretion) [or Community Noise Equivalent Level, CNEL]	Yes		
D. 1. Continuous contours for at least DNL 65, 70, and 75 dB? [or Community Noise Equivalent Level, CNEL]	Yes		All contour figures
2. Has the local land use jurisdiction(s) adopted a lower local standard and, if so, has the sponsor depicted this on the NEM?		No	BTV uses 14 CFR Part 150 land use compatibility guidelines for the development of the NEM. Section 3.4
3. Based on current airport and operational data for the existing condition year NEM, and forecast data representative of the selected year for the forecast NEM?	Yes		
E. Flight tracks for the existing condition and forecast year timeframes (these may be on supplemental graphics which must use the same land use base map and scale as the existing condition and forecast year NEM), which are numbered to correspond to accompanying narrative?	Yes		
F. Locations of any noise monitoring sites (these may be on supplemental graphics which must use the same land use base map and scale as the official NEM)		N/A	No noise monitoring sites
G. Noncompatible land use identification:			
1. Are noncompatible land uses within at least the DNL 65 dB [or Community Noise Equivalent Level, CNEL] noise contour depicted on the map graphics?	Yes		Chapter 5, Figure 12 and Figure 13. Additional detail is provided on Table 3 in Section 5.3.2.
2. Are noise sensitive public buildings and historic properties identified? (Note: If none are within the depicted NEM noise contours, this should be stated in the accompanying narrative text.)	Yes		Chapter 5, Figure 12 and Figure 13. Additional detail is provided on Table 3 in Section 5.3.2.

PART 150 NOISE EXPOSURE MAP CHECKLIST-PART I			
Airport Name: Burlington International Airport (BTV)	**REVIEWER:**		
	Yes	**No**	**Supporting Pages/Review Comments**
3. Are the noncompatible uses and noise sensitive public buildings readily identifiable and explained on the map legend?	Yes		Chapter 5, Figure 12 and Figure 13. Additional detail is provided on Table 3 in Section 5.3.2.
4. Are compatible land uses, which would normally be considered noncompatible, explained in the accompanying narrative?	Yes		Chapter 5
V. NARRATIVE SUPPORT OF MAP DATA: [150.21(a), A150.1, A150.101, A150.103]			
A. 1. Are the technical data and data sources on which the NEM are based adequately described in the narrative?	Yes		Chapter 6 presents current and forecast operational data and other modeling inputs.
2. Are the underlying technical data and planning assumptions reasonable?	Yes		
B. Calculation of Noise Contours:			
1. Is the methodology indicated?	Yes		Chapter 6
a. Is it FAA approved?	Yes		Chapter 6 AEDT 2d and NOISEMAP (NMap 7.3) were used for all modeling. These were the most current versions of the respective models at the time the noise analysis was started.
b. Was the same model used for both maps? (Note: The same model also must be used for NCP submittals associates with NEM determinations already issued by FAA where the NCP is submitted later, unless the airport sponsor submits a combined NEM/NCP submittal as a replacement, in which case the model used must be the most recent version at the time the update was started.)	Yes		
c. Has AEE approval been obtained for use of a model other than those that have previous blanket FAA approval?		N/A	AEDT and NOISEMAP are approved noise models in Section 11.1.4 of the FAA Order 1050.1F Desk Reference.
2. Correct use of noise models:			No calibration. Substitutions are documented in Section 6 and FAA correspondence in Appendix B
a. Does the documentation indicate, or is there evidence, the airport operator (or its consultant) has adjusted or calibrated FAA-approved noise models or substituted one aircraft type for another that was not included on the FAA's pre-approved list of aircraft substitutions?	Yes		
b. If so, does this have written approval from AEE, and is that written approval included in the submitted document?			N/A; This is a draft document.
3. If noise monitoring was used, does the narrative indicate that Part 150 guidelines were followed?		N/A	No monitoring data used.

PART 150 NOISE EXPOSURE MAP CHECKLIST-PART I			
Airport Name: Burlington International Airport (BTV)	**REVIEWER:**		
	Yes	**No**	**Supporting Pages/Review Comments**
4. For noise contours below DNL 65 dB [or Community Noise Equivalent Level, CNEL], does the supporting documentation include an explanation of local reasons? (Note: A narrative explanation, including evidence the local jurisdiction(s) have adopted a noise level less than DNL 65 dB as sensitive for the local community(ies), and including a table or other depiction of the differences from the Federal table, is highly desirable but not specifically required by the rule. However, if the airport sponsor submits NCP measures within the locally significant noise contour, an explanation must be included if it wants the FAA to consider the measure(s) for approval for purposes of eligibility for Federal aid.)		N/A	
C. Noncompatible Land Use Information:			
1. Does the narrative (or map graphics) give estimates of the number of people residing in each of the contours (DNL 65, 70 and 75, at a minimum) [or Community Noise Equivalent Level, CNEL] for both the existing condition and forecast year maps?	Yes		Section 5.3.3 Table 4
2. Does the documentation indicate whether the airport operator used Table 1 of Part 150?	Yes		Section 3.4
a. If a local variation to table 1 was used:			
(1) Does the narrative clearly indicate which adjustments were made and the local reasons for doing so?		N/A	
(2) Does the narrative include the airport operator's complete substitution for table 1?		N/A	
3. Does the narrative include information on self-generated or ambient noise where compatible or noncompatible land use identifications consider non-airport and non-aircraft noise sources?		N/A	
4. Where normally noncompatible land uses are not depicted as such on the NEM, does the narrative satisfactorily explain why, with reference to the specific geographic areas?	Yes		Chapter 5
5. Does the narrative describe how forecast aircraft operations, forecast airport layout changes, and forecast land use changes will affect land use compatibility in the future?	Yes		Chapter 5
VI. MAP CERTIFICATIONS: [150.21(b), 150.21(e)]			
A. Has the operator certified in writing that interested persons have been afforded adequate opportunity to submit views, data, and comments concerning the correctness and adequacy of the draft maps and forecasts?			This is a draft document. Certification will be provided after consultation and opportunity for public comment.

PART 150 NOISE EXPOSURE MAP CHECKLIST-PART I			
Airport Name: Burlington International Airport (BTV)	**REVIEWER:**		
	Yes	**No**	**Supporting Pages/Review Comments**
B. Has the operator certified in writing that each map and description of consultation and opportunity for public comment are true and complete under penalty of 18 U.S.C. Section 1001?			This is a draft document. Certification will be provided after consultation and opportunity for public comment.

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3 Introduction to Noise Terminology and Evaluation

Noise is a complex physical quantity. The properties, measurement, and presentation of noise involve specialized terminology that can be difficult to understand. Throughout the Part 150 update, we will use graphics and everyday comparisons to communicate noise-related quantities and effects in reasonably simple terms.

To provide a basic reference on these technical issues, this chapter introduces fundamentals of noise terminology (Section 3.1), the effects of noise on human activity (Section 3.2), weather and distance effects (Section 3.3), and Part 150 noise-land use compatibility guidelines (Section 3.4).

3.1 Introduction to Noise Terminology

Part 150 relies largely on a measure of cumulative noise exposure over an entire calendar year, in terms of a metric called the Day-Night Average Sound Level (DNL). However, DNL does not provide an adequate description of noise for many purposes. A variety of other measures are available to address essentially any issue of concern, including:

- Sound Pressure Level (SPL) and the Decibel (dB)
- A-Weighted Decibel
- Maximum A-Weighted Sound Level (Lmax)
- Sound Exposure Level (SEL)
- Equivalent A-Weighted Sound Level (Leq)
- Day-Night Average Sound Level (DNL or Ldn)

3.1.1 Sound Pressure Level (SPL) and the Decibel (dB)

All sounds come from a sound source – a musical instrument, a voice speaking, an airplane passing overhead. It takes energy to produce sound. The sound energy produced by any sound source travels through the air in sound waves – tiny, quick oscillations of pressure just above and just below atmospheric pressure. The ear senses these pressure variations and – with much processing in our brain – translates them into "sound."

Our ears are sensitive to a wide range of sound pressures. Although the loudest sounds that we can hear without pain contain about one million times more energy than the quietest sounds we can hear, our ears are incapable of detecting small differences among these pressures. Thus, to better match how we hear this sound energy, we compress the total range of sound pressures to a more meaningful range by introducing the concept of sound pressure level.

Sound pressure levels (SPL) are measured in decibels (or dB). Decibels are logarithmic quantities reflecting the ratio of the two pressures, the numerator being the pressure of the sound source of interest (P_{source}), and the denominator being a reference pressure ($P_{reference}$)[12] (the quietest sound we can hear).

$$Sound\ Pressure\ Level\ (SPL) = 20 * Log\left(\frac{P_{source}}{P_{reference}}\right) dB$$

The logarithmic conversion of sound pressure to SPL means that the quietest sound that we can hear (the reference pressure) has a sound pressure level of about 0 dB, while the loudest sounds that we hear without pain

[12] The reference pressure is approximately the quietest sound that a healthy young adult can hear.

have sound pressure levels of about 120 dB. Most sounds in our day-to-day environment have sound pressure levels from about 40 to 100 dB.[13]

Because decibels are logarithmic quantities, we cannot use common arithmetic to combine them. For example, if two sound sources each produce 100 dB operating individually, when they operate simultaneously they produce 103 dB -- not the 200 dB we might expect. Doubling again the number of sources from two to four, each source producing 100 dB and operating simultaneously, adds another three decibels of noise, resulting in a total SPL of 106 dB. For every doubling of the number of equal sources, the SPL goes up another three decibels. A tenfold increase in the number of sources makes the sound pressure level increase 10 dB.

If one noise source is much louder than another, the louder source "masks" the quieter one and the two sources together produce virtually the same SPL as the louder source alone. For example, a 100 dB source plus an 80 dB source produce approximately 100 dB of noise when operating together (actually, 100.04 dB). The louder source "masks" the quieter one. But if the quieter source gets louder, it will have an increasing effect on the total SPL such that, when the two sources are equal, as described above, they produce a level three decibels above the sound of either one by itself.

People hear changes in sound level according to the following rules of thumb: (1) a 6 to 10 dB increase in the SPL to sometimes described to be about a doubling of loudness,[14] and (2) changes in SPL of less than about three decibels are not readily detectable by the human ear outside of a laboratory environment.

3.1.2 A-Weighted Decibel

An important characteristic of sound is its frequency, or "pitch.” This is the per-second oscillation rate of the sound pressure variation at our ear, expressed in units known as Hertz (Hz).

When analyzing the total noise of any source, acousticians often break the noise into frequency components (or bands) to determine how much is low-frequency noise, how much is middle-frequency noise, and how much is high-frequency noise. This breakdown is important for two reasons:

- Our ear is better equipped to hear mid and high frequencies and is least sensitive to lower frequencies. Thus, we find mid- and high-frequency noise more annoying.
- Engineering solutions to noise problems differ with frequency content. Low-frequency noise is generally harder to control.

The normal frequency range of hearing for most people extends from a low of about 20 Hz to a high of about 10,000 to 15,000 Hz. Most people respond to sound more readily when the predominant frequency is in the range of normal conversation – typically around 1,000 to 2,000 Hz. The acoustical community has defined several “filters,” which approximate this sensitivity of our ear and thus, help us to judge the relative loudness of various sounds made up of many different frequencies.

The "A" filter (or “A weighting”) does this best for most environmental noise sources. A-weighted sound levels are measured in decibels, just like unweighted. To avoid ambiguity, A-weighted sound levels should be identified as such (e.g. "an A-weighted sound level of 85 dB") or stated up front that all noise levels presented in this document are A-weighted unless otherwise specified (as in this study).

Government agencies in the U.S (and most governments worldwide) recommend or require the use of A-weighted sound levels for measuring, modeling, describing, and assessing aircraft sound levels (and sound levels from most other transportation and environmental sources).

Figure 1 depicts A-weighting adjustments to sound from approximately 20 Hz to 10,000 Hz.

[13] The logarithmic ratio used in its calculation means that SPL changes relatively quickly at low sound pressures and more slowly at high pressures. This relationship matches human detection of changes in pressure. We are much more sensitive to changes in level when the SPL is low (for example, hearing a baby crying in a distant bedroom), than we are to changes in level when the SPL is high (for example, when listening to highly amplified music).
[14] A “10 dB per doubling” rule of thumb is the most often used approximation.

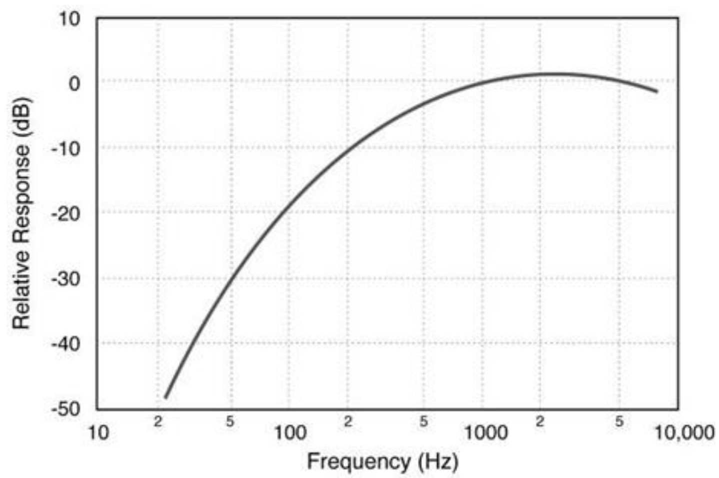


Figure 1. A-Weighting Frequency-Response

Source: HMMH

The A-weighted filter significantly de-emphasizes those parts of the total noise at lower and higher frequencies (below about 500 Hz and above about 10,000 Hz) where we do not hear as well. The filter has very little effect, or is nearly "flat", in the middle range of frequencies between 500 and 10,000 Hz where we hear quite easily. Because this filter generally matches our ears' sensitivity, sounds having higher A-weighted sound levels are usually judged to be louder than those with lower A-weighted sound levels. It is for this reason that acousticians normally use A-weighted sound levels to evaluate environmental noise sources.

All sound pressure levels presented in this document are A-weighted unless otherwise specified.

Figure 2 depicts representative A-weighted sound levels for a variety of common sounds.

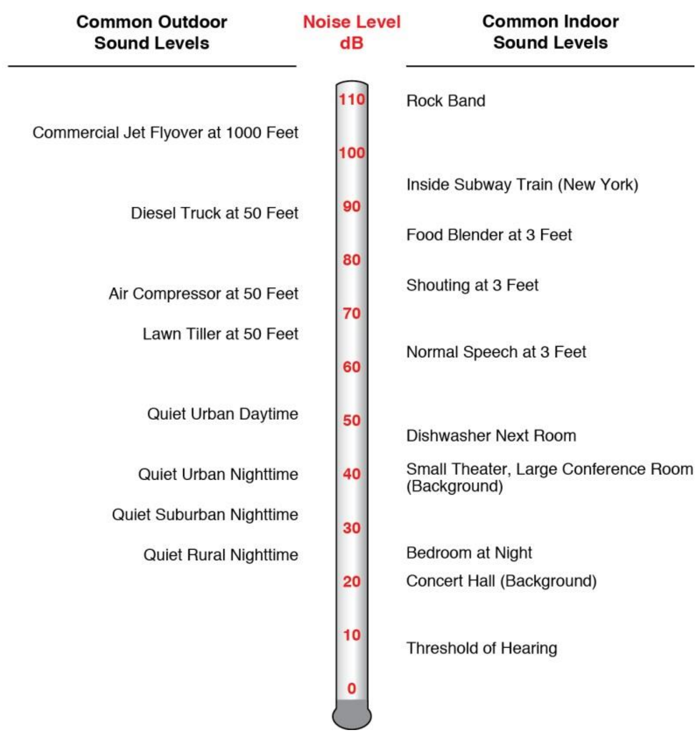


Figure 2. A-Weighted Sound Levels for Common Sounds

Source: HMMH

3.1.3 Maximum A-Weighted Sound Level (Lmax)

An additional dimension to environmental noise is that A-weighted levels vary with time. For example, the sound level increases as a car or aircraft approaches, then falls and blends into the background as the aircraft recedes into the distance. The background or "ambient" level continues to vary in the absence of a distinctive source, for example due to birds chirping, insects buzzing, leaves rustling, etc. It is often convenient to describe a particular noise "event" (such as a vehicle passing by, a dog barking, etc.) by its maximum sound level, abbreviated as L_{max}.

Figure 3 depicts this general concept, for a hypothetical noise event with an L_{max} of approximately 102 dB.

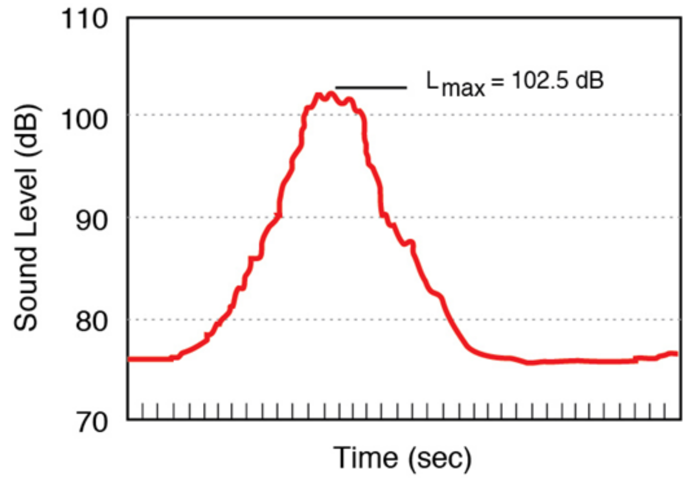


Figure 3. Variation in A-Weighted Sound Level over Time and Maximum Noise Level

Source: HMMH

While the maximum level is easy to understand, it suffers from a serious drawback when used to describe the relative "noisiness" of an event such as an aircraft flyover; i.e., it describes only one dimension of the event and provides no information on the event's overall, or cumulative, noise exposure. In fact, two events with identical maximum levels may produce very different total exposures. One may be of very short duration, while the other may continue for an extended period and be judged much more annoying. The next section introduces a measure that accounts for this concept of a noise "dose," or the cumulative exposure associated with an individual "noise event" such as an aircraft flyover.

3.1.4 Sound Exposure Level (SEL)

The most commonly used measure of cumulative noise exposure for an individual noise event, such as an aircraft flyover, is the Sound Exposure Level (or SEL). SEL is a summation of the A-weighted sound energy over the entire duration of a noise event. SEL expresses the accumulated energy in terms of the one-second-long steady-state sound level that would contain the same amount of energy as the actual time-varying level.

SEL provides a basis for comparing noise events that generally match our impression of their overall "noisiness," including the effects of both duration and level. The higher the SEL, the more annoying a noise event is likely to be. In simple terms, SEL "compresses" the energy for the noise event into a single second. Figure 4 depicts this compression, for the same hypothetical event shown in Figure 4. Note that the SEL is higher than the L_{max}.

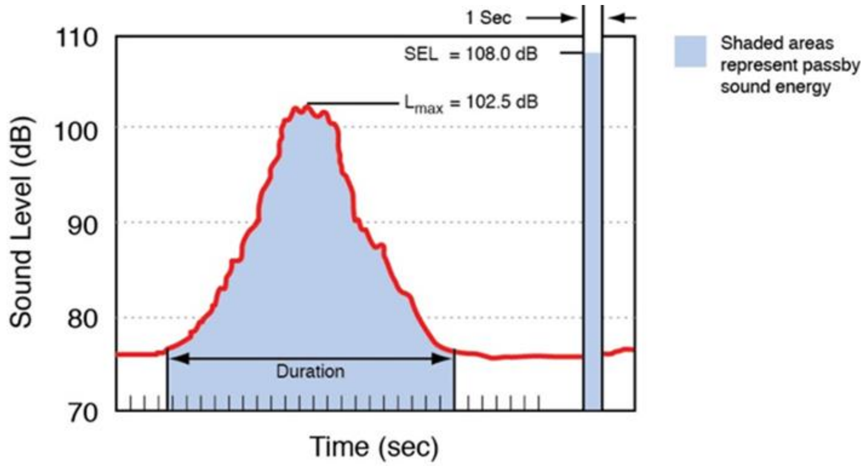


Figure 4. Graphical Depiction of Sound Exposure Level

Source: HMMH

The "compression " of energy into one second means that a given noise event's SEL will almost always will be a higher value than its L_{max}. For most aircraft flyovers, SEL is roughly five to 12 dB higher than L_{max}. Adjustment for duration means that relatively slow and quiet propeller aircraft can have the same or higher SEL than faster, louder jets, which produce shorter duration events.

3.1.5 Equivalent A-Weighted Sound Level (Leq)

The Equivalent Sound Level, abbreviated L_{eq}, is a measure of the exposure resulting from the accumulation of sound levels over a particular period of interest; e.g., one hour, an eight-hour school day, nighttime, or a full 24-hour day. L_{eq} plots for consecutive hours can help illustrate how the noise dose rises and falls over a day or how a few loud aircraft significantly affect some hours.

L_{eq} may be thought of as the constant sound level over the period of interest that would contain as much sound energy as the actual varying level. It is a way of assigning a single number to a time-varying sound level. Figure 5 illustrates this concept for a one-hour period. Note that the L_{eq} is lower than either the L_{max} or SEL.

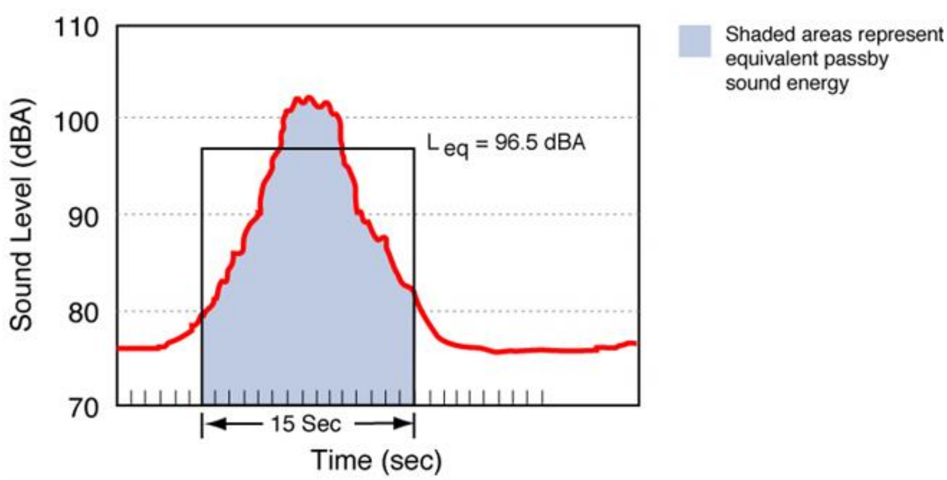


Figure 5. Example of a One-Minuet Equivalent Sound Level

Source: HMMH

In airport noise applications, Leq is often presented for consecutive one-hour periods to illustrate how the hourly noise dose rises and falls throughout a 24-hour period as well as how certain hours may be significantly affected by only a few loud aircraft.

3.1.6 Day-Night Average Sound Level (DNL or Ldn)

The previous sections address noise measures that account for short term fluctuations in levels as sound sources come and go affecting the overall noise environment. The FAA requires that airports use a more complex measure of noise exposure than either a single, peak event metric (Lmax) or a single event total energy metric (SEL or SENEL). Therefore, the Day-Night Average Sound Level (DNL or Ldn) was developed to represent a 24-hour noise dose.

Most aircraft noise studies use computer-generated estimates of DNL, determined by adding up the energy from the SELs for each event, with the 10 dB adjustment applied to night operations. Computed values of DNL are often depicted as noise contours reflecting lines of equal exposure around an airport (much as topographic maps indicate contours of equal elevation). The contours usually reflect long-term (annual-average) operating conditions, taking into account the average flights per day, how often each runway is used throughout the year, and where over the surrounding communities aircraft normally fly. Alternative time frames may also be helpful in understanding shorter term aspects of a noise environment.

Why is DNL used to describe noise around airports? The U.S. Environmental Protection Agency identified DNL as the most appropriate means of evaluating airport noise based on the following considerations.[15]

- The measure should be applicable to the evaluation of pervasive long-term noise in various defined areas and under various conditions over long periods.
- The measure should correlate well with known effects of the noise environment and on individuals and the public.
- The measure should be simple, practical, and accurate. In principal, it should be useful for planning as well as for enforcement or monitoring purposes.
- The required measurement equipment, with standard characteristics, should be commercially available.
- The measure should be closely related to existing methods currently in use.
- The single measure of noise at a given location should be predictable, within an acceptable tolerance, from knowledge of the physical events producing the noise.
- The measure should lend itself to small, simple monitors, which can be left unattended in public areas for long periods.

Most federal agencies dealing with noise have formally adopted DNL. The Federal Interagency Committee on Noise (FICON) reaffirmed the appropriateness of DNL in 1992. The FICON summary report stated; “There are no new descriptors or metrics of sufficient scientific standing to substitute for the present DNL cumulative noise exposure metric.”

DNL is essentially equal to the 24-hour Leq, with one important adjustment: noise occurring at night – from 10:00 p.m. through 7:00 a.m. – is “factored up.” The factoring up can be made in one of two ways:

- Weighting, by counting each nighttime noise contribution 10 times; e.g., if DNL is calculated by summing the SEL of aircraft operations over a 24-hour period, each nighttime operation is represented by 10 identical daytime operations.
- Penalizing, by adding 10 dB to all nighttime noise contributions; e.g., if DNL is calculated from the SEL of aircraft operations occurring over a 24-hour period, 10 dB are added to the SEL values for nighttime operations.

The 10 dB adjustment accounts for our greater sensitivity to nighttime noise and the fact lower ambient levels at night tend to make noise events, such as aircraft flyovers, more intrusive.

DNL can be measured or estimated. Measurements are practical only for obtaining DNL values for limited numbers of points, and, in the absence of a permanently installed monitoring system, only for relatively short

[15] "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety," U. S. EPA Report No. 550/9-74-004, March 1974.

periods. Most airport noise studies use computer-generated DNL estimates depicted as equal-exposure noise contours (much as topographic maps have contours of equal elevation). Part 150 *requires* that airports use computer-generated contours, as discussed in Section 2.1.

More specifically, Part 150 requires that Noise Exposure Maps depict the 65, 70, and 75 dB DNL contours for total annual operations for the existing and forecast conditions cases (2018 and 2023 in this study). The annual DNL is mathematically identical to the DNL for the average annual day; i.e., a day on which the number of operations is equal to the annual total divided by 365 (366 in a leap year).

Figure 6 graphically depicts the manner in which the nighttime adjustment applies in calculating DNL. Each bar in the figure is a one-hour L_{eq}. The 10 dB penalty is added for hours between 10 p.m. and 7 a.m. Figure 7 presents representative outdoor DNL values measured at various U.S. locations.

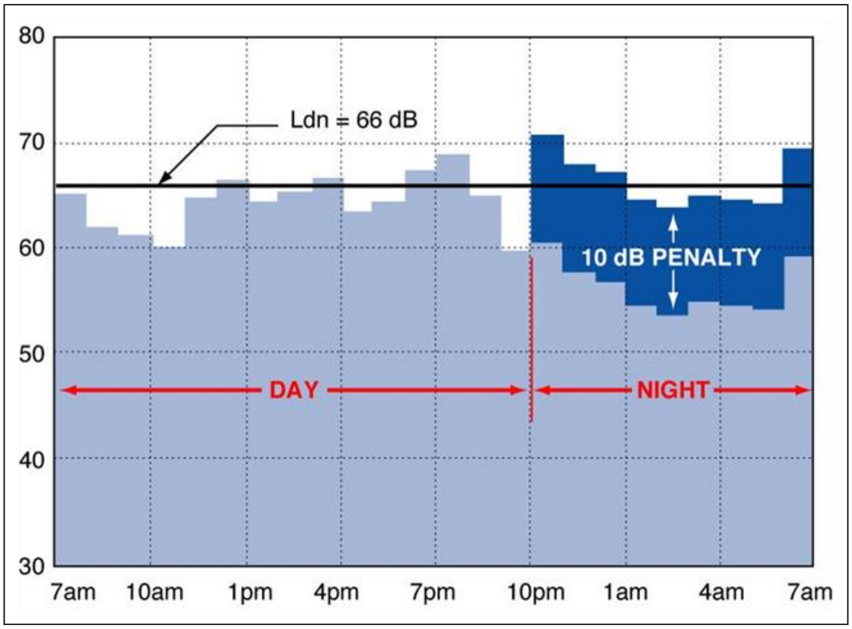


Figure 6. Example of a Day-Night Average Sound Level Calculation

Source: HMMH

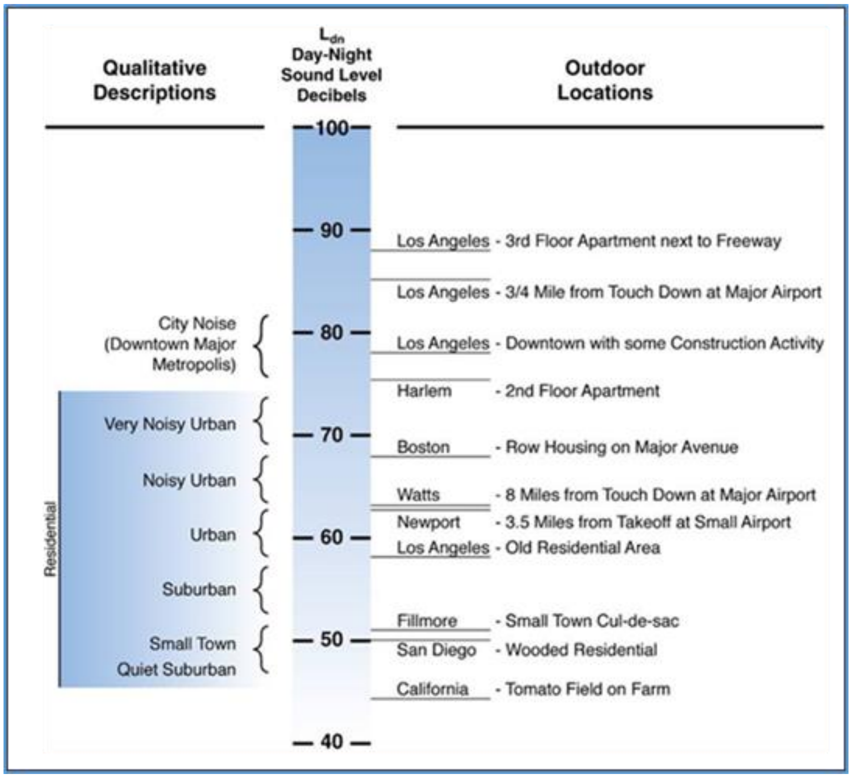


Figure 7. Examples of Measured Day-Night Average Sound Levels, DNL

Source: EPA, 1974. Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety. https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=2000L3LN.txt

3.2 Aircraft Noise Effects on Human Activity

To residents around airports, aircraft noise can be an annoyance and a nuisance. It can interfere with conversation, listening to television, disrupt classroom activities in schools, and disrupt sleep. Relating these effects to specific noise metrics helps in the understanding of how and why people react to their environment.

3.2.1 Speech Interference

A primary effect of aircraft noise is its tendency to "mask" speech, making it difficult to carry on a normal conversation. The sound level of speech decreases as the distance between a talker and listener increases. As the background sound level increases, it becomes harder to hear speech.

Figure 8 presents typical distances between talker and listener for satisfactory outdoor conversations, in the presence of different steady A-weighted background noise levels for raised, normal, and relaxed voice effort. As the background level increases, the talker must raise his/her voice, or the individuals must get closer together to continue talking.

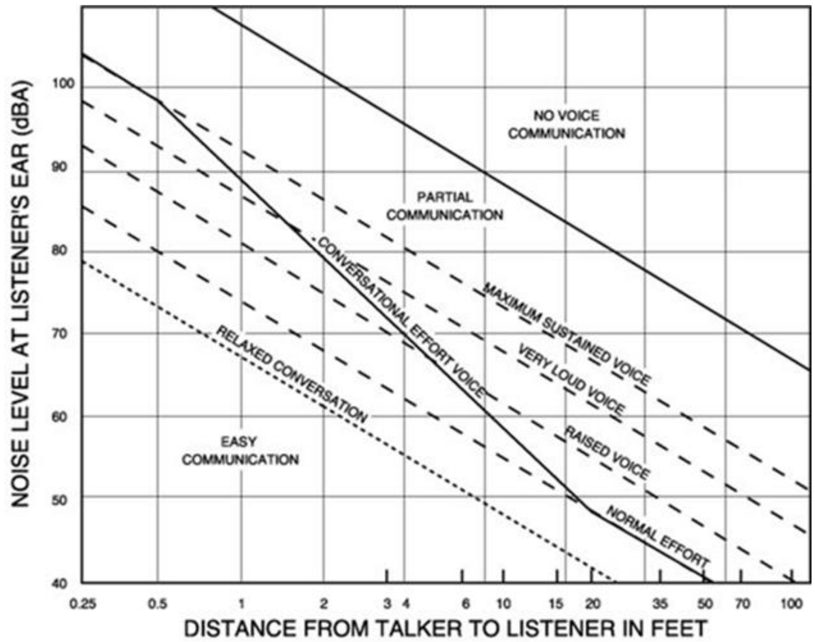


Figure 8. Outdoor Speech Intelligibility

Source: U.S. Environmental Protection Agency, "Public Health and Welfare Criteria for Noise". July, 1973. Pg. 6-5.

As indicated in the figure, "satisfactory conversation" does not always require hearing every word; 95% intelligibility is acceptable for many conversations. However, in relaxed conversation we have higher expectations of hearing speech and generally require closer to 100% intelligibility. Any combination of talker-listener distances and background noise that falls below the bottom line in the figure (which roughly represents the upper boundary of 100% intelligibility) represents an ideal environment for outdoor speech communication. Indoor communication is generally acceptable in this region as well.

One implication of the relationships in Figure 8 is that for typical communication distances of three or four feet, acceptable outdoor conversations can be carried on in a normal voice as long as the background noise outdoors is less than about 65 dB. If the noise exceeds this level, as might occur when an aircraft passes overhead, intelligibility would be lost unless vocal effort were increased or communication distance were decreased.

Indoors, typical distances, voice levels, and intelligibility expectations generally require a background level less than 45 dB. With windows partly open, housing generally provides about 10 to 15 dB of interior-to-exterior noise level reduction. Thus, if the outdoor sound level is 60 dB or less, there a reasonable chance that the resulting indoor sound level will afford acceptable interior conversation. With windows closed, 24 dB of attenuation is typical.

3.2.2 Sleep Interference

Research on sleep disruption from noise has led to widely varying observations. In part, because (1) sleep can be disturbed without awakening, (2) the deeper the sleep the more noise it takes to cause arousal, (3) the tendency to awaken increases with age, and other factors. Figure 9 shows a recent summary of findings on the topic.

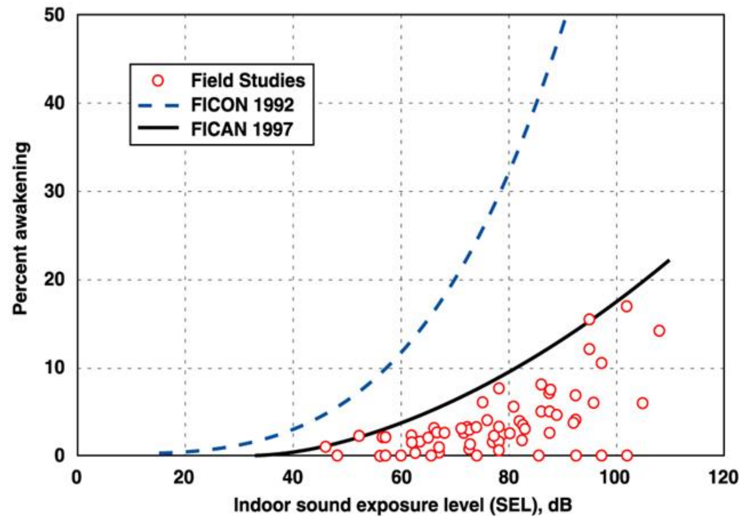


Figure 9. Sleep Interference

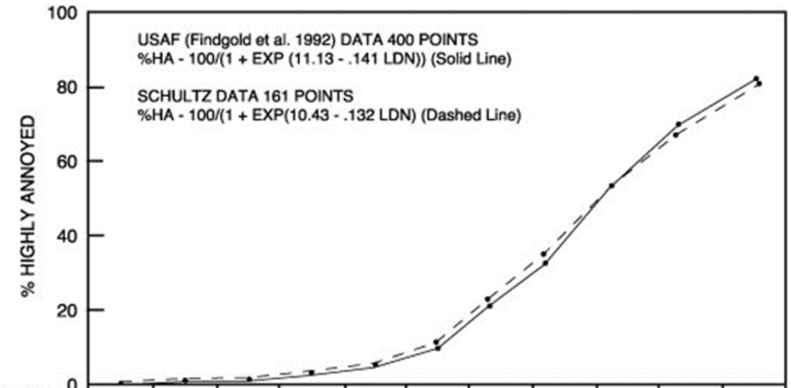
Source: Federal Interagency Committee on Aviation Noise (FICAN), "Effects of Aviation Noise on Awakenings from Sleep", June 1997, page 5

Figure 9 uses indoor SEL as the measure of noise exposure; current research supports the use of this metric in assessing sleep disruption. An indoor SEL of 80 dBA results in a maximum of 10% awakening. Assuming the typical windows-open interior-to-exterior noise level reduction of approximately 12 dBA and a typical L_{max} value for an aircraft flyover 12 dBA lower than the SEL value, an interior SEL of 80 dBA roughly translates into an exterior L_{max} of the same value.[16]

3.2.3 Community Annoyance

Numerous psychoacoustic surveys provide substantial evidence that individual reactions to noise vary widely with noise exposure level. However, since the early 1970s, researchers have determined (and subsequently confirmed) that aggregate community response is generally predictable and relates reasonably well to cumulative noise exposure such as DNL. Figure 10 depicts the widely recognized relationship between environmental noise and the percentage of people "highly annoyed," with annoyance being the key indicator of community response usually cited in this body of research.

[16] The awakening data presented in Figure 9 apply only to individual noise events. The American National Standards Institute (ANSI) has published a standard that provides a method for estimating the number of people awakened at least once from a full night of noise events: ANSI/ASA S12.9-2008 / Part 6, "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." This method can use the information on single events computed by a program such as the FAA's AEDT, to compute awakenings.



