Appendix K

Noise

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APPENDIX K: Noise

The following reports are included as part of this appendix to support the noise analysis:

- Appendix K-1: Introduction to Noise
- Appendix K-2: Existing Conditions Noise Analysis Technical Report
    - Attachment 1: FAA Non-Standard Noise Aircraft Substitution Letter, 9/13/2016
    - Attachment 2: Flight Track Development Figures
- Appendix K-3: Future Scenarios Noise Analysis Technical Report
    - Attachment 1: Future Scenarios Fleet Mixes
- Appendix K-4: NextGen DC Metroplex Post-Implementation Changes and Potential Impacts on BWI EA Noise Contours

Appendix K-1

Introduction to Noise

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APPENDIX K-1: Introduction to Noise

K-1.1 Noise and Its Effect on People

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

K-1.1.1 Noise and its Metrics

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

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

Various federal agencies involved in environmental noise mitigation have agreed on common metrics for environmental impact analysis documents. Furthermore, the Federal Aviation Administration (FAA) has specified which metrics, such as DNL, should be used for federal aviation noise assessments.

This section discusses the following acoustic terms and metrics:

- Decibel (dB)
- A-Weighted Decibel (dBA)
- Maximum Sound Level (L_{max})
- Sound Exposure Level (SEL)
- Equivalent Sound Level (L_{eq})
- Day-Night Average Sound Level (DNL)
- Time-Above a Specified Level (TA)

K-1.1.1.1 The Decibel (dB)

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

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

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

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

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

If one source is much louder than another, the two sources together will produce the same SPL (and sound to our ears) as if the louder source were operating alone. For example, a 100 dB source plus an 80 dB source produce 100 dB when operating together. The louder source "masks" the quieter one. But if the quieter source gets louder, it will have an increasing effect on the total SPL. When the two sources are equal, as described above, they produce a level 3 decibels above the sound level of either one by itself.

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

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

K-1.1.1.2 A-Weighted Decibel (dBA)

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

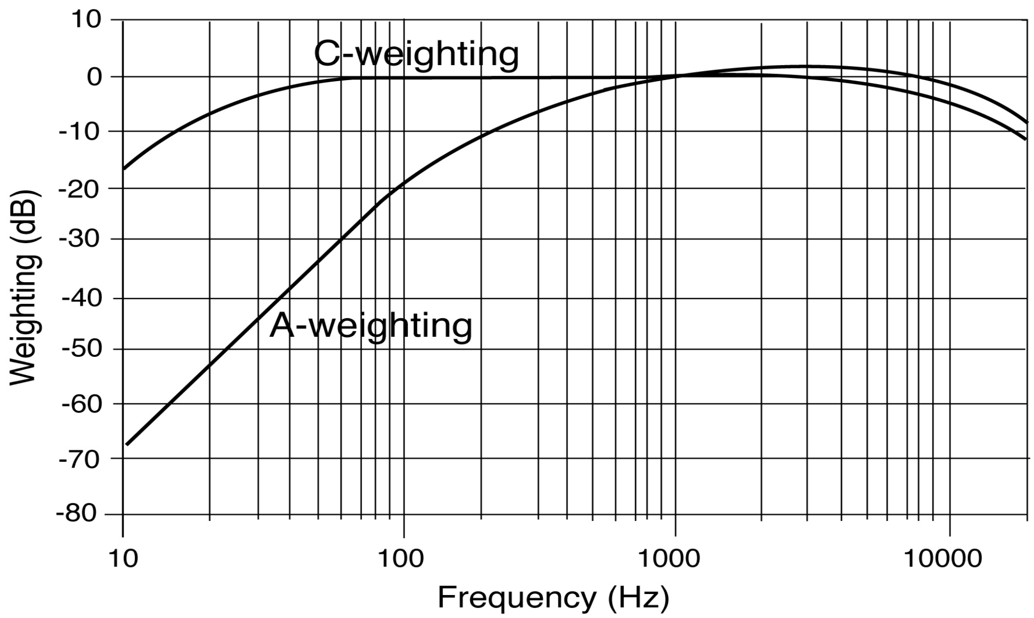
A very good ear can hear sounds with frequencies from 16 Hz to 20,000 Hz. However, most people hear from approximately 20 Hz to approximately 10,000-15,000 Hz. People respond to sound most readily when the predominant frequency is in the range of normal conversation, around 1,000 to 4,000 Hz. Acousticians have developed and applied “filters” or “weightings” to SPLs to match our ears’ sensitivity to the pitch of sounds and to help us judge the relative loudness of sounds made up of different frequencies. Two such filters, “A” and “C,” are most applicable to environmental noises.

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

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

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

Figure K-1-1
Frequency Response Characteristics of Various Weighting Networks



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

Figure K-1-2 presents typical A-weighted sound levels of several common environmental sources. Sound levels measured (or computed) using A-weighting are most properly called "A-weighted sound levels" while sound levels measured without any frequency weighting are most properly called "sound levels." However, since this document deals only with A-weighted sound levels, the adjective "A-weighted" will be hereafter omitted, with A-weighted sound levels referred to simply as sound levels. As long as the use of A-weighting is understood, there is no difference implied by the terms "sound level" and "A-weighted sound level" or by the dB or dBA units.

An additional dimension to environmental noise is that sound levels vary with time and typically have a limited duration, as shown in **Figure K-1-3**. For example, the sound level increases as an aircraft approaches, then falls and blends into the background as the aircraft recedes into the distance (although even the background varies as birds chirp, the wind blows or a vehicle passes by). Sounds can be classified by their duration as continuous like a waterfall, impulsive like a firecracker or sonic boom or intermittent like an aircraft overflight or vehicle passby.

Figure K-1-2

Sound Levels of Typical Noise Sources (dBA)

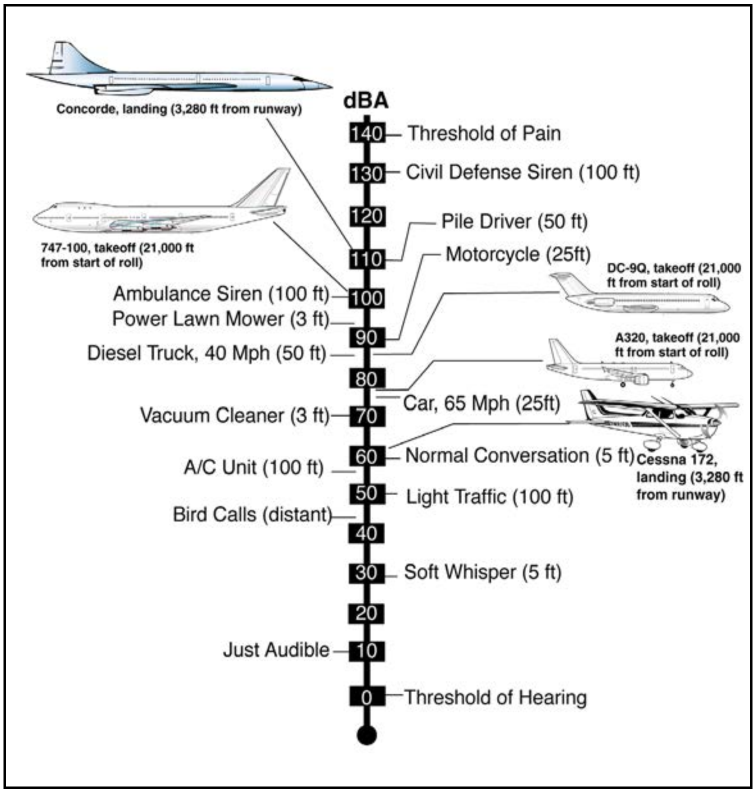
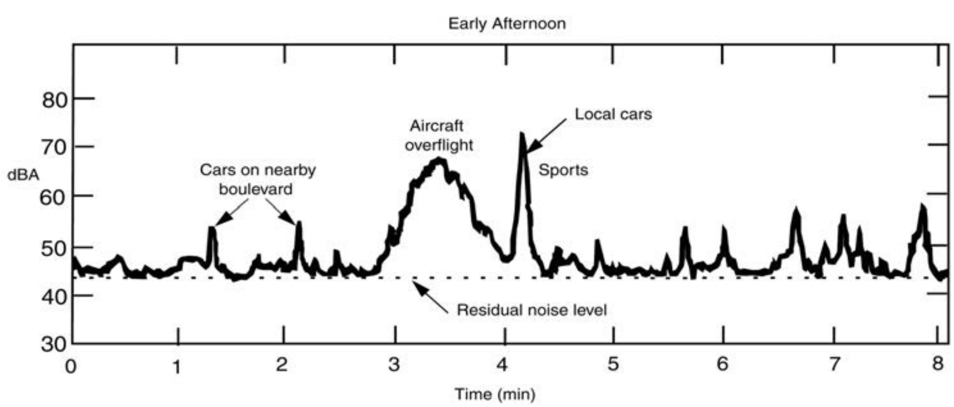


Figure K-1-3

Variation of Community Noise in a Suburban Neighborhood



Source: “Community Noise,” NTID 300.3 EPA, December 1971.