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

Figure 10. Percentage of People Highly Annoyed

Source: Federal Interagency Committee on Noise, Vol. 2, Technical Report. "Federal Agency Review of Selected Airport Noise Analysis Issues". August 1992. (From data provided by USAF Armstrong Laboratory). pp. 3-6

Based on data from 18 surveys conducted worldwide, the curve indicates that at levels as low as DNL 55 dB, something on the order of 3 to 4 percent of the persons would be highly annoyed, whereas this percentage of persons annoyed increases more rapidly as exposure increases above DNL 65 dB.

Separate work by the EPA has shown that overall community reaction to a noise environment is also dependent on DNL, Figure 11 depicts this relationship.

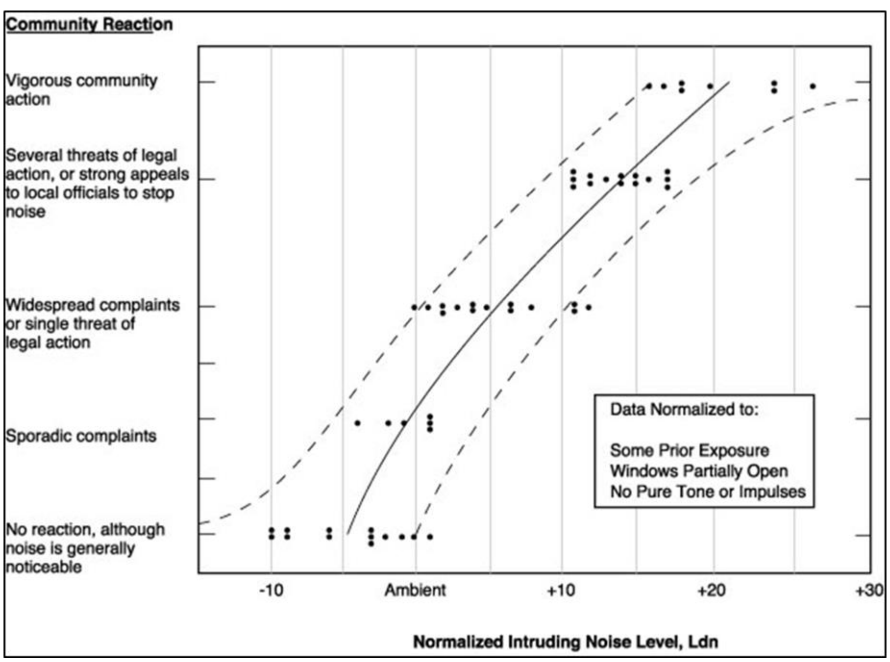


Figure 11. Community Reaction as a Function of Outdoor DNL

Source: U.S. EPA, "Community Noise," NTID300.3, December 1971, derived from Figure 25, page 63.

Data summarized in the figure suggest that little reaction would be expected for intrusive noise levels five decibels below the ambient, while widespread complaints can be expected as intruding noise exceeds background levels by about five decibels. Vigorous action is likely when levels exceed the background by 20 dB.

3.3 Effects of Weather and Distance

Participants in airport noise studies often express interest in two sound-propagation issues: (1) weather and (2) source-to-listener distance.

3.3.1 Weather-Related Effects

Atmospheric effects that can influence the propagation of sound include (in roughly increasing order of importance) humidity, precipitation, temperature and wind gradients, and turbulence (or gustiness). The effect of wind – turbulence in particular – is generally more important than the effects of other factors. Under calm-wind conditions, the importance of temperature (in particular vertical "gradients") can increase, sometimes to very significant levels. Humidity generally has little significance relative to the other effects.

Influence of Humidity and Precipitation

In general, humidity and precipitation have little effect on sound propagation. Humidity can reduce propagation of high-frequency noise under calm-wind conditions. In very cold conditions, listeners often observe that aircraft sound "tinny," because the dry air increases the propagation of high-frequency sound. Rain, snow, and fog also have little, if any noticeable effect on sound propagation. A substantial body of empirical data supports these conclusions.[17]

Influence of Temperature

The velocity of sound in the atmosphere is dependent on the air temperature.[18] As a result, if the temperature varies at different heights above the ground, sound will travel in curved paths rather than straight lines. During the day, temperature normally decreases with increasing height. Under such "temperature lapse" conditions, the atmosphere refracts ("bends") sound waves upwards and an acoustical shadow zone may exist at some distance from the noise source.

Under some weather conditions, an upper level of warmer air may trap a lower layer of cool air. Such a "temperature inversion" is most common in the evening, at night, and early in the morning when heat absorbed by the ground during the day radiates into the atmosphere.[19] The effect of an inversion is just the opposite of lapse conditions. It causes sound propagating through the atmosphere to refract downward.

Often, however, the downward refraction caused by temperature inversions allows sound rays with originally upward-sloping paths to bypass obstructions and ground effects, increasing noise levels at greater distances. This type of effect is most prevalent at night, when temperature inversions are most common and when wind levels often are very low, limiting any confounding factors.[20] Under extreme conditions, one study found that noise from ground-borne aircraft might be amplified 15 to 20 dB by a temperature inversion. In a similar study, noise caused by an aircraft on the ground registered a higher level at an observer location 1.8 miles away than at a second observer location only 0.2 miles from the aircraft.[21]

Influence of Wind

Just as there is a temperature gradient in the atmosphere, there is also a wind gradient; typically higher wind speeds exist at greater heights above the ground. Wind has a strong directional component that can lead to

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[17] Ingard, Uno. "A Review of the Influence of Meteorological Conditions on Sound Propagation," Journal of the Acoustical Society of America, Vol. 25, No. 3, May 1953, p. 407.

[18] In dry air, the approximate velocity of sound can be obtained from the relationship:
$c = 331 + 0.6T_c$ (c in meters per second, Tc in degrees Celsius). Pierce, Allan D., Acoustics: An Introduction to its Physical Principles and Applications. McGraw-Hill. 1981. p. 29.

[19] Embleton, T.F.W., G.J. Thiessen, and J.E. Piercy, "Propagation in an inversion and reflections at the ground," Journal of the Acoustical Society of America, Vol. 59, No. 2, February 1976, p. 278.

[20] Ingard, p. 407.

[21] Dickinson, P.J., "Temperature Inversion Effects on Aircraft Noise Propagation," (Letters to the Editor) Journal of Sound and Vibration. Vol. 47, No. 3, 1976, p. 442.

significant variation in propagation. In general, receivers that are downwind of a source will experience higher sound levels, and those that are upwind will experience lower sound levels. Wind perpendicular to the source-to-receiver path has no significant effect.

The refraction caused by wind direction and temperature gradients is additive.[22] One study suggests that for frequencies greater than 500 Hz, the combined effects of these two factors tends towards two extreme values: approximately 0 dB in conditions of downward refraction (temperature inversion or downwind propagation) and -20 dB in upward refraction conditions (temperature lapse or upwind propagation). At lower frequencies, the effects of refraction due to wind and temperature gradients are less pronounced.[23]

Wind turbulence (or “gustiness”) can also affect sound propagation. Sound levels heard at remote receiver locations will fluctuate with gustiness. In addition, gustiness can cause considerable attenuation of sound due to effects of eddies traveling with the wind. Attenuation due to eddies is essentially the same in all directions, with or against the flow of the wind, and can mask the refractive effects discussed above.[24]

3.3.2 Distance-Related Effects

People often ask how distance from an aircraft to a listener affects sound levels. Changes in distance may be associated with varying terrain, offsets to the side of a flight path, or aircraft altitude. The answer is a bit complex, because distance affects the propagation of sound in several ways.

The principal effect results from the fact that any emitted sound expands in a spherical fashion – like a balloon – as the distance from the source increases, resulting in the sound energy being spread out over a larger volume. With each doubling of distance, spherical spreading reduces instantaneous or maximum level by approximately six decibels, and SEL by approximately three decibels.

“Atmospheric absorption” is a secondary effect. As an overall example, increasing the aircraft-to-listener distance from 2,000’ to 3,000’ could produce reductions of about four to five decibels for instantaneous or maximum levels, and of about two to four decibels for SEL, under average annual weather conditions. This absorption effect drops off relatively rapidly with distance. The Integrated Noise Model (INM) takes these reductions into account.

3.4 Noise/ Land Use Compatibility Guidelines

The Federal Aviation Administration Part 150 Airport Noise Compatibility Planning guidelines provide the following:

1. A basis for comparing existing noise conditions to the effects of noise abatement procedures and/or forecast changes in airport activity.
2. A quantitative basis for identifying potential noise exposure.

Both of these functions require the application of objective criteria for evaluating noise exposure. 14 CFR Part 150 Appendix A provides land use compatibility guidelines as a function of DNL values. Table 2 reproduces those guidelines.

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

[22] Piercy and Embleton, p. 1412. Note, in addition, that as a result of the scalar nature of temperature and the vector nature of wind, the following is true: under lapse conditions, the refractive effects of wind and temperature add in the upwind direction and cancel each other in the downwind direction. Under inversion conditions, the opposite is true.
[23] Piercy and Embleton, p. 1413.
[24] Ingard, pp. 409-410.

Response may also be affected by expectation and experience. People may get used to a level of exposure that guidelines indicate may be unacceptable, and changes in exposure may generate response that is far greater than that which the guidelines might suggest.

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

With these cautions in mind, the Part 150 guidelines can be applied to the DNL contours to identify the potential types, degrees and locations of incompatibility. Measurement of the land areas involved can provide a quantitative measure of impact that allows a comparison of at least the gross effects of existing or forecast operations.

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

14 CFR Part 150 permits airports and local land use control jurisdictions to adopt land use compatibility criteria that differ from the guidelines reproduced in Table 2. Typically, FAA will accept such alternate land use compatibility designations only if the airport bases them on criteria that local land-use control jurisdictions have formally adopted and rigorously enforced. The City and other jurisdictions surrounding BTV have not adopted such alternative criteria. Therefore, the City uses the FAA guidelines as set forth in Part 150 for the determination of land use compatibility.

Table 2. 14 CFR Part 150 Noise / Land Use Compatibility Guidelines

Source:14 CFR Part 150, Appendix A, Table 1

Land Use	Yearly Day-Night Average Sound Level, DNL, in Decibels (Key and notes on following page) <65	65-70	70-75	75-80	80-85	>85
Residential Use						
Residential other than mobile homes and transient lodgings	Y	N(1)	N(1)	N	N	N
Mobile home park	Y	N	N	N	N	N
Transient lodgings	Y	N(1)	N(1)	N(1)	N	N
Public Use						
Schools	Y	N(1)	N(1)	N	N	N
Hospitals and nursing homes	Y	25	30	N	N	N
Churches, auditoriums, and concert halls	Y	25	30	N	N	N
Governmental services	Y	Y	25	30	N	N
Transportation	Y	Y	Y(2)	Y(3)	Y(4)	Y(4)
Parking	Y	Y	Y(2)	Y(3)	Y(4)	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(5)	Y(5)	N	N	N
Outdoor music shells, amphitheaters	Y	N	N	N	N	N
Nature exhibits and zoos	Y	Y	N	N	N	N
Amusements, parks, resorts and camps	Y	Y	Y	N	N	N
Golf courses, riding stables, and water recreation	Y	Y	25	30	N	N

Key to Table 2

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

Notes for Table 2

The designations contained in this table do not constitute a Federal determination that any use of land covered by the program is acceptable or unacceptable under Federal, State, or local law. The responsibility for determining the acceptable and permissible land uses and the relationship between specific properties and specific noise contours rests with the local authorities. FAA determinations under Part 150 are not intended to substitute 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.

(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 started as 5, 10, or 15 dB over standard construction and normally assume mechanical ventilation and closed windows year round. However, the use of NLR criteria will not eliminate outdoor noise problems.

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

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

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

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

(6) Residential buildings require an NLR of 25.

(7) Residential buildings require an NLR of 30.

(8) Residential buildings not permitted.

4 Existing Noise Compatibility Program

This NEM builds on the previous noise compatibility studies at BTV. The existing Noise Compatibility Program (NCP) includes 15 FAA-approved measures with a mix of operational, implementation, and land use elements. The FAA's 2008 Record of Approval (ROA), for the 2008 NCP submission, listed NCP elements in the order presented below. The 2008 NCP, and associated ROA, revised a single measure. Appendix A presents a copy of the 2008 ROA.

The following discussion of the NCP has been organized in the same manner as the FAA's 2008 ROA. The 2018 and 2023 NEM are based on empirical data reflecting the current implementation status of these noise abatement measures. The United State Air Force's Record of Decision for the F-35A Operational Basing Environmental Impact Statement (USAF EIS)[25], agreed to adhere to the 2008 NCP.

Note that the Airport is currently undergoing an update to the NCP. Submission of the updated NCP to the FAA is anticipated to occur in late 2019 or early 2020. A determination of program compliance with Part 150, by the FAA, is followed by a 180-day approval period for any new NCP.

4.1 Airport Operations Measures

4.1.1 Extension of Taxiway G

Taxiway G would be extended from the existing intersection with Taxiway A to Taxiway C, remaining parallel with Runway 15/33 in order to reduce noise levels for residents along Airport Drive (2008 ROA Measure 1).

Status: In progress. The FAA approved the extended Taxiway G at the planning level, it is shown on the updated 2012 Airport Layout Plan. Current Taxiway G is on the northwest side of the airfield and current Taxiway K is on the southeast side. The complete Taxiway G extension will create a single taxiway parallel to Runway 15-33 and linking to the current Taxiway K. Construction of the first phase, at current Taxiway K, started early November 2015 and was completed in July 2016. Construction of the second phase started in October 2016 and was completed in October 2018. The final phase of construction is scheduled to commence in 2020. The 2018 NEM reflects the varying taxiway layout for the year, and the 2023 NEM reflects the forecasted taxiway layout including the extended Taxiway G.

4.1.2 Terminal Power Installation and APU/GPU Restrictions

Installation of terminal power hookups for aircraft would reduce the need for aircraft to use internal auxiliary power units (APU) or ground power units (GPU). Following the installation, a rule prohibiting the use of APUs or GPUs between 10:00 p.m. and 7:00 a.m., would be put in place (2008 ROA Measure 2).

Status: Not fully implemented. The Airport terminal now has "aircraft ground power" (referred to as "terminal power hooks" in the ROA and the 1989 NCP document) capability at all eleven Passenger Boarding Bridges. The Airport will not be implementing the GPU/APU rule between 10:00 p.m. and 7:00 a.m., as a too many flights arrive/depart during those hours. However, use of ground power is required for all aircraft in proximity to an available hookup.

[25] Document was released September 2013. The Air Force issued a Record of Decision (ROD) December 2, 2013. The documents are available at http://www.158fw.ang.af.mil/f-35information.asp

4.1.3 Nighttime Bi-Direction Runway Use

To minimize late-night operations over the City of Winooski, the air traffic control tower would use Runway 15 for departure and Runway 33 for arrivals, traffic conditions permitting (2008 ROA Measure 3).

Status: Not implemented. The BTV ATCT is closed from midnight until 5:00 a.m., which makes implementation of this measure infeasible during these hours. The ATCT has not implemented the procedure during the remaining DNL "nighttime" hours; i.e., from 6:00 to 7:00 a.m.

4.1.4 Noise Abatement Flight Paths for Runway 15 and 33 Departures and Runway 15 Arrivals

New procedures[26] would have civil aircraft fly over less populated areas. Runway 33 departures would turn to a heading of 310 degrees. Runway 15 departures would turn to a heading of 180 degrees (2008 ROA Measure 4).

Status: Not fully implemented. Current procedures involve assignments that result in: (1) most west-bound Runway 15 departures making initial turns to a heading of 190, (2) most west-bound Runway 33 departures maintaining runway heading until past the City of Winooski, and (3) most east-bound Runway33 departures initiating right hand turns over the City of Winooski.

4.1.5 Voluntary Limits of Military C-5A Training

An informal agreement with the military limits C-5A operations to only necessary takeoffs and landings (2008 ROA Measure 5).

Status: Not fully implemented. An agreement is not currently in place, however (1) BTV operations strongly discourage C-5 training at the Airport, because of the runways are only 150 feet wide and wake turbulence from C-5 operations tear up the runway-edge lighting, (2) historically the military has always coordinated the arrival of a C-5 with BTV Operations because of the constraints on the airfield, and (3) all transient military aircraft are limited to two practice approaches.

4.1.6 Voluntary Minimization of F-16 Multiple Aircraft Flights

Military personnel will schedule as many single-aircraft, as opposed to multiple-aircraft, flights as possible (2008 ROA Measure 6).

Status: Not fully implemented. Most VTANG flights require between 2 and 4 aircraft, depending on mission and tactical scenario. Multiple-aircraft flights typically operate with some distance between individual aircraft, so that the aircraft do not produce their maximum noise levels at the same locations at the same time; while aircraft are operating close in time, they are not simultaneous in most cases.

4.1.7 Voluntary Army Guard Helicopter Training Controls

The National Guard helicopter training operations will be conducted away from the Airport when conditions permit. In terms of long range planning, the Guard should consider consolidating operations at Camp Johnson (2008 ROA Measure 7).

Status: Not implemented. The Vermont Army National Guard has continued training operations at BTV.

[26] "New procedures" was the language used in the 1989 NCP.

4.2 Monitoring and Review Elements

4.2.1 Ongoing Monitoring and Review of Noise Exposure Map (NEM) and Noise Compatibility Program (NCP) Status

This measure provides for revision of the NEM and NCP, citing three examples: changes in airport layout, unanticipated changes in the level of airport activity, and non-compliance with the NCP. This measure also included the recommendation of the Technical Advisory Committee (TAC) as a Noise Abatement Committee and purchase of a permanent noise monitoring system (2008 ROA Measure 8).

Status: Not fully implemented. The City of Burlington, Vermont updated the BTV NEM in 1997, 2006 and 2015. This documentation represents the fourth NEM update. The City updated the NCP in 2008 and is currently developing an update to the NCP for 2020 A standing Sound Mitigation Committee meets at various times throughout the year. Currently, there are no plans to purchase and install a noise monitoring system.

4.2.2 Flight Track Monitoring

Utilization of an outside firm to perform flight track analysis of radar data on a temporal sampling basis (2008 ROA Measure 9).

Status: Not fully implemented. The City is moving forward with prospective companies that analyze flight track data. A system is anticipated to be in place in 2019.

4.3 Land Use Measures

Most of the following land use measures require noise contours, and would use the 2018 and 2023 NEM once they are found in compliance with 14 CFR Part 150 by FAA. As discussed in Section 1.2, the City recommends using the extents of the 2023 NEM contours for land use planning.

4.3.1 Land Acquisition and Relocation

Noncompatible land use includes residences within the 65 dB DNL contour. This program is voluntary. Eligible property owners will be paid fair market value for their property at the highest and best rate, and provided relocation assistance in accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (the "Uniform Act") and implementation of Department of Transportation (DOT) regulations. The City, in coordination with applicable jurisdiction, will conduct studies to define program boundaries and to identify options for compatible reuse of the acquired properties.

The City, and the applicable jurisdiction, will develop a land use plan for the area surrounding the Airport that is impacted by noise. This effort will follow the guidance contained in the FAA document "Management of Acquired Noise Land: Inventory Reuse Disposal" dated January 30, 2008, or later superseding documents. (2008 ROA Measure 10).

Status: Implemented. The City has purchased some, and is in the process of purchasing additional, permanent residences in the 65 dB DNL contour. Since the start of federal Fiscal Year 2007 (started October 1, 2006) through September 2015, the FAA has issued 12 grants to the City of Burlington totaling approximately $32.6 million.[27] *The extent of the acquisition area is coordinated with the local land use jurisdiction, in particular the City of South Burlington, and with residential property owners. Note: As with most grant programs, the FAA does have additional eligibility requirements asides from the property being within the 65 dB DNL NEM contour. FAA's*

[27] FAA grant data is available at http://www.faa.gov/airports/aip/grantapportion_data/

eligibility requirements are best described in FAA's Airport Improvement Program (AIP) Handbook.[28] *Both the City and other local municipalities have expressed an interest in ending the voluntary acquisition program and transitioning to other mitigation options. The City's recommendation regarding future of the Land Acquisition and Relocation measure will be discussed in a later chapter of the document.*

4.3.2 Sound Insulation

Qualified compatible residential and noise sensitive land uses within the 65 and 70 dB DNL contours, and qualified compatible non-residential land uses in the 75 dB DNL contour, would be included in a sound insulation program (2008 ROA Measure 11).

Status: Not implemented. To date, the City has chosen to apply available funding to land acquisition. The City intends to start a sound insulation program to provide mitigation for properties eligible, properties that are not included in the land acquisition and relocation program. As with most grant programs, the FAA does have additional eligibility requirements asides from the property being within the 65 dB DNL NEM contour. Other requirements do include, but may not be limited to, an evaluation of the existing structure and when the property was built. FAA's sound insulation eligibility requirements are best described in FAA's AIP Handbook.[29]

4.3.3 Easement Acquisition Related to Soundproofing

The City would attempt to negotiate avigation easements within the 65 dB DNL contour, in return for sound attenuation assistance (2008 ROA Measure 12).

Status: Not implemented. To date, the City has chosen to apply available funding to land acquisition. However, with a future sound insulation program the City is weighing the requirement of easements for properties that receive soundproofing. The recommendation for easements will be included in the new NCP.

4.3.4 Airport Zoning Overlay District

Land use measure that would restrict uses which are highly sensitive to noise and could also feature construction standards for sound insulation (2008 ROA Measure 13).

Status: Not implemented. Although a formal Airport Zoning Overlay District has not been adopted, the City of South Burlington has actively worked to consider airport noise when addressing land-use decisions around the Airport.

4.3.5 Easement Acquisition for New Development

Easements would be obtained for new development within the 65, 70 and 75 dB DNL contours (2008 ROA Measure 14).

Status: Not implemented.

4.3.6 Real Estate Disclosure

A real estate disclosure policy would be developed for land uses within the 65 DNL contour, and implemented through revisions to zoning ordinances (2008 ROA Measure 15).

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[28] FAA's current guidance, policy and procedures are documented in FAA Order 5100.38D "Airport Improvement Program (AIP) Handbook", effective September 30, 2014.
http://www.faa.gov/airports/aip/aip_handbook/

[29] See footnote 28 for the AIP Handbook's citation. In particular, see sections C-5, R-9, and R-10 of the AIP Handbook effective September 30, 2014.

Status: Not implemented. The Airport has not actively encouraged the use of Real Estate Disclosures for properties within the 65 dB DNL. However, outside the Part 150 process, a disclosure of airport noise, particularly related to anticipate changes of Vermont Air National Guard Aircraft, has been included in many real estate transactions.

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5 Updated Existing and Forecast Conditions Noise Exposure Maps with Existing Noise Compatibility Program

The most fundamental elements of the NEM submission are cumulative noise exposure contours for annual operations at the airport for: (1) data representing the existing condition and (2) data representing a forecast condition of at least five years in the future.

For this NEM Update the existing conditions noise contours represent 2018 and the five-year forecast contours represent 2023. This section describes the updated NEM figures and associated land use compatibility as follows:

- Section 5.1 presents the NEM figures
- Section 5.2 compares historical contours from previous Part 150 Studies
- Section 5.3 documents the incompatible land uses within the NEM noise contours

5.1 2018 and 2023 Noise Exposure Maps

Figure 12 presents the existing condition NEM for 2018 operations. Figure 13 presents the forecast condition NEM for 2023 operations. <u>These are the official NEMs that the City of Burlington, Vermont is submitting under Part 150 for FAA review and determination of compliance, pursuant to §150.21(c).</u>

As is discussed in Section 1.2, The City recommends using the extents of the 2023 NEM contours for future land-use planning.

The figures present noise contours for 2018 operations and 2023 forecast operations on a map depicting land uses, in generalized Part 150 land use categories. The land uses are color-coded. Consistent with Part 150 requirements, the figures also depict airport, municipal, and county boundaries, and discrete noise sensitive receptors (e.g., educational facilities and houses of worship) within the 65 dB DNL contours (some discrete noise sensitive receptors outside the 65 dB DNL contours are shown for reference, but do not represent a full inventory and are not required for Part 150). The 80 dB and 85 dB DNL contours are not shown, as they are completely on airport property and/or do not include any potentially noncompatible land uses.

Both NEMs reflect continuation of the noise abatement elements of the existing NCP (as summarized in Chapter 4) and the existing airport layout. Consistent with Part 150 requirements, the City will submit revised NEMs should either of these assumptions change, or if "any change in the operation of the airport would create any 'substantial, new noncompatible use' in any area depicted on the map beyond that which is forecast for the fifth calendar year after the date of submission."[30]

The 2018 and 2023 noise modeling assumptions differ in terms of the level and mix of aircraft activity operating at the Airport. Section 6.4 presents the modeling "fleet mixes" for those two years. Figure 14 compares the 65 dB DNL contours for 2018 and 2023, to illustrate the effect of the anticipated change in activity. For clarity, the higher contour levels are omitted from this figure. Section 5.3.1 includes further discussion regarding differences between the 2018 and 2023 65 dB DNL contours.

The local municipalities (land use control jurisdictions) within the 2018 65 dB DNL NEM contour include:

- Town of Williston ("Williston"); and
- City of South Burlington ("South Burlington" or "So. Burlington") ; and
- City of Winooski ("Winooski").

[30] In 14 CFR §150.21(d).

The local municipalities (land use control jurisdictions) within the 2023 65 dB DNL NEM contour include:

- Town of Williston (“Williston”);
- City of South Burlington (“South Burlington” or “So. Burlington”);
- City of Burlington (“City” or “Burlington”);
- City of Winooski (“Winooski”);
- Town of Colchester (“Colchester”) ; and
- Town of Essex (“Essex”)

All of these municipalities are within Chittenden County. The maps include building outlines as reference, where such data were available. Non-contiguous 65 dB DNL contour areas are present in the 2018 NEM and 2023 NEM due to the effects of terrain.

Additional discussion is presented in the sections below.

5.2 Comparison of Various Noise Contours for 2015 through 2023

To provide a historical frame of reference, Figure 15 compares the 65 dB DNL contours for three previously documented noise contours along with the 2018 and 2023 contours that are part of this submission. The four contours, and the respective approximate land area, are listed below.

- The 2015 existing condition contour from the most recent NEM update study, accepted by FAA on December 22, 2015. Approximately 2,059 acres.
- The “ANG Scenario 1” contour from the USAF’s September 2013 FEIS, Figure BR3.2-2.[31] Note that this noise contour is based on the USAF’s 228 flying days. All the others noise contours in this figure, and in this document, are based on 365 days, as required by Part 150 and FAA guidance. Approximately 3,132 acres.
- The 2018 existing condition contour from this submission. Approximately 1,063 acres.
- The 2023 existing condition contour from this submission. Approximately 2,655 acres.

The comparison of these contours would not be complete without noting that these contours were developed at different times and with different information. The development of the 2018 and 2023 contours is discussed in Chapter 6 of this document, while the development of the 2015 contour is discussed in the 2015 NEM update. For the purpose of this comparison, only the 2015 65 dB DNL main contour is referenced since the 2015 and 2020 65 dB DNL contours differ very little from each other.

Both the 2015 NEM and the 2018 NEM include VTANG F-16C aircraft. The 2018 65 dB DNL contour is overall smaller than the 2015 and 2023 contours due primarily to the following two factors occurring during 2018:

1. The VTANG is in the process of drawing down numbers of F-16C aircraft and operations in preparation for the arrival of the F-35A aircraft in 2019.
2. Periods of construction on Runway 15/33 resulted in reduced usage of afterburner departures by the VTANG F-16C aircraft.

As a result of the two factors mentioned above, the 2018 NEM DNL contours are representative of an atypical and short term reduced state of operations for the VTANG.

The total acreage of the 2023 65 dB DNL contour is reduced relative to the EIS “ANG Scenario 1” contour. As noted previously, the EIS F-35A noise modeling was based on 228 flying days rather than the 365 annual day period required by 14 CFR Part 150. The overall reduction in acreage results primarily from the change in the number of days over which annual aircraft operations are averaged for modeling. Taken by itself, this change in the

[31] The exact graphical files used to produce this Figure BR3.2-2 were not available, so the contour presented here is approximate and may differ very slightly from the FEIS.

methodology used for calculating average daily aircraft operations results in a reduction of approximately 2 dB DNL at all locations. Forecast annual activity for the VTANG F-35A aircraft in the 2023 NEM remains unchanged from that presented in the FEIS “ANG Scenario 1”.

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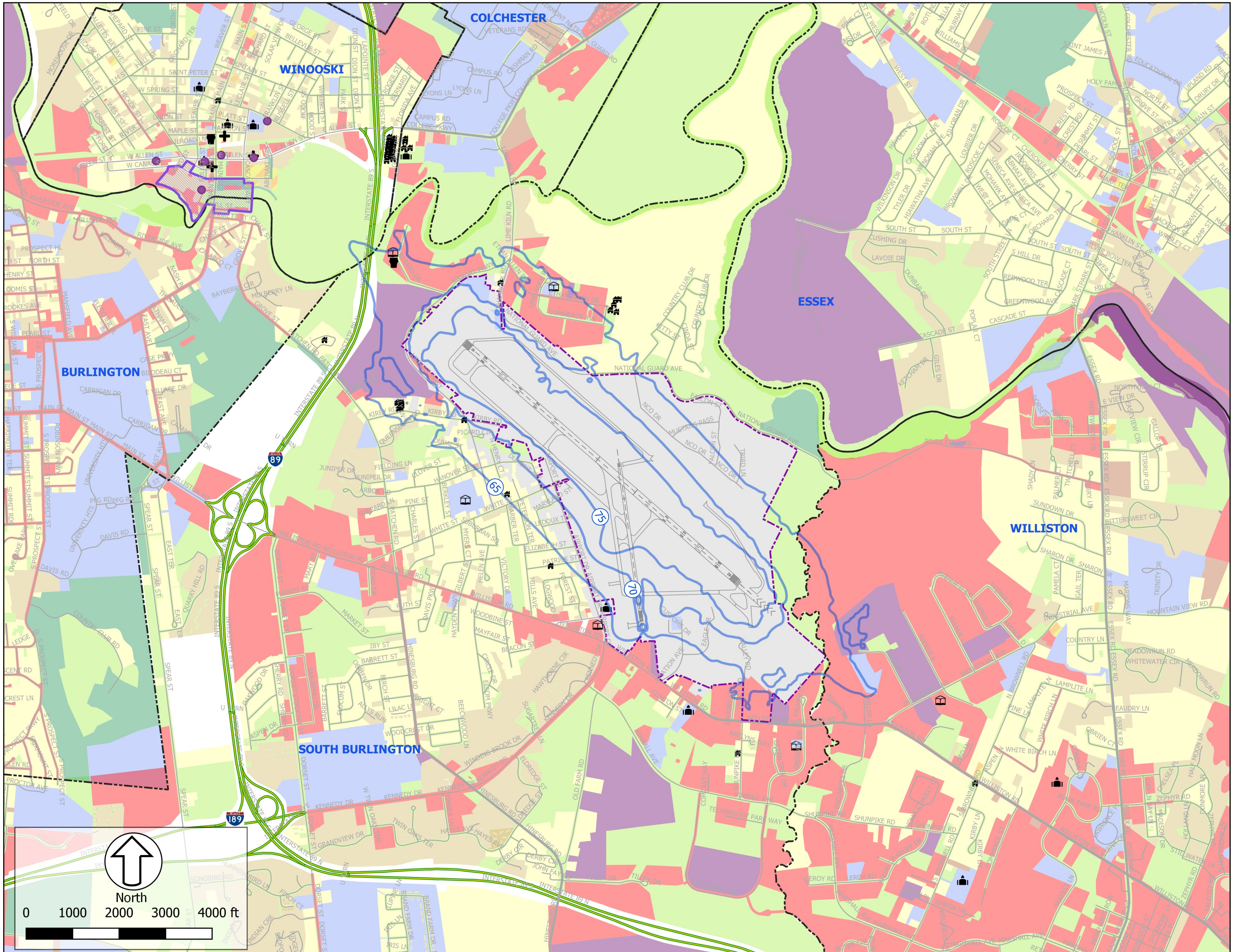


BURLINGTON INTERNATIONAL AIRPORT

PART 150 - NOISE EXPOSURE MAP UPDATE

Figure 12
2018 Existing Conditions Noise Exposure Map

2018 DNL Contour

Town Boundary
Airport Property Boundary
Historic Districts
Historic Sites
Local Roads
Major Roads
Highways

Education
Health Care
Place of Worship
Public Gathering
Residential

2018 Land Use

Single Family Residential (1)
Multi Family Residential (1)
Other Residential (1)
Mixed Use (1)
Public Use (1)

*Possible sound insulation areas

Airport
Transportation (2)
Commercial (2)
Manufacturing & Production (2)
Recreational (2)
Open Space

(1) Potentially non-compatible within 65 dB DNL contour as discussed in Section 3.4.
(2) Potentially non-compatible within 70 dB DNL contour as discussed in Section 3.4.

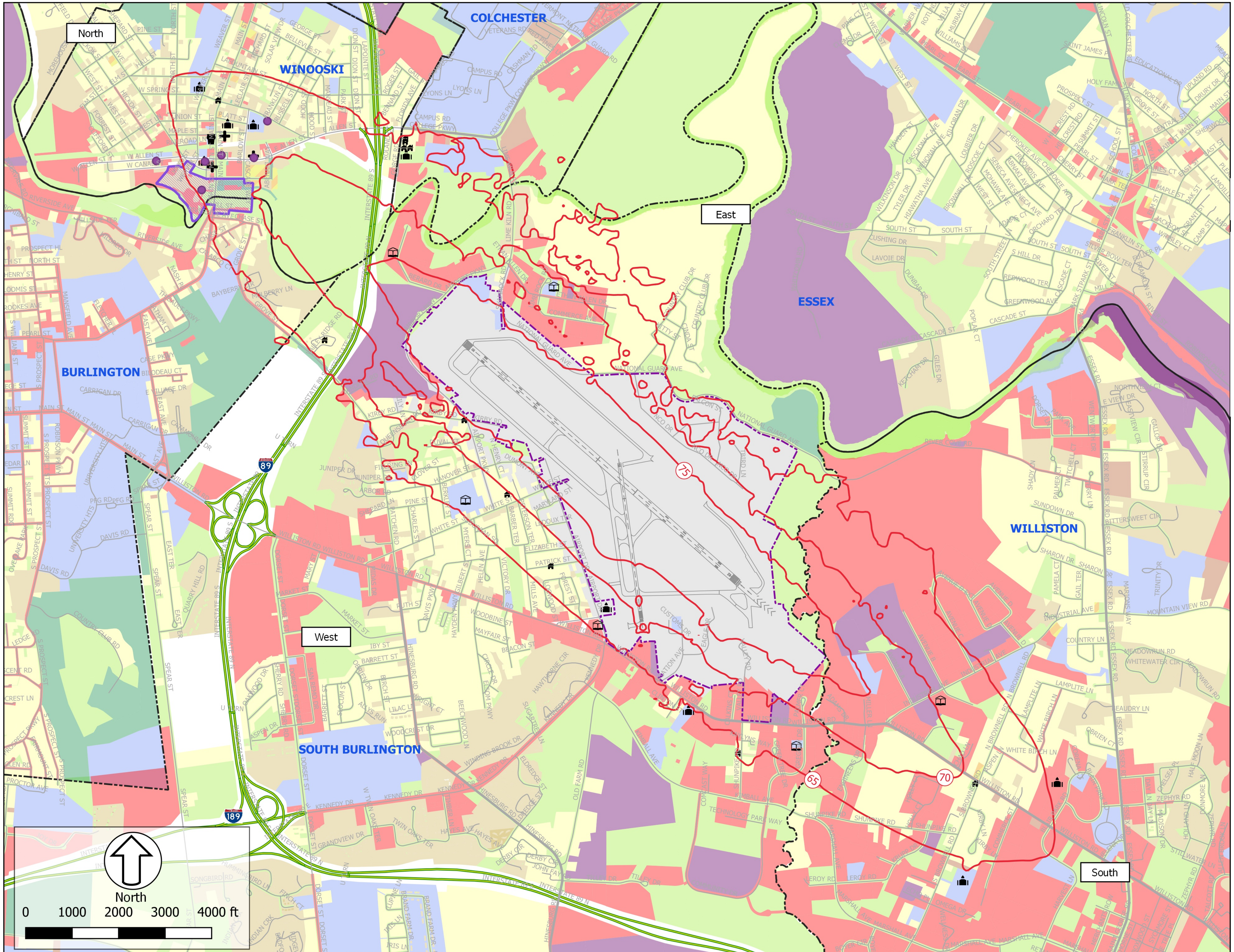
Data Source:
Vermont Center for Geographic Information Inc. (VCGI), United States Census Bureau, National Register of Historic Places, Burlington Internationa Airport, Harris Miller Miller & Hanson Inc.

The Jones Payne Group, Inc.

BURLINGTON
INTERNATIONAL AIRPORT

PART 150 - NOISE EXPOSURE MAP UPDATE

Figure 13 - Overall
2023 Forecast Conditions Noise Exposure Map



2023 DNL Contour

Town Boundary
Airport Property Boundary
Historic Districts
Historic Sites
Local Roads
Major Roads
Highways

Education
Health Care
Place of Worship
Public Gathering
Residential

2018 Land Use

Single Family Residential (1)
Multi Family Residential (1)
Other Residential (1)
Mixed Use (1)
Public Use (1)

*Possible sound insulation areas

Airport
Transportation (2)
Commercial (2)
Manufacturing & Production (2)
Recreational (2)
Open Space

(1) Potentially non-compatible within 65 dB DNL contour as discussed in Section 3.4.
(2) Potentially non-compatible within 70 dB DNL contour as discussed in Section 3.4.

Data Source:
Vermont Center for Geographic Information Inc. (VCGI), United States Census Bureau, National Register of Historic Places, Burlington Internationa Airport, Harris Miller Miller & Hanson Inc.