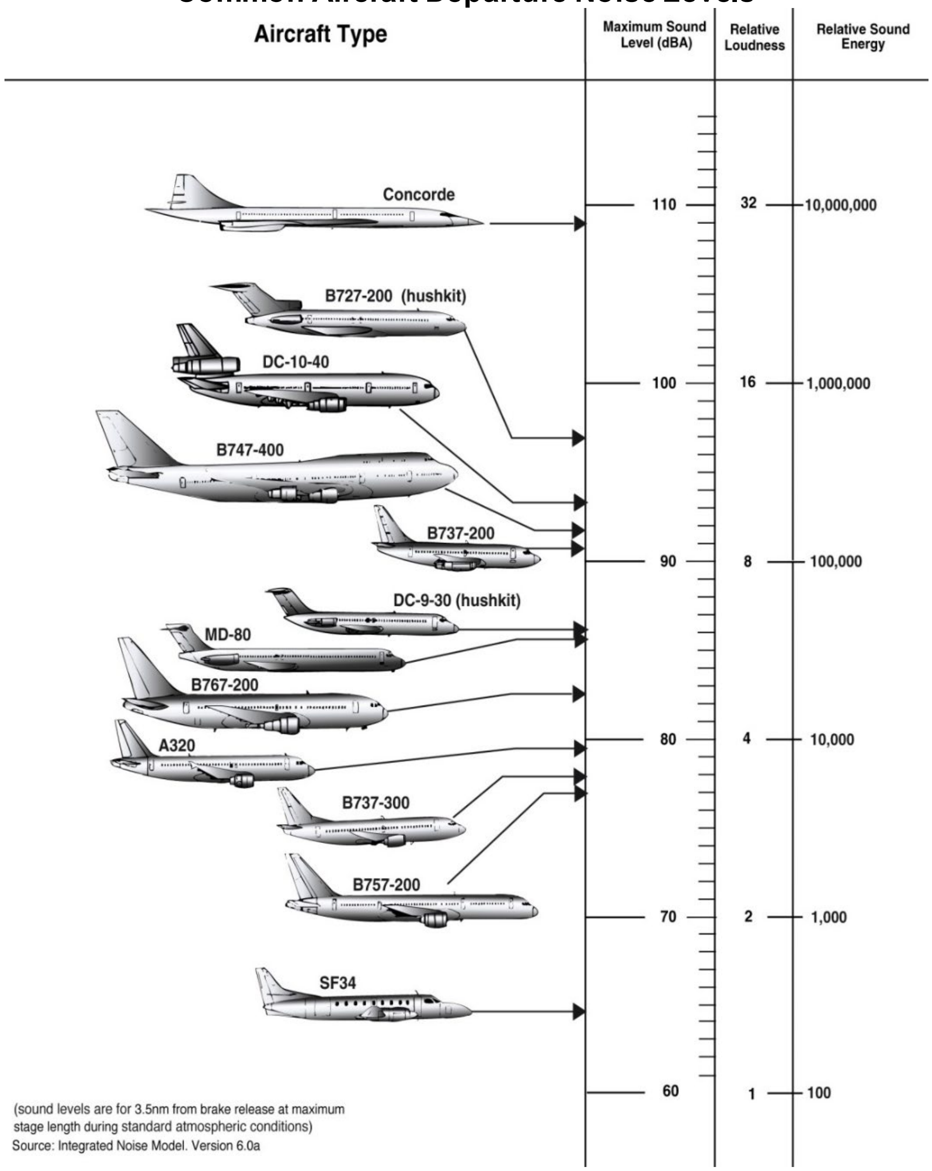
K-1.1.1.3 Maximum Sound Level (L_{max})

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

Figure K-1-4 shows L_{max} values for a variety of common aircraft from the FAA's Integrated Noise Model (INM) database. These L_{max} values for each aircraft type are for aircraft performing a maximum stage (trip) length departure on a day with standard atmospheric conditions at a reference distance of 3.5 nautical miles (NM) from their brake release point. Of the dozen aircraft types listed on the figure, the Concorde has the highest L_{max} and the Saab 340 (SF340) has the lowest L_{max}.

Figure K-1-4

Common Aircraft Departure Noise Levels



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

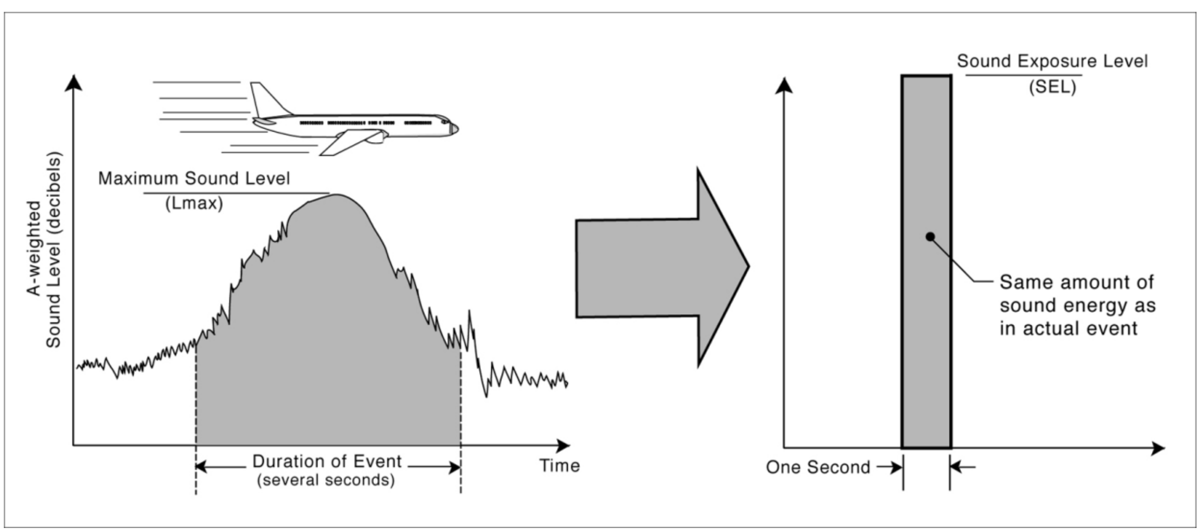
K-1.1.1.4 Sound Exposure Level (SEL)

A frequently used metric of noise exposure for a single aircraft flyover is the Sound Exposure Level, or SEL. SEL may be considered an accumulation of the sound energy over the duration of an event. The shaded area in **Figure K-1-5** illustrates that portion of the sound energy (or "dose") included in an SEL computation. The dose is then normalized (standardized) to a duration of one second. This "revised" dose is the SEL, shown as the shaded rectangular area in Figure K-1-5. Mathematically, the SEL represents the sound level of the constant sound that would, in one second, generate the same acoustic energy as the actual time-varying noise event. For events that last more than one second, SEL does not directly represent the sound level heard at any given time, but rather provides a measure of the net impact of the entire acoustic event.

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

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

Figure K-1-5
Relationship Between Single Event Noise Metrics



K-1.1.1.5 Equivalent Sound Level (L_{eq})

Maximum A-weighted level and SEL are used to measure the noise associated with individual events. The following metrics apply to longer-term cumulative noise exposure that often includes many events.

The first cumulative noise metric, the Equivalent Sound Level (abbreviated L_{eq}), is a measure of the exposure resulting from the accumulation of A-weighted sound levels over a particular period of interest (e.g., an hour, an 8-hour school day, nighttime or a full 24-hour day). However, because the length of the period can be different depending on the time frame of interest, the applicable period should always be identified or clearly understood when discussing the metric. Such durations are often identified through a subscript, for example $L_{eq(8)}$ or $L_{eq(24)}$.

As for its application to aircraft noise issues, L_{eq} is often presented for consecutive 1-hour periods to illustrate how the hourly noise dose rises and falls throughout a 24-hour period, as well as how certain hours are significantly affected by a few loud aircraft. Since the period of interest for this study is in a full 24-hour day, $L_{eq(24)}$ is the proper nomenclature.

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

K-1.1.1.6 Day-Night Average Sound Level (DNL)

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

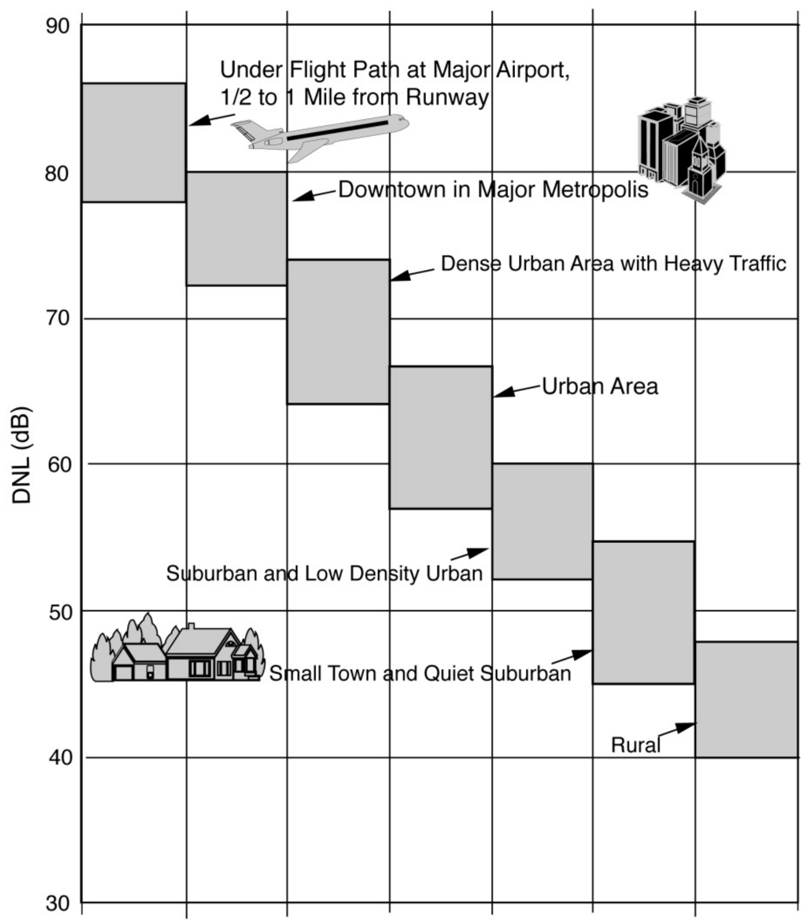
Typical DNL values for a variety of noise environments are shown in **Figure K-1-6** to indicate the range of noise exposure levels usually encountered.

Due to the DNL metric's excellent correlation with the degree of community annoyance from aircraft noise, DNL has been formally adopted by most federal agencies for measuring and evaluating aircraft noise for land use planning and noise impact assessment. Federal interagency committees such as the Federal Interagency Committee on Urban Noise (FICUN) and the Federal Interagency Committee on Noise (FICON) which include the EPA, FAA, Department of Defence, Department of Housing and Urban Development (HUD), and Veterans Administration, found DNL to be the best metric for land use planning. They also found no new cumulative sound descriptors or metrics of sufficient scientific standing to substitute for DNL. Other cumulative metrics could be used only to supplement, not replace DNL. Furthermore, FAA Order 1050.1E for environmental documents requires that DNL be used in describing cumulative noise exposure and in identifying aircraft noise/land use compatibility issues.[1 2 3 4 5]

Measurements of DNL are practical only for obtaining values for a relatively limited number of points. Instead, many noise studies, including this document, are based on estimates of DNL using an FAA-approved computer-based noise model.

Figure K-1-6

Typical Range of Outdoor Community Day-Night Average Sound Levels



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

K-1.1.1.7 Time-Above a Specified Level (TA)

The Time-Above a Specified Level (TA) metric describes the total number of minutes that instantaneous sound levels (usually from aircraft) are above a given threshold. For example, if 65 dB is the specified threshold, the metric would be referred to as “TA65.” Like DNL, the TA metric is typically associated with a 24-hour annual average day or only for the DNL nighttime period of 10 p.m. to 7 a.m.

When the TA calculation is expressed as a percentage of the day it is referred to as “%TA.” Although the threshold chosen for the TA calculation is arbitrary, it is usually the ambient level for the location of interest or 65 dB for comparison to a level of 65 dB DNL.

K-1.1.2 The Effects of Aircraft Noise on People

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

K-1.1.2.1 Community Annoyance

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

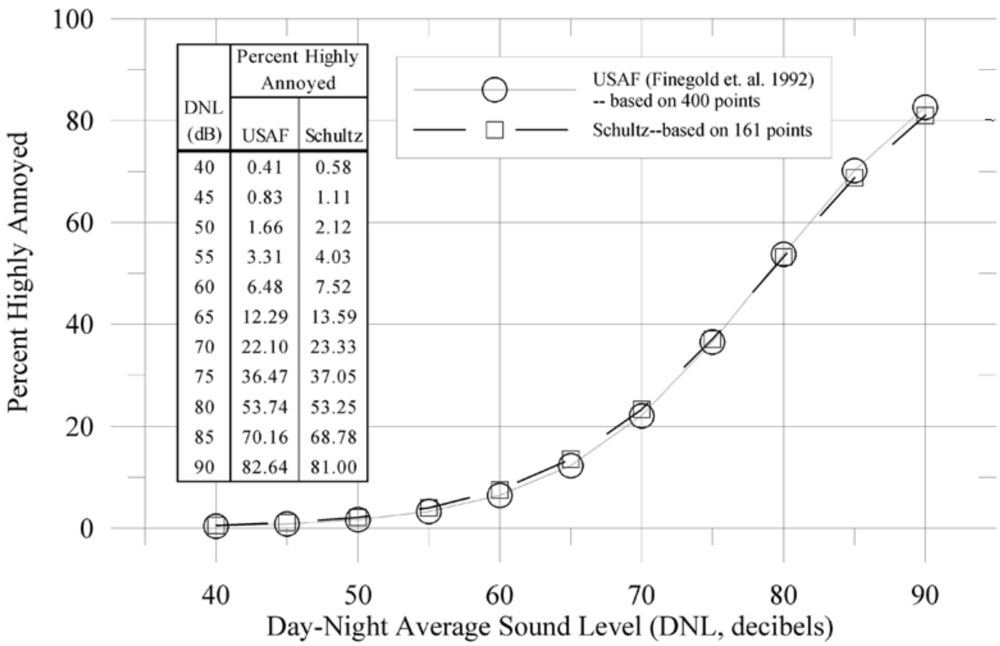
Scientific studies [1 2 3 6 7] and a large number of social/attitudinal surveys [8 9] have been conducted to appraise the U.S. and inter-national community of annoyance due to all types of environmental noise, especially aircraft events. These studies and surveys have found the DNL to be the best measure of that annoyance.

This relation between community annoyance and time-average sound level has been confirmed, even for infrequent aircraft noise events.[10] For helicopter overflights occurring at a rate of 1 to 52 per day, the stated reactions of community individuals correlated with the daily time-average sound levels of the helicopter overflights.

The relationship between annoyance and DNL that has been determined by the scientific community and endorsed by many federal agencies, including the FAA, is shown in **Figure K-1-7.** Two lines in Figure 7 represent two large sets of social/ attitudinal surveys: one for a curve fit of 161 data points compiled by an individual researcher, Ted Schultz, in 1978[8] and one for a curve fit of 400 data points (which include Schultz’s 161 points) compiled in 1992 by the U.S. Air Force.[11] The agreement of these two curves simply means that when one combines the more recent studies with the early landmark surveys in 1978, the results of the early surveys (i.e., the quantified effect of noise on annoyance) are confirmed.

Figure K-1-7

Relationship Between Annoyance and Day-Night Average Sound Level



DNL (dB)	Percent Highly Annoyed	
	USAF	Schultz
40	0.41	0.58
45	0.83	1.11
50	1.66	2.12
55	3.31	4.03
60	6.48	7.52
65	12.29	13.59
70	22.10	23.33
75	36.47	37.05
80	53.74	53.25
85	70.16	68.78
90	82.64	81.00

Source: Federal Interagency Committee on Noise (FICON),
"*Federal Agency Review of Selected Airport Noise Analysis Issues*",
August 1992, p. 3-6, Figure 3.1

Figure 7 shows the percentage of people "highly annoyed" by a given DNL. For example, the two curves in the figure yield a value of about 13% for the percentage of people that would be highly annoyed by a DNL exposure of 65 dB. The figure also shows that at very low values of DNL, such as 45 dB or less, 1% or less of the exposed population would be highly annoyed. Furthermore, at very high values of DNL, such as 90 dB, more than 80% of the ex-posed population would be highly annoyed.

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

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

It is often suggested that a lower DNL, such as 60 or 55 dB, be adopted as the threshold of community noise annoyance for FAA environmental analysis documents. While there is no technical reason why a lower level cannot be measured or calculated for comparison purposes, a DNL of 65 dB:

- Provides a valid basis for comparing and assessing community noise effects.
- Represents a noise exposure level that is normally dominated by aircraft noise and not other community or nearby highway noise sources.
- Reflects the FAA's threshold for grant-in-aid funding of airport noise mitigation projects.
- HUD also established a DNL standard of 65 dB for eligibility for federally guaranteed home loans.