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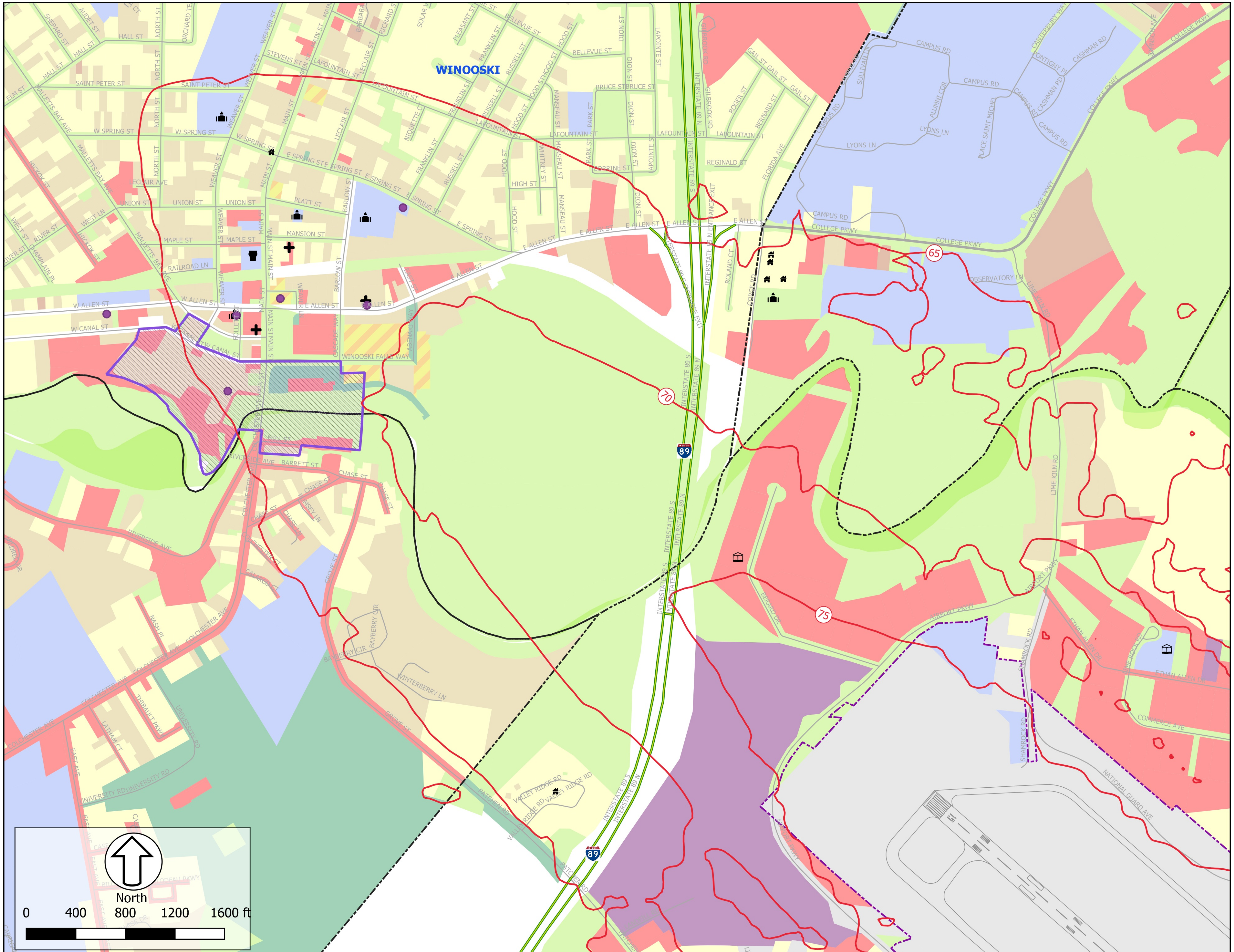
BURLINGTON INTERNATIONAL AIRPORT

PART 150 - NOISE EXPOSURE MAP UPDATE

Figure 13 - North
2023 Forecast Conditions Noise Exposure Map



2023 DNL Contour

Town Boundary
Airport Property Boundary
Historic Districts
Historic Sites
Local Roads
Major Roads
Highways

Education
Health Care
Place of Worship
Public Gathering
Residential

2018 Land Use

Single Family Residential (1)
Multi Family Residential (1)
Other Residential (1)
Mixed Use (1)
Public Use (1)

*Possible sound insulation areas

Airport
Transportation (2)
Commercial (2)
Manufacturing & Production (2)
Recreational (2)
Open Space

(1) Potentially non-compatible within 65 dB DNL contour as discussed in Section 3.4.
(2) Potentially non-compatible within 70 dB DNL contour as discussed in Section 3.4.

Data Source:
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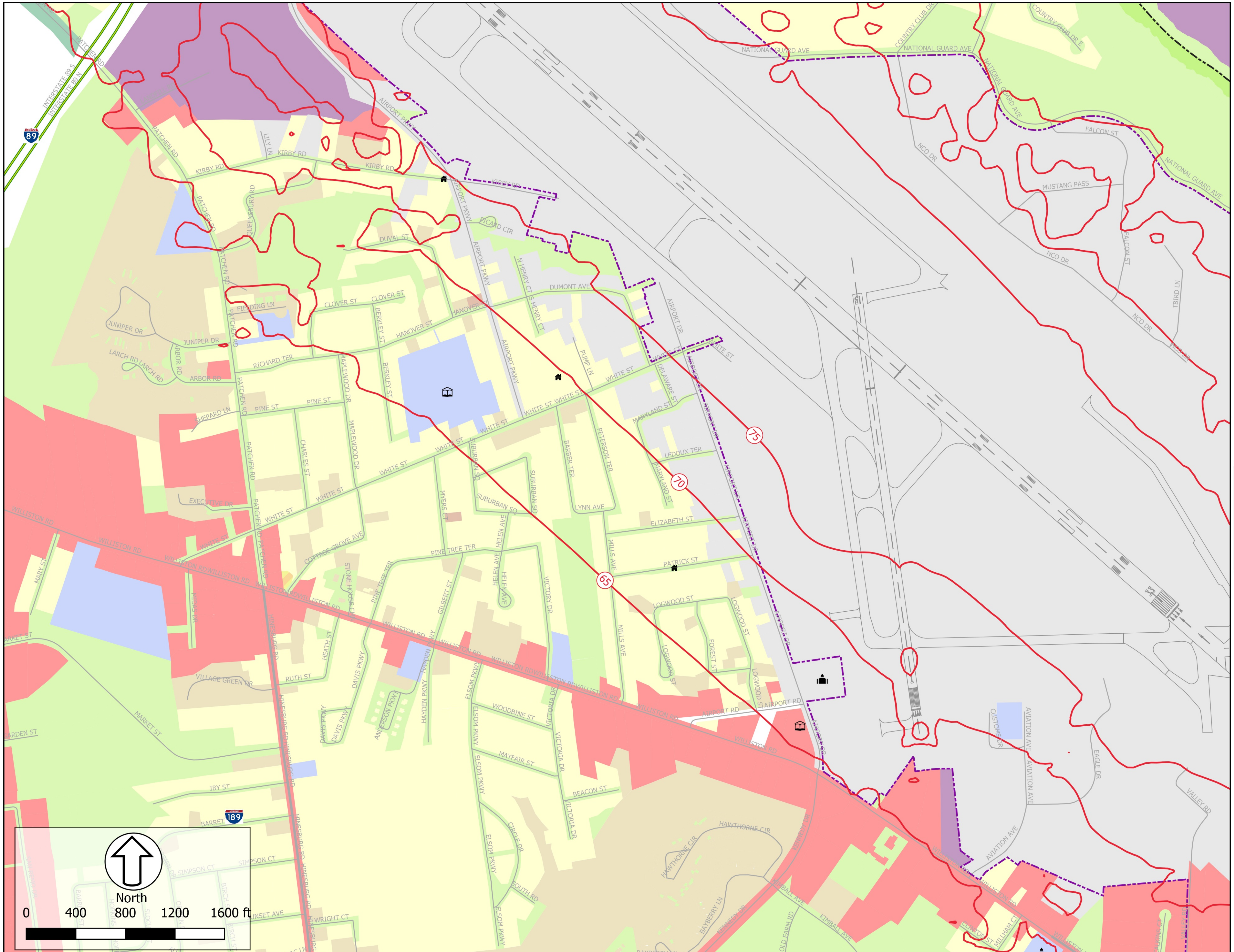
BURLINGTON INTERNATIONAL AIRPORT

PART 150 - NOISE EXPOSURE MAP UPDATE

Figure 13 - West
2023 Forecast Conditions Noise Exposure Map



2023 DNL Contour

Town Boundary
Airport Property Boundary
Historic Districts
Historic Sites
Local Roads
Major Roads
Highways

Education
Health Care
Place of Worship
Public Gathering
Residential

2018 Land Use

Single Family Residential (1)
Multi Family Residential (1)
Other Residential (1)
Mixed Use (1)
Public Use (1)

*Possible sound insulation areas

Airport
Transportation (2)
Commercial (2)
Manufacturing & Production (2)
Recreational (2)
Open Space

(1) Potentially non-compatible within 65 dB DNL contour as discussed in Section 3.4.
(2) Potentially non-compatible within 70 dB DNL contour as discussed in Section 3.4.

Data Source:
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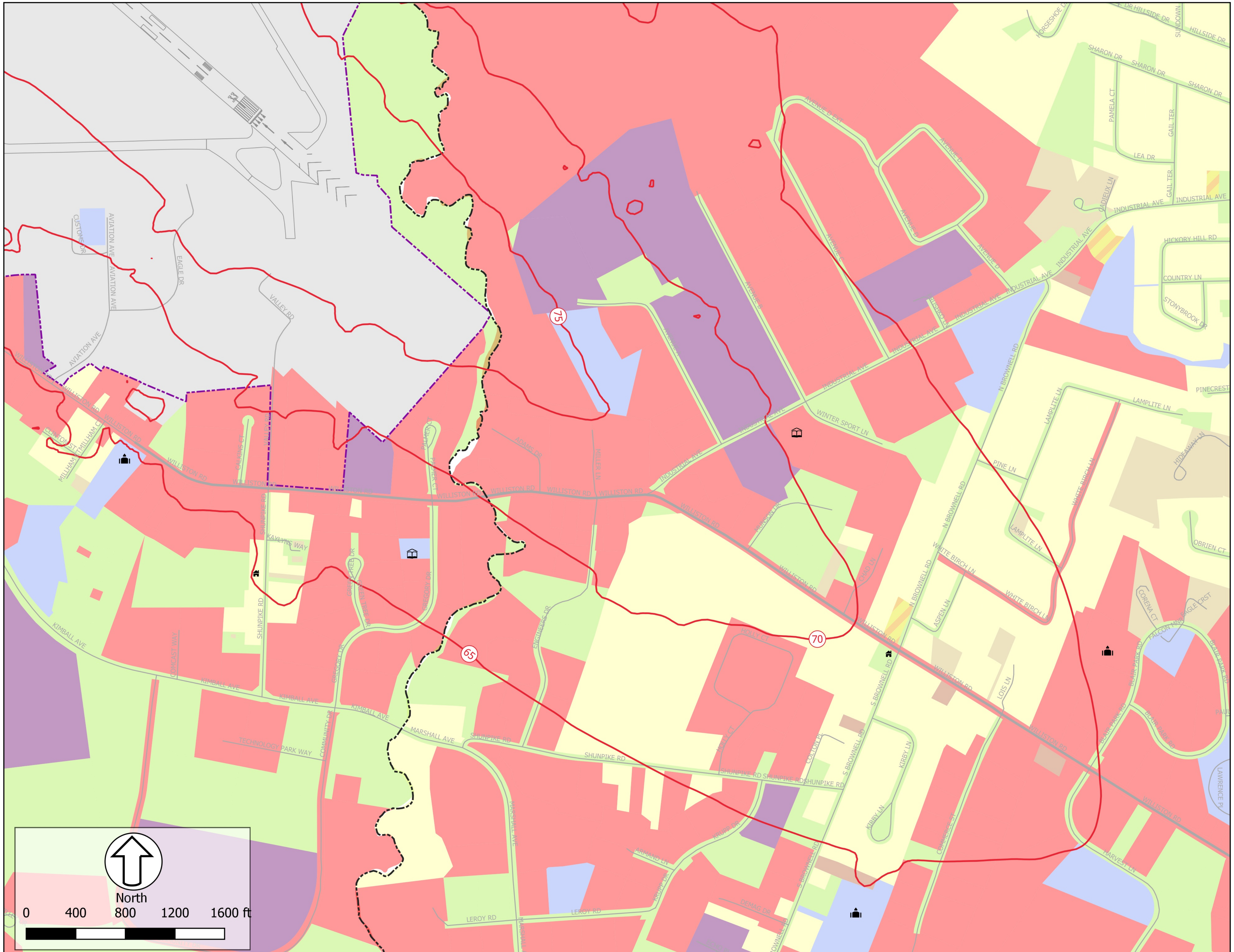

BURLINGTON INTERNATIONAL AIRPORT

PART 150 - NOISE EXPOSURE MAP UPDATE

Figure 13 - South
2023 Forecast Conditions Noise Exposure Map

2023 DNL Contour

Town Boundary
Airport Property Boundary
Historic Districts
Historic Sites
Local Roads
Major Roads
Highways

Education
Health Care
Place of Worship
Public Gathering
Residential

2018 Land Use

Single Family Residential (1)
Multi Family Residential (1)
Other Residential (1)
Mixed Use (1)
Public Use (1)

*Possible sound insulation areas

Airport
Transportation (2)
Commercial (2)
Manufacturing & Production (2)
Recreational (2)
Open Space

(1) Potentially non-compatible within 65 dB DNL contour as discussed in Section 3.4.
(2) Potentially non-compatible within 70 dB DNL contour as discussed in Section 3.4.

Data Source:
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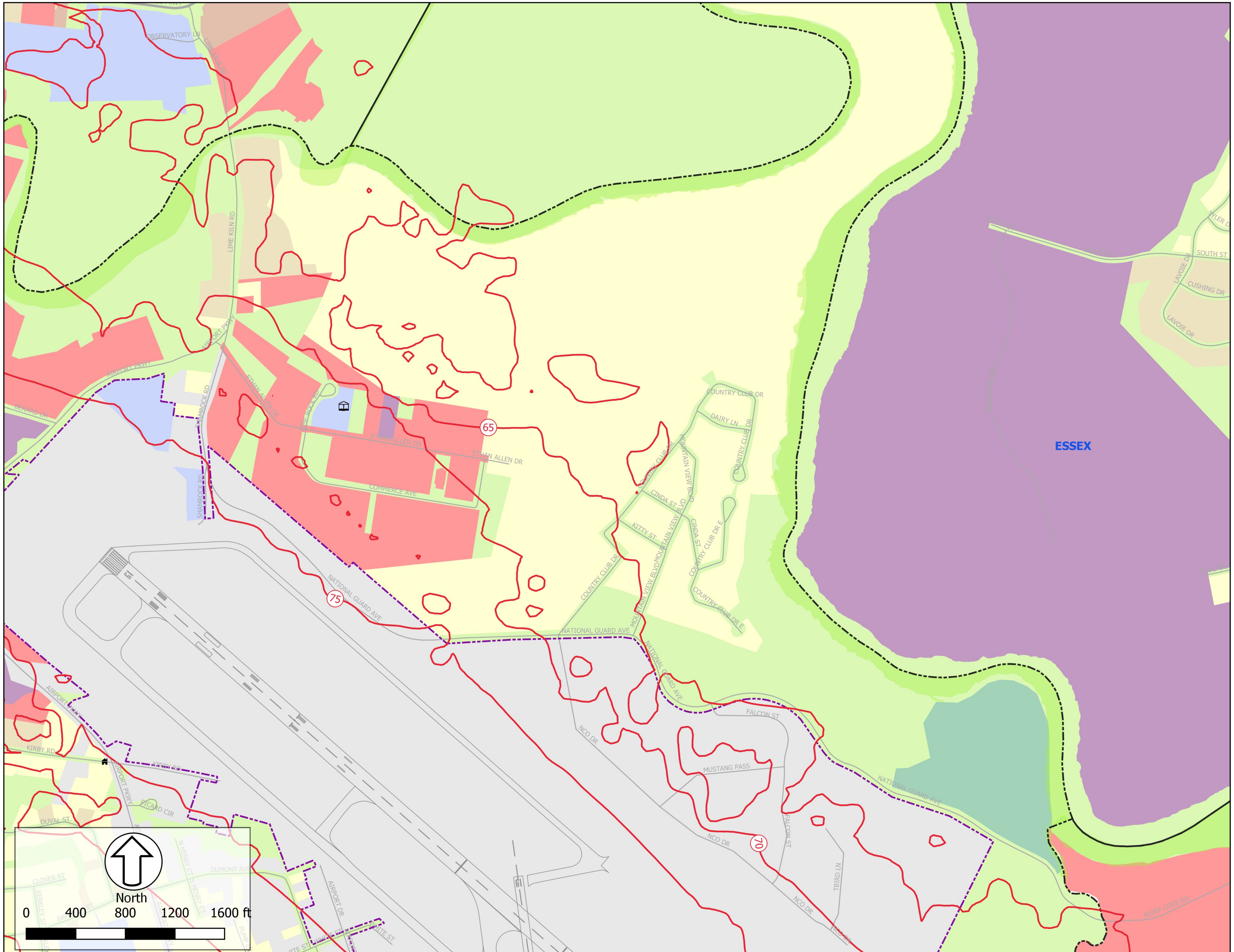
The Jones Payne Group, Inc.



BURLINGTON
INTERNATIONAL AIRPORT

PART 150 - NOISE EXPOSURE MAP UPDATE

Figure 13 - East
2023 Forecast Conditions Noise Exposure Map

2023 DNL Contour

Town Boundary
Airport Property Boundary
Historic Districts
Historic Sites
Local Roads
Major Roads
Highways

Education
Health Care
Place of Worship
Public Gathering
Residential

2018 Land Use

Single Family Residential (1)
Multi Family Residential (1)
Other Residential (1)
Mixed Use (1)
Public Use (1)

*Possible sound insulation areas

Airport
Transportation (2)
Commercial (2)
Manufacturing & Production (2)
Recreational (2)
Open Space

(1) Potentially non-compatible within 65 dB DNL contour as discussed in Section 3.4.
(2) Potentially non-compatible within 70 dB DNL contour as discussed in Section 3.4.

Data Source:
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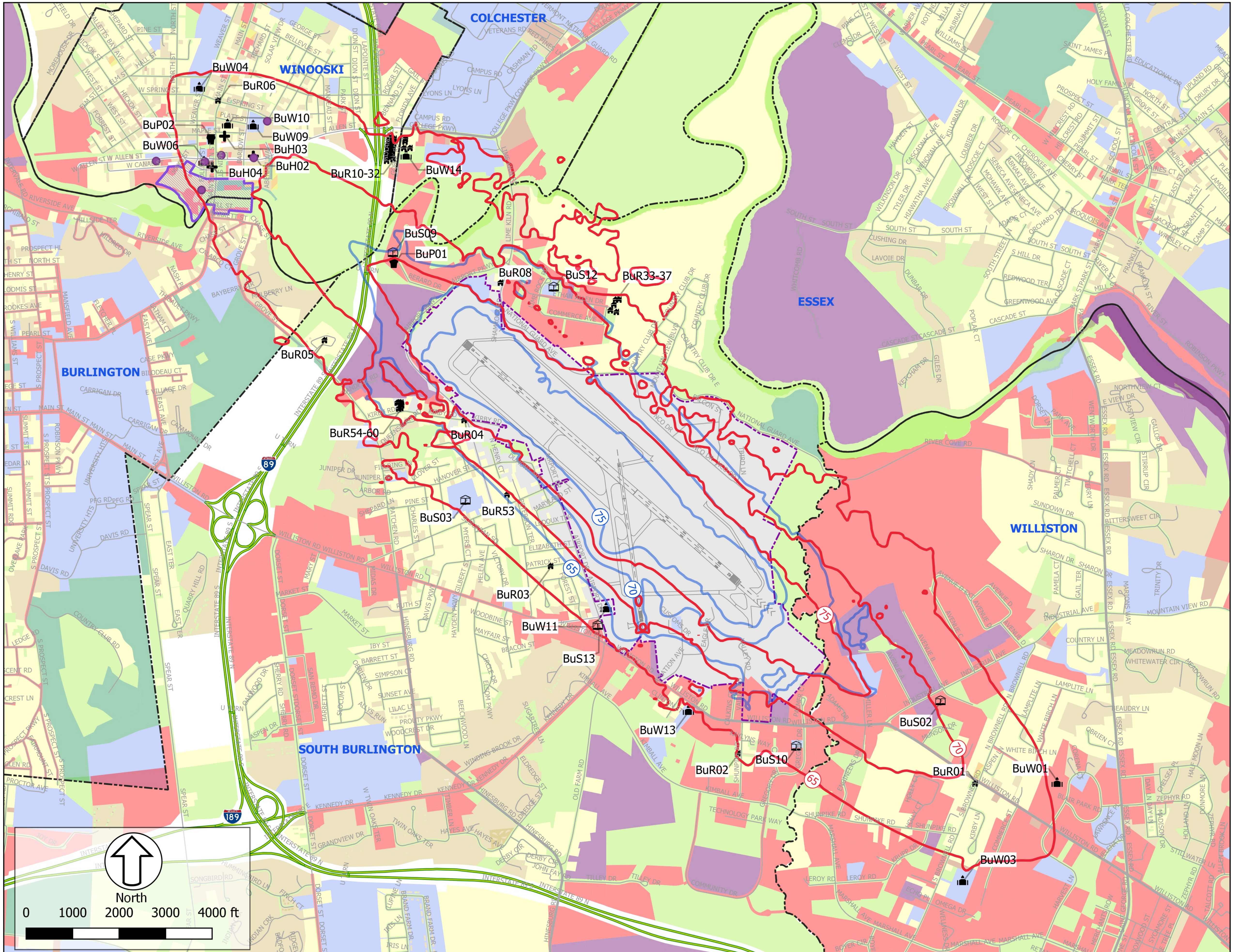
PART 150 - NOISE EXPOSURE MAP UPDATE

Figure 14
Comparison of 2018 and 2023 Day-Night Average Sound Level (DNL) Contours



2018 DNL Contour
2023 DNL Contour

Town Boundary
Airport Property Boundary
Historic Districts
Historic Sites
Local Roads
Major Roads
Highways
Education
Health Care
Place of Worship
Public Gathering
Residential

2018 Land Use

Single Family Residential (1)
Multi Family Residential (1)
Other Residential (1)
Mixed Use (1)
Public Use (1)

*Possible sound insulation areas

Airport
Transportation (2)
Commercial (2)
Manufacturing & Production (2)
Recreational (2)
Open Space

(1) Potentially non-compatible within 65 dB DNL contour as discussed in Section 3.4.
(2) Potentially non-compatible within 70 dB DNL contour as discussed in Section 3.4.

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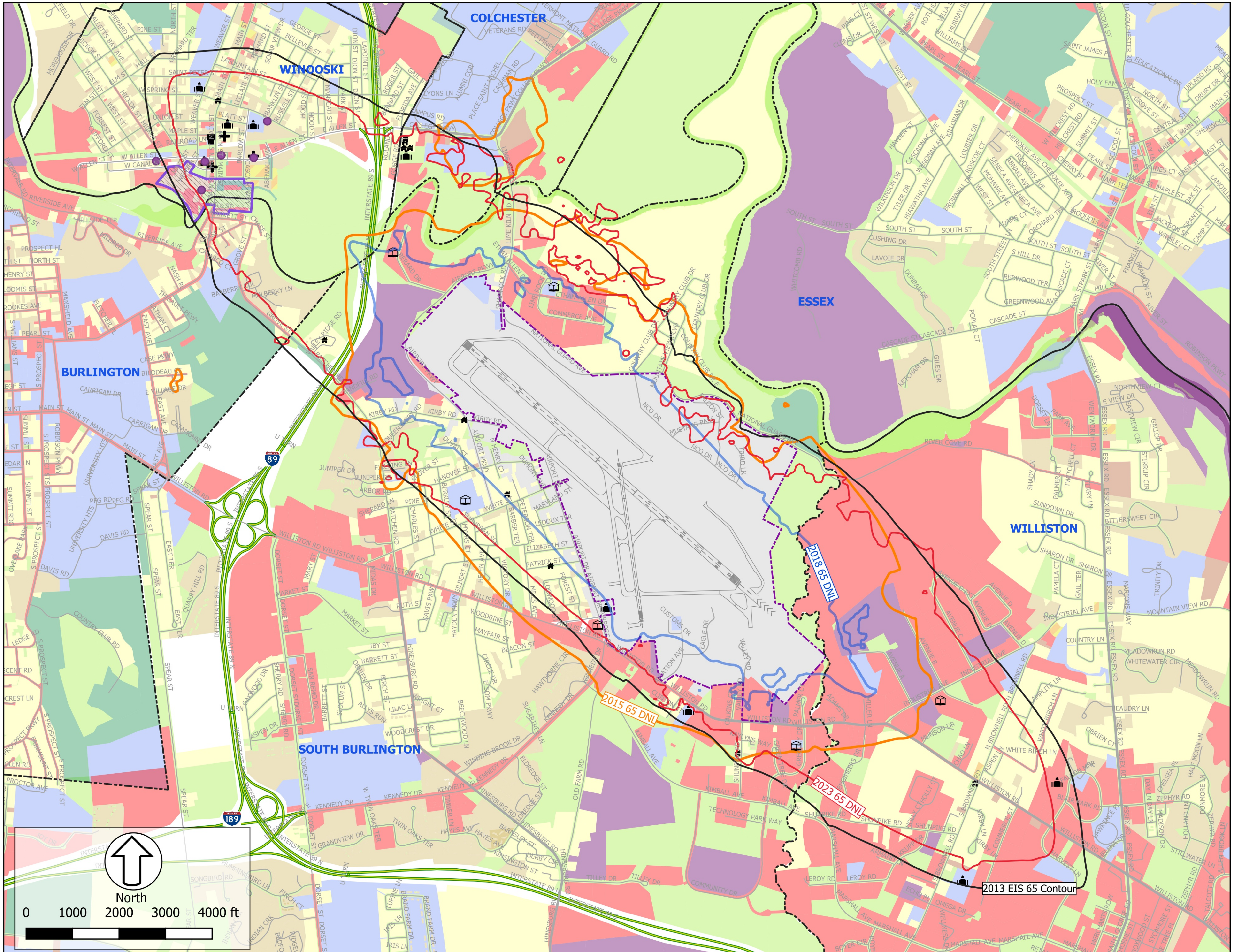


BURLINGTON INTERNATIONAL AIRPORT

PART 150 - NOISE EXPOSURE MAP UPDATE

Figure 15 - Overall Comparison of 65 dB Day-Night Average Sound Level (DNL) Contours for 2015, 2018, 2023, and the F-35A EIS

2018 65 DNL Contour	2013 EIS 65 Countour
2023 65 DNL Contour	2015 65 DNL Contour
Town Boundary	Education
Airport Property Boundary	Health Care
Historic Districts	Place of Worship
Historic Sites	Public Gathering
Local Roads	Residential
Major Roads	
Highways	

2018 Land Use

- Single Family Residential (1)
- Multi Family Residential (1)
- Other Residential (1)
- Mixed Use (1)
- Public Use (1)

*Possible sound insulation areas

- Airport
- Transportation (2)
- Commercial (2)
- Manufacturing & Production (2)
- Recreational (2)
- Open Space

(1) Potentially non-compatible within 65 dB DNL contour as discussed in Section 3.4.
(2) Potentially non-compatible within 70 dB DNL contour as discussed in Section 3.4.

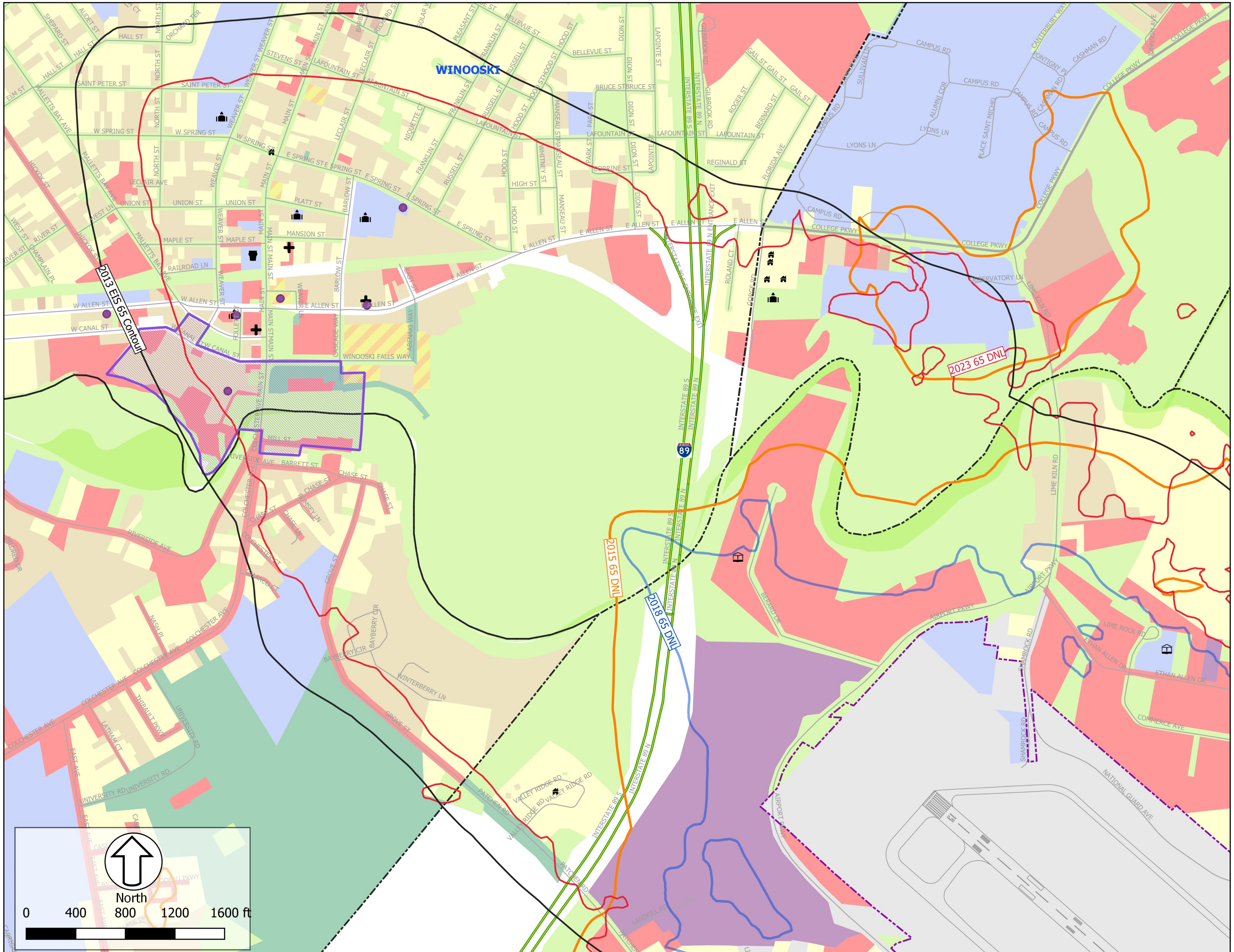
Data Source:
Vermont Center for Geographic Information Inc. (VCGI), United States Census Bureau, National Register of Historic Places, Burlington Internationa Airport, Harris Miller Miller & Hanson Inc.

The Jones Payne Group, Inc.

BURLINGTON INTERNATIONAL AIRPORT

PART 150 - NOISE EXPOSURE MAP UPDATE

Figure 15 - North
Comparison of 65 dB Day-Night Average Sound Level (DNL) Contours for 2015, 2018, 2023, and the F-35A EIS



2018 65 DNL Contour
2013 EIS 65 Countour
2023 65 DNL Contour
2015 65 DNL Contour

Town Boundary
Education
Airport Property Boundary
Health Care
Historic Districts
Place of Worship
Historic Sites
Public Gathering
Local Roads
Residential
Major Roads
Highways

2018 Land Use

Single Family Residential (1)
Multi Family Residential (1)
Other Residential (1)
Mixed Use (1)
Public Use (1)

*Possible sound insulation areas

Airport
Transportation (2)
Commercial (2)
Manufacturing & Production (2)
Recreational (2)
Open Space

(1) Potentially non-compatible within 65 dB DNL contour as discussed in Section 3.4.
(2) Potentially non-compatible within 70 dB DNL contour as discussed in Section 3.4.

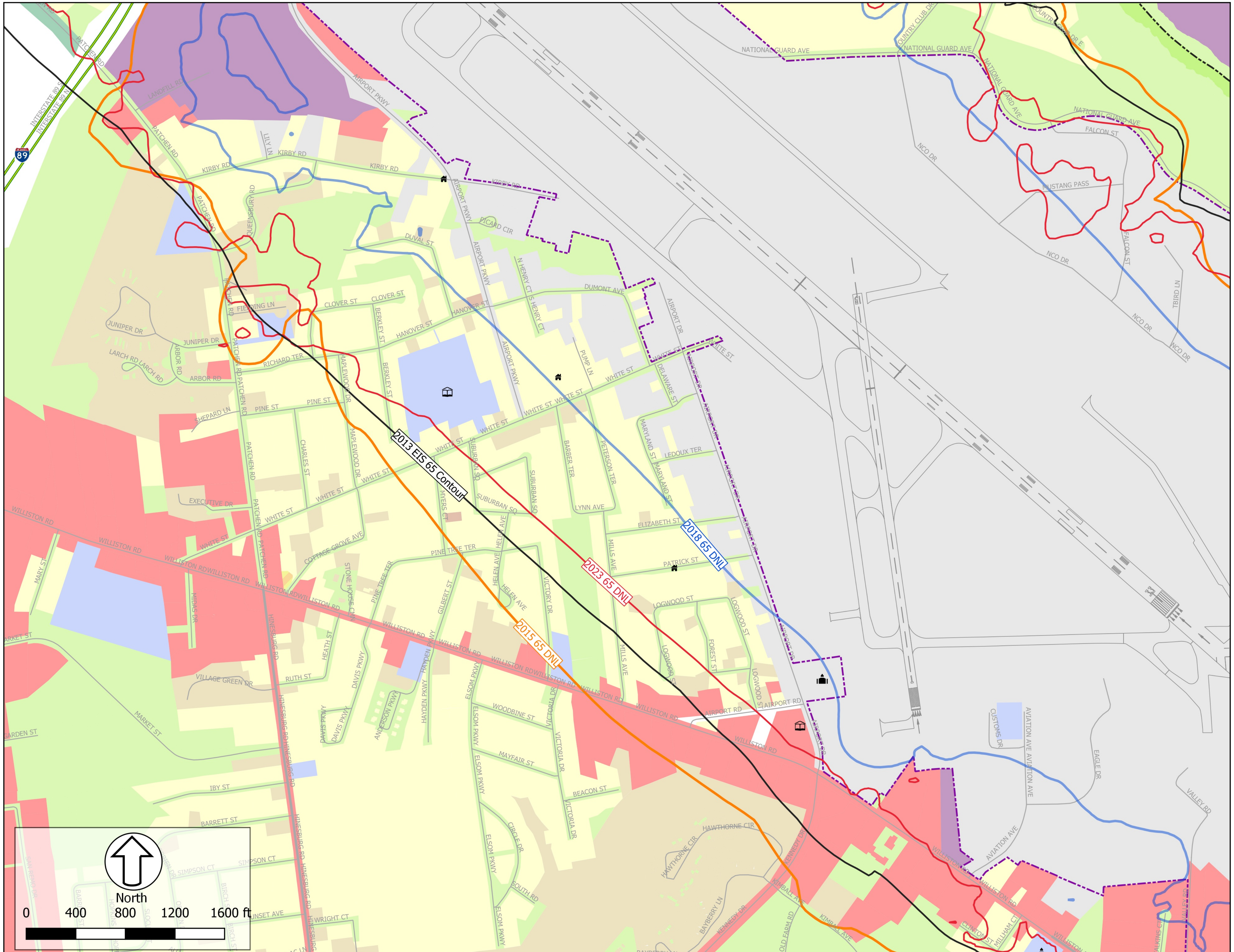
Data Source:
Vermont Center for Geographic Information Inc. (VCGI), United States Census Bureau, National Register of Historic Places, Burlington Internationa Airport, Harris Miller Miller & Hanson Inc.

The Jones Payne Group, Inc.

BURLINGTON INTERNATIONAL AIRPORT

PART 150 - NOISE EXPOSURE MAP UPDATE

Figure 15 - West
Comparison of 65 dB Day-Night Average Sound Level (DNL) Contours for 2015, 2018, 2023, and the F-35A EIS



- 2018 65 DNL Contour
- 2023 65 DNL Contour
- 2013 EIS 65 Countour
- 2015 65 DNL Contour
- Town Boundary
- Airport Property Boundary
- Historic Districts
- Historic Sites
- Local Roads
- Major Roads
- Highways
- Education
- Health Care
- Place of Worship
- Public Gathering
- Residential

2018 Land Use

- Single Family Residential (1)
- Multi Family Residential (1)
- Other Residential (1)
- Mixed Use (1)
- Public Use (1)

*Possible sound insulation areas

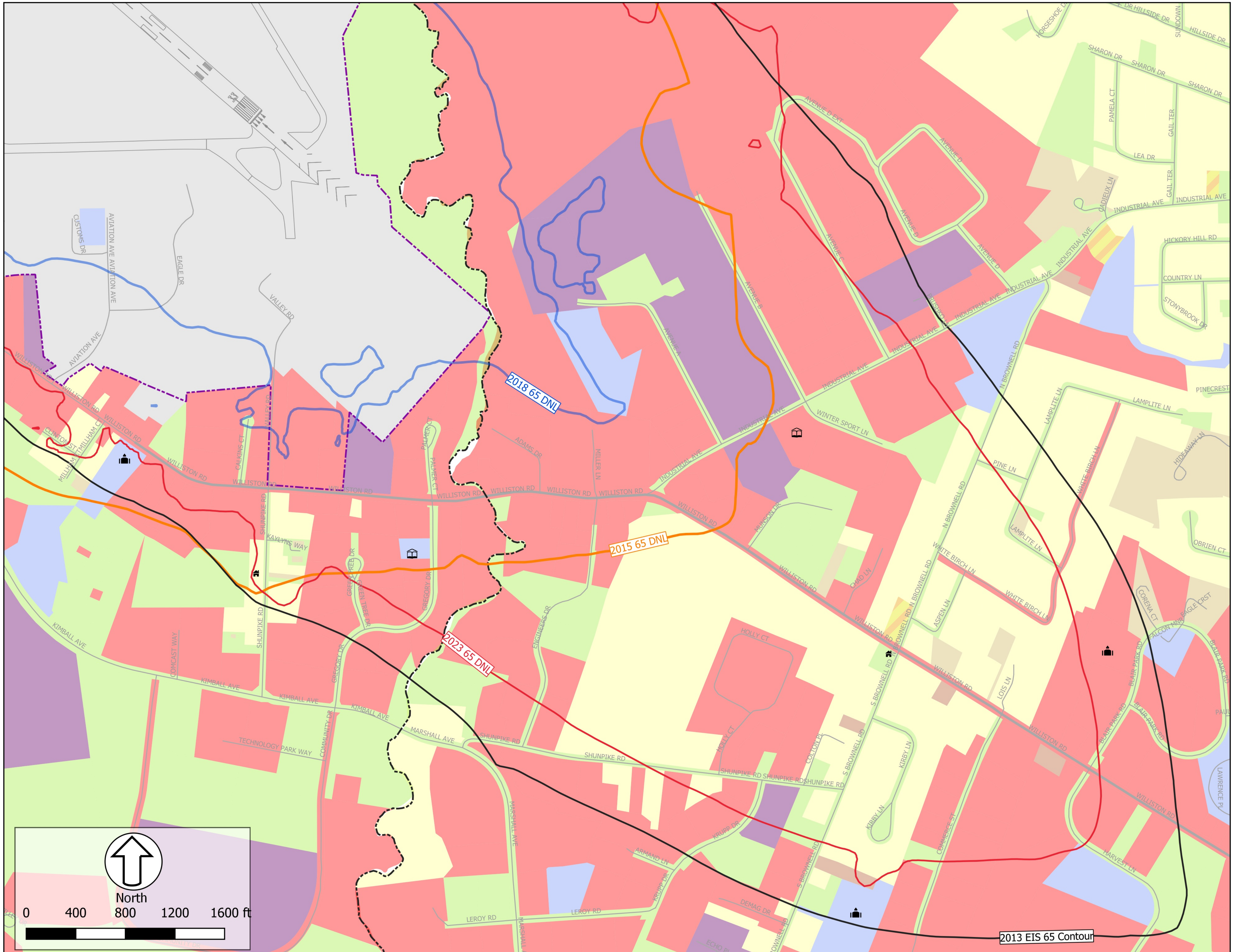
- Airport
- Transportation (2)
- Commercial (2)
- Manufacturing & Production (2)
- Recreational (2)
- Open Space

(1) Potentially non-compatible within 65 dB DNL contour as discussed in Section 3.4.
(2) Potentially non-compatible within 70 dB DNL contour as discussed in Section 3.4.