K-1.1.2.2 Speech Interference

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

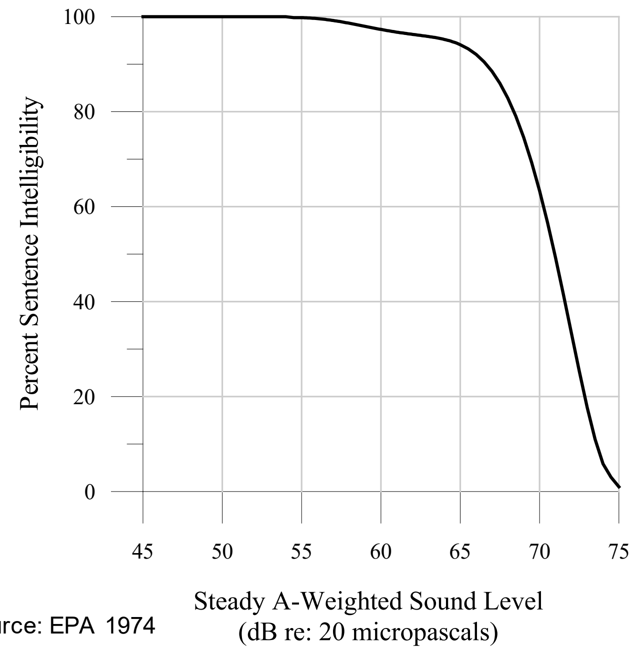
Speech interference associated with aircraft noise is a primary cause of annoyance to individuals on the ground. The disruption of routine activities, such as radio or television listening, telephone use or family conversation, causes frustration and aggravation. Research has shown that "whenever intrusive noise exceeds approximately 60 dB indoors, there will be interference with speech communication."[1]

Indoor speech interference can be expressed as a percentage of sentence intelligibility among two people speaking in relaxed conversation approximately one meter apart in a typical living room or bedroom.[1] The percentage of sentence intelligibility is a non-linear function of the (steady) indoor background sound level, as shown in **Figure K-1-8**. This curve was digitized and curve-fitted for the purposes of this document. Such a curve-fit yields 100 percent sentence intelligibility for background levels below 57 dB and yields less than 10 percent intelligibility for background levels above 73 dB. Note that the function is especially sensitive to changes in sound level between 65 dB and 75 dB. As an example of the sensitivity, a 1 dB increase in background sound level from 70 dB to 71 dB yields a 14 percent decrease in sentence intelligibility.

In the same document from which Figure K-1-8 was taken, the EPA established an indoor criterion of 45 dB DNL as requisite to protect against speech interference indoors.

Figure K-1-8

Percent Sentence Intelligibility



Source: EPA 1974

K-1.1.2.3 Sleep Disturbance

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

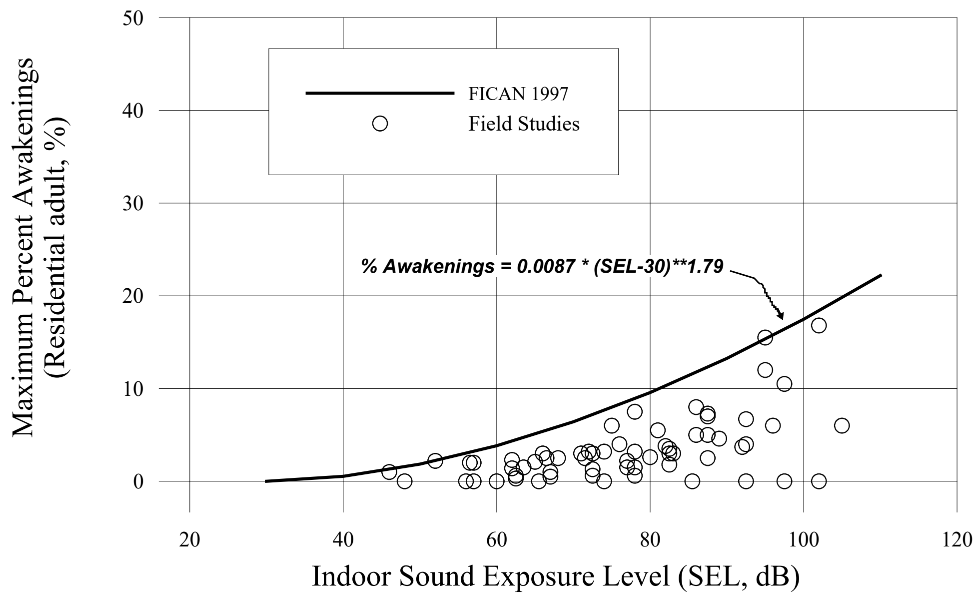
Sleep disturbance can be measured in one of two ways: "Arousal" represents awakening from sleep, while a change in "sleep stage" represents a shift from one of four sleep stages to another stage of lighter sleep without awakening. In general, arousal requires a higher noise level than does a change in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

In terms of average daily noise levels, some guidance is available to judge sleep disturbance. The EPA identified an indoor DNL of 45 dB as necessary to protect against sleep interference.[1]

In June 1997, the Federal Interagency Committee on Aviation Noise (FICAN) reviewed the sleep disturbance issue and presented a sleep disturbance dose-response prediction curve.[12] FICAN based their curve on data from field studies[13] [14] [15] [16] and recommends the curve as the tool for analysis of potential sleep disturbance for residential areas. **Figure K-1-9** shows this curve which, for an indoor SEL of 60 dB, predicts that a maximum of approximately 5 percent of the residential population exposed are expected to be behaviourally awakened. FICAN cautions that this curve should only be applied to long-term adult residents.

Figure K-1-9

Sleep Disturbance Dose-Response Relationship



Source: FICAN, 1997

K-1.2 Airport Noise Modeling

K-1.2.1 Introduction

Noise levels in the vicinity of an airport can be modeled using the aircraft fleet, the time of day of operations, the runway orientation, layout, and utilization, representative noise model flight tracks and their respective utilization, aircraft performance data, weather and terrain input data. For projects that require federal actions, the FAA mandates the use of Aviation Environmental Design Tool (AEDT) to conduct aviation noise modeling. In addition, DNL (See Section K-1.1.1.6) was used as the primary noise metrics for this study.

K-1.2.2 Noise Modeling Software

In 2015, the FAA released the Aviation Environmental Design Tool version 2b (AEDT 2b), which replaces both the INM and the Emissions and Dispersion Modeling System (EDMS), used for air quality analysis. The FAA issued a policy statement effective May 29, 2015 that required the use of AEDT 2b for new projects. Since the release of the AEDT 2b, the FAA has published several service packs that fixed various bugs and expanded its modeling capabilities. On September 12th, 2016, the FAA released AEDT version 2c (AEDT 2c) that incorporates various additional upgrades, which is the most current version when this report was written.

K-1.2.3 Noise Metrics - DNL

The DNL is the noise metric adopted by the Federal government to assess cumulative (i.e., multiple aircraft events) noise in the vicinity of airports. Therefore, in this analysis, aircraft noise is reported in terms of DNL. Details on DNL is included in Section K-1.1.1.6.

K-1.2.4 Operations

K-1.2.4.1 Average Annual Day (AAD)

AEDT uses the Average Annual Day (AAD) to represent the time and frequency of flights at the airport. AAD operations are representative of all aircraft operations that occur over the course of a year, averaged over 365 days.

K-1.2.4.2 Stage Length

Stage length is a noise modeling term used to refer to trip distance for an aircraft departure from origin to destination, and is a surrogate for aircraft weight. The trip distance influences the take-off weight (and therefore the thrust and performance) of the aircraft, as more fuel is required to fly longer distances and therefore adds weight to the aircraft.

K-1.2.4.3 Day/Night Split

As described in Section K-1.1.1.6, one operation occurring during nighttime (10pm – 7am) is equivalent to 10 daytime operations in terms of noise due to its annoyance.

K-1.2.5 Runway and Track Utilization

Runway use is a primary factor in the determination of noise exposure as how much each runway and helipad is utilized may determine the overall shape of the noise contour.

To determine projected noise levels on the ground, it is necessary to determine not only the frequency of aircraft operations, but also the altitude and location in which they fly. Flight routes to and from an airport, which are modeled as tracks in AEDT, are generally a function of the geometry of the airport's runways and the surrounding airspace structure in the vicinity of the airfield.

K-1.2.6 Maintenance Engine Run-ups

Engine run-ups can be modeled in AEDT, and depending on their frequency, may influence the size and location of noise exposure contours

K-1.2.7 Terrain

Terrain data is used to account for effects that variations in terrain have on noise propagation.

K-1.2.8 Weather

The noise model allows for the modeling of atmospheric conditions in the calculation of noise exposure, taking into consideration temperature and humidity. Temperature is an important factor in aircraft performance, as higher temperatures decrease the density of air, which increases aircraft takeoff distance and reduces climb performance. This generally results in increased noise propagation in hot temperatures, as compared to colder temperatures.

Endnotes

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

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

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

[4] 14 CFR Part 150, Airport Noise Compatibility Planning, Amendment 150-3, Updated April 2012.

[5] FAA Order 1050.1E, Chg 1, Environmental Impacts: Policies and Procedures, Department of Transportation, Federal Aviation Administration, March 20, 2006.

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Appendix K-2

Existing Conditions Noise Analysis

Technical Report

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ATTACHMENTS

APPENDIX K-2: Existing Conditions Noise Analysis

This appendix summarizes the data sources, assumptions and methodologies used to develop the Existing Conditions noise contour for BWI Marshall Airport, which was also compared to the Part 150 Study noise contour.

K-2.1 BWI Marshall Part 150 Study and Airport Noise Zone (ANZ) Study

The most recent BWI Part 150 Study was accepted by the FAA on August 31st, 2016[1]. The most recent BWI Airport Noise Zone (ANZ) Update Study was completed in December 2014[2]. The Part 150 Study and ANZ Study included the existing conditions (2014) and future conditions (2019) noise contours. The ANZ Study also included an additional year (2024) for the future conditions. The existing conditions noise contour was based on radar data from April 2012 to March 2013. The noise contours were modeled using the Integrated Noise Model (INM).

K-2.2 BWI Marshall Airport Facilities

BWI Marshall Airport has 3 runways including 10-28, 15L-33R, and 15R-33L. Helicopter operations are currently directed to hover taxi to the GA ramp as the helipad was eliminated in 2017. Therefore, the helipad is modeled close to the GA ramp. **Table K-2.1** shows the runway and helipad characteristics for the Existing Conditions.

There are displaced thresholds on Runway 10-28 and 15R-33L to meet FAA design standards. The arrival threshold is displaced by 550 feet at Runway 10 and 700 feet at Runway 28. For Runway 15R-33L, the arrival threshold is displaced 301 feet at Runway 15R and 500 feet at Runway 33L.

The majority of departures from Runway 28 starts their takeoff roll at the intersections with Taxiway C, approximately 500 feet from the physical runway end. Aircraft that may require the full length of the runway may start their takeoff roll at the physical end of the runway. For aircraft departures at other runways, the takeoff roll starts from the physical end of the runway.

Table K-2.1
BWI Marshall Runway Characteristics

Runway Characteristics	Units	Runway	
		10	28
Length	feet	10,502	
Width	feet	150	
Latitude	degree	39.174747	39.172632
Longitude	degree	-76.689617	-76.652675
Elevation	feet	139.0	126.2
Arrival Displaced Threshold	feet	550	700
Departure Displaced Threshold	feet	0	500 (typical)
Threshold Crossing Height	feet	50	50

Runway Characteristics	Units	Runway	
		15L	33R
Length	feet	5,000	
Width	feet	100	
Latitude	degree	39.187374	39.176236
Longitude	degree	-76.663540	-76.653232
Elevation	feet	141.5	114.1
Arrival Displaced Threshold	feet	0	0
Departure Displaced Threshold	feet	0	0
Threshold Crossing Height	feet	47	47

Runway Characteristics	Units	Runway	
		15R	33L
Length	feet	9,500	
Width	feet	150	
Latitude	degree	39.185366	39.164207
Longitude	degree	-76.681983	-76.662384
Elevation	feet	138.6	129.2
Arrival Displaced Threshold	feet	300	500
Departure Displaced Threshold	feet	0	0
Threshold Crossing Height	feet	50	50

Helipad Characteristics	Units	Helipad
Latitude	degree	39.184259
Longitude	degree	-76.658340
Elevation	feet	132

Sources: BWI Marshall Airport Layout Plan (ALP), conditionally approved April 2015.

K-2.3 Aviation Environmental Design Tool (AEDT)

In 2015, the FAA released the Aviation Environmental Design Tool version 2b (AEDT 2b), which replaces both INM and the Emissions and Dispersion Modeling System (EDMS), used for air quality analysis. The FAA issued a policy statement effective May 29, 2015 that required the use of AEDT 2b for new projects[3]. Since the release of the AEDT 2b, the FAA has published several service packs that fixed various bugs and expanded its modeling capabilities. On September 12th, 2016, the FAA released AEDT version 2c (AEDT 2c) that incorporates various additional upgrades. On September 27th, 2017, the FAA released AEDT version 2d (AEDT 2d) with additional upgrades and improvements to AEDT 2c. The Existing Conditions noise contour was modeled with AEDT 2d.

K-2.4 Existing Conditions Noise Model Inputs

The Existing Conditions noise contour was modeled using the fleet mix developed as part of this EA, 2018-2019 radar data, and information provided by MDOT MAA and HMMH. See *Appendix C, Aviation Activity Forecast* for additional details. This section describes the assumptions and methodologies applied in the noise modeling.

K-2.4.1 Fleet Mix

An Existing Conditions fleet mix was developed as part of the EA. On an Average Annual Day (AAD) basis, the total number of operations for the Existing Conditions is 719.06. The AAD operations are representative of all aircraft operations that occur over of the course of a year, averaged over 365 days. Operations were categorized into Air Carrier, Air Taxi, General Aviation, and Military.

The AEDT 2d includes noise data for a range of civilian and military fixed-wing aircraft and helicopters. In addition, AEDT 2d incorporates a list of noise aircraft substitution for aircraft without a direct representative noise aircraft. Most aircraft in operation at BWI Marshall Airport have a direct corresponding AEDT 2d aircraft type. However, some aircraft in the fleet mix do not have an AEDT 2d aircraft type or substitute aircraft. In this situation, the FAA Office of Environment and Energy (AEE) provides guidance on the identification of a suitable aircraft (with similar noise characteristics) for use in the model[4]. For these aircraft, coordination with the AEE was undertaken to identify the appropriate noise model aircraft, as shown in **Attachment 1**.

Using the aircraft and aircraft substitution list, as well as substitutions recommended by the AEE, the aircraft in the fleet mix were converted to the representative AEDT 2d noise aircraft. **Table K-2.2** shows the number of AAD operations, by arrivals, departures and touch-and-goes, and by day and night, for each noise aircraft in the fleet mix.

Table K-2.2

Existing Conditions Fleet Mix

Aircraft Category	AEDT Aircraft ID	Arrivals		Departures		Touch-and-Goes		Total
		Day	Night	Day	Night	Day	Night	
Air Carrier	717200	0.11	0.01	0.11	0.01	-	-	0.24
	727EM2	0.02	0.01	0.02	0.01	-	-	0.05
	737400	0.15	0.02	0.15	0.02	-	-	0.35
	737500	0.01	-	0.01	-	-	-	0.02
	737700	114.60	18.92	112.15	21.38	-	-	267.05
	737800	63.09	16.55	67.58	12.07	-	-	159.29
	7378MAX	3.76	0.53	3.88	0.41	-	-	8.57
	737N17	0.00	-	0.00	0.00	-	-	0.01
	737N9	0.00	-	0.00	0.00	-	-	0.01
	74720B	0.01	-	0.01	0.01	-	-	0.02
	747400	0.15	0.08	0.15	0.09	-	-	0.48
	757300	0.01	0.00	0.01	0.00	-	-	0.02
	757PW	0.23	0.74	0.60	0.37	-	-	1.94
	757RR	0.29	0.62	0.70	0.21	-	-	1.82
	767300	2.22	3.65	2.27	3.59	-	-	11.72
	767400	0.02	0.00	0.02	0.01	-	-	0.05
	767CF6	1.20	1.23	1.93	0.50	-	-	4.86
	767JT9	0.06	0.07	0.03	0.11	-	-	0.27
	777200	0.11	0.06	0.10	0.07	-	-	0.33
	7878R	0.98	0.01	0.83	0.15	-	-	1.96
	A300-622R	0.63	0.74	0.76	0.60	-	-	2.73
	A310-304	0.00	-	-	0.00	-	-	0.01
	A319-131	8.24	3.33	10.40	1.17	-	-	23.14
	A320-211	3.72	0.51	3.85	0.38	-	-	8.46
	A320-232	14.09	5.65	16.83	2.91	-	-	39.49
	A321-232	3.97	1.90	4.96	0.91	-	-	11.73
	A330-301	0.00	0.00	0.00	0.00	-	-	0.01
	A330-343	0.01	0.00	0.00	0.01	-	-	0.02
	BEC58P	0.00	-	0.00	-	-	-	0.01
	CL600	7.73	0.41	7.58	0.56	-	-	16.27
	CNA208	13.04	1.87	13.25	1.66	-	-	29.82
	CNA750	0.00	-	0.00	-	-	-	0.01
	CRJ9-ER	0.84	0.06	0.88	0.01	-	-	1.79
	DC1010	0.04	0.02	0.02	0.03	-	-	0.11
	DC1030	0.04	0.03	0.03	0.04	-	-	0.14
	DHC6	0.01	-	0.01	-	-	-	0.01
	DHC8	0.01	-	0.01	-	-	-	0.01