Data Source:
Vermont Center for Geographic Information Inc. (VCGI), United States Census Bureau, National Register of Historic Places, Burlington Internationa Airport, Harris Miller Miller & Hanson Inc.

hmmh

jp The Jones Payne Group, Inc.



BURLINGTON INTERNATIONAL AIRPORT

PART 150 - NOISE EXPOSURE MAP UPDATE

Figure 15 - South
Comparison of 65 dB Day-Night Average Sound Level (DNL) Contours for 2015, 2018, 2023, and the F-35A EIS

- 2018 65 DNL Contour
- 2013 EIS 65 Countour
- 2023 65 DNL Contour
- 2015 65 DNL Contour
- Town Boundary
- Education
- Airport Property Boundary
- Health Care
- Historic Districts
- Place of Worship
- Historic Sites
- Public Gathering
- Local Roads
- Residential
- Major Roads
- Highways

2018 Land Use

- Single Family Residential (1)
- Multi Family Residential (1)
- Other Residential (1)
- Mixed Use (1)
- Public Use (1)

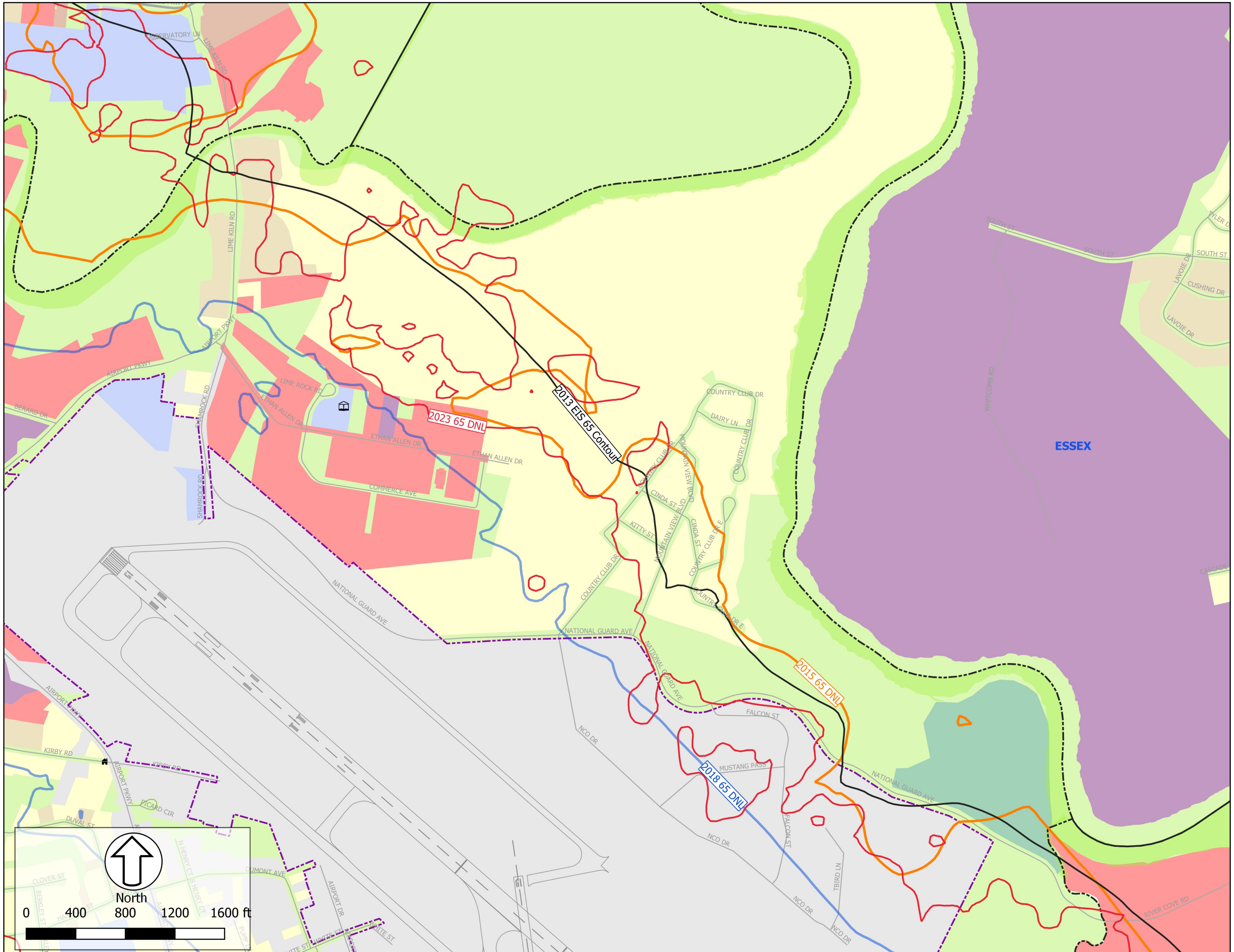
*Possible sound insulation areas

- Airport
- Transportation (2)
- Commercial (2)
- Manufacturing & Production (2)
- Recreational (2)
- Open Space

(1) Potentially non-compatible within 65 dB DNL contour as discussed in Section 3.4.
(2) Potentially non-compatible within 70 dB DNL contour as discussed in Section 3.4.

Data Source:
Vermont Center for Geographic Information Inc. (VCGI), United States Census Bureau, National Register of Historic Places, Burlington Internationa Airport, Harris Miller Miller & Hanson Inc.

The Jones Payne Group, Inc.



BURLINGTON INTERNATIONAL AIRPORT

PART 150 - NOISE EXPOSURE MAP UPDATE

Figure 15 - East
Comparison of 65 dB Day-Night Average Sound Level (DNL) Contours for 2015, 2018, 2023, and the F-35A EIS

- 2018 65 DNL Contour
- 2013 EIS 65 Countour
- 2023 65 DNL Contour
- 2015 65 DNL Contour
- Town Boundary
- Education
- Airport Property Boundary
- Health Care
- Historic Districts
- Place of Worship
- Historic Sites
- Public Gathering
- Local Roads
- Residential
- Major Roads
- Highways

2018 Land Use

- Single Family Residential (1)
- Multi Family Residential (1)
- Other Residential (1)
- Mixed Use (1)
- Public Use (1)

*Possible sound insulation areas

- Airport
- Transportation (2)
- Commercial (2)
- Manufacturing & Production (2)
- Recreational (2)
- Open Space

(1) Potentially non-compatible within 65 dB DNL contour as discussed in Section 3.4.
(2) Potentially non-compatible within 70 dB DNL contour as discussed in Section 3.4.

Data Source:
Vermont Center for Geographic Information Inc. (VCGI), United States Census Bureau, National Register of Historic Places, Burlington Internationa Airport, Harris Miller Miller & Hanson Inc.

The Jones Payne Group, Inc.

5.3 Potential Noncompatibile Land Uses within the Noise Contours

Based on the land use compatibility guidelines presented in Table 2, the following land uses are *potentially* noncompatible with aircraft noise exposure, within the 65 dB DNL contours.[32]

- Residential land use within the 65 dB and higher contours (shown in various shades of yellow in the figures. This includes residential elements of areas shown as "Mixed Use").
- Residential homes on agricultural land within 65 dB and higher contours.
- Public and private schools within 65 dB and higher contours.
- Day care facilities within the 65 dB and higher contours, considered schools.
- Places of worship within 65 dB and higher contours.
- Auditoriums, concert halls, and public meeting areas within 65 dB and higher contours.
- Government service, Manufacturing and Wholesale Trade, General Sales and Services, Transportation, Communication, and Utilities buildings within the 70 dB and higher contours.

These potential noncompatible land uses fall into two principal categories: (1) discrete sensitive uses or "receptors", and (2) residential. Section 5.3.1 discusses the expected changes in noncompatible land-use between 2018 and 2023. Section 5.3.2 identifies the discrete noise sensitive locations within the 65 dB DNL contours while Section 5.3.3 presents the estimated population contours within 65 dB DNL contours.

A key element of the FAA-approved NCP for BTV is voluntary property acquisitions and associated relocation. BTV has pursued this program, with FAA funding support. This process was discussed in Section 4.3.1, Section 4.3.2, and Section 4.3.3. The City of Burlington and other local municipalities have expressed an interest in ending the voluntary acquisition program and transition to other mitigation options. The City would like to continue acquisitions to the extent the homeowner, land use jurisdiction, the FAA and the Airport/City are in agreement. Going forward, the City's preference is to implement sound insulation as the primary mitigation measure.

5.3.1 Comparison of the 2018 and 2023 Noncompatibile Land Uses

Comparison of the 2018 and 2023 contours, as depicted in Figure 14, show that the area within the 65 dB DNL contours is expected to increase in all directions for the 2023 forecast year, resulting in increases to noncompatible land uses. The most notable increases occur to the northwest and southeast of the airfield in line with Runway 15/33, while areas adjacent to the runway show a still notable but lesser degree of expansion. It should be noted, however, that 2018 represents an atypically low level of operations by the VTANG, due to removal of F-16C aircraft from their inventory in preparation for the arrival of the first F-35A aircraft in 2019. Furthermore, runway construction in 2018 hindered the use of afterburners for F-16C departures during much of the year. These two factors combined, result in the 2018 65 dB DNL contour being notably reduced in extent relative to the prior 2015 and 2020 NEMs. These circumstances unique to 2018, result in greater increases to the area within the 65 dB DNL contour from the existing condition to the forecast condition than would be encountered when comparing forecast conditions to a typical historic year of unimpeded VTANG operations.

5.3.2 Discrete Sensitive Receptors and National Register of Historic Places within the Noise Contours

The existing and forecast condition NEMs (Figure 12 and Figure 13) also show the locations of potentially noise sensitive discrete locations, both non-residential and select residential locations, at noise levels of 65 dB DNL or greater for either of the NEM conditions. One of these locations is currently listed on the National Register of

[32] As indicated in the notes to Table 2, the ultimate compatibility determination depends on the amount of outdoor to indoor "Noise Level Reduction" incorporated into the building, or for some land uses, certain portions of the building.

Historic Places. These locations are depicted on the NEMs and the status within the 2018 NEM and the 2023 NEM are listed in Table 3. Figure 14 presents these locations labeled with the IDs designated in Table 3.

These noise sensitive locations could be either compatible or noncompatible depending on the buildings outdoor-to-indoor Noise Level Reduction (NLR). The appropriate NLR for each activity is specified in Table 2. The facilities identified in Table 3 and in the 65-70 dB DNL contours would require a NLR of 25 dB while facilities in the 70-75 dB DNL contour would require a NLR of 30 dB. The NLR is only beneficial for activities within the facilities' structure and does not provide benefit for outdoor activities.

Table 3. Discrete Noise Sensitive Locations within, or near, the 65 dB DNL Contours for 2018 and 2023

City/Town	Type	Facility Name	2018 NEM Contour Interval	2023 NEM Contour Interval	ID on Figure 14 [2]
South Burlington	Education	Chamberlain Elementary School	< 65	65-70	BuS03
South Burlington	Education	Champlain Valley Gymnastics, Inc.	65-70	70-75	BuS09
South Burlington	Education	Union Training Center, IBEW Local 300	< 65	65-70	BuS10
South Burlington	Education	Kid Logic Learning	65-70	70-75	BuS12
South Burlington	Education	Centerpoint - Private School	< 65	65-70	BuS13
South Burlington	Place of Worship	Eldredge Cemetery	< 65	65-70	BuW11
South Burlington	Place of Worship	Community Bible Church	< 65	< 65	BuW13
South Burlington	Residential	Shunpike Road	< 65	65-70	BuR02
South Burlington	Residential	Patrick Street	< 65	65-70	BuR03
South Burlington	Residential	Airport Parkway/Kirby Road	65-70	70-75	BuR04
South Burlington	Residential	Valley Ridge Road	< 65	65-70	BuR05
Williston	Education	Center for Science Education	< 65	65-70	BuS02
Williston	Place of Worship	Calvary Chapel	< 65	< 65	BuW01
Williston	Place of Worship	Maranatha Christian Church	< 65	< 65	BuW03
Williston	Residential	Williston Road at S Brownell Road	< 65	65-70	BuR01
Winooski	Health Care	Health Care	< 65	65-70	BuH02
Winooski	Health Care	O'Brien Health Center	< 65	65-70	BuH03
Winooski	Health Care	Casey Family Services	< 65	65-70	BuH04
Winooski	Place of Worship	Sisters of Providence Church	< 65	65-70	BuW04
Winooski	Place of Worship	Winooski United Methodist Church [1]	< 65	65-70	BuW06
Winooski	Place of Worship	Saint Stephen Church	< 65	65-70	BuW09
Winooski	Place of Worship	Faith Baptist Church	< 65	65-70	BuW10
Winooski	Place of Worship	St Stephens Cemetery	< 65	65-70	BuW14
Winooski	Public Gathering	Veterans of Foreign Wars	< 65	65-70	BuP02
Winooski	Residential	Main Street/E Spring Street	< 65	65-70	BuR06

Table 3 Notes:
1) The above property is on the National Register of Historic Places.
2) Designators are the same as the USAF FEIS where appropriate. This NEM continued designators in the same number scheme. Some locations are identified solely in just one of the documents and not necessarily in both.

5.3.3 Residential Population within the Noise Contours

Table 4 presents the estimated residential population within the 2018 and 2023 contours. These estimates were developed by multiplying the number of dwelling units within each DNL contour band by the average number of residents per dwelling unit. Based on 2010 Census data, the average household size for units within the Census blocks encompassed by the 2018 and 2023 65 dB DNL contours is 2.32 residents.

The table presents estimates of the number of residential dwelling units, based on data compiled from multiple sources by the Vermont Center for Geographic Information, airport staff, aerial photography, and street view. If a parcel was intersected by a contour, all dwelling units within that parcel are assumed to experience the higher interval level.

The estimated dwelling and population counts include all residential properties identified to date. Each jurisdiction provided zoning information and building point data that further refined the current land use. There are 3 areas where there are large multi-family structures, generally identified as Lime Kiln Rd., Winooski Falls, and Wollen Mill. When the unit count for these structures was not available, aerial photography was used to estimate the total. See the footnotes on Table 4 for the specific building addresses and estimated unit counts.

The 2018 NEM includes all of the same residential properties in the 2023 NEM. The 2023 NEM contour will be utilized by the City for future land-use planning.

Table 4. Estimated Residential Population within for 2018 and 2023 Contour Cases

Sources: US Census (2010), Jones Payne Group (2018)

Day-Night Average Sound Level (DNL) Contour Interval	Estimated Dwelling Units and Population	Burlington		Colchester		Essex		South Burlington		Williston		Winooski		Total	
		2018	2023	2018	2023	2018	2023	2018	2023	2018	2023	2018	2023	2018	2023
Single Family Parcels															
65-70 dB	Dwelling Units	-	51	-	9	-	-	126	356	-	105	-	260	126	781
	Population	-	118	-	21	-	-	292	826	-	244	-	603	292	1,812
70-75 dB	Dwelling Units	-	-	-	-	-	-	8	96	-	1	-	-	8	97
	Population	-	-	-	-	-	-	19	223	-	2	-	-	19	225
75 dB +	Dwelling Units	-	-	-	-	-	-	-	12	-	-	-	-	-	12
	Population	-	-	-	-	-	-	-	28	-	-	-	-	-	28
Total 65 dB +	Dwelling Units	-	51	-	9	-	-	134	464	-	106	-	260	134	890
	Population	-	118	-	21	-	-	311	1,076	-	246	-	603	311	2,065
Multi-Family & Mixed Use Parcels															
65-70 dB	Dwelling Units	-	209	-	13	-	-	30	344 [1]	-	4	-	993 [2]	30	1,563
	Population	-	485	-	30	-	-	70	798 [1]	-	9	-	2,304 [2]	70	3,626
70-75 dB	Dwelling Units	-	81 [3]	-	-	-	-	-	14	-	2	-	89 [4,5]	-	186
	Population	-	188 [3]	-	-	-	-	-	32	-	5	-	206 [4,5]	-	432
75 dB +	Dwelling Units	-	-	-	-	-	-	-	1	-	-	-	-	-	1
	Population	-	-	-	-	-	-	-	2	-	-	-	-	-	2
Total 65 dB +	Dwelling Units	-	290	-	13	-	-	30	359	-	6	-	1,082	30	1,750
	Population	-	673	-	30	-	-	70	833	-	14	-	2,510	70	4,060
Estimated Totals - All Parcel Types															
65-70 dB	Dwelling Units	-	260	-	22	-	-	156	700	-	109	-	1,253	156	2,344
	Population	-	603	-	51	-	-	362	1,624	-	253	-	2,907	362	5,438
70-75 dB	Dwelling Units	-	81	-	-	-	-	8	110	-	3	-	89	8	283
	Population	-	188	-	-	-	-	19	255	-	7	-	206	19	657
75 dB +	Dwelling Units	-	-	-	-	-	-	-	13	-	-	-	-	-	13
	Population	-	-	-	-	-	-	-	30	-	-	-	-	-	30
Total 65 dB +	Dwelling Units	-	341	-	22	-	-	164	823	-	112	-	1,342	164	2,640
	Population	-	791	-	51	-	-	380	1,909	-	260	-	3,113	380	6,125

Notes:

1 Includes estimated units at: 303 Lime Kiln Rd. (18); 305 Lime Kiln Rd. (18); 325 Lime Kiln Rd. (40); 327 Lime Kiln Rd. (40); 331 Lime Kiln Rd. (40); 378 Lime Kiln Rd. (24); 380 Lime Kiln Rd. (24); 418 Lime Kiln Rd. (24)

2 Includes estimated units at: 81 E Allen St. (2); 20 W Canal St. (96); 79 W Canal St. (24); 23 Weaver Ln. (4); 4 Weaver Ln. (2); 240 E Allen St. (0); 114 Main St. (5); 54 Leclair St. (2); 158 Main St. (6); 167 Main St. (3); 99 Weaver St. (3)

3 No city records available for 109 Mulberry Ln. and 116 Mulberry Ln.

4 Includes estimates for 1 Abeanki Way (26)

5 Includes 106 E Allen St., which is a new building with an unknown unit count.

Additonal:

- A single family parcel has a single dwelling on the property while a multi-family parcels has two or more dwelling units. All units are assumed to have an average population of 2.32, based on US Census data.

- Each property considered for inclusion in the program also must meet any other eligibility requirements that the FAA may adopt. For example, consistent with FAA policy guidance set out in 14 CFR Part 150, Docket No. 28149, “Final Policy on Part 150 Approval of Noise Mitigation Measures: Effect on the Use of Federal Grants for Noise Mitigation Projects”, effective October 1, 1998, new non-compatible land uses established after that date within October 1, 1998, will not be eligible for acquisition. Current FAA guidelines are probably best described in the FAA’s Airport Improvement Program (AIP) Handbook, September 30, 2014. See also footnotes 26 and 27 in Section 4.3 of this document.

Table 5 presents the estimated residential population within the three historical contours presented in Figure 15 along with the 2018 and 2023 NEM contours. The purpose of this table is to provide a dwelling and population comparison to the historical contours presented in Figure 15, all with the same land use data and dwelling inventory methodology used in this NEM. The dwelling unit and population estimates in the middle three columns of Table 5 (labeled as “Land Use Inventoried and Depicted for this 2018/2023 NEM”) were developed from the same land use data set used for this NEM update. Therefore, the numbers provided differ from the original documents, each of which used different land use data and/or methodologies. Table 5 also provides the comparable values from the respective original documents in the right columns (labeled as "Comparable Previously Documented Values"), where applicable, and the notes to the table provide specific references.

Table 5. Estimated Residential Population within for 65 dB DNL Historical Contour Cases

Sources: US Census (2010), Jones Payne Group (2018)

65 dB Day-Night Average Sound Level, DNL Contour	Estimated Dwelling Units and Population	Land Use Inventoried and Depicted for this 2018/2023 NEM [2]			Comparable Previously Documented Values [3]
		On Single Family Parcels	On Multi-Family & Mixed Use Parcels	Estimated Total	Estimated Total
2015 Noise Exposure Map	Dwelling Units	616	203	**819**	**976** [1]
	Population	1,429	471	**1,900**	**2,267 (2,531)** [1]
"ANG Scenraio 1" Contour from the USAF's September 2013 FEIS, Figure BR3.2-8.	Dwelling Units	1,186	1,758	**2,944**	**2,963** [4]
	Population	2,752	4,079	**6,830**	**6,663** [4]
2018 Noise Exposure Map	Dwelling Units	134	30	**164**	
	Population	311	70	**380**	
2023 Noise Exposure Map	Dwelling Units	890	1,750	**2,640**	
	Population	2,065	4,060	**6,125**	

Notes:

1 Dwelling units do not include the dormitories at Saint Michael's College. Estimated Population numbers in parenthesis include estimates of residents in the dormitory facilities at Saint Michael's College.

2 All land use counts in these three columns are based on data collected for this project instead of the original published document. This allows for comparison to Table 4. "On Single Family Parcels" and "On Multi-Family Parcels" correspond to the color coding in the NEM Figures. A single family parcel has a single dwelling on the property while a multi-family parcels has two or more dwelling units. All single family and multi-family units are assumed to have an average population of 2.32, based on US Census data.

3 These are comparable values reported in the respective original document. Each document used different land use data and assumed a different average population per residential unit. Details are provided in the respective documents.

4 USAF's September 2013 FEIS, Table BR3.2-8. Note that this noise contour is based on the USAF's 228 flying days. All the others noise contours referred to in this table are based on 365 days, as required by Part 150 and FAA guidance.

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6 Development of Noise Contours

The DNL contours for this study were prepared using FAA recommended practices as required by 14 CFR Part 150 and FAA's guidance documents. This chapter presents information pertaining to the development of the 2018 and 2023 NEM contours.

6.1 Noise Models

Per guidance from the FAA Office of Environment and Energy (AEE), the US Department of Defense's NOISEMAP software was used to model based military aircraft operations (arrivals, departures, touch and goes, and maintenance activity) for the BTV NEM. The FAA's Aviation Environmental Design Tool (AEDT) was used to model the remaining civilian and transient military operations for the BTV NEM. The output grid results from these two models were then added together utilizing the grid combining feature of the AEDT. NOISEMAP uses many of the same inputs as AEDT, and are included in discussion and tables below, as appropriate.

Each noise model was run separately and the outputs were combined to present an average annual day contour and grid point values using the hybrid approach recommended by FAA.

The hybrid modeling approach recommended by FAA for this project has also been used for several other Part 150 projects at other civilian airports with military activity. Examples of similar projects in the New England region include:

- Westover Metropolitan Airport/ Westover Air Reserve Base Noise Exposure Map and Noise Compatibility Program Update (FAA accepted NEM in July 2014)
- Westfield-Barnes Airport Part 150 Noise Compatibility Study Update (FAA accepted NEM in April 2009)
- Burlington Vermont International Airport Noise Exposure Map Update (FAA accepted NEM in December 2015)

6.1.1 AEDT

The BTV NEM contours were prepared with the most recent version of FAA's Aviation Environmental Design Tool (AEDT), a software system that models aircraft performance in space and time to estimate fuel consumption, emissions, noise, and air quality consequences. The AEDT includes databases containing information that includes aircraft noise and emissions profiles and airport layout data, which are used in conjunction with various user inputs to perform the noise computations. AEDT model input data includes:

- Physical description of the airport layout
- Number and mix of aircraft flight operations
- Aircraft noise and performance characteristics
- Runway utilization rates
- Prototypical flight track descriptions and accompanying utilization rates
- Terrain data
- Meteorological Conditions
- Meteorological data
- Terrain data

AEDT version 2.d was used to prepare all noise exposure contours without any unauthorized "calibration" or "adjustment" as presented in this NEM update.

6.1.2 NOISEMAP

NOISEMAP is a suite of computer modeling programs developed by the U.S. Air Force for prediction of noise exposures from aircraft flight, maintenance, and ground run-up operations. NOISEMAP includes several modules.[34]

The BTV NEM contours were prepared with the most recent version of NOISEMAP (NMap Version 7.3) to represent the VTANG F-16C and F-35A, and VTARNG helicopter operations. The modeling inputs can be categorized in a similar manner as the AEDT. NOISEMAP modeling inputs, documented in the following sections, were based on the inputs used in the United States Air Force F-35A Operational Basing Final Environmental Impact Statement (USAF EIS)[35] and additional data provided by the VTANG for F-16C operations in 2018.

6.2 Airport Physical Parameters

BTV is located in northern Vermont, approximately three miles east of downtown Burlington. BTV has two operational runways: Runway 15/33 and Runway 1/19. The primary runway, Runway 15/33, is 8,319 feet long and 150 feet wide. Runway 1/19 is 4,112 feet long and 75 feet wide. The published airport elevation is 335 feet above mean sea level. The runway layout and airport property are shown on all of the contour and flight track figures in this document.

The AEDT includes an internal airport layout database, including runway locations, orientation, start-of-takeoff roll points, runway end elevations, landing thresholds, approach angles, etc. The AEDT data was updated with the latest Airport Layout Plan. Table 6 provides the runway details, including the runway end coordinates.

The primary information that AEDT uses with regards to runways are:

- departure thresholds (i.e. where aircraft begin their take-off roll);
- arrival threshold (a location marked on the runway);
- arrival threshold crossing height (TCH) (the height that arriving aircraft cross the arrival threshold);
- runway gradient (i.e. is the runway slightly uphill or downhill);
- runway location; and
- runway direction.

Runway length, runway width, instrumentation and declared distances do not directly affect noise calculations, although these parameters may affect which aircraft might use a particular runway and under what conditions, and therefore how often a runway would be used relative to the other runways at the Airport.

[34] Additional documentation is available at http://wasmerconsulting.com/baseops.htm
[35] Document was released September 2013. The Air Force issued a Record of Decision (ROD) December 2, 2013. The documents are available at http://www.158fw.ang.af.mil/f-35information.asp

Table 6. Runway Details

Source: FAA NASR effective 21 June 2018 https://www.faa.gov/air_traffic/flight_info/aeronav/aero_data/NASR_Subscription/

Runway	Latitude	Longitude	Elevation (ft MSL)	Length (ft)	Displaced Arrival Threshold (ft)	Displaced Departure Threshold (ft)
1	44.463826	-73.151003	333.7	4,112	225	0
19	44.474978	-73.153352	326.8	4,112	500	0
15	44.480674	-73.165879	305.5	8,319	0	0
33	44.465758	-73.141763	334.2	8,319	500 (982)[1]	0 (982)[1]

[1]Displaced threshold in place 12 Apr - 12 July 2018 (91 days). A proportional share of operations on this runway were modeled with the displaced threshold for the current conditions case.

6.3 Aircraft Noise and Performance Characteristics

Specific noise and performance data must be entered into AEDT for each aircraft type operating at the Airport. Noise data is included in the form of sound exposure level (SEL – see Section 3.1.4) at a range of distances (from 200 feet to 25,000 feet) from a particular aircraft with engines at a specific thrust level. Performance data includes thrust, speed and altitude profiles for takeoff and landing operations. The AEDT database contains standard noise and performance data for over 300 different fixed wing aircraft types, most of which are civilian aircraft. AEDT automatically accesses the noise and performance data for takeoff and landing operations by those aircraft.

Additional modeling inputs were created for this study and submitted to the FAA for approval. The details of these changes and the submission to FAA Office of Environment and Energy (AEE-100) are provided in Appendix B. In summary, these changes include the following topics:

- Non-standard substitutions
- Taxiways and ramp activity

6.3.1 Non-Standard Substitutions

Not all aircraft types identified as operating at BTV have specific AEDT aircraft types or FAA-approved substitutions. Therefore, for those aircraft types, recommended substitutions were submitted to the FAA, as provided in Appendix B. For those aircraft types not in the AEDT standard database, FAA approved substitutions were used to model the aircraft with a similar type that was in the database, or a user-defined aircraft was created for that specific aircraft type. FAA approved substitutions and user-defined aircraft came from the following two sources:

- AEDT Version 2d, which includes the current list of standard FAA substitutions;
- BTV Part 150 specific request to the FAA for non-standard substitutions and user-defined aircraft (request documented in Appendix B). These aircraft include the:
  - Embraer 175 Long Wing (substitution with EMB175)
  - Embraer 175 Short Wing (substitution with EMB175)
  - Cessna Citation Latitude (substitution with CNA680)
  - Bombardier Challenger 350 (substitution with CL600)
  - Diamond Club Star DA40 (substitution with GASEPV)
  - Mooney M-20C Ranger (substitution with GASEPV)
  - Piper Cherokee Arrow (substitution with GASEPV)
  - Piper Malibu (substitution with GASEPV)

6.3.2 Taxiways and Ramp Activity

Taxiway noise is associated with aircraft taxiing to and from the runways to their respective parking areas or gates on the ramp. The taxiing may also include a queue time, where the aircraft is stationary, awaiting clearance to proceed, and the engines are at idle. Non-standard modeling inputs were prepared so that AEDT could represent taxiway operations. Section 6.7.1 provides additional details.

6.3.3 F-16C and F-35A Profiles

The Department of Defense's NOISEMAP software was utilized for noise modeling of VTANG F-16C and F-35A aircraft operations at BTV. Based on inputs provided by the VTANG, F-16C flight profiles from the EIS were updated to better reflect operation of the aircraft at BTV during 2018. F-35A flight profiles developed for the EIS were carried forward for use in the 2023 NEM. Approval of noise model flight profile data was provided by the VTANG on August 8, 2018[36].

6.4 Aircraft Operations

Civilian and transient military aircraft operations are based on a twelve month data sample obtained from Vector Airport Systems, LLC, covering the period of November 1, 2017 through October 31, 2018. These 2017/2018 operations counts were scaled to the FAA Terminal Area Forecast (TAF) for 2018 and 2023 to determine the operations totals for the NEM study years. Due to the expected retirement of MD-88 aircraft, operations by these aircraft were assigned to Airbus 319 aircraft for the 2023 case.

Based military operations were developed from multiple sources. Forecast F-35A operations for 2023 were taken from the modeling data used in the USAF EIS "ANG Scenario 1", and existing F-16C operations for 2018 were developed based on input from the VTANG. Because the USAF EIS modeling data used 228 annual flying days, average daily F-35A operations were scaled to represent 365 annual operating days according to 14 CFR Part 150s definition of average annual day for the purposes of an NEM. Both the NEM and the USAF EIS assume the same number of annual operations for the F-35A aircraft. Existing 2018 and forecast 2023 operations for the UH-72 and HH-60M helicopter were provided by the Vermont Army National Guard (VTARNG).

Table 7 and Table 8 provide summaries of operations for the baseline and forecast years. The operations are condensed into categories specified by FAA Order 7210.3 "Facility Operation and Administration"; namely Air Carrier (AC), Air Taxi (AT), General Aviation (GA), and Military (ML). AC and AT are commercial categories distinguished by aircraft capacity, while GA includes all non-commercial, non-military operations.

Among civilian aircraft, TAF anticipates a notable shift from smaller AT aircraft to larger AC aircraft over the course of the study period. This results in a decrease of more than 20% in total commercial operations, while passenger numbers are forecast to increase moderately.

[36] Email communication from Colonel Christopher Tumilowicz USAF 158 OG, subject "VT ANG", August 8, 2018

Table 7. Existing 2018 Annual Operations Summary and Comparison

Sources: FAA, HMMH, VTANG, and VTARNG (2018)

FAA Category [1]		2018 Modeled Operations	2017 Reported (OPSNET)	2018 Forecast (TAF)
Itinerant	Air Carrier	12,612	12,941	12,612
	Air Taxi	15,758	13,873	15,759
	GA	22,481	18,747	22,481
	Military [2,3]	4,748	4,242	3,357
Local	GA	11,138	10,833	11,138
	Military [2,3]	1,305	1,365	1,789
Total		68,042	62,001	67,136

Notes:

1 Operational Categories are those defined in FAA Order 7210.3AA at Chapter 12, Section 12-1-5 (September 12, 2017). See report footnote 43.

2 Military operations were developed using the TFMSC, OPSNET, USAF EIS, and input from the Vermont Air and Army National Guard.

3 Modeled military operations account for the fact that the tower may consider multiple military aircraft flying in formation as a single count. This practice is documented in FAA Order 7210.3Y at Chapter 12, Section 12-2-1 (April 3, 2014) and verified with FAA staff. Typically 2 or more aircraft take off in formation (single count) and then returning individually (2 or more counts). Over the course of a year, for every 100 tower counts for the based F-16s, there are approximately 142 actually operations. As a result, total modeled military aircraft operations numbers exceed those reported in the TAF.

Table 8. Forecast 2023 Annual Operations Summary and Comparison

Sources: FAA, HMMH, VTANG, VTARNG (2018)

FAA Category [1]		2023 Modeled Operations [3]	2023 Forecast (TAF)
Itinerant	Air Carrier	17,378	17,378
	Air Taxi	5,087	5,087
	GA	22,636	22,636
	Military [2,3]	6,846	3,357
Local	GA	11,138	11,133
	Military [2,3]	1,458	1,789
Total		64,543	61,380

Notes:

1 Operational Categories are those defined in FAA Order 7210.3AA at Chapter 12, Section 12-1-5 (September 12, 2017). See report footnote 43.

2 Military operations were developed using the TFMSC, OPSNET, USAF EIS, and input from the Vermont Air and Army National Guard.

3 Modeled military operations account for the fact that the tower may consider multiple military aircraft flying in formation as a single count. This practice is documented in FAA Order 7210.3Y at Chapter 12, Section 12-2-1 (April 3, 2014) and verified with FAA staff. Typically 2 or more aircraft take off in formation (single count) and then returning individually (2 or more counts). Over the course of a year, for every 100 tower counts for the based VTANG aircraft, there are approximately 142 actually operations. As a result, total modeled military aircraft operations numbers exceed those reported in the TAF.

Table 9 and Table 10 present the detailed aircraft modeling fleet mixes for the 2018 Existing Conditions NEM (Table 9) and the 2023 Forecast NEM (Table 10). The tables present fleet mix detail broken down by type of operation (departures, arrivals, and touch and go cycles), the DNL "day" and "night" time periods (7:00 a.m. – 10:00 p.m. and 10:00 p.m. – 7:00 a.m., respectively, and as discussed in Section 3.1.6), and AEDT database aircraft types. The day/night breakdown is critical to the calculation of DNL, because the metric weights night operations by a factor of 10 (mathematically equivalent to adding ten decibels to the noise level produced by aircraft operating at night). Within the AEDT model departures are further subdivided by stage length, the distance to the first destination. AEDT uses stage length to determine the aircraft's flight profile, because the fuel load required to fly a given distance is a major determinant of aircraft weight and, therefore the climb rate, speed, power setting, and noise emissions associated with a given departure.

Table 9. Modeled 2018 Annual Aircraft Operations

Sources: FAA, HMMH, VTANG, VTARNG (2018)

Category	Engine Type	ICAO Code	AEDT Equip. ID	ANP Type	Arrivals		Departures		Local (Touch and Go)		Total
					Day	Night	Day	Night	Day	Night	
Air Carrier	Jet	A319	4930	A319-131	142	80	133	89	-	-	445
		A320	4900	A320-232	91	132	147	76	-	-	447
		B712	88	717200	52	137	39	150	-	-	377
		B737	4861	737700	11	69	20	60	-	-	160
		B738	5294	737800	87	86	119	53	-	-	345
		B739	2502	737800	5	47	8	44	-	-	104
		B752	2512	757PW	243	-	238	5	-	-	487
		CRJ7	4211	CRJ9-ER	708	132	718	122	-	-	1,681
		CRJ9	2548	CRJ9-ER	773	566	882	457	-	-	2,679
		E170	3070	EMB170	128	16	139	6	-	-	289
		E190	4288	EMB190	968	438	1,005	400	-	-	2,811
		E75L	3071	EMB175	484	225	469	240	-	-	1,417
		E75S	3816	EMB175	487	120	395	212	-	-	1,213
		MD88	2074	MD83	13	38	6	46	-	-	104
	Turbine Propeller	DH8D	4778	DHC830	27	-	27	-	-	-	55
Air Carrier Totals					**4,221**	**2,085**	**4,346**	**1,960**	**-**	**-**	**12,612**

Note: Totals and subtotals may not match due to rounding.