Table K-2.2
Existing Conditions Fleet Mix

Aircraft Category	AEDT Aircraft ID	Arrivals		Departures		Touch-and-Goes		Total
		Day	Night	Day	Night	Day	Night	
	DHC830	0.02	-	0.02	-	-	-	0.03
	EMB145	9.37	0.43	9.31	0.49	-	-	19.60
	EMB170	3.07	0.64	2.93	0.78	-	-	7.43
	EMB175	0.05	0.01	0.05	0.01	-	-	0.13
	EMB190	4.07	1.04	4.05	1.07	-	-	10.23
	FAL20	-	0.01	0.00	0.00	-	-	0.01
	LEAR35	0.07	0.04	0.07	0.04	-	-	0.21
	MD11GE	0.02	0.32	0.21	0.14	-	-	0.69
	MD11PW	0.01	0.14	0.09	0.06	-	-	0.29
	MD82	0.18	0.00	0.19	-	-	-	0.37
	MD83	6.80	1.46	7.64	0.62	-	-	16.52
	MD9025	2.54	0.34	2.50	0.38	-	-	5.76
	MD9028	2.84	0.37	2.79	0.43	-	-	6.44
Air Carrier Total		268.45	61.82	278.98	51.29	-	-	660.54
Air Taxi	1900D	0.01	-	0.01	-	-	-	0.01
	737700	0.02	-	0.01	0.01	-	-	0.05
	A109	0.00	-	0.00	-	-	-	0.00
	B206L	0.00	-	0.00	-	-	-	0.00
	B407	0.00	0.00	0.00	0.00	-	-	0.01
	B427	0.00	-	0.00	-	-	-	0.00
	B429	0.00	-	0.00	-	-	-	0.01
	B430	0.00	-	0.00	-	-	-	0.00
	BD-700-1A10	0.07	0.01	0.08	-	-	-	0.15
	BD-700-1A11	0.07	-	0.07	0.01	-	-	0.15
	BEC58P	0.05	0.01	0.05	0.01	-	-	0.12
	C12	0.02	0.01	0.02	0.01	-	-	0.07
	CIT3	0.01	-	0.01	-	-	-	0.01
	CL600	1.23	0.09	1.26	0.06	-	-	2.65
	CL601	0.24	0.02	0.24	0.02	-	-	0.52
	CNA172	0.01	-	0.01	0.00	-	-	0.03
	CNA182	0.01	-	0.01	0.00	-	-	0.01
	CNA208	0.44	0.02	0.43	0.03	-	-	0.92
	CNA441	0.02	0.01	0.03	-	-	-	0.06
	CNA500	0.21	0.01	0.21	0.01	-	-	0.45
	CNA510	0.13	-	0.13	-	-	-	0.27
	CNA525C	0.03	-	0.03	0.00	-	-	0.07

Table K-2.2
Existing Conditions Fleet Mix

Aircraft Category	AEDT Aircraft ID	Arrivals		Departures		Touch-and-Goes		Total
		Day	Night	Day	Night	Day	Night	
	CNA55B	1.16	0.05	1.17	0.05	-	-	2.43
	CNA560E	0.11	0.01	0.10	0.01	-	-	0.23
	CNA560U	0.11	0.01	0.10	0.01	-	-	0.23
	CNA560XL	1.28	0.06	1.28	0.05	-	-	2.67
	CNA680	1.19	0.07	1.22	0.04	-	-	2.53
	CNA750	1.07	0.08	1.09	0.06	-	-	2.31
	COMSEP	0.03	-	0.02	0.00	-	-	0.05
	CRJ9-ER	0.01	-	0.01	0.00	-	-	0.03
	DC93LW	0.00	-	0.00	-	-	-	0.01
	DHC6	0.39	0.04	0.40	0.03	-	-	0.86
	EC130	0.00	-	0.00	-	-	-	0.00
	EMB120	-	0.00	-	0.00	-	-	0.01
	EMB145	0.06	0.02	0.08	0.01	-	-	0.16
	FAL20	0.01	0.00	0.01	0.00	-	-	0.02
	GASEPF	0.02	-	0.02	-	-	-	0.03
	GASEPV	0.04	0.00	0.04	0.00	-	-	0.09
	GII	0.00	-	0.00	-	-	-	0.01
	GIV	0.54	0.04	0.55	0.02	-	-	1.16
	GV	0.13	0.01	0.14	0.01	-	-	0.29
	H500D	0.00	-	0.00	-	-	-	0.00
	IA1125	0.14	0.02	0.15	0.01	-	-	0.32
	LEAR25	0.00	-	0.00	-	-	-	0.01
	LEAR35	0.66	0.06	0.65	0.07	-	-	1.44
	MU3001	0.50	0.03	0.51	0.02	-	-	1.05
	PA28	0.00	-	0.00	-	-	-	0.01
	PA42	0.33	0.03	0.34	0.02	-	-	0.72
	R44	0.00	-	0.00	-	-	-	0.00
	S70	0.00	-	0.00	-	-	-	0.00
	S76	0.02	-	0.02	0.00	-	-	0.04
	SA330J	0.04	0.01	0.04	0.00	-	-	0.09
	SA350D	0.00	-	0.00	0.00	-	-	0.01
	SA365N	0.00	-	0.00	-	-	-	0.00
	SF340	0.00	-	0.00	-	-	-	0.01
Air Taxi Total		10.45	0.71	10.59	0.58	-	-	22.32
General Aviation	1900D	0.01	0.00	0.01	-	-	-	0.03
	737700	0.01	0.00	0.01	-	-	-	0.03
	737N17	0.00	-	0.00	0.00	-	-	0.00

Table K-2.2
Existing Conditions Fleet Mix

Aircraft Category	AEDT Aircraft ID	Arrivals		Departures		Touch-and-Goes		Total
		Day	Night	Day	Night	Day	Night	
	737N9	0.00	-	0.00	0.00	-	-	0.00
	A109	0.00	0.00	0.00	0.00	-	-	0.01
	B206L	0.05	0.01	0.06	0.00	-	-	0.12
	B407	0.03	0.00	0.02	0.01	-	-	0.07
	B427	0.01	0.00	0.01	0.00	-	-	0.03
	B429	0.14	0.01	0.15	0.00	-	-	0.31
	B430	0.04	0.01	0.05	0.01	-	-	0.11
	BD-700-1A10	0.17	0.01	0.16	0.01	-	-	0.35
	BD-700-1A11	0.05	-	0.05	-	-	-	0.10
	BEC58P	0.54	0.02	0.56	0.01	-	-	1.13
	C12	0.23	0.01	0.23	0.02	-	-	0.48
	CIT3	0.22	0.02	0.22	0.02	-	-	0.48
	CL600	0.65	0.04	0.66	0.03	-	-	1.37
	CL601	0.25	0.02	0.25	0.01	-	-	0.53
	CNA172	0.62	0.01	0.63	0.00	0.01	-	1.27
	CNA182	0.15	0.00	0.14	0.01	0.01	-	0.31
	CNA206	0.20	0.00	0.20	0.00	-	-	0.41
	CNA208	0.63	0.80	0.55	0.88	-	-	2.86
	CNA20T	0.01	-	0.01	0.00	-	-	0.01
	CNA441	0.34	0.02	0.35	0.01	0.00	0.00	0.72
	CNA500	0.73	0.04	0.74	0.03	-	-	1.54
	CNA510	0.16	0.02	0.16	0.02	-	-	0.35
	CNA525C	0.15	0.02	0.16	0.00	-	-	0.33
	CNA55B	0.34	0.03	0.33	0.05	-	-	0.75
	CNA560E	0.13	0.01	0.12	0.02	-	-	0.27
	CNA560U	0.13	0.01	0.12	0.02	-	-	0.27
	CNA560XL	0.66	0.02	0.65	0.02	-	-	1.35
	CNA680	0.37	0.01	0.37	0.01	-	-	0.76
	CNA750	1.80	0.16	1.85	0.11	-	-	3.92
	COMSEP	1.37	0.03	1.26	0.13	-	-	2.79
	DC3	0.00	-	0.00	-	-	-	0.01
	DHC6	0.47	0.04	0.46	0.04	0.00	0.00	1.01
	DO328	0.00	-	0.00	-	-	-	0.01
	EC130	0.03	0.01	0.04	0.00	-	-	0.09
	ECLIPSE500	0.09	0.00	0.08	0.01	-	-	0.18
	EMB145	0.04	0.02	0.05	0.01	-	-	0.12