Table 9. Modeled 2018 Annual Aircraft Operations (Continued)

Category	Engine Type	ICAO Code	AEDT Equip. ID	ANP Type	Arrivals		Departures		Local (Touch and Go)		Total
					Day	Night	Day	Night	Day	Night	
Air Taxi	Jet	BE40	5296	MU3001	110	-	110	-	-	-	220
		C560	4929	CNA560U	28	-	26	1	-	-	56
		C56X	4794	CNA560XL	154	6	156	4	-	-	321
		C680	5184	CNA680	39	1	38	3	-	-	81
		C68A	5347	CNA680	74	5	77	3	-	-	159
		C750	1314	CNA750	73	-	73	-	-	-	146
		CL30	4856	CL600	98	3	101	-	-	-	202
		CL35	5345	CL600	105	6	111	-	-	-	222
		CL60	4805	CL601	23	-	23	-	-	-	45
		CRJ2	1250	CL600	2,669	212	2,555	326	-	-	5,761
		E145	2557	EMB14L	1,362	112	1,413	62	-	-	2,949
		E45X	4874	EMB145	1,337	82	1,276	143	-	-	2,838
		E55P	4917	CNA55B	96	3	96	3	-	-	197
		F2TH	4804	CNA750	19	1	20	-	-	-	40
		F900	4034	CNA750	45	6	49	3	-	-	104
		GLEX	3734	BD-700-1A10	24	-	24	-	-	-	48
	Turbine Propeller	B350	1539	DHC6	114	1	110	5	-	-	230
		BE99	4918	DHC6	78	-	78	-	-	-	157
		BE9L	4918	DHC6	21	-	21	-	-	-	43
		E110	1498	DHC6	605	-	605	-	-	-	1,209
		PC12	3122	CNA208	329	37	328	38	-	-	732
Air Taxi Totals					**7,403**	**476**	**7,289**	**590**	**-**	**-**	**15,759**

Note: Totals and subtotals may not match due to rounding.

Table 9. Modeled 2018 Aircraft Operations (Continued)

Category	Engine Type	ICAO Code	AEDT Equip. ID	ANP Type	Arrivals		Departures		Local (Touch and Go)		Total
					Day	Night	Day	Night	Day	Night	
General Aviation	Jet	BE40	5296	MU3001	53	5	50	8	-	-	116
		C25A	3974	CNA525C	131	10	125	16	-	-	281
		C25B	3974	CNA525C	407	5	330	82	-	-	824
		C25C	4276	CNA525C	100	3	103	-	-	-	206
		C525	3974	CNA525C	75	3	78	-	-	-	156
		C550	4327	CNA55B	148	5	146	8	-	-	306
		C560	4929	CNA560U	53	-	50	3	-	-	105
		C56X	4794	CNA560XL	332	23	340	15	-	-	708
		C680	5184	CNA680	181	18	193	5	-	-	397
		C750	1314	CNA750	43	3	40	5	-	-	90
		CL30	4856	CL600	48	-	48	-	-	-	95
		CL60	4805	CL601	60	3	63	-	-	-	126
		E35L	5351	CNA55B	40	-	40	-	-	-	80
		E50P	4902	CNA510	95	3	95	3	-	-	196
		E55P	4917	CNA55B	53	-	53	-	-	-	105
		F2TH	4804	CNA750	50	3	47	5	-	-	105
		F900	4034	CNA750	65	-	65	-	-	-	131
		G280	4198	IA1125	105	-	98	8	-	-	211
		GL5T	3732	BD-700-1A11	108	13	118	3	-	-	241
		GLF4	5267	GIV	63	5	68	-	-	-	136
		GLF5	4858	GV	116	5	115	5	-	-	241
		H25B	2014	LEAR35	70	18	83	5	-	-	176
		H25C	4758	LEAR35	50	3	53	-	-	-	105
		LJ45	4843	LEAR35	40	3	40	3	-	-	85
		LJ60	2033	LEAR35	241	5	224	22	-	-	492
		WW24	1973	IA1125	95	13	92	16	-	-	216
	Turbine Propeller	AA5	1532	GASEPF	50	-	50	-	-	-	100
		B350	1539	DHC6	88	-	88	-	-	-	176
		BE20	3790	DHC6	216	8	215	9	-	-	447
		BE9L	4918	DHC6	153	8	155	5	-	-	322
		C441	1287	CNA441	163	-	155	9	-	-	327
		P46T	1465	GASEPF	70	-	65	5	-	-	141
		PC12	3122	CNA208	285	71	266	90	-	-	713
		TBM7	1533	CNA208	85	-	85	-	-	-	171
		TBM8	2580	CNA441	68	-	68	-	-	-	136
		TBM9	4677	CNA208	45	3	48	-	-	-	95

Note: Totals and subtotals may not match due to rounding.

Table 9. Modeled 2018 Aircraft Operations (Continued)

Category	Engine Type	ICAO Code	AEDT Equip. ID	ANP Type	Arrivals		Departures		Local (Touch and Go)		Total
					Day	Night	Day	Night	Day	Night	
General Aviation	Piston Propeller	BE33	1271	GASEPV	60	-	60	-	-	-	121
		BE35	1271	GASEPV	75	-	73	3	-	-	151
		BE36	1276	CNA208	264	3	258	8	-	-	533
		BE58	1196	BEC58P	279	-	274	5	-	-	558
		C150	1882	GASEPF	40	-	40	-	-	-	80
		C172	1267	CNA172	3,414	88	3,409	92	10,187	137	17,327
		C180	1271	GASEPV	53	-	53	-	-	-	105
		C182	1262	CNA182	234	-	234	-	-	-	467
		C206	3172	CNA206	72	4	70	5	-	-	151
		C340	2116	BEC58P	98	5	103	-	-	-	206
		C414	2119	BEC58P	58	3	58	3	-	-	121
		DA40	1271	GASEPV	63	-	63	-	-	-	126
		M20P	1271	GASEPV	146	-	146	-	-	-	291
		P28A	3178	PA28	217	4	219	3	-	-	442
		P28R	1271	GASEPV	352	5	357	-	728	4	1,446
		P32R	1271	GASEPV	40	3	43	-	-	-	85
		PA24	1901	GASEPV	55	-	55	-	81	-	191
		PA27	1194	BEC58P	35	5	35	5	-	-	80
		PA28	2102	GASEPF	103	-	103	-	-	-	206
		PA31	779	BEC58P	216	28	224	20	-	-	487
		PA32	1271	GASEPV	40	-	40	-	-	-	80
		PA34	2103	BEC58P	47	6	48	5	-	-	105
		PA46	1271	GASEPV	88	-	88	-	-	-	176
		S22T	1325	COMSEP	98	-	98	-	-	-	196
		SR22	1325	COMSEP	650	13	643	20	-	-	1,326
General Aviation Totals					**10,844**	**397**	**10,742**	**498**	**10,996**	**142**	**33,619**

Note: Totals and subtotals may not match due to rounding.

Table 9. Modeled 2018 Aircraft Operations (Concluded)

Category	Engine Type	ICAO Code	AEDT Equip. ID	ANP Type	Arrivals		Departures		Local (Touch and Go)		Total
					Day	Night	Day	Night	Day	Night	
Based Military	Jet	F16	N/A	N/A	1,535	-	1,535	-	307	-	3,377
	Helicopter	H72	N/A	N/A	211	18	229	-	-	-	458
		H60	N/A	N/A	324	133	361	96	-	-	914
Transient Military	Jet	B752	2512	757PW	16	-	16	-	96	-	128
		C17	1401	C17	11	-	11	-	72	-	94
		K35R	1981	KC135R	11	-	11	-	72	-	94
		DC10	1349	DC1030	5	-	5	-	30	-	40
		C560	4929	CNA560U	19	1	19	1	125	7	172
		GLF5	4858	GV	18	1	19	-	120	4	162
	Turbine Propeller	BE20	3790	DHC6	10	-	10	-	66	-	86
		C130	1203	C130	27	-	25	2	176	8	238
		CN35	42	SF340	11	-	11	-	72	-	94
		DH8C	4778	DHC830	10	-	10	-	66	-	86
		C208	4677	CNA208	3	-	3	-	20	-	26
	Piston Propeller	C206	3172	CNA206	9	-	9	-	58	-	76
		C421	1287	CNA441	1	-	1	-	6	-	8
Based Military Total					**2,070**	**151**	**2,125**	**96**	**307**	**-**	**4,749**
Transient Military Total					**151**	**2**	**150**	**3**	**979**	**19**	**1,304**
Overall Totals					**24,689**	**3,111**	**24,652**	**3,147**	**12,282**	**161**	**68,042**

Note: Totals and subtotals may not match due to rounding.

Table 10. Modeled 2023 Annual Aircraft Operations

Sources: FAA, HMMH, VTANG, VTARNG (2018)

Category	Engine Type	ICAO Code	AEDT Equip. ID	ANP Type	Arrivals		Departures		Local (Touch and Go)		Total
					Day	Night	Day	Night	Day	Night	
Air Carrier	Jet	A319	4930	A319-131	196	110	183	123	-	-	613
		A320	4900	A320-232	126	182	203	105	-	-	616
		B712	88	717200	71	188	54	206	-	-	520
		B737	4861	737700	16	95	28	82	-	-	221
		B738	5294	737800	120	118	164	73	-	-	476
		B739	2502	737800	6	65	10	61	-	-	143
		B752	2512	757PW	335	-	329	7	-	-	671
		CRJ7	4211	CRJ9-ER	976	182	990	168	-	-	2,316
		CRJ9	2548	CRJ9-ER	1,066	780	1,216	630	-	-	3,691
		E170	3070	EMB170	177	22	191	8	-	-	398
		E190	4288	EMB190	1,333	603	1,385	551	-	-	3,873
		E75L	3071	EMB175	666	310	646	330	-	-	1,952
		E75S	3816	EMB175	671	165	544	292	-	-	1,671
		MD88	2074	MD83	19	53	8	64	-	-	143
	Turbine Propeller	DH8D	4778	DHC830	38	-	38	-	-	-	75
Air Carrier Totals					**5,816**	**2,873**	**5,989**	**2,700**	**-**	**-**	**17,378**

Note: Totals and subtotals may not match due to rounding.

Table 10. Modeled 2023 Annual Aircraft Operations (Continued)

Category	Engine Type	ICAO Code	AEDT Equip. ID	ANP Type	Arrivals		Departures		Local (Touch and Go)		Total
					Day	Night	Day	Night	Day	Night	
Air Taxi	Jet	BE40	5296	MU3001	35	-	35	-	-	-	71
		C560	4929	CNA560U	9	-	9	-	-	-	18
		C56X	4794	CNA560XL	50	2	50	1	-	-	104
		C680	5184	CNA680	13	-	12	1	-	-	26
		C68A	5347	CNA680	24	2	25	1	-	-	51
		C750	1314	CNA750	24	-	24	-	-	-	47
		CL30	4856	CL600	32	1	33	-	-	-	65
		CL35	5345	CL600	34	2	36	-	-	-	72
		CL60	4805	CL601	7	-	7	-	-	-	15
		CRJ2	1250	CL600	861	68	825	105	-	-	1,860
		E145	2557	EMB14L	440	36	456	20	-	-	952
		E45X	4874	EMB145	431	27	412	46	-	-	916
		E55P	4917	CNA55B	31	1	31	1	-	-	64
		F2TH	4804	CNA750	6	-	7	-	-	-	13
		F900	4034	CNA750	15	2	16	1	-	-	33
		GLEX	3734	BD-700-1A10	8	-	8	-	-	-	15
	Turbine Propeller	B350	1539	DHC6	37	-	35	2	-	-	74
		BE99	4918	DHC6	25	-	25	-	-	-	51
		BE9L	4918	DHC6	7	-	7	-	-	-	14
		E110	1498	DHC6	195	-	195	-	-	-	390
		PC12	3122	CNA208	106	12	106	12	-	-	236
Air Taxi Totals					**2,390**	**154**	**2,353**	**190**	**-**	**-**	**5,087**

Note: Totals and subtotals may not match due to rounding.

Table 10. Modeled 2023 Annual Aircraft Operations (Continued)

Category	Engine Type	ICAO Code	AEDT Equip. ID	ANP Type	Arrivals		Departures		Local (Touch and Go)		Total
					Day	Night	Day	Night	Day	Night	
General Aviation	Jet	BE40	5296	MU3001	53	5	51	8	-	-	116
		C25A	3974	CNA525C	132	10	126	16	-	-	283
		C25B	3974	CNA525C	410	5	332	83	-	-	830
		C25C	4276	CNA525C	101	3	104	-	-	-	207
		C525	3974	CNA525C	76	3	78	-	-	-	157
		C550	4327	CNA55B	149	5	147	8	-	-	309
		C560	4929	CNA560U	53	-	50	3	-	-	106
		C56X	4794	CNA560XL	334	23	342	15	-	-	713
		C680	5184	CNA680	182	18	194	5	-	-	400
		C750	1314	CNA750	43	3	40	5	-	-	91
		CL30	4856	CL600	48	-	48	-	-	-	96
		CL60	4805	CL601	61	3	63	-	-	-	126
		E35L	5351	CNA55B	40	-	40	-	-	-	81
		E50P	4902	CNA510	96	3	95	3	-	-	197
		E55P	4917	CNA55B	53	-	53	-	-	-	106
		F2TH	4804	CNA750	51	3	48	5	-	-	106
		F900	4034	CNA750	66	-	66	-	-	-	132
		G280	4198	IA1125	106	-	99	8	-	-	212
		GL5T	3732	BD-700-1A11	109	13	119	3	-	-	243
		GLF4	5267	GIV	63	5	68	-	-	-	137
		GLF5	4858	GV	116	5	116	6	-	-	243
		H25B	2014	LEAR35	71	18	83	5	-	-	177
		H25C	4758	LEAR35	51	3	53	-	-	-	106
		LJ45	4843	LEAR35	40	3	40	3	-	-	86
		LJ60	2033	LEAR35	243	5	226	22	-	-	496
		WW24	1973	IA1125	96	13	92	16	-	-	218
	Turbine Propeller	AA5	1532	GASEPF	51	-	51	-	-	-	101
		B350	1539	DHC6	89	-	89	-	-	-	177
		BE20	3790	DHC6	218	8	216	9	-	-	450
		BE9L	4918	DHC6	154	8	157	5	-	-	324
		C441	1287	CNA441	164	-	156	9	-	-	329
		P46T	1465	GASEPF	71	-	66	5	-	-	142
		PC12	3122	CNA208	287	72	268	91	-	-	718
		TBM7	1533	CNA208	86	-	86	-	-	-	172
		TBM8	2580	CNA441	68	-	68	-	-	-	137
		TBM9	4677	CNA208	46	3	48	-	-	-	96

Note: Totals and subtotals may not match due to rounding.

Table 10. Modeled 2023 Annual Aircraft Operations (Continued)

Category	Engine Type	ICAO Code	AEDT Equip. ID	ANP Type	Arrivals		Departures		Local (Touch and Go)		Total
					Day	Night	Day	Night	Day	Night	
General Aviation	Piston Propeller	BE33	1271	GASEPV	61	-	61	-	-	-	121
		BE35	1271	GASEPV	76	-	73	3	-	-	152
		BE36	1276	CNA208	266	3	260	8	-	-	536
		BE58	1196	BEC58P	281	-	276	5	-	-	561
		C150	1882	GASEPF	40	-	40	-	-	-	81
		C172	1267	CNA172	3,437	89	3,433	93	10,187	137	17,376
		C180	1271	GASEPV	53	-	53	-	-	-	106
		C182	1262	CNA182	235	-	235	-	-	-	470
		C206	3172	CNA206	72	4	71	5	-	-	152
		C340	2116	BEC58P	99	5	104	-	-	-	207
		C414	2119	BEC58P	58	3	58	3	-	-	121
		DA40	1271	GASEPV	63	-	63	-	-	-	126
		M20P	1271	GASEPV	147	-	147	-	-	-	293
		P28A	3178	PA28	219	4	220	3	-	-	445
		P28R	1271	GASEPV	354	5	359	-	728	4	1,450
		P32R	1271	GASEPV	40	3	43	-	-	-	86
		PA24	1901	GASEPV	56	-	56	-	81	-	193
		PA27	1194	BEC58P	35	5	35	5	-	-	81
		PA28	2102	GASEPF	104	-	104	-	-	-	207
		PA31	779	BEC58P	218	28	225	20	-	-	491
		PA32	1271	GASEPV	40	-	40	-	-	-	81
		PA34	2103	BEC58P	47	6	48	5	-	-	106
		PA46	1271	GASEPV	89	-	89	-	-	-	177
		S22T	1325	COMSEP	99	-	99	-	-	-	197
		SR22	1325	COMSEP	655	13	647	20	-	-	1,335
General Aviation Totals					**10,919**	**399**	**10,816**	**502**	**10,996**	**142**	**33,774**

Note: Totals and subtotals may not match due to rounding.

Table 10. Modeled 2023 Annual Aircraft Operations (Concluded)

Category	Engine Type	ICAO Code	AEDT Equip. ID	ANP Type	Arrivals		Departures		Local (Touch and Go)		Total
					Day	Night	Day	Night	Day	Night	
Based Military	Jet	F35	N/A	N/A	2,520	-	2,520	-	446	-	5,486
	Helicopter	H72	N/A	N/A	211	18	229	-	-	-	458
		H60	N/A	N/A	324	133	361	96	-	-	914
Transient Military	Jet	F16	N/A	N/A	64	-	64	-	14	-	142
		B752	2512	757PW	16	0	16	0	96	0	128
		C17	1401	C17	11	0	11	0	72	0	94
		K35R	1981	KC135R	11	0	11	0	72	0	94
		DC10	1349	DC1030	5	0	5	0	30	0	40
		C560	4929	CNA560U	19	1	19	1	125	7	172
		GLF5	4858	GV	18	1	19	0	120	4	162
	Turbine Propeller	BE20	3790	DHC6	10	0	10	0	66	0	86
		C130	1203	C130	27	0	25	2	176	8	238
		CN35	42	SF340	11	0	11	0	72	0	94
		DH8C	4778	DHC830	10	0	10	0	66	0	86
		C208	4677	CNA208	3	0	3	0	20	0	26
	Piston Propeller	C206	3172	CNA206	9	0	9	0	58	0	76
		C421	1287	CNA441	1	0	1	0	6	0	8
Based Military Total					**3,055**	**151**	**3,110**	**96**	**446**	**0**	**6,858**
Transient Military Total					**215**	**2**	**214**	**3**	**993**	**19**	**1,446**
Overall Totals					**22,395**	**3,579**	**22,482**	**3,491**	**12,435**	**161**	**64,543**

Note: Totals and subtotals may not match due to rounding.

6.5 Runway Utilization

The primary factor affecting runway use at airports is weather, in particular, the wind direction and wind speed. Additional factors that may affect runway use include the position of the facility or ramp relative to the runways or operational proficiency training for military units. There are no anticipated changes to the runway utilization expected from 2018 to 2023.

Runway utilization percentages, that is the percent of time a runway is used, were based upon a radar sample covering November 1, 2017 through October 31, 2018. Military aircraft were mostly excluded from the data sample.

Table 12, Table 13 and Table 14 present the modeled runway use for arrival, departure, and pattern operations, respectively, for the 2018 and 2023 NEM contours.

Table 11. Arrival Operation Runway Utilization for 2018 and 2023 Noise Exposure Map Contours

Source: Vector Airport Systems, LLC radar sample covering November 1, 2017 through October 31, 2018

Aircraft Category	Runway End			
	15	33	01	19
Air Carrier Cargo Jet	66%	34%	0%	0%
Air Carrier Passenger Jet	59%	41%	0%	0%
Air Carrier Passenger Turbine Propeller	45%	55%	0%	0%
Air Taxi Jet	54%	46%	0%	0%
Air Taxi Turbine Propeller	49%	44%	1%	6%
General Aviation Jet	53%	47%	0%	0%
General Aviation Piston Propeller	18%	37%	17%	28%
General Aviation Turbine Propeller	46%	40%	4%	10%
Military (Fixed wing) Based	50%	50%	0%	0%
Military (Fixed wing) Transient	53%	47%	0%	0%

Table 12. Departure Operation Runway Utilization for 2018 and 2023 Noise Exposure Map Contours

Source: Vector Airport Systems, LLC radar sample covering November 1, 2017 through October 31, 2018

Aircraft Category	Runway End			
	15	33	01	19
Air Carrier Cargo Jet	30%	70%	0%	0%
Air Carrier Passenger Jet	52%	48%	0%	0%
Air Carrier Passenger Turbine Propeller	35%	65%	0%	0%
Air Taxi Jet	50%	50%	0%	0%
Air Taxi Turbine Propeller	38%	57%	0%	5%
General Aviation Jet	44%	56%	0%	0%
General Aviation Piston Propeller	13%	37%	11%	38%
General Aviation Turbine Propeller	35%	48%	5%	12%
Military (Fixed wing) Based	50%	50%	0%	0%
Military (Fixed wing) Transient	44%	56%	0%	0%

Table 13. Touch and Go Operation Runway Utilization Rates for 2018 and 2023 Noise Exposure Map Contours

Source: Vector Airport Systems, LLC radar sample covering November 1, 2017 through October 31, 2018

Aircraft Category	Runway End			
	15	33	01	19
General Aviation Piston Propeller	10%	37%	12%	40%
Military (Fixed wing) Based	50%	50%	0%	0%

The Army Aviation Support Facility/Readiness Center apron, located on the northwest side of the Airport property, is the location for all military helicopter arrivals and departures. The location is denoted with an "H" on various figures in this document.

6.6 Flight Track Geometry and Utilization

A standard input for the AEDT includes representative aircraft flight tracks. Flight tracks are typically associated with a runway and there are separate flight tracks for arrivals, departures and touch and goes. Flight tracks are defined as the ground path that the aircraft flies, while the flight track utilization defines how often that track is flown. All utilization rates for this Part 150 are defined relative to the runway end. The number of operations using each runway end can be determined for the respective study years by multiplying the operations presented in Section 6.4 by the runway use presented in Section 6.5 for each individual aircraft type.

Flight track modeling inputs for this NEM update utilize those developed from the radar data analysis conducted for the 2015 NEM. The flight operations radar data analyzed included information on aircraft tracks over the ground and aircraft altitudes. The data also included flight identification information (such as aircraft type, flight origin or destination, tail number, etc.) for aircraft operating under a flight plan filed with the FAA.

Flight operation tracks were grouped by runway, operation type, and aircraft category. These groups were then loaded into the AEDT for model track creation.

The flight track data obtained were used to develop both flight track geometry and percent utilization of each track for civilian and military transient operations. The utilization rates were calculated on a runway-end basis for each track group; i.e., for each type of operation, runway-end and aircraft category group, the track utilization rates add up to 100%.

The military based flight track geometry and utilization were developed from the USAF EIS modeling data. The NOISEMAP study used for the BTV NEM modeling includes flight track geometry and utilization provided in the USAF EIS analysis. Table 15 presents the arrival track utilization rates, Table 16 presents the departure track utilization rates, and Table 17 presents the pattern track utilization rates.

Figure 16 and Figure 17 present generalized depictions of all the flight tracks and operations used to develop the 2018 contours. Rather than presenting every individual track equally, these “flight track density plots” use color gradations to depict the flight track geometry, dispersion, and the relative frequency of flights over specific geographical areas (called density). The color ranges are assigned based on the relative density of aircraft operations within the data set. Note that flight track density plots do not by themselves, indicate noise exposure nor do they provide aircraft altitude information, something which strongly influences noise exposure.

The modeled flight tracks are plotted in Figure 18 through Figure 25. Figure 18 through Figure 24 are plotted at the same scale and have the same base map as the NEMs presented in Figure 12 and Figure 13 and therefore conform to Part 150 requirements. Figure 25 presents the modeled taxiway tracks, and is plotted at a larger scale to allow clear display of the track geometries.

The same tracks and utilization rates apply to day and night operations in both the 2018 and 2023 cases unless otherwise noted.

Table 14. Aircraft Arrival Flight Track Utilization Rates

Sources: 2015 BTV NEM

Operation Type	RWY	Flight Track ID	Flight Track Utilization Percentages by Runway								
			Jet				Propeller				
							Turbine			Piston	
			Air Carrier Passenger	Air Carrier Cargo	Air Taxi	General Aviation	Air Carrier	Air Taxi	General Aviation	Air Taxi	General Aviation
Arrival	15	15A01	15%	87%	39%	18%					
		15A02	85%	4%	57%	59%					
		15A03		9%	2%	15%					
		15A04			3%	9%					
		15A05						29%	10%		12%
		15A06						8%			
		15A07					37%	6%	24%		
		15A08I					13%	12%	24%	50%	14%
		15A08V					50%	39%	38%	50%	38%
		15A09						5%	3%		
		15A12									12%
		15A13I									8%
		15A13V									15%
	33	33A01	9%	25%	24%	10%					
		33A02	43%		34%	20%					
		33A03	2%	25%	13%	10%					
		33A04	43%	25%	23%	18%					
		33A05			1%	6%					
		33A06	3%	25%	3%	16%					
		33A07			2%	18%					
		33A09						45%	58%	60%	34%
		33A10					38%	18%	8%	20%	17%
		33A11					17%	30%	17%		23%
		33A12					46%	7%	17%		11%
		33A17								20%	14%
	01	01A01						30%	30%	30%	30%
		01A02						70%	70%	70%	70%
	19	19A01						25%	18%	25%	18%
		19A02						25%	29%	25%	29%
		19A03						25%	21%	25%	21%
		19A04						25%	32%	25%	32%

Table 15. Departure and Pattern Flight Track Utilization Rates

Sources: 2015 BTV NEM

Operation Type	RWY	Flight Track ID	Flight Track Utilization Percentages by Runway								
			Jet				Propeller				
							Turbine			Piston	
			Air Carrier Passenger	Air Carrier Cargo	Air Taxi	General Aviation	Air Carrier	Air Taxi	General Aviation	Air Taxi	General Aviation
Departure	15	15D01	13%		29%	12%					
		15D02	1%	60%	12%	17%					
		15D03	76%		48%	42%					
		15D04	8%		8%	9%					
		15D06	2%	40%	1%	4%					
		15D05			1%	17%					
		15D07					100%	60%	83%	75%	49%
		15D08						40%	17%	25%	51%
	33	33D01	2%	14%	2%						
		33D02	13%	5%	34%	3%					
		33D03	2%	64%	13%	24%					
		33D04	83%	18%	51%	74%					
		33D06					19%	5%	26%		12%
		33D07					78%	38%	58%	50%	47%
		33D08					3%	10%		25%	12%
		33D05						40%	11%	25%	19%
		33D09						8%	5%		
		33D11									10%
	19	19D01						14%	20%	14%	20%
		19D02						29%	40%	29%	40%
		19D04						57%	21%	57%	21%
		19D03							20%		20%
Touch & Go (Pattern)	15	01T1				50%			50%		50%
		01T2				50%			50%		50%
	33	15T1				50%			50%		50%
		15T2				50%			50%		50%
	1	19T1				40%			40%		40%
		19T2				60%			60%		60%
	19	33T1				29%			29%		29%
		33T2				71%			71%		71%

Table 16. Vermont Air National Guard Operation Flight Track Utilization Rates

Sources: USAF EIS (2013), VTANG (2018)

Operation Type	RWY	Flight Track ID	Vermont Air National Guard F-16C	Vermont Air National Guard F-35A
Departure	15	15D1	80%	10%
		15D3	20%	23%
		15D4		57%
		15D5		10%
	33	33D1	80%	53%
		33D2		10%
		33D3	20%	10%
		33D4		27%
Arrival	15	15A1	41%	41%
		15A3	5%	5%
		15A4	50%	50%
		15A5	4%	4%
	33	33A1	41%	41%
		33A2	5%	5%
		33A3	4%	
		33A3b		4%
		33A5	50%	50%
Pattern	15	15C1	100%	100%
	33	33C1	100%	100%

Table 17. Vermont Army National Guard Operation Flight Track Utilization Rates

Sources: VTARNG (2018)

Operation Type	Pad Location	Flight Track ID	Vermont Army National Guard UH-72	Vermont Army National Guard HH-60M
Departure	VTARNG Ramp	AG-DA	20%	20%
		AG-DC	15%	15%
		AG-DD	20%	20%
		AG-DF	1%	1%
	Taxiway E	AG-DB	10%	10%
	Taxiway C	AG-DG	30%	30%
	Taxiway L	AG-DE	4%	4%
Arrival	VTARNG Ramp	AG-AA	20%	20%
		AG-AC	15%	15%
		AG-AD	20%	20%
		AG-AF	1%	1%
	Taxiway E	AG-AB	10%	10%
	Taxiway C	AG-AG	30%	30%
	Taxiway L	AG-AE	4%	4%

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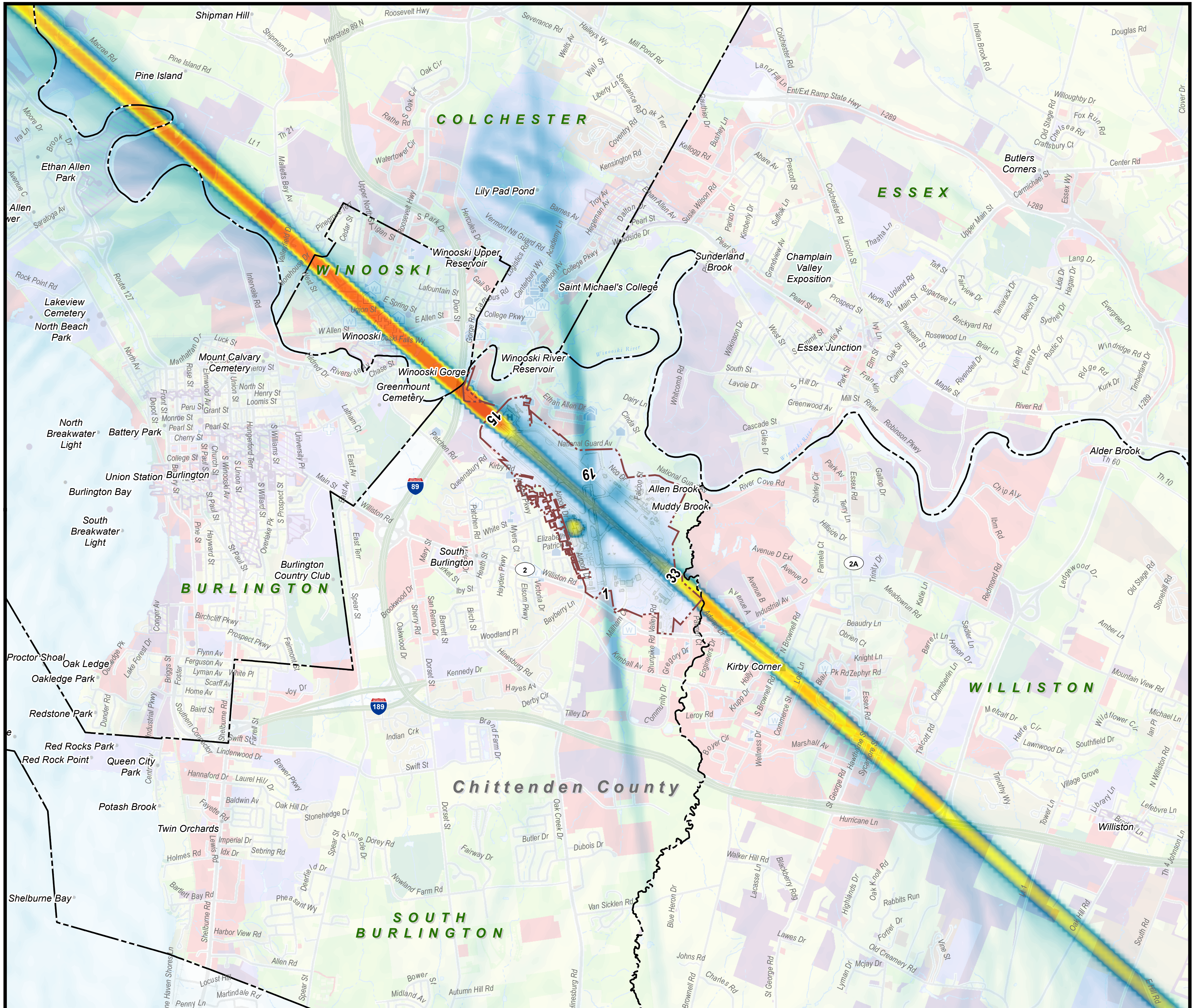

BURLINGTON INTERNATIONAL AIRPORT

Part 150 - Noise Exposure Map Update

Figure 16
Radar Sample Arrival Tracks

Radar Track Density

Low — Medium — High

- Airport Property Boundary
- Town Boundary
- Helicopter Pad
- Highways
- Major Roads
- Local Roads
- Education
- Place of Worship
- Residential
- Health Care
- Public Gathering
- National Register Historic District
- National Register Historic Site

Land Use

- Single Family Residential
- Multi Family Residential
- Other Residential
- Mixed Use
- Public Use
- Airport
- Transportation
- Commercial Use
- Manufacturing & Production
- Recreational
- Open Space

Data Sources:
Chittenden County Regional Planning Commission, Vermont Center for Geographic Information, Inc. (VCGI), United States Census Bureau, Burlington International Airport, Campbell & Paris Engineers P.C., Harris Miller Miller & Hanson Inc.

0 2,000 4,000 8,000 Feet

North

hmmh jp

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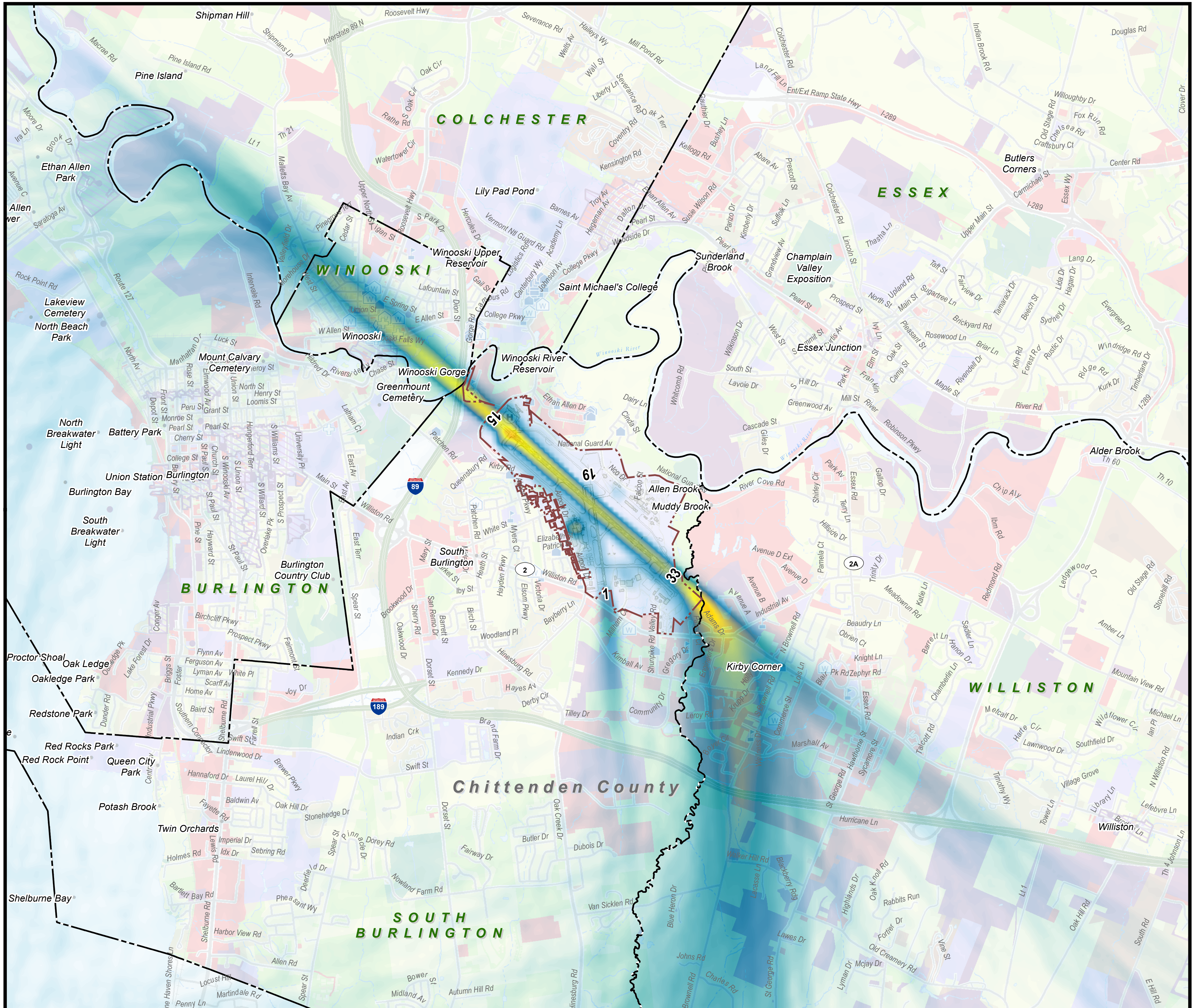
BURLINGTON INTERNATIONAL AIRPORT

PART 150 - NOISE EXPOSURE MAP UPDATE

Figure 17
Radar Sample Departure Tracks



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Radar Track Density

Low — Medium — High

- Airport Property Boundary
- Town Boundary
- Helicopter Pad
- Highways
- Major Roads
- Local Roads
- Education
- Place of Worship
- Residential
- Health Care
- Public Gathering
- National Register Historic District
- National Register Historic Site

Land Use

- Single Family Residential
- Multi Family Residential
- Other Residential
- Mixed Use
- Public Use
- Airport
- Transportation
- Commercial Use
- Manufacturing & Production
- Recreational
- Open Space

Data Sources: Chittenden County Regional Planning Commission, Vermont Center for Geographic Information, Inc. (VCGI), United States Census Bureau, Burlington International Airport, Campbell & Paris Engineers P.C., Harris Miller Miller & Hanson Inc.