Table K-2.2
Existing Conditions Fleet Mix

Aircraft Category	AEDT Aircraft ID	Arrivals		Departures		Touch-and-Goes		Total
		Day	Night	Day	Night	Day	Night	
	EMB170	0.00	-	0.00	-	-	-	0.01
	EMB190	0.03	-	0.02	0.00	-	-	0.05
	FAL20	0.04	-	0.04	-	-	-	0.07
	GASEPF	0.08	0.01	0.09	0.01	0.02	0.01	0.23
	GASEPV	0.61	0.01	0.60	0.02	-	-	1.25
	GII	0.01	-	0.01	-	-	-	0.02
	GIV	0.47	0.05	0.46	0.06	-	-	1.04
	GV	0.51	0.07	0.55	0.03	-	-	1.16
	H500D	0.00	0.00	0.00	0.00	-	-	0.01
	HS748A	0.01	-	0.01	-	-	-	0.01
	IA1125	0.33	0.03	0.33	0.02	-	-	0.71
	LEAR35	1.30	0.14	1.33	0.12	-	-	2.88
	MU3001	0.30	0.03	0.31	0.01	-	-	0.65
	PA28	0.04	0.01	0.05	0.01	-	-	0.11
	PA30	0.01	-	0.01	-	-	-	0.01
	PA42	0.10	0.00	0.09	0.01	0.00	-	0.20
	R44	0.01	0.00	0.01	0.00	-	-	0.03
	S70	0.01	0.00	0.01	0.00	-	-	0.01
	S76	0.11	0.01	0.11	0.01	-	-	0.24
	SA330J	0.03	0.01	0.03	0.01	-	-	0.06
	SA350D	0.01	0.00	0.01	0.00	-	-	0.01
	SA365N	0.00	0.00	0.00	0.00	-	-	0.00
	SF340	0.00	-	0.00	-	-	-	0.01
	T33A	0.00	-	0.00	-	-	-	0.01
General Aviation Total		14.82	1.77	14.78	1.81	0.04	0.02	33.24
Military	737700	0.01	0.00	0.01	0.00	-	-	0.02
	A321-232	0.00	0.00	0.00	0.00	-	-	0.01
	B429	0.00	0.00	0.00	0.00	-	-	0.01
	BAC111	0.13	0.01	0.13	0.00	-	-	0.27
	BD-700-1A10	0.00	0.00	0.00	0.00	-	-	0.01
	BD-700-1A11	0.00	0.00	0.00	0.00	-	-	0.01
	BEC58P	0.01	0.00	0.01	0.00	-	-	0.02
	C12	0.18	0.01	0.18	0.01	-	-	0.38
	C-130E	0.01	0.00	0.01	0.00	-	-	0.03
	C130HP	0.00	0.00	0.00	0.00	-	-	0.01
	CL600	0.01	0.00	0.01	0.00	-	-	0.02

Table K-2.2
Existing Conditions Fleet Mix

Aircraft Category	AEDT Aircraft ID	Arrivals		Departures		Touch-and-Goes		Total
		Day	Night	Day	Night	Day	Night	
	CL601	0.00	0.00	0.00	0.00	-	-	0.00
	CNA172	0.01	0.00	0.01	0.00	-	-	0.02
	CNA182	0.03	0.00	0.03	0.00	-	-	0.07
	CNA206	0.00	0.00	0.00	0.00	-	-	0.01
	CNA208	0.00	0.00	0.00	0.00	-	-	0.01
	CNA55B	0.01	0.00	0.01	0.00	-	-	0.02
	CNA560E	0.01	0.00	0.01	0.00	-	-	0.02
	CNA560U	0.01	0.00	0.01	0.00	-	-	0.02
	CNA680	0.01	0.00	0.01	0.00	-	-	0.02
	CNA750	0.01	0.00	0.01	0.00	-	-	0.02
	COMSEP	0.00	0.00	0.00	0.00	-	-	0.01
	CRJ9-ER	0.50	0.02	0.51	0.02	-	-	1.05
	DHC6	0.01	0.00	0.01	0.00	-	-	0.02
	DHC6QP	0.00	0.00	0.00	0.00	-	-	0.01
	DHC8	0.15	0.01	0.15	0.00	-	-	0.31
	DHC830	0.00	0.00	0.00	0.00	-	-	0.00
	DO328	0.01	0.00	0.01	0.00	-	-	0.03
	F-18	0.01	0.00	0.01	0.00	-	-	0.02
	GASEPV	0.02	0.00	0.02	0.00	-	-	0.05
	GII	0.03	0.00	0.03	0.00	-	-	0.06
	GIV	0.04	0.00	0.04	0.00	-	-	0.08
	GV	0.05	0.00	0.05	0.00	-	-	0.10
	KC135R	0.00	0.00	0.00	0.00	-	-	0.01
	LEAR25	0.00	0.00	0.00	0.00	-	-	0.01
	LEAR35	0.01	0.00	0.01	0.00	-	-	0.03
	MU3001	0.01	0.00	0.01	0.00	-	-	0.02
	S70	0.02	0.00	0.02	0.00	-	-	0.03
	S76	0.00	0.00	0.00	0.00	-	-	0.01
	SA365N	0.00	0.00	0.00	0.00	-	-	0.01
	SABR80	0.07	0.00	0.07	0.00	-	-	0.15
	T-38A	0.00	0.00	0.00	0.00	-	-	0.01
Military Total		1.42	0.06	1.43	0.05	-	-	2.96
Grand Total		295.14	64.36	305.79	53.72	0.04	0.02	719.06

Sources: HNTB Fleet Mix Forecast for BWI EA, 2019.

K-2.4.2 Stage Length

Stage length is a noise modeling term referring to trip distance for an aircraft departure from origin to destination, and is a surrogate for aircraft weight. The trip distance influences the take-off weight (and therefore the thrust and performance) of the aircraft, as more fuel is required to fly longer distances and therefore adds weight to the aircraft.

The departure stage lengths for the Existing Conditions were calculated from the radar data which were also used for the fleet mix development. However, a small percentage of the aircraft had departure stage lengths that exceeded the maximum available stage lengths in AEDT 2d. In the absence of these profiles, the maximum stage length noise profiles for the aircraft in question were used. **Table K-2.3** shows the distribution of the departure stage lengths.

Table K-2.3
Distribution of Departure Stage Lengths

Stage Length	Distance Bracket (nm)	Percentage		
		Day	Night	Total
1	0-500	43.2%	51.1%	44.4%
2	501-1,000	34.8%	32.5%	34.4%
3	1,001-1,500	11.3%	7.3%	10.7%
4	1,501-2,500	10.4%	8.1%	10.0%
5	2,501-3,500	0.3%	0.8%	0.4%
6	3,501-4,500	0.0%	0.2%	0.1%
7	4,501-5,500	0.0%	0.0%	0.0%

Source: MDOT MAA Radar Data and HNTB Analysis, 2019.

K-2.4.3 Day and Night Operations

The DNL is the noise metric adopted by the Federal government to assess cumulative (i.e., multiple aircraft events) noise near airports. Therefore, in this analysis, aircraft noise is reported in terms of DNL. The DNL is a cumulative metric with a 10-decibel (dB) penalty applied to nighttime aircraft events. For the purposes of the DNL metric, daytime is defined as 07:00 a.m. to 9:59 p.m., and nighttime is defined as 10:00 p.m. to 06:59 a.m.

The Existing Conditions analysis indicates that approximately 83.6% of all operations occurred during the daytime. Approximately 16.4% of all operations occur during the night time. **Table K-2.4** shows the distribution of daytime and night time operations.

Table K-2.4
Distribution of Day and Night Operations

Operation Type	Percentage	
	Daytime	Nighttime
Arrival	82.1%	17.9%
Departure	85.1%	14.9%
Touch-and-Go	66.8%	33.2%
Total	83.6%	16.4%

Sources: MDOT MAA Radar Data and HNTB Analysis 2019.

K-2.4.4 Aircraft Maintenance Engine Run-ups

Aircraft maintenance engine run-ups can be modeled in AEDT 2d, and depending on their frequency and orientation, may influence the size and location of noise exposure contours. The MAA provided detailed engine run-up logs for use in the engine run-up contour modeling.

At BWI Marshall, engine run-up operations were permitted at the holding block of Runway 10, with the aircraft nose positioned between 190^0 to 220^0 to the magnetic north[5]. A total number of 6 run-up operations from 2018 were included. Three of the run-up operations occurred during acoustic daytime and three occurred during acoustic nighttime. **Table K-2.5** shows the type of aircraft and associated run-up operations.

Table K-2.5
Run-up Operations

Aircraft	Operations
Boeing 737-700	1
Boeing 737-800	2
Boeing MD88	2
Boeing MD90	1

Sources: MDOT MAA and HNTB Analysis, 2019.

K-2.4.5 Meteorological Conditions

The noise model allows for the modeling of atmospheric conditions in the calculation of noise exposure, taking into consideration temperature and humidity. Compared with the legacy noise model, AEDT 2d applies a newer atmospheric absorption algorithm as described in the Society of Automotive Engineers (SAE) Aerospace Recommended Practice (ARP) 5534[4].