0 2,000 4,000 8,000 Feet

North

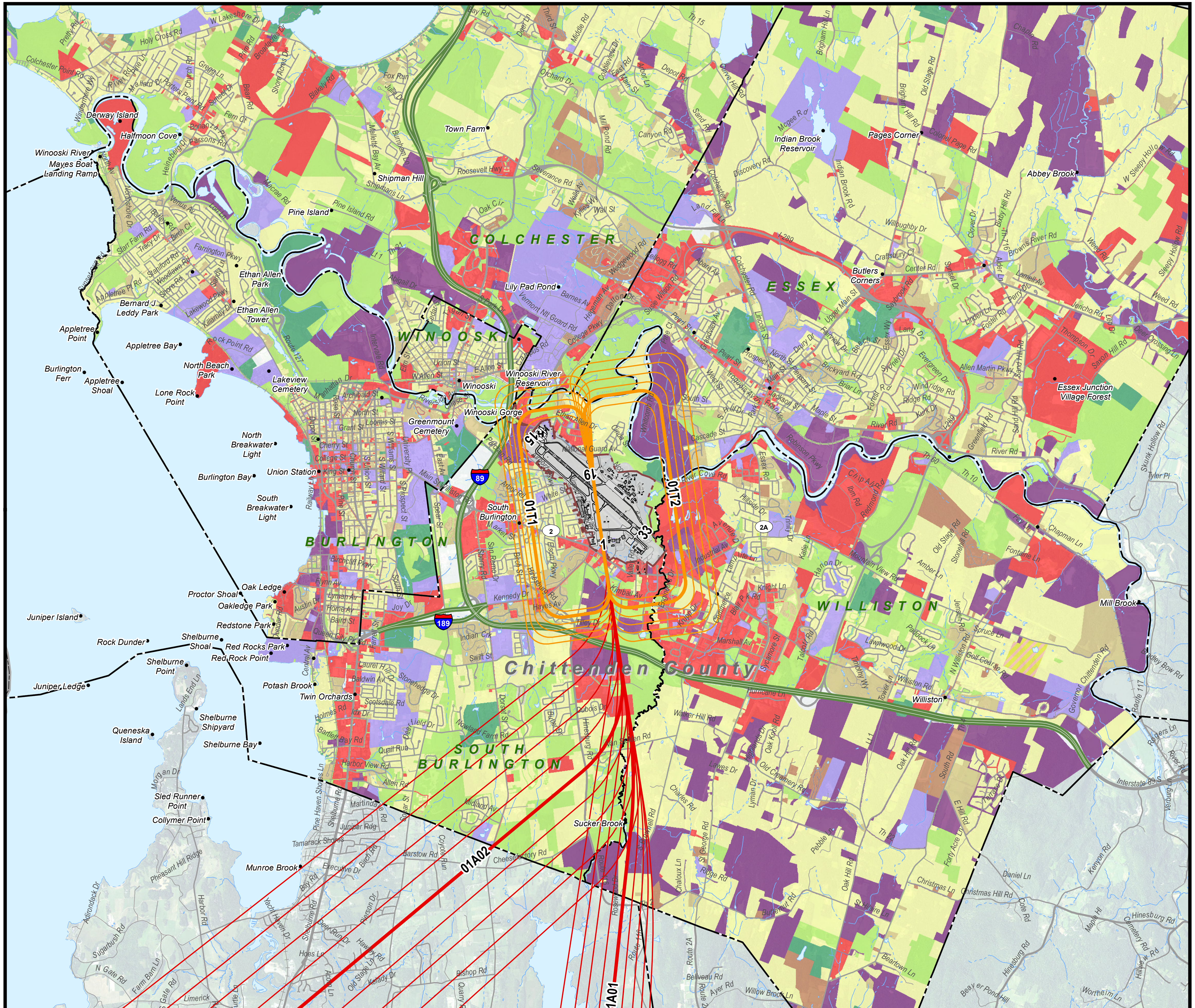
hmmh

jp

BURLINGTON INTERNATIONAL AIRPORT

PART 150 - NOISE EXPOSURE MAP UPDATE

Figure 18
Civilian and Transient Military Modeled Tracks for Runway 1



Backbone Model Tracks
- Arrival Model Tracks
- Departure Model Tracks
- Touch and Go Model Tracks

Dispersed Model Tracks
- Arrival Model Tracks
- Departure Model Tracks
- Touch and Go Model Tracks

- Airport Property Boundary
- Town Boundary
- Helicopter Pad
- Highways
- Major Roads
- Local Roads

Land Use
- Single Family Residential
- Multi Family Residential
- Other Residential
- Mixed Use
- Public Use
- Airport
- Transportation
- Commercial Use
- Manufacturing & Production
- Recreational
- Open Space

Data Sources: Chittenden County Regional Planning Commission, Vermont Center for Geographic Information, Inc. (VCGI), United States Census Bureau, Burlington International Airport, Campbell & Paris Engineers P.C., Harris Miller Miller & Hanson Inc.

0 0.5 1 2 Nautical Miles

North

hmmh

jp

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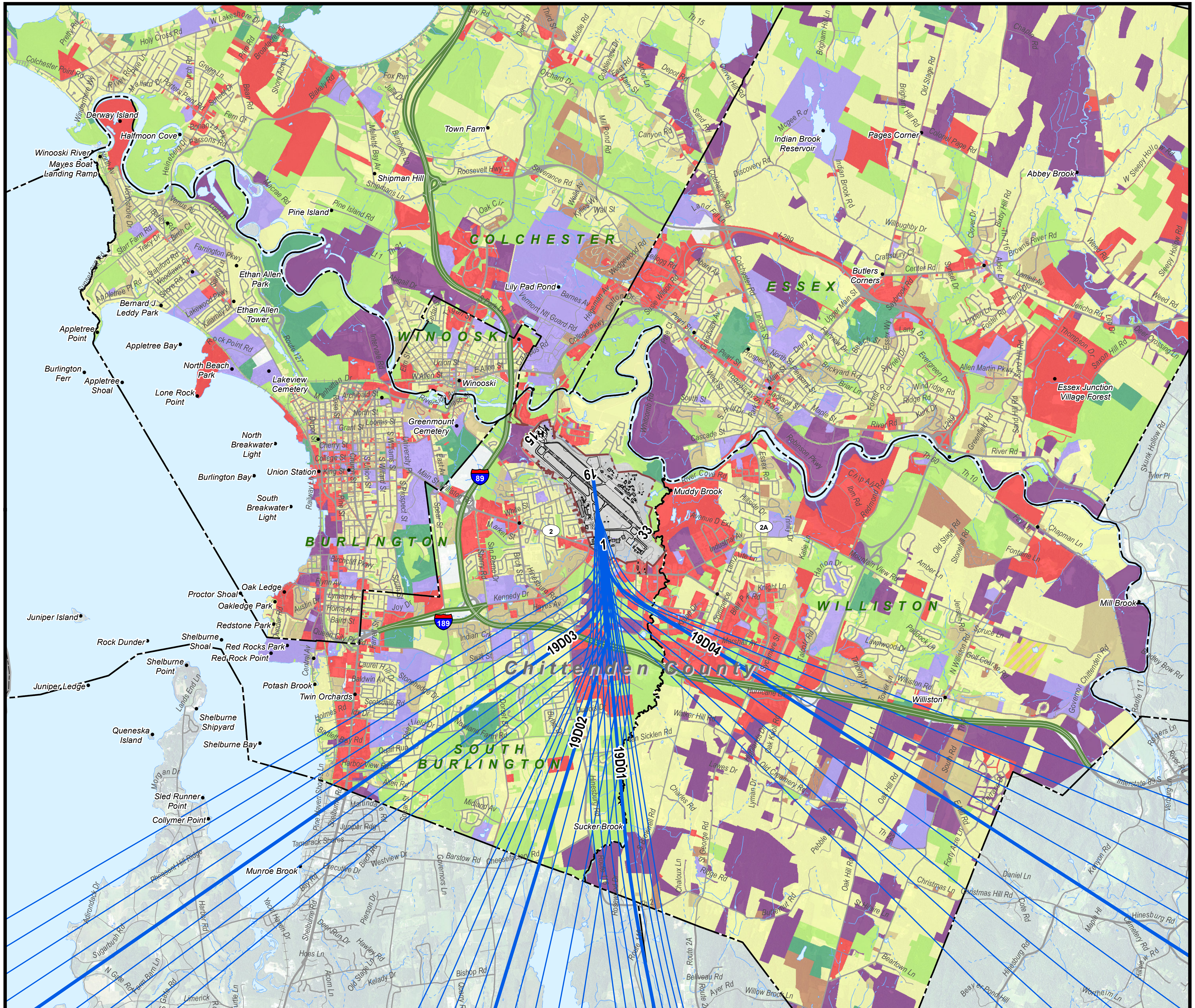
BURLINGTON INTERNATIONAL AIRPORT

PART 150 - NOISE EXPOSURE MAP UPDATE

Figure 19
Civilian and Transient Military Modeled Tracks for Runway 19



Backbone Model Tracks
- Arrival Model Tracks
- Departure Model Tracks
- Touch and Go Model Tracks
- Airport Property Boundary
- Helicopter Pad
- Highways

Dispersed Model Tracks
- Arrival Model Tracks
- Departure Model Tracks
- Touch and Go Model Tracks
- Town Boundary
- Major Roads
- Local Roads

Land Use
- Single Family Residential
- Multi Family Residential
- Other Residential
- Mixed Use
- Public Use
- Airport
- Transportation
- Commercial Use
- Manufacturing & Production
- Recreational
- Open Space

Data Sources:
Chittenden County Regional Planning Commission, Vermont Center for Geographic Information, Inc. (VCGI), United States Census Bureau, Burlington International Airport, Campbell & Paris Engineers P.C., Harris Miller Miller & Hanson Inc.

0 0.5 1 2 Nautical Miles

North

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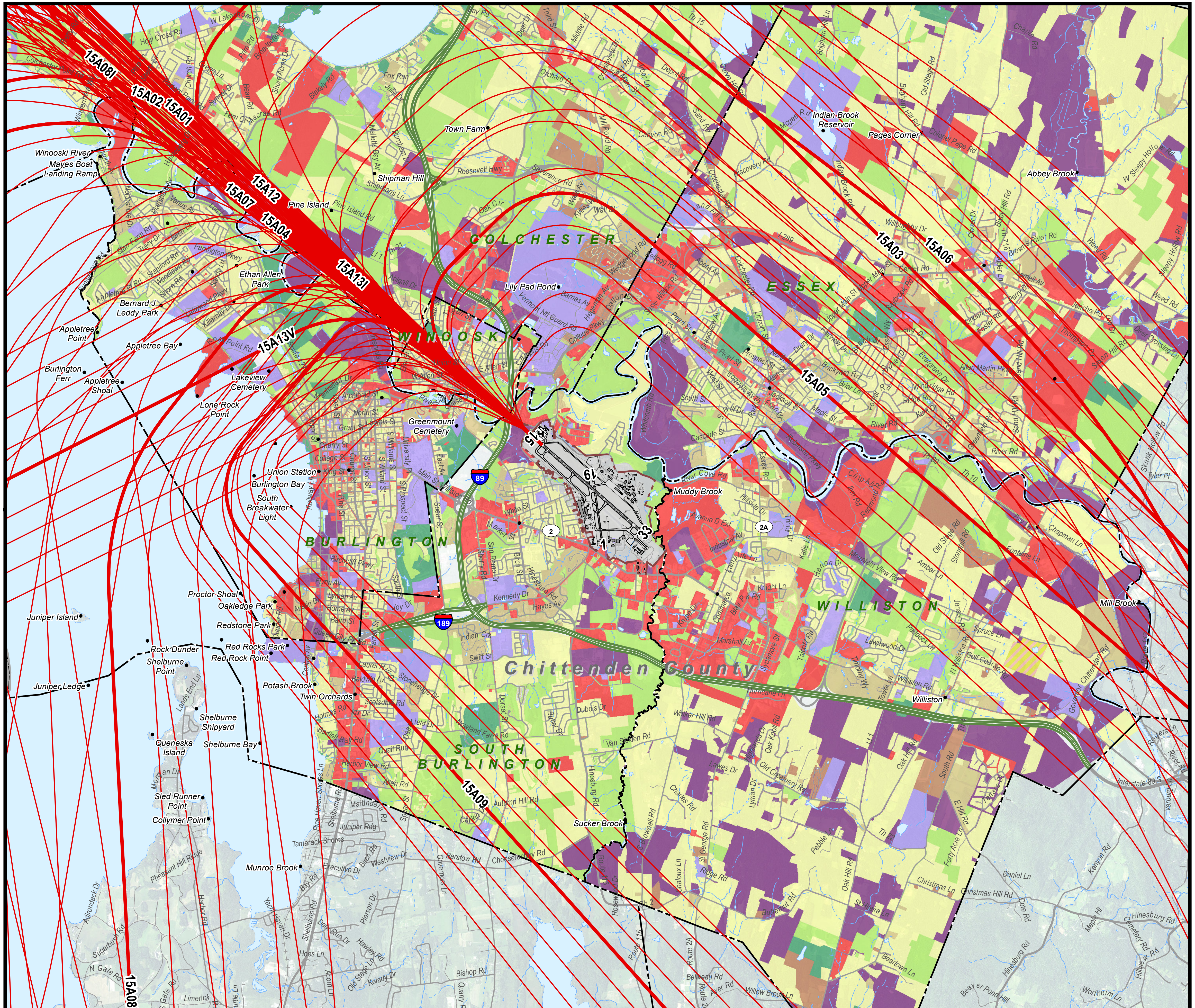

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BURLINGTON INTERNATIONAL AIRPORT

PART 150 - NOISE EXPOSURE MAP UPDATE

Figure 20
Civilian and Transient Military Modeled Tracks for Runway 15

Backbone Model Tracks
- Arrival Model Tracks
- Departure Model Tracks
- Touch and Go Model Tracks

Dispersed Model Tracks
- Arrival Model Tracks
- Departure Model Tracks
- Touch and Go Model Tracks

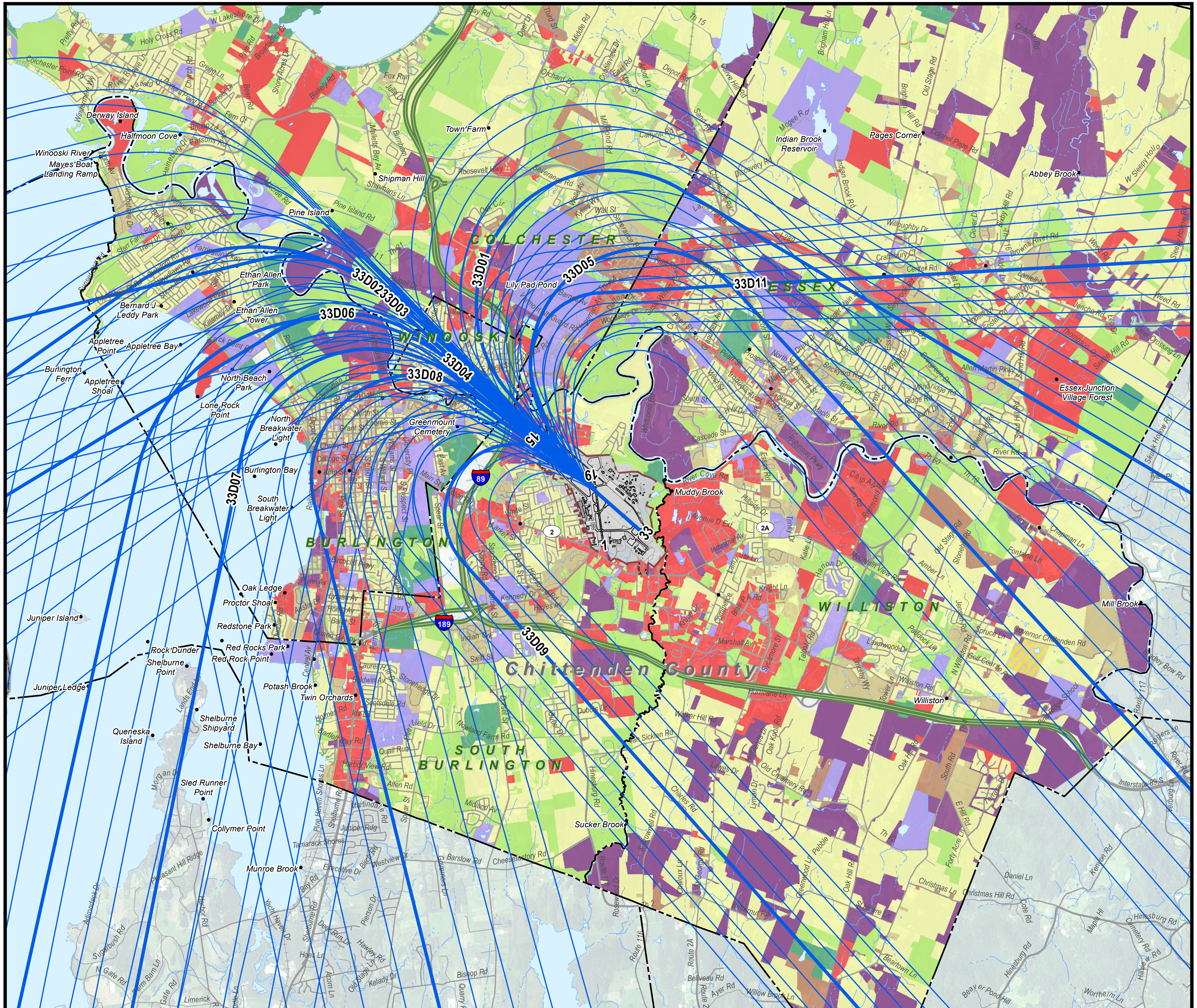
- Airport Property Boundary
- Town Boundary
- Helicopter Pad
- Highways
- Major Roads
- Local Roads

Land Use
- Single Family Residential
- Multi Family Residential
- Other Residential
- Mixed Use
- Public Use
- Airport
- Transportation
- Commercial Use
- Manufacturing & Production
- Recreational
- Open Space

Data Sources:
Chittenden County Regional Planning Commission, Vermont Center for Geographic Information, Inc. (VCGI), United States Census Bureau, Burlington International Airport, Campbell & Paris Engineers P.C., Harris Miller Miller & Hanson Inc.

0 0.5 1 2 Nautical Miles

North



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BURLINGTON INTERNATIONAL AIRPORT

PART 150 - NOISE EXPOSURE MAP UPDATE

Figure 21
Civilian and Transient Military Modeled Tracks for Runway 33

Backbone Model Tracks
- Arrival Model Tracks
- Departure Model Tracks
- Touch and Go Model Tracks
- Airport Property Boundary
- Helicopter Pad

Dispersed Model Tracks
- Arrival Model Tracks
- Departure Model Tracks
- Touch and Go Model Tracks
- Town Boundary

Highways | Major Roads | Local Roads

Land Use
- Single Family Residential
- Multi Family Residential
- Other Residential
- Mixed Use
- Public Use
- Airport
- Transportation
- Commercial Use
- Manufacturing & Production
- Recreational
- Open Space

Data Sources:
Chittenden County Regional Planning Commission, Vermont Center for Geographic Information, Inc. (VCGI), United States Census Bureau, Burlington International Airport, Campbell & Paris Engineers P.C., Harris Miller Miller & Hanson Inc.

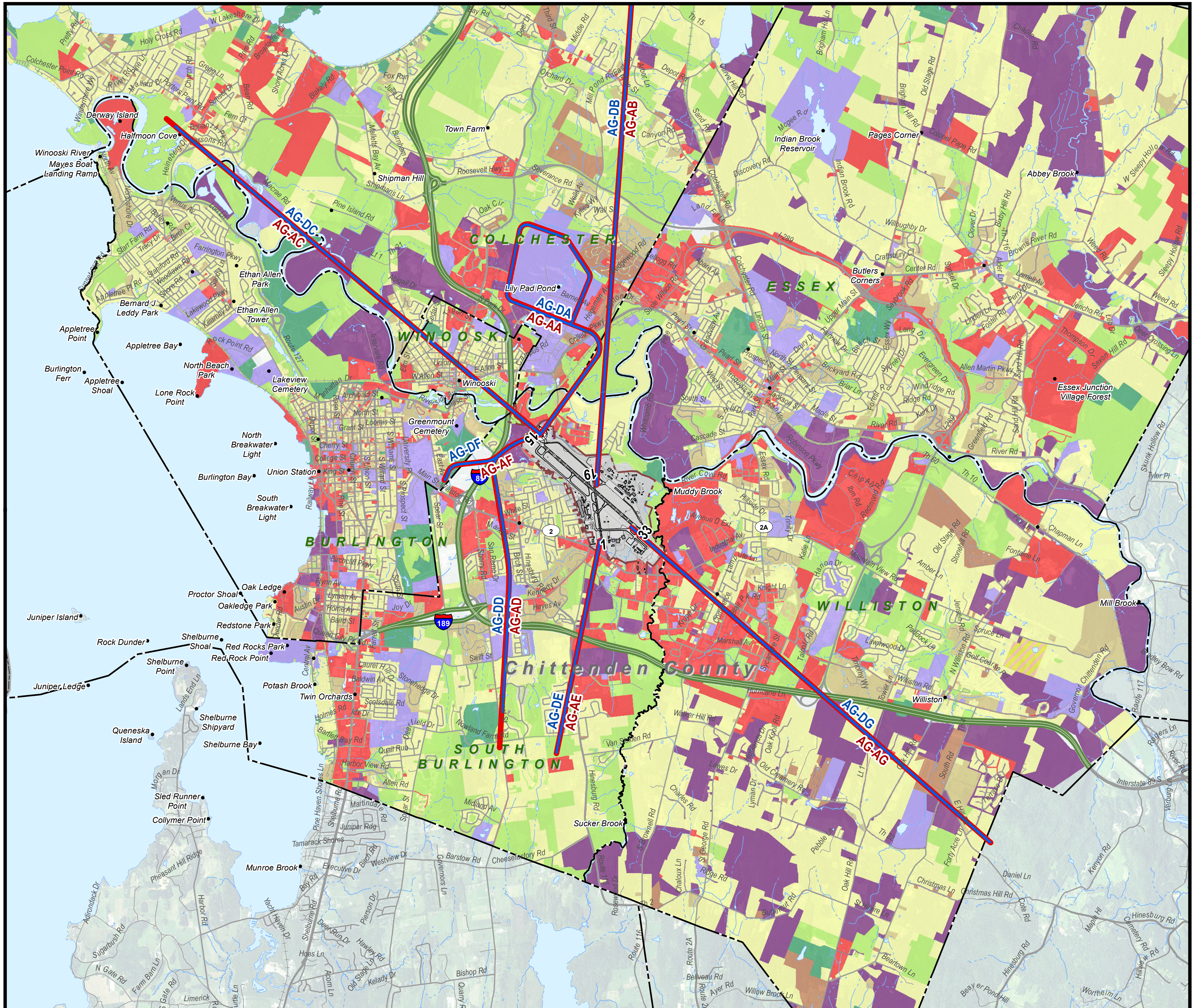
0 0.5 1 2 Nautical Miles

North

BURLINGTON INTERNATIONAL AIRPORT

Part 150 - Noise Exposure Map Update

Figure 22
Vermont Army National Guard Helicopter Modeled Tracks



Backbone Model Tracks

- Arrival Model Tracks
- Departure Model Tracks

- Airport Property Boundary
- Town Boundary
- Helicopter Pad
- Highways
- Major Roads
- Local Roads

Land Use

- Single Family Residential
- Multi Family Residential
- Other Residential
- Mixed Use
- Public Use
- Airport
- Transportation
- Commercial Use
- Manufacturing & Production
- Recreational
- Open Space

Data Sources:
Chittenden County Regional Planning Commission, Vermont Center for Geographic Information, Inc. (VCGI), United States Census Bureau, Burlington International Airport, Campbell & Paris Engineers P.C., Harris Miller Miller & Hanson Inc.

0 0.5 1 2 Nautical Miles

North

hmmh

jp

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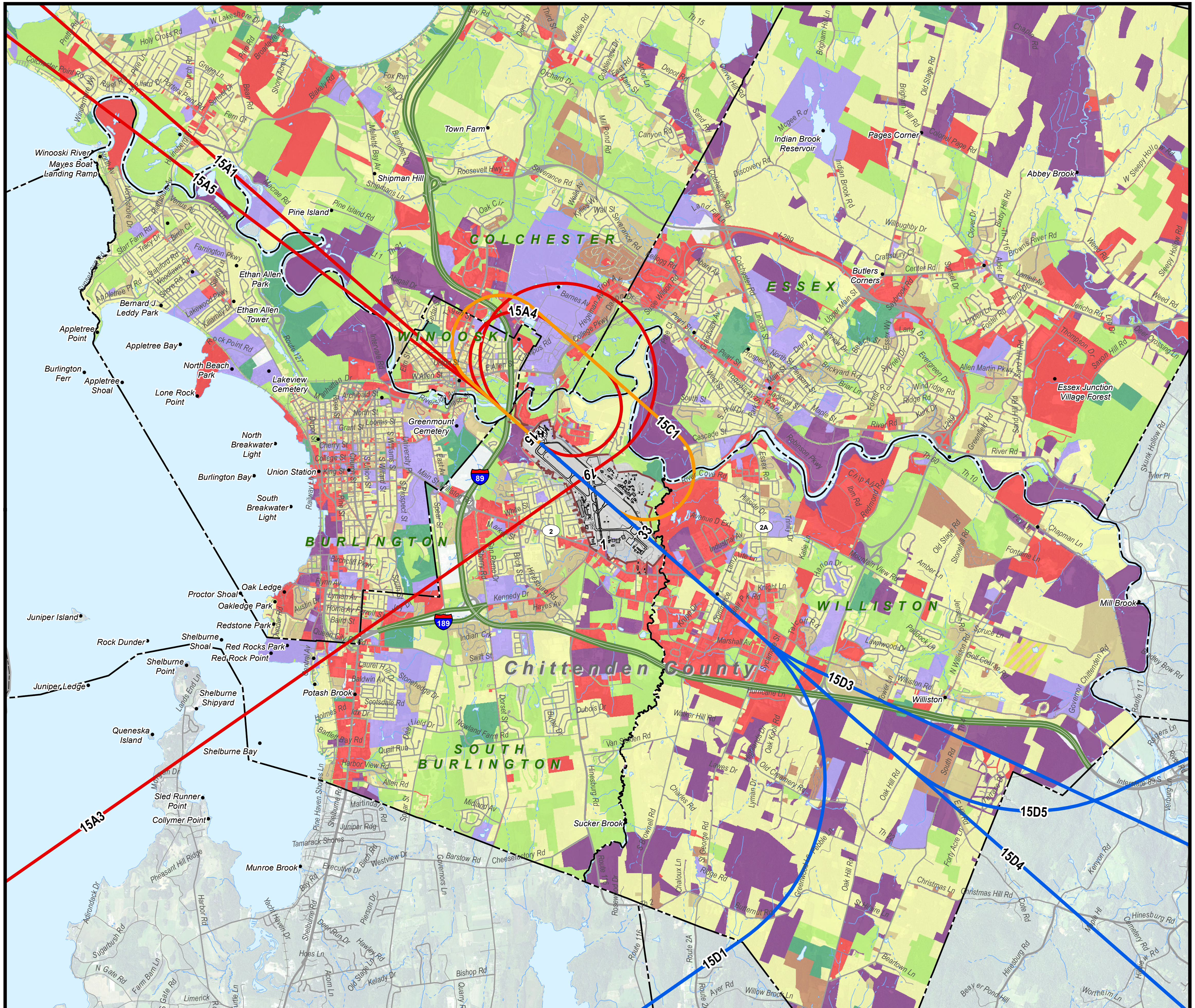

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BURLINGTON
INTERNATIONAL AIRPORT

PART 150 - NOISE EXPOSURE MAP UPDATE

Figure 23
Vermont Air National Guard F-16 and F-35 Modeled Tracks for Runway 15

Backbone Model Tracks

- Arrival Model Tracks
- Departure Model Tracks
- Touch and Go Model Tracks
- Airport Property Boundary
- Town Boundary
- Helicopter Pad
- Highways
- Major Roads
- Local Roads

Land Use

- Single Family Residential
- Multi Family Residential
- Other Residential
- Mixed Use
- Public Use
- Airport
- Transportation
- Commercial Use
- Manufacturing & Production
- Recreational
- Open Space

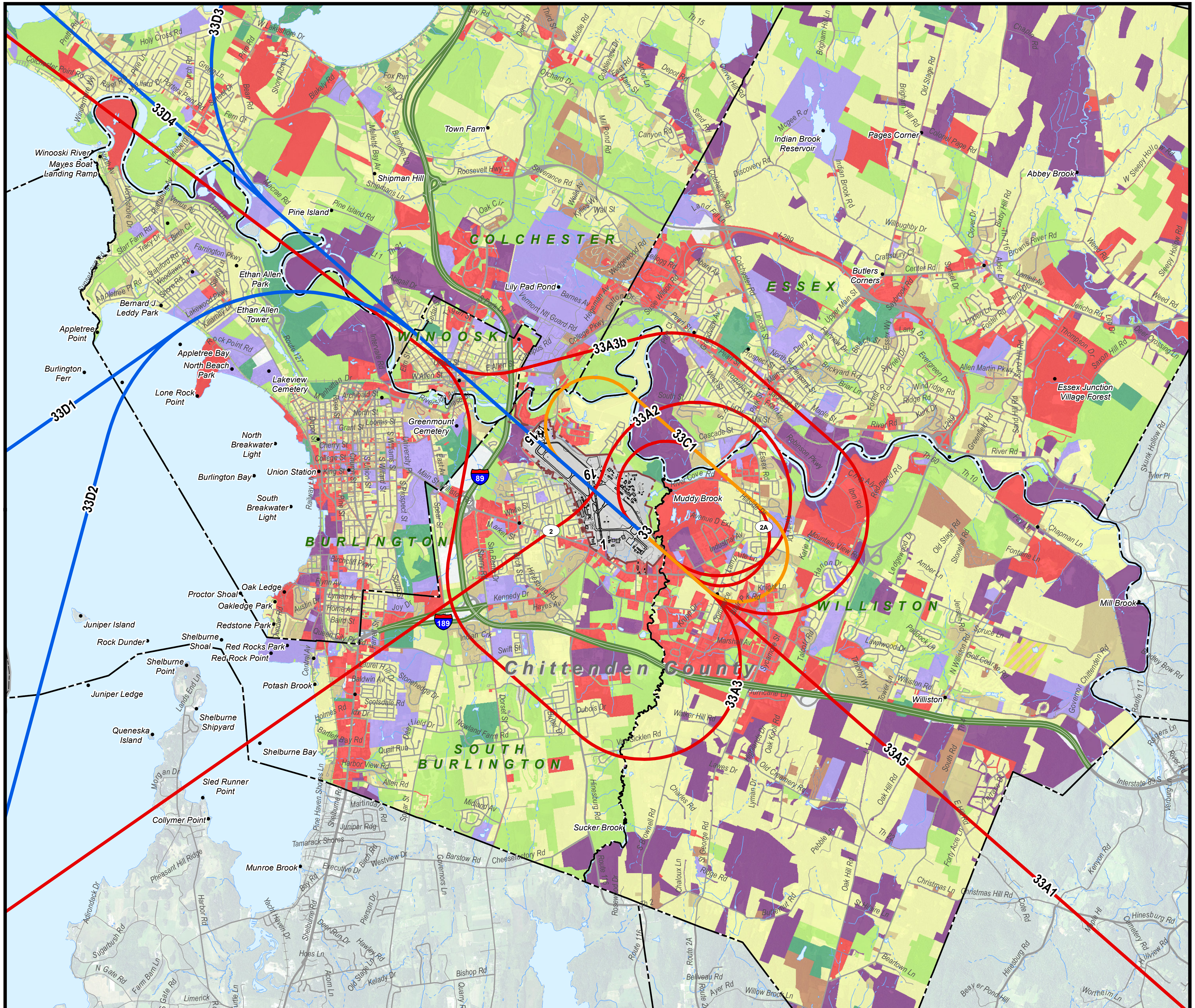
Data Sources:
Chittenden County Regional Planning Commission, Vermont Center for Geographic Information, Inc. (VCGI), United States Census Bureau, Burlington International Airport, Campbell & Paris Engineers P.C., Harris Miller Miller & Hanson Inc.

0 0.5 1 2 Nautical Miles

North

hmmh

jp



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BURLINGTON
INTERNATIONAL AIRPORT

PART 150 - NOISE EXPOSURE MAP UPDATE

Figure 24
Vermont Air National Guard F-16 and F-35 Modeled Tracks for Runway 33

Backbone Model Tracks

- Arrival Model Tracks
- Departure Model Tracks
- Touch and Go Model Tracks
- Airport Property Boundary
- Town Boundary
- Helicopter Pad
- Highways
- Major Roads
- Local Roads

Land Use

- Single Family Residential
- Multi Family Residential
- Other Residential
- Mixed Use
- Public Use
- Airport
- Transportation
- Commercial Use
- Manufacturing & Production
- Recreational
- Open Space

Data Sources:
Chittenden County Regional Planning Commission, Vermont Center for Geographic Information, Inc. (VCGI), United States Census Bureau, Burlington International Airport, Campbell & Paris Engineers P.C., Harris Miller Miller & Hanson Inc.

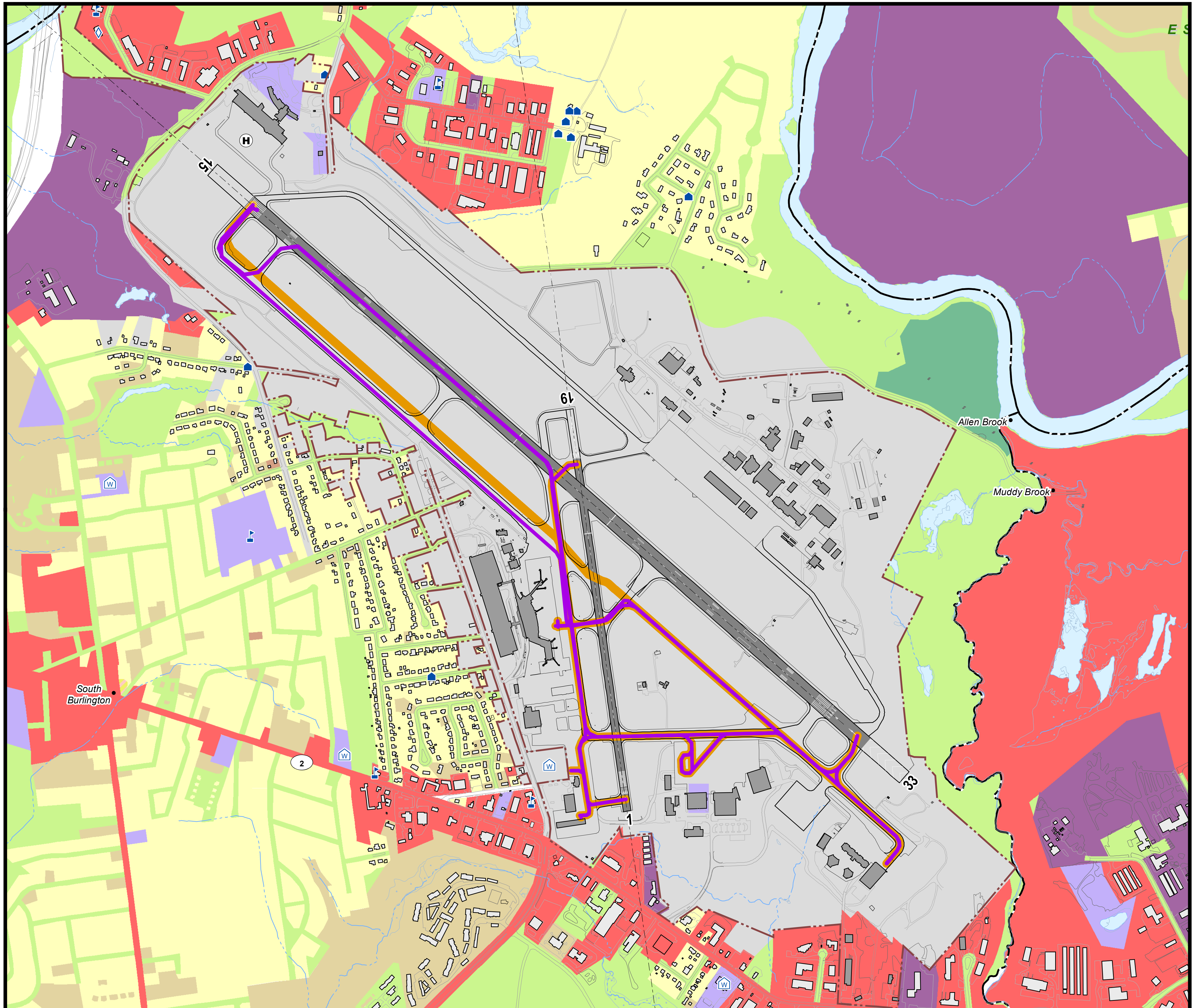
0 0.5 1 2 Nautical Miles

North

BURLINGTON INTERNATIONAL AIRPORT

Part 150 - Noise Exposure Map Update

Figure 25
Taxi Model Tracks



2018 Taxi Model Tracks
2023 Taxi Model Tracks

Airport Property Boundary
Town Boundary
Helicopter Pad
Highways
Major Roads
Local Roads
Education
Place of Worship
Residential
Health Care
Public Gathering
National Register Historic District
National Register Historic Site

Land Use

Single Family Residential
Multi Family Residential
Other Residential
Mixed Use
Public Use
Airport
Transportation
Commercial Use
Manufacturing & Production
Recreational
Open Space

Data Sources:
Chittenden County Regional Planning Commission, Vermont Center for Geographic Information, Inc. (VCGI), United States Census Bureau, Burlington International Airport, Campbell & Paris Engineers P.C., Harris Miller Miller & Hanson Inc.

0 500 1,000 2,000 Feet

North

hmmh

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6.7 Ground Noise

Ground noise includes the aircraft noise not associated with airborne (i.e. arrivals, departures or touch and go) operations. While the AEDT automatically includes the ground roll portion of airborne operations (e.g. departing aircraft accelerating down the runway, arrival aircraft apply thrust reversers), the models do not automatically include taxing noise or maintenance run-up operations.

This NEM includes taxiway noise and maintenance run-up operations as documented below.

6.7.1 Taxiway Noise

Taxiway noise is associated with aircraft taxiing to and from the runways and their respective parking areas or gates on the ramp. The taxiing may also include a queue time, where the aircraft is stationary, awaiting clearance to proceed, and the engines are at idle.

Five primary ramp areas modeled are:

- Terminal Gates,
- Cargo area,
- South West general aviation ramp, and
- South East general aviation ramp.

Details of the FAA-approved taxiway noise modeling are provided in Appendix B. AEDT was used for all taxiway modeling. Only civil aircraft types were included in taxiway modeling.

Figure 25 shows the modeled taxiway tracks for both 2018 and 2023. The 2018 taxipaths reflect the existing airport layout. The 2023 taxipaths represent the anticipated runway layout in 2023, including the extended Taxiway G.[37]

6.7.2 Maintenance Run-Ups

Maintenance run-ups are usually performed by stationary aircraft to test various functions of the aircraft. The maintenance run-up information for this Part 150 was collected from the USAF EIS modeling data and from various interviews. Several organizations at BTV, both military and civilian, perform engine maintenance and therefore conduct run-ups on a regular basis. Six run-up areas were modeled and include:

- Three flight line check spots on the Air National Guard ramp;
- Air National Guard "hush-house", located on the south east side of the ANG base;
- Commercial hanger area west of Runway 1-19 and south of the terminal building; and
- Taxiway K, near the intersection with Taxiway C.

6.8 Meteorological Conditions

AEDT has several settings that affect aircraft performance profiles and sound propagation based on meteorological data. Meteorological settings include average annual temperature, barometric pressure, and relative humidity at the airport. AEDT holds the following values for annual-average weather conditions at Burlington International Airport:

- Temperature: 45.0^{o} Fahrenheit

[37] Section 4.1.1 provides additional discussion related to Taxiway G.

- Sea-level Pressure: 1015.9 milibars
- Relative humidity: 68.08 percent.
- Dew Point: 36.01°F
- Wind Speed: 7.14 Knots

For consistency, the same weather data used in the AEDT study was used in the BTV NEM NOISEMAP study.

6.9 Terrain

Terrain data describes the elevation of the ground within and surrounding airport property. If the AEDT user selects the use of terrain data, AEDT uses terrain data to adjust the ground level under the flight paths. The terrain data does not affect the aircraft's performance or noise levels, but does affect the vertical distance between the aircraft and a "receiver" on the ground. This in turn affects noise propagation assumptions about how noise propagates over ground. The terrain data were obtained from the United States Geological Survey (USGS) National Map Viewer and was used with the terrain feature of the AEDT in generating the noise contours for the BTV NEM.

Appendix A Non-Standard Noise Modeling Substitution Request

HMMH memorandum “Nonstandard AEDT Modeling Request for the 2018 BTV Noise Exposure Map Update Study” dated May 14, 2019. This memorandum describes the contractor’s recommended non-standard modeling methodology, prepared in accordance to FAA July 2009 guidance.
https://www.faa.gov/airports/environmental/policy_guidance/media/nonstd-inm-modeling.pdf

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TECHNICAL MEMORANDUM

To:	Richard Doucette, FAA 1200 District Ave #3 Burlington MA 01803
From:	Brandon Robinette, Principal Consultant Scott McIntosh, Consultant
Date:	May 14, 2019
Subject:	Nonstandard AEDT Modeling Request for the 2018 BTV Noise Exposure Map Update Study
Reference:	HMMH Project Number 308770.008

1. Introduction

Burlington International Airport (BTV) has contracted Jones Payne Group (JPG) and HMMH to perform an update of the Noise Exposure Map (NEM) for base year 2018 and forecast year 2023. HMMH is performing the modeling for this study primarily using AEDT version 2d. Due to substantial military activity at BTV by based units of the Vermont Air National Guard (VTANG) and Vermont Army National Guard (VTARNG), modeling of operations by these aircraft is carried out in NMap. The NMap result grids are imported into AEDT and combined with AEDT results for civilian and transient military aircraft to generate the final NEM for the study.

This memo describes and requests approval for nonstandard inputs and/or techniques in the NEM modeling. These topics are:

- Nonstandard aircraft noise and performance data substitutions
- Taxiway modeling

2. Aircraft Substitutions

HMMH obtained operations data for activity at BTV through the FAA's Traffic Flow Management System Counts (TFMSC), which identifies aircraft by their aircraft identifiers that are defined in FAA Order 7360.1D "Aircraft Type Designators" and ICAO document 8643. Table 1 shows aircraft type designators that do not appear in AEDT's FltActypeToUniqueEquipMap table in the FLEET database. Approval is requested for the use of the Aircraft Noise Performance (ANP) types shown in Table 1 based on the following considerations:

E75L, E75S – Embraer 175: These are new aircraft type designators for this aircraft. Prior to the introduction of designators E75L and E75S, Embraer 175s were included in the broader type designator E170. The Embraer 175 ANP data are in AEDT, but not associated with the E75L and E75S type designators.

C68A – Cessna Citation Latitude: Variant of the Cessna 680 Citation Sovereign (designator C680), which is a standard AEDT aircraft with ANP type CNA680.

CL35 – Bombardier Challenger 350: Use of the ANP type CL600 was approved by AEE 9/13/2016 for the Bombardier Challenger 350 for the Draft Environmental Assessment for Proposed Improvements 2016-2020 at Baltimore/Washington International Airport (BWI DEA).

DA40 – Diamond Club Star DA-40: Use of ANP type GASEPV was approved for the BWI DEA.

M20P – Mooney M-20C Ranger: Use of the ANP type GASEPV was approved by AEE 3/23/2015 for the Mooney M-20C Ranger for the Draft Environmental Assessment for Southern California Optimization of Airspace and Procedures in the Metroplex (SoCal OAPM).

P28R – Piper Cherokee Arrow: Use of GASEPV was a standard substitution for this aircraft defined INM 7.0d (INM 7.0d identifier PA28CA).

PA46 – Piper Malibu: Use of GASEPV is a standard substitution for this aircraft in INM 7.0d (INM 7.0d identifier PA46).

Table 1. ICAO Identifiers Not In FltActypeToUniqueEquipMap

Aircraft Designator	Aircraft Description	Proposed AEDT Equipment ID	Proposed ANP Type
E75L	Embraer 175 (Long Wing)	3071	EMB175
E75S	Embraer 175 (Short Wing)	3816	EMB175
C68A	Cessna Citation Latitude	5347	CNA680
CL35	Bombardier Challenger 350	5345	CL600
DA40	Diamond Club Star DA40	1271	GASEPV
M20P	Mooney M-20C Ranger	1271	GASEPV
P28R	Piper Cherokee Arrow	1271	GASEPV
PA46	Piper Malibu	1271	GASEPV

3. Taxiway modeling

3.1 Methodology overview

BTV has expressed the desirability of taxiway modeling in their NEM studies due to community interest in this aspect of airport-related noise. Although taxiway modeling is not a built-in feature of AEDT, HMMH has developed methodology to implement taxiing activity in AEDT, consistent with the guidance outlined in the INM 7.0 User's Guide, Section 9.8.7. This methodology has been used with FAA approval for previous BTV NEM updates in 2006 and 2015, as well as the 2014 NEM for Portsmouth International Airport. HMMH requests re-approval of this methodology for the current study.

Taxi tracks have been constructed connecting four parking locations (terminal, cargo, and two GA ramps) to the four runway ends. These tracks reflect the current taxiway configuration (accounting for construction closures) for the current conditions case, and the planned realignment/connections of Taxiways G and K for the forecast conditions case. These track layouts are shown in Figure 1.

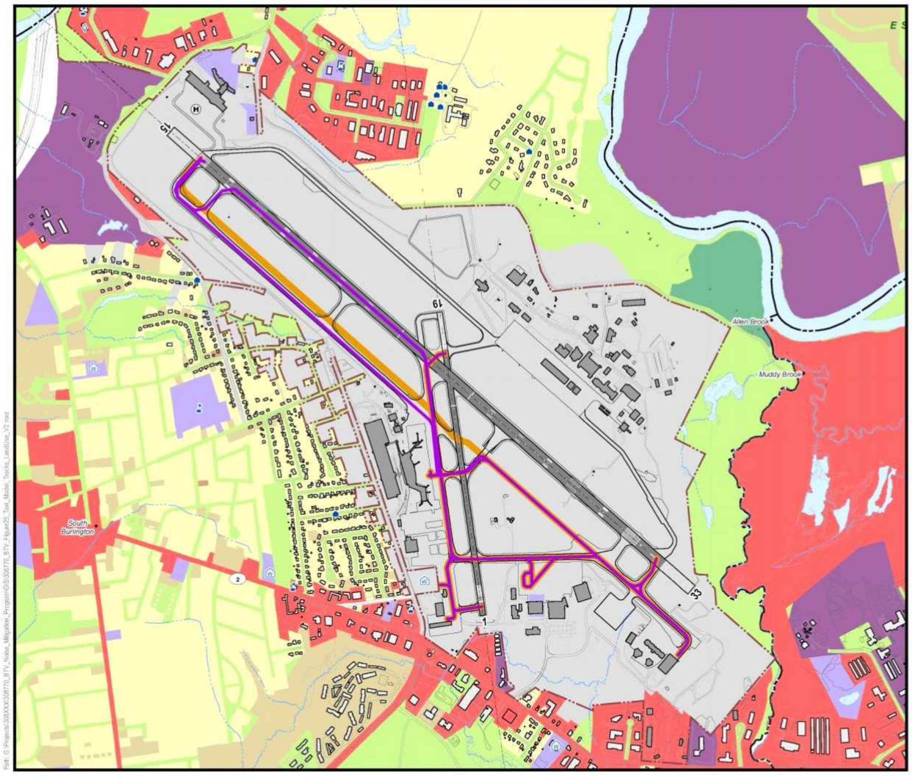

Figure 1: Modeled 2018 (Purple) and 2023 (Orange) Taxi Tracks

Figure 2 shows modeled DNL 65 dB contours for 2018 conditions with and without taxiway activity. The taxiway activity expands the contour near the Runway 1 end due to activity on Taxiways A and C.

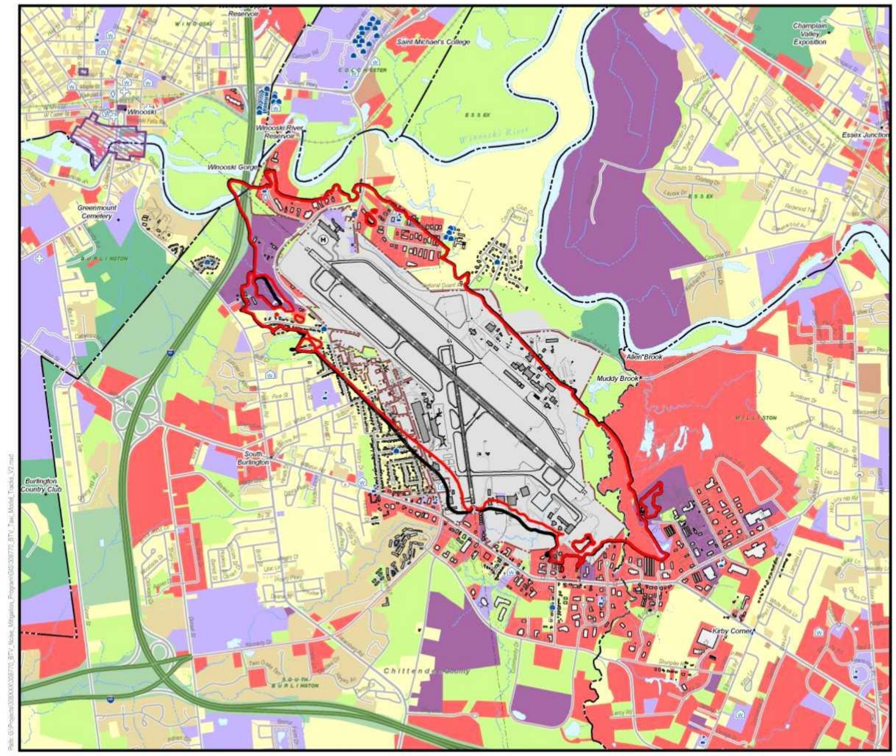

Figure 2: Modeled 2018 DNL 65 dB Contours With (black) and Without (red) Taxiway Activity

Richard Doucette
14 May 2019
Page 5

Figure 3 shows the DNL 65 dB contours for 2023 with and without taxiway activity. In this case, with the larger overall contour, the change in extent of the contour is smaller, but since more of the contour is in areas of noncompatible land use, the inclusion of taxiway noise potentially results in greater impact.

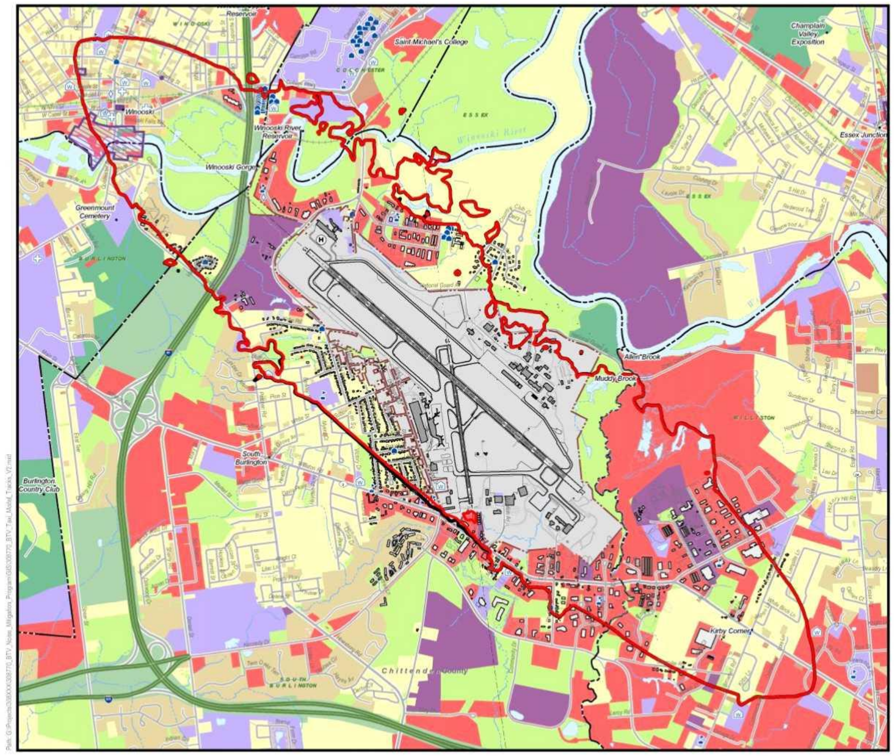

Figure 2: Modeled 2023 DNL 65 dB Contours With (black) and Without (red) Taxiway Activity

Several overflight profiles are used to represent the operations for the taxiways in this project, all of which are described below. These profiles include various stationary segments where appropriate. These stationary segments include:[1]

- Five and a half minute taxi hold/queue (based on data provided by US Department of Transportation, Bureau of Transportation Statistics, database: "Airline On-Time Performance Data" and interviews[2])
- Two minute idle warm-up
- One minute hold for crossing Runway 1/19 (HMMH experience)

As per the INM 7.0 User's Guide, the stationary positions are modeled as slow moving aircraft through the area. This slow movement representation is used because the INM/AEDT overflight profiles cannot model 0 velocity profile segments, and the slow movement area represents multiple "average annual" positions at which individual aircraft may actually stop.

Each ANP aircraft type used in this study has up to forty-eight unique proposed overflight profiles which correspond to the correct length and speeds of the particular taxi-way ground track and the parameters for the particular aircraft (although not all ANP aircraft will use all of the profiles). Therefore, the following profile description uses variables to describe several of the parameters.

In summary, all of the profiles use an overflight operation type and an altitude of 10 ft[3]. The taxiing portion (i.e. moving) of the profile will be at a constant speed (10 knots) at an idle power setting defined as 10% of the static thrust for that aircraft[4]. The stationary positions are represented with several profile points and are described below.

Each stationary position portion of the profile is represented with six points entered in the FLT_ANP_PROFILE_POINTS table, as described in

Table 2. The points represent the deceleration from 10 knots to "0 knots" over 50 ft., slow movement over a respective distance to represent the desired stationary time and aircraft movement through that same area at 10 knots, and then acceleration from "0 knots" to 10 knots. The acceleration portions include segments at 30% of the static thrust value for the respective aircraft. The derivation of using 30% of the static thrust value is provided in Section 3.2.

Table 3 presents the profile points for taxi after arrival. These profiles are much simpler, with only two points. The aircraft taxi with a constant speed of 10 knots and idle thrust for the full length of the profile.

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[1] Data are consistent with the 2015 NEM taxiway modeling unless otherwise noted.

[2] Interviews during the 2006 NEM preparation with airport staff and FAA indicate that aircraft turn off their engines if they queue for more than 10 minutes. In addition, estimates indicate that without queuing, aircraft need approximately seven minutes for idle warm-up and taxi from the terminal to the departure threshold. Therefore, the individual "TaxiOut" times provided in the "Airline On-Time Performance Data" was bound between seven minutes (taxiout, no queue) and seventeen minutes (taxi out, maximum duration queue with engines on) and then averaged. Data used was 5,216 individual operations listed from 08/01/2012 through 07/31/2013 that did not have DepTime = NULL. The Airline On-Time Performance Data is available at http://www.transtats.bts.gov/Tables.asp?DB_ID=120&DB_Name=Airline%20On-Time%20Performance%20Data&DB_Short_Name=On-Time

[3] Previous analyses have shown no effect for small changes in elevation. Therefore, the analysis was simplified by assuming all engines were 10 ft above airport elevation.

[4] When the aircraft thrust in the noise-power-distance curves is not expressed in pounds (as determined from the THR_SET field in the FLT_ANP_AIRPLANE_NPD_CURVES table), the thrust is modeled using 10% of the highest thrust value in the noise-power-distance curves.

Richard Doucette
14 May 2019
Page 7

Table 2: Profile Points for Taxi to Departure

OP_TYPE	PROF_ID1	PT_NUM	DISTANCE (ft)	ALTITUDE (ft)	SPEED (Knots)	THR_SET
V	[TX]	1	0	10	0.1	[IDLE]
V	[TX]	2	11	10	0.1	[IDLE]
V	[TX]	3	21	10	0.1	[ACL]
V	[TX]	4	71	10	10	[ACL]
V	[TX]	5	81	10	10	[IDLE]
V	[TX]	6	[START]-50	10	10.0	[IDLE]
V	[TX]	7	[START]	10	[AS]	[IDLE]
V	[TX]	8	[END]-10	10	[AS]	[IDLE]
V	[TX]	9	[END]	10	[AS]	[ACL]
V	[TX]	10	[END]+50	10	10.0	[ACL]
V	[TX]	11	[END]+60	10	10.0	[IDLE]
V	[TX]	12	[S]	10	10.0	[IDLE]

[TX] = Name of the taxi way track

[START] = Profile distance to beginning of stationary area (ft)

[END] = Profile distance to end of stationary area (ft)

[S] = The length of the taxiway track.

[AS] = Adjust speed – speed that will provide the desired stationary time in the stationary area and the necessary time to taxi through the area at 10 knots.

[IDLE] = Idle thrust setting represented by 10% of the aircraft's static thrust; for aircraft with NPD curves where the thrust is not expressed in lbs, 10% of the highest thrust in the departure NPD curves

[ACL] = Accelerating thrust for taxi, 0 to 10 knots in 50 ft., 30% of the static thrust associated with the aircraft; for aircraft with NPD curves where the thrust is not expressed in lbs, 30% of the highest thrust in the departure NPD curves.

Table 3: Profile Points for Taxi from Arrival

OP_TYPE	PROF_ID1	PT_NUM	DISTANCE (ft)	ALTITUDE (ft)	SPEED (Knots)	THR_SET
V	[TX]	1	0	10	10.0	[IDLE]
V	[TX]	2	[START]-50	10	10.0	[IDLE]
V	[TX]	3	[START]	10	[AS]	[IDLE]
V	[TX]	4	[END]-10	10	[AS]	[IDLE]
V	[TX]	5	[END]	10	[AS]	[ACL]
V	[TX]	6	[END]+50	10	10.0	[ACL]
V	[TX]	7	[END]+60	10	10.0	[IDLE]
V	[TX]	8	[S]	10	10.0	[IDLE]

[TX] = Name of the taxi way track

[START] = Profile distance to beginning of stationary area (ft)

[END] = Profile distance to end of stationary area (ft)

[S] = The length of the taxiway track.

[AS] = Adjust speed – speed that will provide the desired stationary time in the stationary area and the necessary time to taxi through the area at 10 knots.

[IDLE] = Idle thrust setting represented by 10% of the aircraft's static thrust; for aircraft with NPD curves where the thrust is not expressed in lbs, 10% of the highest thrust in the departure NPD curves

[ACL] = Accelerating thrust for taxi, 0 to 10 knots in 50 ft., 30% of the static thrust associated with the aircraft; for aircraft with NPD curves where the thrust is not expressed in lbs, 30% of the highest thrust in the departure NPD curves.

3.2 Derivation of taxiing acceleration thrust

The derivation of accelerating thrust uses basic physics and some simplifying assumptions. This analysis assumes that aerodynamic drag and wheel friction are negligible, that the aircraft is on a level surface, and the only force (thrust) required is to accelerate the mass of the aircraft to the desired speed and within the desired distance. This analysis also assumes that an aircraft's maximum static thrust is approximately 30% of the aircraft weight[5]. The result of the analysis is that approximately 30% static thrust is required to accelerate the aircraft from 0 to 10 knots (16.88 ft/s) within 50 ft.

Equation 1 represents one of the equations of motion and relates acceleration and distance to a change in velocity.

$$\text{Velocity}_{\text{Final}}^2 = \text{Velocity}_{\text{Initial}}^2 + 2 * \text{Acceleration} * \text{Distance} \quad (1)$$

Equation 2 uses Equation 1 and expresses the acceleration required to change velocity from 0 to 10 knots (16.88 ft/s) within 50 ft. This is the desired acceleration.

$$\text{Acceleration}_{\text{Desired}} = (16.88\ \text{ft/s})^2/(2*50\ \text{ft}) = 2.85\ \text{ft/s}^2 \quad (2)$$

Equation 3 represents the relationship between force, mass and acceleration (Newton's Second Law of Motion).

$$\text{Force} = \text{Mass} * \text{Acceleration} \quad (3)$$

[5] Estimated by comparison of static thrust and maximum take-off weights for various INM types used in this study, as provided in the AEDT fleet database.

Equation 4 relates the weight of the aircraft to its mass based on Equation 3 and the acceleration of gravity ($32.17\ ft/s^2$)

$$\text{Weight} = \text{Mass}*32.17\ ft/s^2 \quad (4)$$

Equation 5 is based on Equation 3 and relates the desired thrust to the desired acceleration.

$$\text{Thrust}_{\text{Desired}} = \text{Mass} * \text{Acceleration}_{\text{Desired}} \quad (5)$$

Equation 6 replaces the mass in Equation 5 with the relationship presented in equation 4.

$$\text{Thrust}_{\text{Desired}} = (\text{Weight}/32.17\ ft/s^2) * \text{Acceleration}_{\text{Desired}} \quad (6)$$

Equation 7 presents the observed relationship between the static thrust and aircraft weight, based on comparison of relevant aircraft in the AEDT fleet database.

$$\text{Thrust}_{\text{Static}} = 0.30 * \text{Weight} \quad (7)$$

Equation 8 replaces the weight in equation 6 with the function of static thrust given in equation 7, yielding the final relationship between the desired thrust and static thrust.

$$\text{Thrust}_{\text{Desired}} = ((\text{Thrust}_{\text{Static}}/0.30)/32.17\ ft/s^2) * \text{Acceleration}_{\text{Desired}} \quad (8)$$

$$\text{Thrust}_{\text{Desired}} = ((\text{Thrust}_{\text{Static}}/0.30)/32.17\ ft/s^2) * 2.85\ ft/s^2$$

$$\text{Thrust}_{\text{Desired}} = 0.30*\text{Thrust}_{\text{Static}}$$

3.3 Omission of F-16C and F-35A Aircraft from Taxiway Modeling

AEDT modeling for the 2018 and 2023 NEMs excludes taxiway modeling for VTANG F-16C and F-35A aircraft. This differs from the modeling conducted for the 2015 and 2020 NEMs, which included INM taxiway modeling of VTANG F-16C aircraft for both years. Taxiway modeling of the F-35A aircraft is not currently possible as AEDT 2d does not contain noise data for the F-35A aircraft. In order to maintain consistent modeling methodology across existing and forecast for this NEM update, taxiway modeling of VTANG F-16C aircraft has been omitted from the AEDT modeling for 2018 as well.

Appendix B Airport Layout and Operations Assumptions for Existing and Forecast Conditions

HMMH memorandum "Noise Exposure Map Study for Burlington International Airport - Base and Forecast Year Modeling Inputs and Assumptions" dated May 14, 2019. This memorandum describes the runway layout and aircraft operations assumptions for the noise contours for calendar year 2018, and the forecast noise contours for calendar year 2023.

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TECHNICAL MEMORANDUM

To:	Richard Doucette, FAA Federal Aviation Administration 1200 District Ave Burlington MA 01803
From:	Brandon Robinette, Principal Consultant Scott McIntosh, Consultant
Date:	May 14, 2019
Subject:	Noise Exposure Map Study for Burlington International Airport - Base and Forecast Year Modeling Inputs and Assumptions
Reference:	HMMH Project Number 308770

1. Background

This memo describes and requests approval for the data inputs and assumption developed for the Burlington International Airport Noise Exposure Map Update modeling.

HMMH is assisting the Burlington Airport Commission and Jones Payne Group in a Noise Exposure Map (NEM) update for Burlington International Airport (BTV). The memorandum summarizes the aircraft noise modeling assumptions and inputs for the BTV base year (calendar year 2018) and forecast year (calendar year 2023). HMMH will use the Federal Aviation Administration's (FAA) Aviation Environmental Design Tool, Version 2d, (AEDT 2d) to calculate aircraft noise exposure levels from civilian and transient military operations for the BTV 2018 NEM base year and 2023 forecast year. The Vermont Air and Army National Guard's aircraft operations will be evaluated with the Department of Defense's Noisemap software, Version 7.3 (NMap 7.3). The noise grid outputs of these models will be combined to generate the 2018 and 2023 annual Day-Night Average Sound Level (DNL) contours for the NEM update.

This memo primarily addresses the development of civilian and transient military operations data for modeling in the AEDT. The subsequent sections address the required data inputs for the AEDT noise model:

- 2. Physical Description of the Airport Layout
- 3. Aircraft Operations
- 4. Aircraft Noise and Performance Characteristics
- 5. Runway utilization
- 6. Flight track geometry and use
- 7. Ground noise
- 8. Meteorological conditions
- 9. Terrain data

2. Physical Description of the Airport Layout

BTV is located in Chittenden County and the city of South Burlington, north and west of Interstate 89 and south of the Winooski River. The airfield layout comprises two runways, primary Runway 15/33 and crosswind Runway 1/19. Figure 1 shows the current airport diagram and Table 1 provides the runway information used in modeling the 2018 base year and 2023 forecast year. Runway length, runway width, instrumentation, and declared distances affect which runway an aircraft will use and under what conditions, and therefore, will determine the use of a runway relative to the other runways at the airport.

Burlington International Airport NEM Update Modeling
May 14, 2019
Page 2

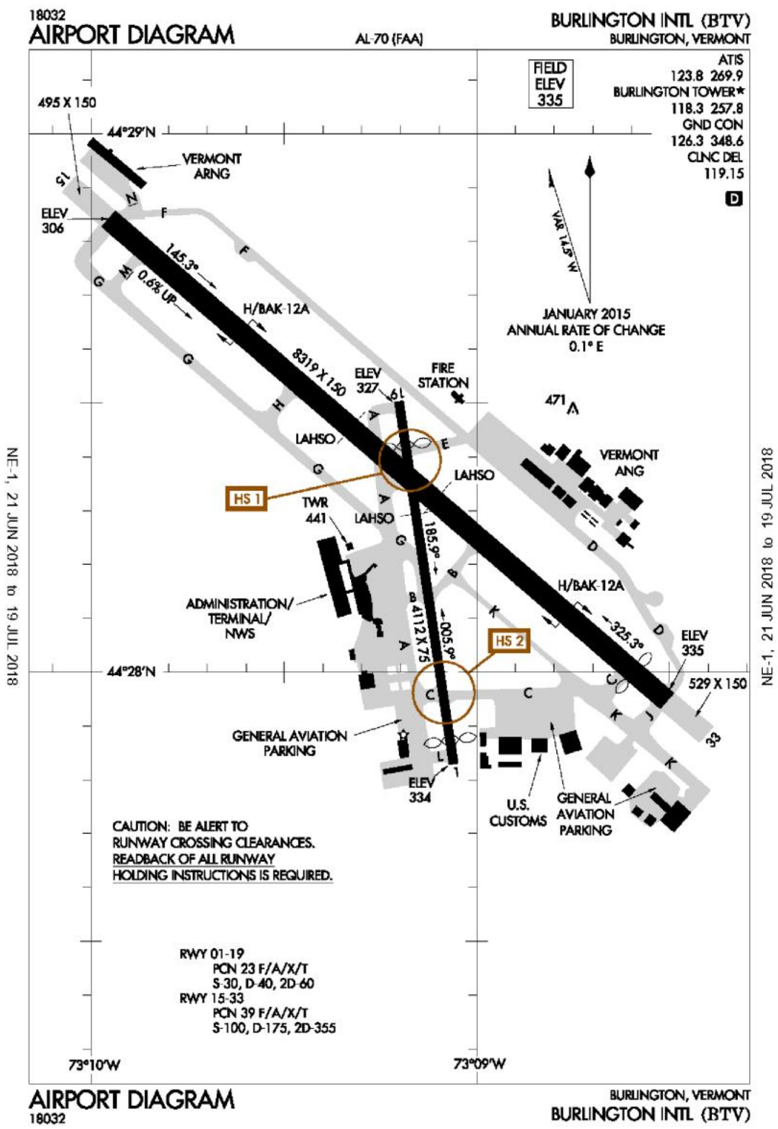

Figure 1: Base Year Airport Diagram

Source: FAA, effective, 21 June 2018 to 19 July 2018

Table 1: Current Runway Data

Source: FAA 5010

Runway End	Latitude	Longitude	Elevation (ft. MSL)	Length (ft.)	Approach Angle (degrees)	Displaced Threshold (ft)
01	44.463826	-73.151003	333.7	4,112	3.5	225
19	44.474978	-73.153352	326.8	4,112	3.0	500
15	44.480674	-73.165879	305.5	8,319	3.0	0
33	44.465758	-73.141763	334.2	8,319	3.2	500

3. Aircraft Operations

Civilian and transient military aircraft operations are based on a twelve month data sample obtained from Vector Airport Systems, LLC, covering the period of November 1, 2017 through October 31, 2018. These 2017/2018 operations counts were scaled to the FAA Terminal Area Forecast (TAF) for 2018 and 2023 to determine the operations totals for the NEM study years. Due to the expected retirement of MD-88 aircraft, operations by these aircraft were assigned to Airbus 319 aircraft for the 2023 case.

Table 2 and Table 3 provide summaries of operations for the baseline and forecast years. The operations are condensed into categories specified by FAA Order 7210.3 "Facility Operation and Administration"; namely Air Carrier (AC), Air Taxi (AT), General Aviation (GA), and military (ML). AC and AT are commercial categories distinguished by aircraft capacity, while GA includes all non-commercial, non-military operations.

Among civilian aircraft, TAF anticipates a notable shift from smaller AT aircraft to larger AC aircraft over the course of the study period. This results in a decrease of more than 20% in total commercial operations, while passenger numbers are forecast to increase moderately.

Operations by military aircraft based at BTV were determined through extensive consultation with the operating units, the Vermont Air National Guard (VTANG) and Vermont Army National Guard (VTARNG). The following process was followed in determining transient military totals for the two study years:

- A representative fleet mix was determined from the 2017/2018 radar data sample, 2017 TFMSC data, and input from BTV personnel.
- 2017 operations reported by the based units were compared to OPSNET military totals for 2017. The difference was assumed to be from transient aircraft.
- Transient totals for the 2018 study year were determined by scaling the 2017 totals by the ratio of the 2018 TAF to the 2017 OPSNET, with separate scaling for itinerant and local operations.
- The TAF totals for 2018 and 2023 are identical. However, the VTANG expects 128 itinerant and 14 local operations per year by transient F-16C aircraft for training exercises with the VTANG F-35A fleet. These operations are added to the 2018 transient totals for the 2023 study. Otherwise the transient operations are identical for both study years.

Modeled based military operations account for the fact that the tower may consider multiple military aircraft flying in formation as a single count. This practice is documented in FAA Order 7210.3Y at Chapter 12, Section 12-2-1 (April 3, 2014) and verified with FAA staff. Typically 2 or more aircraft take off in formation (single count) and then returning individually (2 or more counts). Over the course of a year, for every 100 tower counts for the based VTANG aircraft, there are approximately 142 actually operations. As a result, total modeled military aircraft operations numbers exceed those reported in the TAF.

Burlington International Airport NEM Update Modeling
May 14, 2019
Page 4

Table 2: BTV Operations Summary for Calendar Year 2018

Category		Itinerant						Local			Modeling Totals			TAF Totals
		Arrivals			Departures			Closed Patterns						
		Day (0700-2200)	Night (2200-0700)	Total	Day (0700-2200)	Night (2200-0700)	Total	Day (0700-2200)	Night (2200-0700)	Total	Day (0700-2200)	Night (2200-0700)	Grand	
Civil	AC	4,221	2,085	6,306	4,346	1,960	6,306	-	-	-	8,567	4,045	12,612	12,612
	AT	7,403	476	7,879	7,289	590	7,879	-	-	-	14,692	1,066	15,758	15,759
	GA	10,844	397	11,241	10,742	498	11,240	10,996	142	11,138	32,582	1,037	33,619	33,619
Military	VTANG	1,535	-	1,535	1,535	-	1,535	307	-	307	3,377	-	3,377	5,146
	VTARNG	535	151	686	590	96	686	-	-	-	1,125	247	1,372	
	Transient	151	2	153	150	3	153	979	19	998	1,280	24	1,304	
Civil Total		**22,468**	**2,958**	**25,426**	**22,377**	**3,048**	**25,425**	**10,996**	**142**	**11,138**	**55,841**	**6,148**	**61,989**	**61,990**
Military Total		**2,221**	**153**	**2,374**	**2,275**	**99**	**2,374**	**1,286**	**19**	**1,305**	**5,782**	**271**	**6,053**	**5,146**
Combined Totals		**24,689**	**3,111**	**27,800**	**24,652**	**3,147**	**27,799**	**12,282**	**161**	**12,443**	**61,623**	**6,419**	**68,042**	**67,136**

Note: TAF totals based on 2018 TAF for calendar year 2018

Table 3: BTV Operations Summary for Calendar Year 2023

Category		Itinerant						Local			Totals			TAF Totals
		Arrivals			Departures			Closed Patterns						
		Day (0700-2200)	Night (2200-0700)	Total	Day (0700-2200)	Night (2200-0700)	Total	Day (0700-2200)	Night (2200-0700)	Total	Day (0700-2200)	Night (2200-0700)	Grand	
Civil	AC	5,816	2,873	8,689	5,989	2,700	8,689	-	-	-	11,805	5,573	17,378	17,378
	AT	2,390	154	2,544	2,353	190	2,543	-	-	-	4,743	344	5,087	5,087
	GA	10,919	399	11,318	10,816	502	11,318	10,996	142	11,138	32,731	1,043	33,774	33,769
Military	VTANG	2,520	-	2,520	2,520	-	2,520	446	-	446	5,486	-	5,486	5,146
	VTARNG	535	151	686	590	96	686	-	-	-	1,125	247	1,372	
	Transient	215	2	217	214	3	217	993	19	1,012	1,422	24	1,446	
Civil Total		**19,125**	**3,426**	**22,551**	**19,158**	**3,392**	**22,550**	**10,996**	**142**	**11,138**	**49,279**	**6,960**	**56,239**	**56,234**
Military Total		**3,270**	**153**	**3,423**	**3,324**	**99**	**3,423**	**1,439**	**19**	**1,458**	**8,033**	**271**	**8,304**	**5,146**
Combined Totals		**22,395**	**3,579**	**25,974**	**22,482**	**3,491**	**25,973**	**12,435**	**161**	**12,596**	**57,312**	**7,231**	**64,543**	**61,380**

Note: TAF totals based on 2018 TAF for calendar year 2023

Table 4 and Table 5 provide detailed operations counts for each ICAO aircraft type within the three categories.

Table 4: BTV Annual Flight Operations for 2018

Category	Engine Type	ICAO Code	AEDT Equip. ID	ANP Type	Arrivals		Departures		Local		Total
					Day	Night	Day	Night	Day	Night	
Air Carrier (AC)	Jet	A319	4930	A319-131	142	80	133	89	-	-	445
		A320	4900	A320-232	91	132	147	76	-	-	447
		B712	88	717200	52	137	39	150	-	-	377
		B737	4861	737700	11	69	20	60	-	-	160
		B738	5294	737800	87	86	119	53	-	-	345
		B739	2502	737800	5	47	8	44	-	-	104
		B752	2512	757PW	243	-	238	5	-	-	487
		CRJ7	4211	CRJ9-ER	708	132	718	122	-	-	1,681
		CRJ9	2548	CRJ9-ER	773	566	882	457	-	-	2,679
		E170	3070	EMB170	128	16	139	6	-	-	289
		E190	4288	EMB190	968	438	1,005	400	-	-	2,811
		E75L	3071	EMB175	484	225	469	240	-	-	1,417
		E75S	3816	EMB175	487	120	395	212	-	-	1,213
		MD88	2074	MD83	13	38	6	46	-	-	104
	Turbine Propeller	DH8D	4778	DHC830	27	-	27	-	-	-	55
Air Carrier Totals					**4,221**	**2,085**	**4,346**	**1,960**	**-**	**-**	**12,612**

Table 4: BTV Annual Flight Operations for 2018 (Continued)

Category	Engine Type	ICAO Code	AEDT Equip. ID	ANP Type	Arrivals		Departures		Local		Total
					Day	Night	Day	Night	Day	Night	
Air Taxi (AT)	Jet	BE40	5296	MU3001	110	-	110	-	-	-	220
		C560	4929	CNA560U	28	-	26	1	-	-	56
		C56X	4794	CNA560XL	154	6	156	4	-	-	321
		C680	5184	CNA680	39	1	38	3	-	-	81
		C68A	5347	CNA680	74	5	77	3	-	-	159
		C750	1314	CNA750	73	-	73	-	-	-	146
		CL30	4856	CL600	98	3	101	-	-	-	202
		CL35	5345	CL600	105	6	111	-	-	-	222
		CL60	4805	CL601	23	-	23	-	-	-	45
		CRJ2	1250	CL600	2,669	212	2,555	326	-	-	5,761
		E145	2557	EMB14L	1,362	112	1,413	62	-	-	2,949
		E45X	4874	EMB145	1,337	82	1,276	143	-	-	2,838
		E55P	4917	CNA55B	96	3	96	3	-	-	197
		F2TH	4804	CNA750	19	1	20	-	-	-	40
		F900	4034	CNA750	45	6	49	3	-	-	104
		GLEX	3734	BD-700-1A10	24	-	24	-	-	-	48
	Turbine Propeller	B350	1539	DHC6	114	1	110	5	-	-	230
		BE99	4918	DHC6	78	-	78	-	-	-	157
		BE9L	4918	DHC6	21	-	21	-	-	-	43
		E110	1498	DHC6	605	-	605	-	-	-	1,209
		PC12	3122	CNA208	329	37	328	38	-	-	732
Air Taxi Totals					**7,403**	**476**	**7,289**	**590**	**-**	**-**	**15,759**

Table 4: BTV Annual Flight Operations for 2018 (Continued)

Category	Engine Type	ICAO Code	AEDT Equip. ID	ANP Type	Arrivals		Departures		Local		Total
					Day	Night	Day	Night	Day	Night	
General Aviation (GA)	Jet	BE40	5296	MU3001	53	5	50	8	-	-	116
		C25A	3974	CNA525C	131	10	125	16	-	-	281
		C25B	3974	CNA525C	407	5	330	82	-	-	824
		C25C	4276	CNA525C	100	3	103	-	-	-	206
		C525	3974	CNA525C	75	3	78	-	-	-	156
		C550	4327	CNA55B	148	5	146	8	-	-	306
		C560	4929	CNA560U	53	-	50	3	-	-	105
		C56X	4794	CNA560XL	332	23	340	15	-	-	708
		C680	5184	CNA680	181	18	193	5	-	-	397
		C750	1314	CNA750	43	3	40	5	-	-	90
		CL30	4856	CL600	48	-	48	-	-	-	95
		CL60	4805	CL601	60	3	63	-	-	-	126
		E35L	5351	CNA55B	40	-	40	-	-	-	80
		E50P	4902	CNA510	95	3	95	3	-	-	196
		E55P	4917	CNA55B	53	-	53	-	-	-	105
		F2TH	4804	CNA750	50	3	47	5	-	-	105
		F900	4034	CNA750	65	-	65	-	-	-	131
		G280	4198	IA1125	105	-	98	8	-	-	211
		GL5T	3732	BD-700-1A11	108	13	118	3	-	-	241
		GLF4	5267	GIV	63	5	68	-	-	-	136
		GLF5	4858	GV	116	5	115	5	-	-	241
		H25B	2014	LEAR35	70	18	83	5	-	-	176
		H25C	4758	LEAR35	50	3	53	-	-	-	105
		LJ45	4843	LEAR35	40	3	40	3	-	-	85
		LJ60	2033	LEAR35	241	5	224	22	-	-	492
		WW24	1973	IA1125	95	13	92	16	-	-	216
	Turbine Propeller	AA5	1532	GASEPF	50	-	50	-	-	-	100
		B350	1539	DHC6	88	-	88	-	-	-	176
		BE20	3790	DHC6	216	8	215	9	-	-	447
		BE9L	4918	DHC6	153	8	155	5	-	-	322
		C441	1287	CNA441	163	-	155	9	-	-	327
		P46T	1465	GASEPF	70	-	65	5	-	-	141
		PC12	3122	CNA208	285	71	266	90	-	-	713
		TBM7	1533	CNA208	85	-	85	-	-	-	171
		TBM8	2580	CNA441	68	-	68	-	-	-	136
		TBM9	4677	CNA208	45	3	48	-	-	-	95

Table 4: BTV Annual Flight Operations for 2018 (Continued)

Category	Engine Type	ICAO Code	AEDT Equip. ID	ANP Type	Arrivals		Departures		Local		Total
					Day	Night	Day	Night	Day	Night	
General Aviation (GA)	Piston Propeller	BE33	1271	GASEPV	60	-	60	-	-	-	121
		BE35	1271	GASEPV	75	-	73	3	-	-	151
		BE36	1276	CNA208	264	3	258	8	-	-	533
		BE58	1196	BEC58P	279	-	274	5	-	-	558
		C150	1882	GASEPF	40	-	40	-	-	-	80
		C172	1267	CNA172	3,414	88	3,409	92	10,187	137	17,327
		C180	1271	GASEPV	53	-	53	-	-	-	105
		C182	1262	CNA182	234	-	234	-	-	-	467
		C206	3172	CNA206	72	4	70	5	-	-	151
		C340	2116	BEC58P	98	5	103	-	-	-	206
		C414	2119	BEC58P	58	3	58	3	-	-	121
		DA40	1271	GASEPV	63	-	63	-	-	-	126
		M20P	1271	GASEPV	146	-	146	-	-	-	291
		P28A	3178	PA28	217	4	219	3	-	-	442
		P28R	1271	GASEPV	352	5	357	-	728	4	1,446
		P32R	1271	GASEPV	40	3	43	-	-	-	85
		PA24	1901	GASEPV	55	-	55	-	81	-	191
		PA27	1194	BEC58P	35	5	35	5	-	-	80
		PA28	2102	GASEPF	103	-	103	-	-	-	206
		PA31	779	BEC58P	216	28	224	20	-	-	487
		PA32	1271	GASEPV	40	-	40	-	-	-	80
		PA34	2103	BEC58P	47	6	48	5	-	-	105
		PA46	1271	GASEPV	88	-	88	-	-	-	176
		S22T	1325	COMSEP	98	-	98	-	-	-	196
		SR22	1325	COMSEP	650	13	643	20	-	-	1,326
General Aviation Totals					**10,844**	**397**	**10,742**	**498**	**10,996**	**142**	**33,619**

Table 4: BTV Annual Flight Operations for 2018 (Concluded)

Category	Engine Type	ICAO Code	AEDT Equip. ID	ANP Type	Arrivals		Departures		Local		Total
					Day	Night	Day	Night	Day	Night	
Based Military (ML)*	Jet	F16	N/A	N/A	1,535	-	1,535	-	307	-	3,377
	Helicopter	H72	N/A	N/A	211	18	229	-	-	-	458
		H60	N/A	N/A	324	133	361	96	-	-	914
Transient Military (ML)	Jet	B752	2512	757PW	16	0	16	0	96	0	128
		C17	1401	C17	11	0	11	0	72	0	94
		K35R	1981	KC135R	11	0	11	0	72	0	94
		DC10	1349	DC1030	5	0	5	0	30	0	40
		C560	4929	CNA560U	19	1	19	1	125	7	172
		GLF5	4858	GV	18	1	19	0	120	4	162
	Turbine Propeller	BE20	3790	DHC6	10	0	10	0	66	0	86
		C130	1203	C130	27	0	25	2	176	8	238
		CN35	42	SF340	11	0	11	0	72	0	94
		DH8C	4778	DHC830	10	0	10	0	66	0	86
		C208	4677	CNA208	3	0	3	0	20	0	26
	Piston Propeller	C206	3172	CNA206	9	0	9	0	58	0	76
		C421	1287	CNA441	1	0	1	0	6	0	8
Based Military Total					**2,070**	**151**	**2,125**	**96**	**307**	**-**	**4,749**
Transient Military Total					**151**	**2**	**150**	**3**	**979**	**19**	**1,304**
Overall Totals					**24,689**	**3,111**	**24,652**	**3,147**	**12,282**	**161**	**68,042**

Note: Totals and sub-totals may not match due to rounding

* Based military aircraft modeled with Noisemap (NMap 7.3)

Table 5. BTV Annual Flight Operations for 2023

Category	Engine Type	ICAO Code	AEDT Equip. ID	ANP Type	Arrivals		Departures		Local		Total
					Day	Night	Day	Night	Day	Night	
Air Carrier (AC)	Jet	A319	4930	A319-131	196	110	183	123	-	-	613
		A320	4900	A320-232	126	182	203	105	-	-	616
		B712	88	717200	71	188	54	206	-	-	520
		B737	4861	737700	16	95	28	82	-	-	221
		B738	5294	737800	120	118	164	73	-	-	476
		B739	2502	737800	6	65	10	61	-	-	143
		B752	2512	757PW	335	-	329	7	-	-	671
		CRJ7	4211	CRJ9-ER	976	182	990	168	-	-	2,316
		CRJ9	2548	CRJ9-ER	1,066	780	1,216	630	-	-	3,691
		E170	3070	EMB170	177	22	191	8	-	-	398
		E190	4288	EMB190	1,333	603	1,385	551	-	-	3,873
		E75L	3071	EMB175	666	310	646	330	-	-	1,952
		E75S	3816	EMB175	671	165	544	292	-	-	1,671
		MD88	2074	MD83	19	53	8	64	-	-	143
	Turbine Propeller	DH8D	4778	DHC830	38	-	38	-	-	-	75
Air Carrier Totals					**5,816**	**2,873**	**5,989**	**2,700**	**-**	**-**	**17,378**

Table 5: BTV Annual Flight Operations for 2023 (Continued)

Category	Engine Type	ICAO Code	AEDT Equip. ID	ANP Type	Arrivals		Departures		Local		Total
					Day	Night	Day	Night	Day	Night	
Air Taxi (AT)	Jet	BE40	5296	MU3001	35	-	35	-	-	-	71
		C560	4929	CNA560U	9	-	9	-	-	-	18
		C56X	4794	CNA560XL	50	2	50	1	-	-	104
		C680	5184	CNA680	13	-	12	1	-	-	26
		C68A	5347	CNA680	24	2	25	1	-	-	51
		C750	1314	CNA750	24	-	24	-	-	-	47
		CL30	4856	CL600	32	1	33	-	-	-	65
		CL35	5345	CL600	34	2	36	-	-	-	72
		CL60	4805	CL601	7	-	7	-	-	-	15
		CRJ2	1250	CL600	861	68	825	105	-	-	1,860
		E145	2557	EMB14L	440	36	456	20	-	-	952
		E45X	4874	EMB145	431	27	412	46	-	-	916
		E55P	4917	CNA55B	31	1	31	1	-	-	64
		F2TH	4804	CNA750	6	-	7	-	-	-	13
		F900	4034	CNA750	15	2	16	1	-	-	33
		GLEX	3734	BD-700-1A10	8	-	8	-	-	-	15
	Turbine Propeller	B350	1539	DHC6	37	-	35	2	-	-	74
		BE99	4918	DHC6	25	-	25	-	-	-	51
		BE9L	4918	DHC6	7	-	7	-	-	-	14
		E110	1498	DHC6	195	-	195	-	-	-	390
		PC12	3122	CNA208	106	12	106	12	-	-	236
Air Taxi Totals					**2,390**	**154**	**2,353**	**190**	**-**	**-**	**5,087**

Burlington International Airport NEM Update Modeling
May 14, 2019
Page 12

Table 5: BTV Annual Flight Operations for 2023 (Continued)

Category	Engine Type	ICAO Code	AEDT Equip. ID	ANP Type	Arrivals		Departures		Local		Total
					Day	Night	Day	Night	Day	Night	
General Aviation (GA)	Jet	BE40	5296	MU3001	53	5	51	8	-	-	116
		C25A	3974	CNA525C	132	10	126	16	-	-	283
		C25B	3974	CNA525C	410	5	332	83	-	-	830
		C25C	4276	CNA525C	101	3	104	-	-	-	207
		C525	3974	CNA525C	76	3	78	-	-	-	157
		C550	4327	CNA55B	149	5	147	8	-	-	309
		C560	4929	CNA560U	53	-	50	3	-	-	106
		C56X	4794	CNA560XL	334	23	342	15	-	-	713
		C680	5184	CNA680	182	18	194	5	-	-	400
		C750	1314	CNA750	43	3	40	5	-	-	91
		CL30	4856	CL600	48	-	48	-	-	-	96
		CL60	4805	CL601	61	3	63	-	-	-	126
		E35L	5351	CNA55B	40	-	40	-	-	-	81
		E50P	4902	CNA510	96	3	95	3	-	-	197
		E55P	4917	CNA55B	53	-	53	-	-	-	106
		F2TH	4804	CNA750	51	3	48	5	-	-	106
		F900	4034	CNA750	66	-	66	-	-	-	132
		G280	4198	IA1125	106	-	99	8	-	-	212
		GL5T	3732	BD-700-1A11	109	13	119	3	-	-	243
		GLF4	5267	GIV	63	5	68	-	-	-	137
		GLF5	4858	GV	116	5	116	6	-	-	243
		H25B	2014	LEAR35	71	18	83	5	-	-	177
		H25C	4758	LEAR35	51	3	53	-	-	-	106
		LJ45	4843	LEAR35	40	3	40	3	-	-	86
		LJ60	2033	LEAR35	243	5	226	22	-	-	496
		WW24	1973	IA1125	96	13	92	16	-	-	218
	Turbine Propeller	AA5	1532	GASEPF	51	-	51	-	-	-	101
		B350	1539	DHC6	89	-	89	-	-	-	177
		BE20	3790	DHC6	218	8	216	9	-	-	450
		BE9L	4918	DHC6	154	8	157	5	-	-	324
		C441	1287	CNA441	164	-	156	9	-	-	329
		P46T	1465	GASEPF	71	-	66	5	-	-	142
		PC12	3122	CNA208	287	72	268	91	-	-	718
		TBM7	1533	CNA208	86	-	86	-	-	-	172
		TBM8	2580	CNA441	68	-	68	-	-	-	137
		TBM9	4677	CNA208	46	3	48	-	-	-	96

Table 5: BTV Annual Flight Operations for 2023 (Continued)

Category	Engine Type	ICAO Code	AEDT Equip. ID	ANP Type	Arrivals		Departures		Local		Total
					Day	Night	Day	Night	Day	Night	
General Aviation (GA)	Piston Propeller	BE33	1271	GASEPV	61	-	61	-	-	-	121
		BE35	1271	GASEPV	76	-	73	3	-	-	152
		BE36	1276	CNA208	266	3	260	8	-	-	536
		BE58	1196	BEC58P	281	-	276	5	-	-	561
		C150	1882	GASEPF	40	-	40	-	-	-	81
		C172	1267	CNA172	3,437	89	3,433	93	10,187	137	17,376
		C180	1271	GASEPV	53	-	53	-	-	-	106
		C182	1262	CNA182	235	-	235	-	-	-	470
		C206	3172	CNA206	72	4	71	5	-	-	152
		C340	2116	BEC58P	99	5	104	-	-	-	207
		C414	2119	BEC58P	58	3	58	3	-	-	121
		DA40	1271	GASEPV	63	-	63	-	-	-	126
		M20P	1271	GASEPV	147	-	147	-	-	-	293
		P28A	3178	PA28	219	4	220	3	-	-	445
		P28R	1271	GASEPV	354	5	359	-	728	4	1,450
		P32R	1271	GASEPV	40	3	43	-	-	-	86
		PA24	1901	GASEPV	56	-	56	-	81	-	193
		PA27	1194	BEC58P	35	5	35	5	-	-	81
		PA28	2102	GASEPF	104	-	104	-	-	-	207
		PA31	779	BEC58P	218	28	225	20	-	-	491
		PA32	1271	GASEPV	40	-	40	-	-	-	81
		PA34	2103	BEC58P	47	6	48	5	-	-	106
		PA46	1271	GASEPV	89	-	89	-	-	-	177
		S22T	1325	COMSEP	99	-	99	-	-	-	197
		SR22	1325	COMSEP	655	13	647	20	-	-	1,335
General Aviation Totals					**10,919**	**399**	**10,816**	**502**	**10,996**	**142**	**33,774**

Table 5: BTV Annual Flight Operations for 2023 (Concluded)

Category	Engine Type	ICAO Code	AEDT Equip. ID	ANP Type	Arrivals		Departures		Local		Total
					Day	Night	Day	Night	Day	Night	
Based Military (ML)*	Jet	F35	N/A	N/A	2,520	-	2,520	-	446	-	5,486
	Helicopter	H72	N/A	N/A	211	18	229	-	-	-	458
		H60	N/A	N/A	324	133	361	96	-	-	914
Transient Military (ML)	Jet	F16	N/A	N/A	64	-	64	-	14	-	142
		B752	2512	757PW	16	0	16	0	96	0	128
		C17	1401	C17	11	0	11	0	72	0	94
		K35R	1981	KC135R	11	0	11	0	72	0	94
		DC10	1349	DC1030	5	0	5	0	30	0	40
		C560	4929	CNA560U	19	1	19	1	125	7	172
		GLF5	4858	GV	18	1	19	0	120	4	162
	Turbine Propeller	BE20	3790	DHC6	10	0	10	0	66	0	86
		C130	1203	C130	27	0	25	2	176	8	238
		CN35	42	SF340	11	0	11	0	72	0	94
		DH8C	4778	DHC830	10	0	10	0	66	0	86
		C208	4677	CNA208	3	0	3	0	20	0	26
	Piston Propeller	C206	3172	CNA206	9	0	9	0	58	0	76
		C421	1287	CNA441	1	0	1	0	6	0	8
Based Military Total					**3,055**	**151**	**3,110**	**96**	**446**	**0**	**6,858**
Transient Military Total					**215**	**2**	**214**	**3**	**993**	**19**	**1,446**
Overall Totals					**22,395**	**3,579**	**22,482**	**3,491**	**12,435**	**161**	**64,543**

Note: Totals and sub-totals may not match due to rounding

* Based military aircraft modeled with Noisemap (NMap 7.3)

4. Aircraft Noise and Performance Characteristics

AEDT requires the use of specific noise and performance data for each aircraft type operating at the airport. Noise data is in the form of Sound Exposure Level (SEL) at a range of distances (from 200 feet to 25,000 feet) from a particular aircraft with engines at a range of thrust levels. Performance data includes thrust, speed and altitude profiles for takeoff and landing operations. The AEDT database contains standard noise and performance data for over 300 different fixed-wing aircraft types, most of which are civilian aircraft.

Within the AEDT database, it is standard for aircraft takeoff or departure profiles to be defined by a range of trip distances identified as "stage lengths." Higher stage lengths (longer trip distances) are associated with a heavier aircraft due to the increase in fuel requirements for the flight. For the BTV NEM, stage lengths are derived using the city-pairs reported in the 2017/2018 radar data sample.

AEDT includes a range of performance profiles specifying thrust, speed and altitude criteria for all operation types. HMMH will use AEDT default profiles, which do not require FAA review, for civilian and transient military operations in the modeling of the BTV NEM.

5. Runway Utilization

Civilian and transient military runway utilization percentages are also based on the twelve month data sample obtained from Vector Airport Systems, LLC, covering the period of November 1, 2017 through October 31, 2018. This data set specified the ICAO aircraft identifier and runway for each operation. The identifier was matched to the fleet mix from Section 3 above to determine proportions of operations by each aircraft type in each category (AC, AT, GA, ML), and an overall runway use percentage was determined for each category.

Tables 6 - 8 provides runway use percentages according to aircraft category and propulsion class. Runway utilization is identical for the base year and forecast year.

Table 6: Arrival Runway Utilization

Aircraft Category	Runway End			
	15	33	01	19
Air Carrier Cargo Jet	66%	34%	0%	0%
Air Carrier Passenger Jet	59%	41%	0%	0%
Air Carrier Passenger Turbine Propeller	45%	55%	0%	0%
Air Taxi Jet	54%	46%	0%	0%
Air Taxi Turbine Propeller	49%	44%	1%	6%
General Aviation Jet	53%	47%	0%	0%
General Aviation Piston Propeller	18%	37%	17%	28%
General Aviation Turbine Propeller	46%	40%	4%	10%
Military (Fixed wing) Based	50%	50%	0%	0%
Military (Fixed wing) Transient	53%	47%	0%	0%

Table 7: Departure Runway Utilization

Aircraft Category	Runway End			
	15	33	01	19
Air Carrier Cargo Jet	30%	70%	0%	0%
Air Carrier Passenger Jet	52%	48%	0%	0%
Air Carrier Passenger Turbine Propeller	35%	65%	0%	0%
Air Taxi Jet	50%	50%	0%	0%
Air Taxi Turbine Propeller	38%	57%	0%	5%
General Aviation Jet	44%	56%	0%	0%
General Aviation Piston Propeller	13%	37%	11%	38%
General Aviation Turbine Propeller	35%	48%	5%	12%
Military (Fixed wing) Based	50%	50%	0%	0%
Military (Fixed wing) Transient	44%	56%	0%	0%

Table 8: Touch and Go (Pattern) Runway Utilization

Aircraft Category	Runway End			
	15	33	01	19
General Aviation Piston Propeller	10%	37%	12%	40%
Military (Fixed wing) Based	50%	50%	0%	0%

6. Flight Track Geometry and Use

Civilian published procedures have not changed since the 2015 NEM. Therefore flight track geometry used the analysis developed for the 2015 NEM. Flight track use for civilian aircraft comes from a combination the 2015 NEM and the 2017 TFMSC data.

During the 2015 NEM, a 42-day 2012 radar flight track data sample was used for developing flight tracks to which operations are assigned for modeling. The radar tracks are separated by operation type (e.g., arrival or departure), runway end and aircraft groups used for the runway use. Next, flight track groups are defined according to origin or destination direction. HMMH analyzed flight tracks with the same operation type, runway end, and origin/destination direction for similar geometry and this resulted in the final flight track bundles used to create model tracks. For example, tracks departing to the west-southwest from Runway 33 were bundled together to create model track 33D02. The dispersion around this backbone track is represented by a set of subtracks, and operations are assigned to these tracks according to the distribution of the original radar track data. Model track 33D02 and its subtracks are shown in Figure 2 for illustration.

Figure 3 through Figure 10 show the complete set of model tracks overlaid with BTV airspace as reference. Only backbone tracks are shown in these figures for clarity, but for modeling, each backbone track is accompanied by a set of subtracks similar to those depicted in in Figure 2. Complete flight tracks, with backbones and sub-tracks are also depicted in the 2015 NEM

Table 9 and Table 10 present track utilization rates for arrivals, departures, and local touch and go operations.

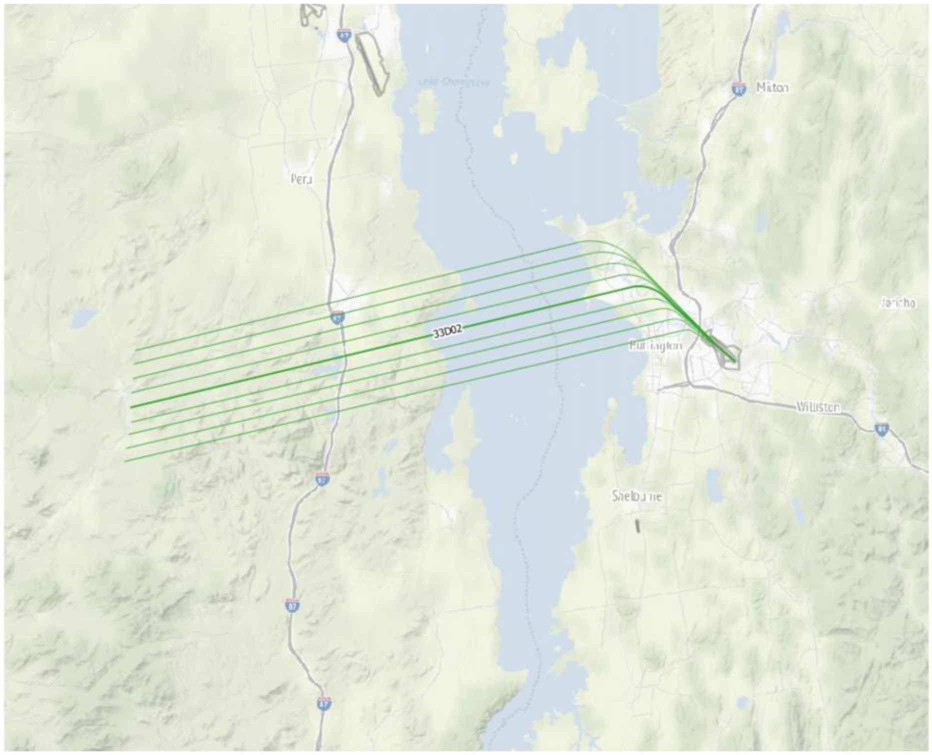

Figure 2: Example Model Track (33D02) with Subtracks

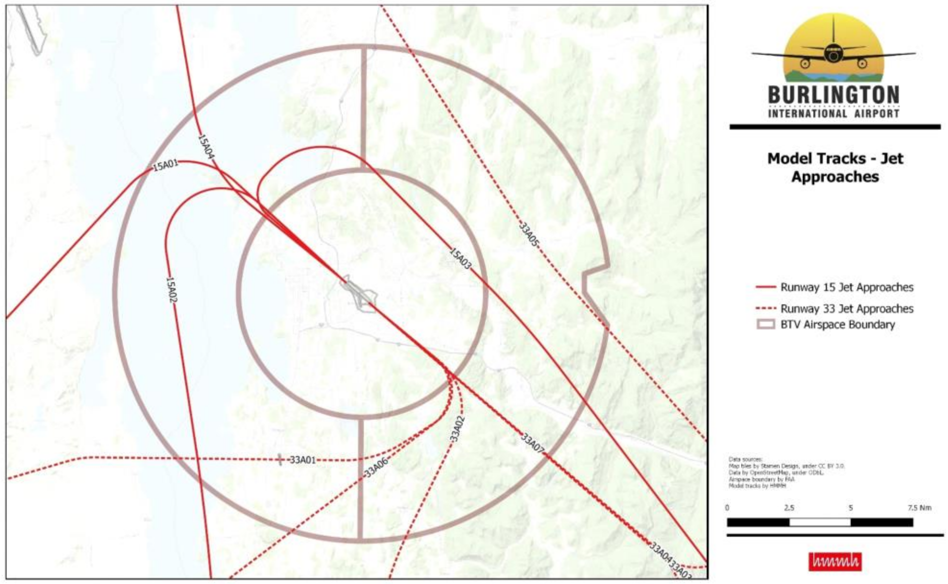

Figure 3: Model Backbone Tracks – Jet Approaches

Figure 4: Model Backbone Tracks – Jet Departures

Figure 5: Model Backbone Tracks – Propeller Approaches Runway 15/33

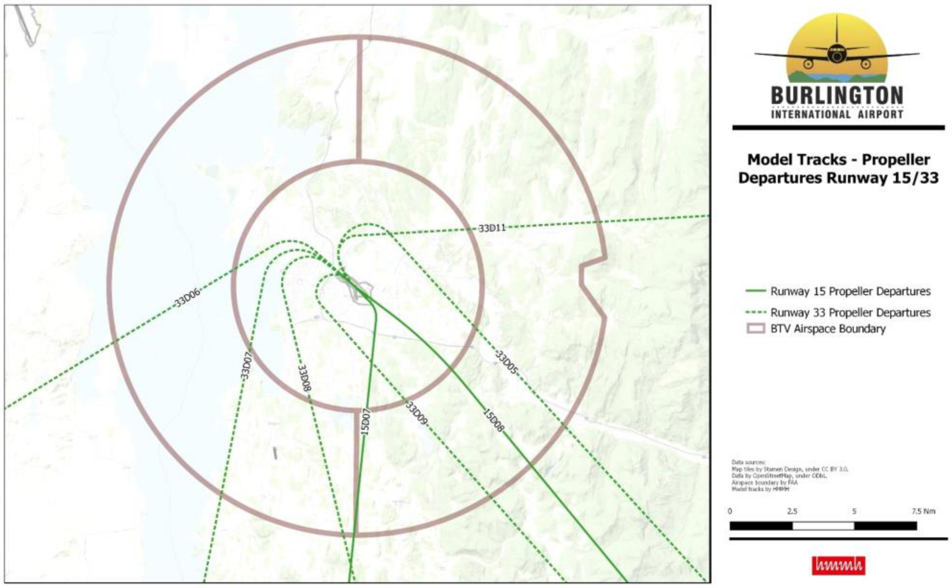

Figure 6: Model Backbone Tracks – Propeller Departures Runway 15 /33

Burlington International Airport NEM Update Modeling
May 14, 2019
Page 22

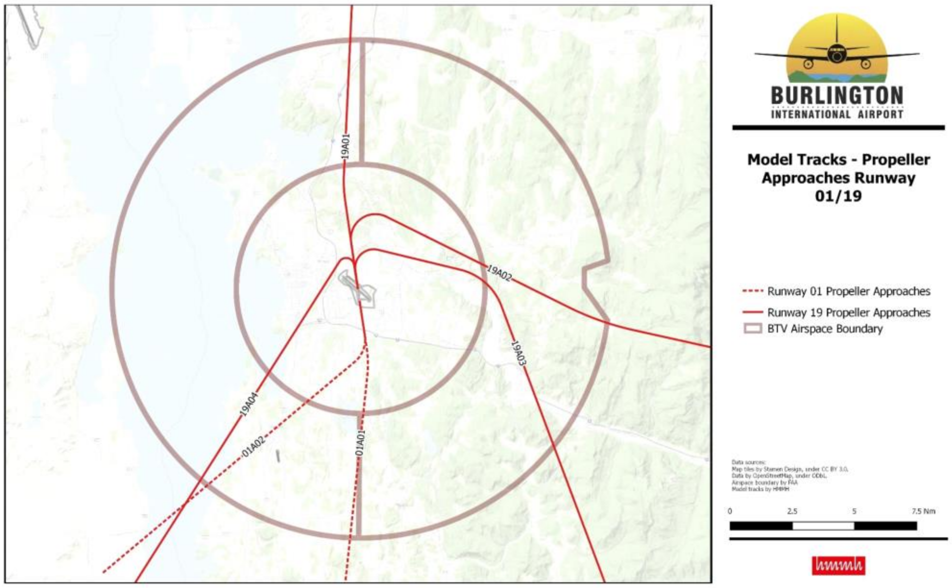

Figure 7: Model Backbone Tracks – Propeller Approaches Runway 01/19

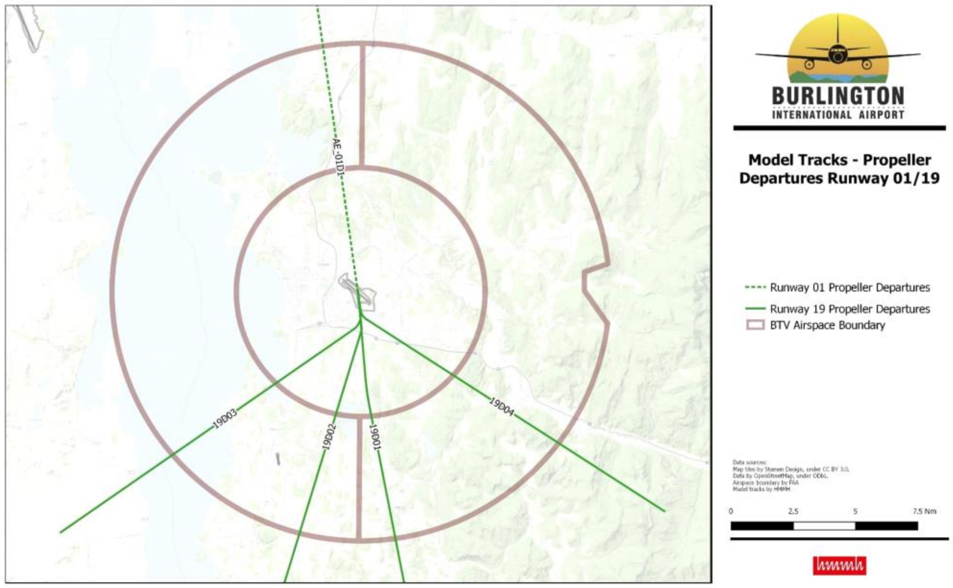

Figure 8: Model Backbone Tracks – Propeller Departures Runway 01/19

Figure 9: Model Backbone Tracks - Closed Patterns Runway 15/33

Figure 10: Model Backbone Tracks - Closed Patterns Runway 01/19

Burlington International Airport NEM Update Modeling
May 14, 2019
Page 26

Table 9 Arrival Flight Track Utilization
Source: 2015 BTV NEM

Operation Type	RWY	Flight Track ID	Flight Track Utilization Percentages by Runway								
			Jet				Propeller				
							Turbine			Piston	
			Air Carrier Passenger	Air Carrier Cargo	Air Taxi	General Aviation	Air Carrier	Air Taxi	General Aviation	Air Taxi	General Aviation
Arrival	15	15A01	15%	87%	39%	18%					
		15A02	85%	4%	57%	59%					
		15A03		9%	2%	15%					
		15A04			3%	9%					
		15A05						29%	10%		12%
		15A06						8%			
		15A07					37%	6%	24%		
		15A08I					13%	12%	24%	50%	14%
		15A08V					50%	39%	38%	50%	38%
		15A09						5%	3%		
		15A12									12%
		15A13I									8%
		15A13V									15%
	33	33A01	9%	25%	24%	10%					
		33A02	43%		34%	20%					
		33A03	2%	25%	13%	10%					
		33A04	43%	25%	23%	18%					
		33A05			1%	6%					
		33A06	3%	25%	3%	16%					
		33A07			2%	18%					
		33A09						45%	58%	60%	34%
		33A10					38%	18%	8%	20%	17%
		33A11					17%	30%	17%		23%
		33A12					46%	7%	17%		11%
		33A17								20%	14%
	01	01A01						30%	30%	30%	30%
		01A02						70%	70%	70%	70%
	19	19A01						25%	18%	25%	18%
		19A02						25%	29%	25%	29%
		19A03						25%	21%	25%	21%
		19A04						25%	32%	25%	32%

Table 10 Departure and Touch and Go Flight Track Utilization

Source: 2015 BTV NEM

Operation Type	RWY	Flight Track ID	Flight Track Utilization Percentages by Runway								
			Jet				Propeller				
							Turbine			Piston	
			Air Carrier Passenger	Air Carrier Cargo	Air Taxi	General Aviation	Air Carrier	Air Taxi	General Aviation	Air Taxi	General Aviation
Departure	15	15D01	13%		29%	12%					
		15D02	1%	60%	12%	17%					
		15D03	76%		48%	42%					
		15D04	8%		8%	9%					
		15D06	2%	40%	1%	4%					
		15D05			1%	17%					
		15D07					100%	60%	83%	75%	49%
		15D08						40%	17%	25%	51%
	33	33D01	2%	14%	2%						
		33D02	13%	5%	34%	3%					
		33D03	2%	64%	13%	24%					
		33D04	83%	18%	51%	74%					
		33D06					19%	5%	26%		12%
		33D07					78%	38%	58%	50%	47%
		33D08					3%	10%		25%	12%
		33D05						40%	11%	25%	19%
		33D09						8%	5%		
		33D11									10%
	01	AE_01D1							100%	100%	100%
	19	19D01						14%	20%	14%	20%
		19D02						29%	40%	29%	40%
		19D03							20%		20%
		19D04						57%	21%	57%	21%
Touch & Go (Pattern)	01	01T1				50%			50%		50%
		01T2				50%			50%		50%
	19	19T1				40%			40%		40%
		19T2				60%			60%		60%
	15	15T1				50%			50%		50%
		15T2				50%			50%		50%
	33	33T1				29%			29%		29%
		33T2				71%			71%		71%

7. Ground Noise

7.1 Maintenance Run-ups

Maintenance run-ups are normally performed by stationary aircraft to test functions and performance of the aircraft. Based military run-ups will be modeled separately in Noisemap. Run-ups will be modeled in AEDT at the following locations, shown below in Figure 11:

- 2018 NEM: Taxiway K
- 2023 NEM: Valley West apron and a future holding bay to be constructed at the north end of Taxiway G.

Figure 11: Maintenance Runup Locations

7.2 Taxiway Track Geometry and Use

Aircraft taxiing has historically been included in noise modeling at BTV due to the proximity of several homes to the taxiways and consequent community interest. The analysis performed for the 2015 NEM will be repeated with the exception of modifications to the taxiing tracks due to ongoing taxiway reconstruction. The method constitutes nonstandard modeling and thus requires FAA approval, which has been granted for past NEMs at BTV.

The outline of the method is as follows:

- An overflight operational profile is used, with an altitude of 10 ft to account for engine height.
- All taxiing occurs at a speed of 10 knots.
- Idle power is used for the aircraft at hold points
  - A setting of 30% maximum static thrust is used to briefly to accelerate from hold points to up to the taxing speed of 10 knots.

A taxiway reconstruction project is currently underway at BTV. This project will result in a full-length taxiway parallel to Runway 15/33. The phases of this project are shown in Figure 12:

- Extension of Taxiway K to the intersection with Taxiway B (completed).
- Displacement of Taxiway G to align with the extended Taxiway K (in progress).
- A connecting segment to join Taxiways G and K (future, but expected to be completed before 2023).

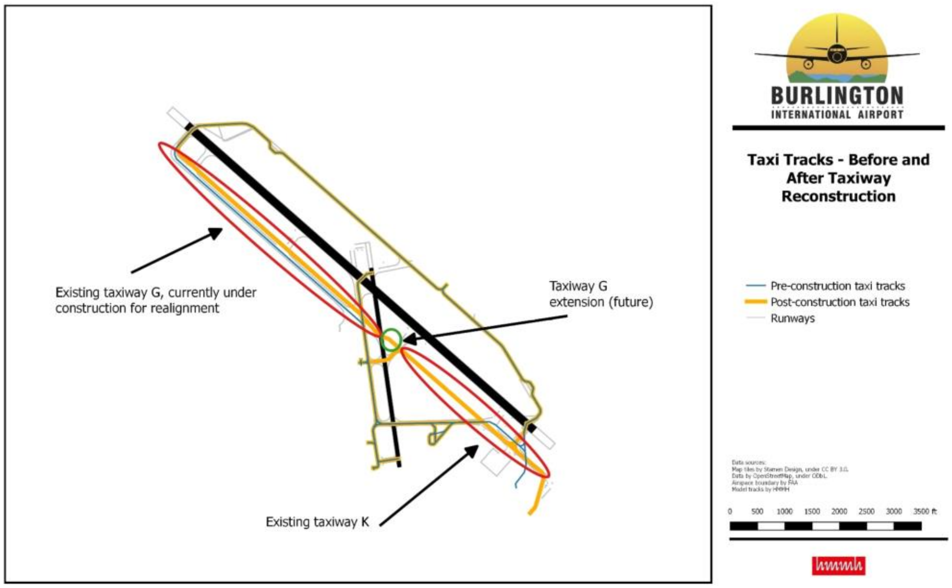

Figure 12: Taxiways and taxiing tracks

8. Meteorological Conditions

AEDT has several settings that affect aircraft performance profiles and sound propagation based on meteorological data. Meteorological settings include average annual temperature, barometric pressure, and relative humidity at the airport. The AEDT database includes 30-year average data from the National Climatic Data Center (NCDC) for US airports. The annual average weather conditions at BTV are:

- Temperature: 45.0° F
- Sea-level Pressure: 1015.9 millibars
- Relative Humidity 68.08%
- Dew Point: 36.01° F
- Wind Speed: 7.14 Knots

9. Terrain Data

Terrain data describes the elevation of the ground surrounding the airport and on airport property. The AEDT uses terrain data to adjust the ground level under the flight paths. The terrain data does not change the aircraft's performance or noise levels, but does alter the vertical distance between the aircraft and a "receiver" on the ground. HMMH obtained the terrain data from the National Elevation Dataset (NED) via the United States Geological Survey (USGS) National Map Viewer[1].

[1] https://viewer.nationalmap.gov/basic/