For the Existing Conditions, parameters in **Table K-2.6** were applied based on the default meteorological parameters in AEDT 2d for BWI Marshall Airport.

Table K-2.6
Meteorological Parameters

Parameters	Units	Value
Temperature	Fahrenheit	54.0
Pressure	Millibar	1010.9
Relative Humidity	Percentage	67.9
Headwind Speed	Knot	6.1

Source: AEDT 2d default for BWI Marshall.

K-2.4.6 Terrain

Terrain data is used to account for effects that variations in terrain have on noise propagation. Terrain data was obtained from the National Land Cover Database (NLCD) developed by the U.S. Department of the Interior[6].

K-2.4.7 Runway Utilization

The runway utilization represents the percentage of time that a specific aircraft utilizes a specific runway. The Existing Conditions runway utilization was obtained from the most recent radar data (May 2018 to April 2019). No extended runway closures were recorded during this period. The runway utilization was calculated by aircraft type to reflect the runway use strategies and noise abatement protocols at BWI Marshall Airport.

In general, the runway utilization reflected in the radar data agrees with the Part 150 runway utilization. However, there are differences that may impact noise contour outputs. Comparing the radar data with the Part 150 Study utilization, Runway 10 was utilized more frequently for arrivals while Runway 28 was utilized less frequently for departures. Runway 15R was utilized more frequently for departures while Runway 33L was utilized less frequently for arrivals.

Table K-2.7 shows the runway utilization for the Existing Conditions.

Table K-2.7
Existing Conditions Runway Utilization

Source	Runway	Arrivals		Departures	
		Day	Night	Day	Night
Radar Data	10	33.1%	37.3%	0.5%	0.7%
	28	3.4%	2.3%	55.7%	57.1%
	15L	3.0%	1.5%	3.8%	2.4%
	33R	6.8%	3.7%	6.8%	4.4%
	15R	1.0%	1.4%	32.4%	34.7%
	33L	52.5%	53.7%	0.5%	0.6%
	H01	0.2%	0.1%	0.2%	0.1%
Grand Total		100.00%	100.00%	100.00%	100.00%

Sources: MDOT MAA Radar Data and HNTB Analysis 2019.

K-2.4.8 Track Geometry and Utilization

To model noise impacts in the vicinity of BWI Marshall Airport, it is essential to determine not only the frequency of aircraft operations, but also the altitude and location in which they fly. To reduce the amount of data processed, four representative weeks were selected that include one week each in spring, fall, summer, and winter. The selected representative weeks include the following:

- 7/26/2018 – 8/1/2018
- 9/20/2018 – 9/26/2018
- 11/29/2018 - 12/5/2018
- 3/22/2019 – 3/28/2019

The aircraft were categorized into five operation groups including commercial jets, commercial propellers, GA jets, GA propellers, and helicopters. The flight tracks were developed by operation type (arrival and departure), runway, and operation group. For operation categories with few radar tracks, straight-in and straight-out tracks were modeled. Existing navigation fixes and terminal arrival and departure procedures were used as references.

Figure K-2-1 and **Figure K-2-2** show the arrival and departure flight tracks developed from the four-week radar data sample. Representative model tracks were developed to the extends of the available data and necessary for noise modeling. Detailed track development figures are included in **Attachment 2**.

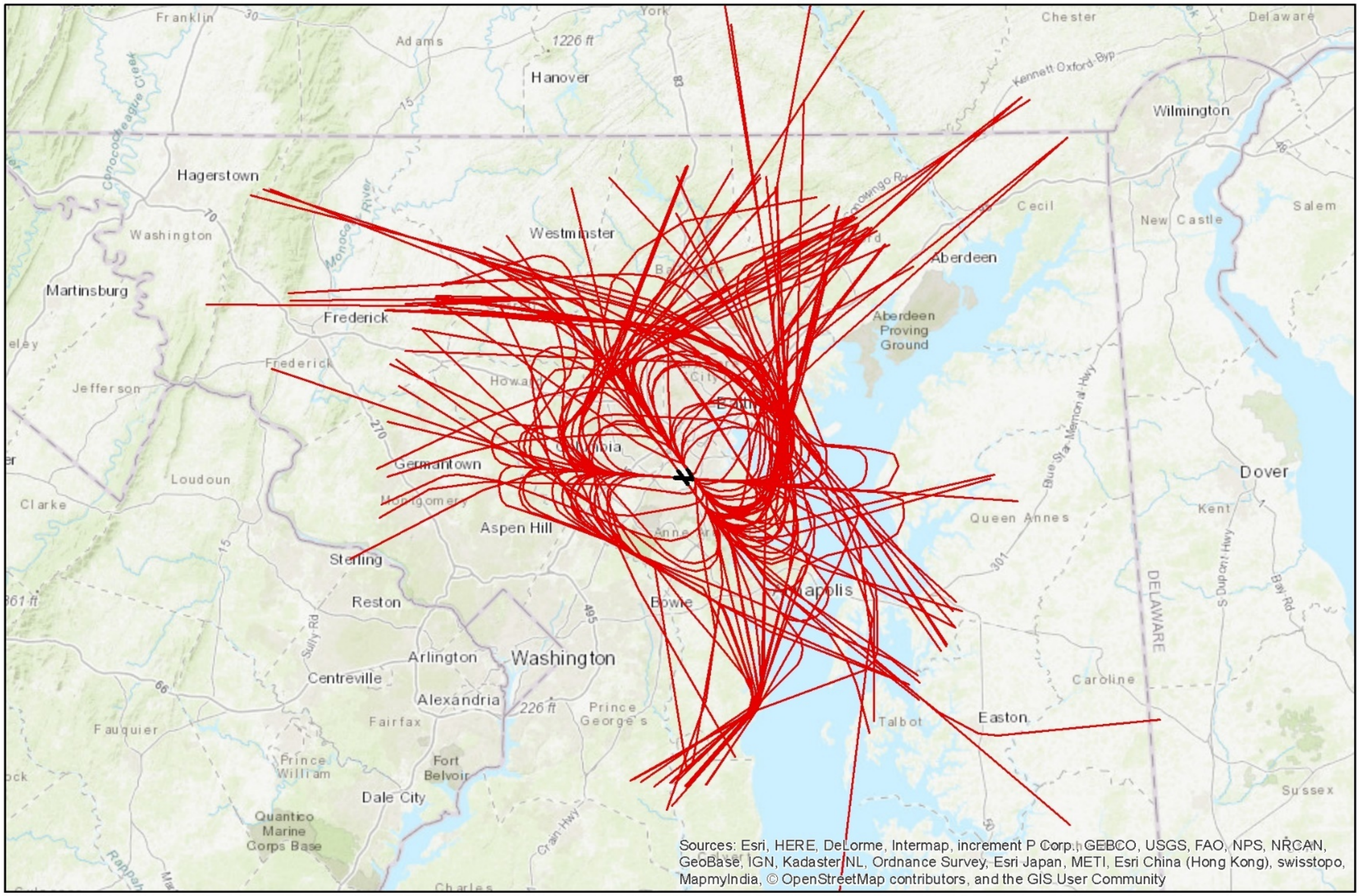
K-2.5 Noise Contour and Comparison

The Existing Conditions noise contour was modeled using the noise inputs described above. **Figure K-2-3** shows the Existing Conditions noise contour. **Figure K-2-4** compares the Existing Conditions noise contour with the 2014 noise contour included in the Part 150 Study.

Compared with the Part 150 Study noise contour, the Existing Conditions noise contour is noticeably larger along Runway 10-28 and Runway 15R-33L. The differences may attribute to several factors including the differences in the noise models and fleet mixes. The Part 150 Study used the legacy noise model INM while the EA noise contour was modeled using AEDT. The FAA has acknowledged that the noise contour outputs between INM and AEDT might be different due to different system architecture, design and capabilities[7]. In addition, the differences in the fleet mixes of the two studies drive the differences in the two contours. Although the total number of operations used in the BWI EA Existing Conditions is approximately 0.4% lower than that of the Part 150 Study, the number of night operations is approximately 32.1% higher. Since a 10-dB penalty is applied to the nighttime aircraft events in the noise calculation, the increase in the night operations would have a larger impact on the area of the contour than the decrease in the total operations. Furthermore, fleet changes also contribute to the noise contour area increase. For example, compared with the Part 150 Study, Boeing 717-200 operations decreased while Boeing 737-800 operations increased. In addition, the BWI EA Existing Conditions include wide-body cargo aircraft operations that were not included in the Part 150 Study, which may also have contributed to the increase of the noise contour area.

BWI Marshall Airport Arrival Flight Tracks

HNTB



LEGEND

- Arrival Flight Tracks
- Runway

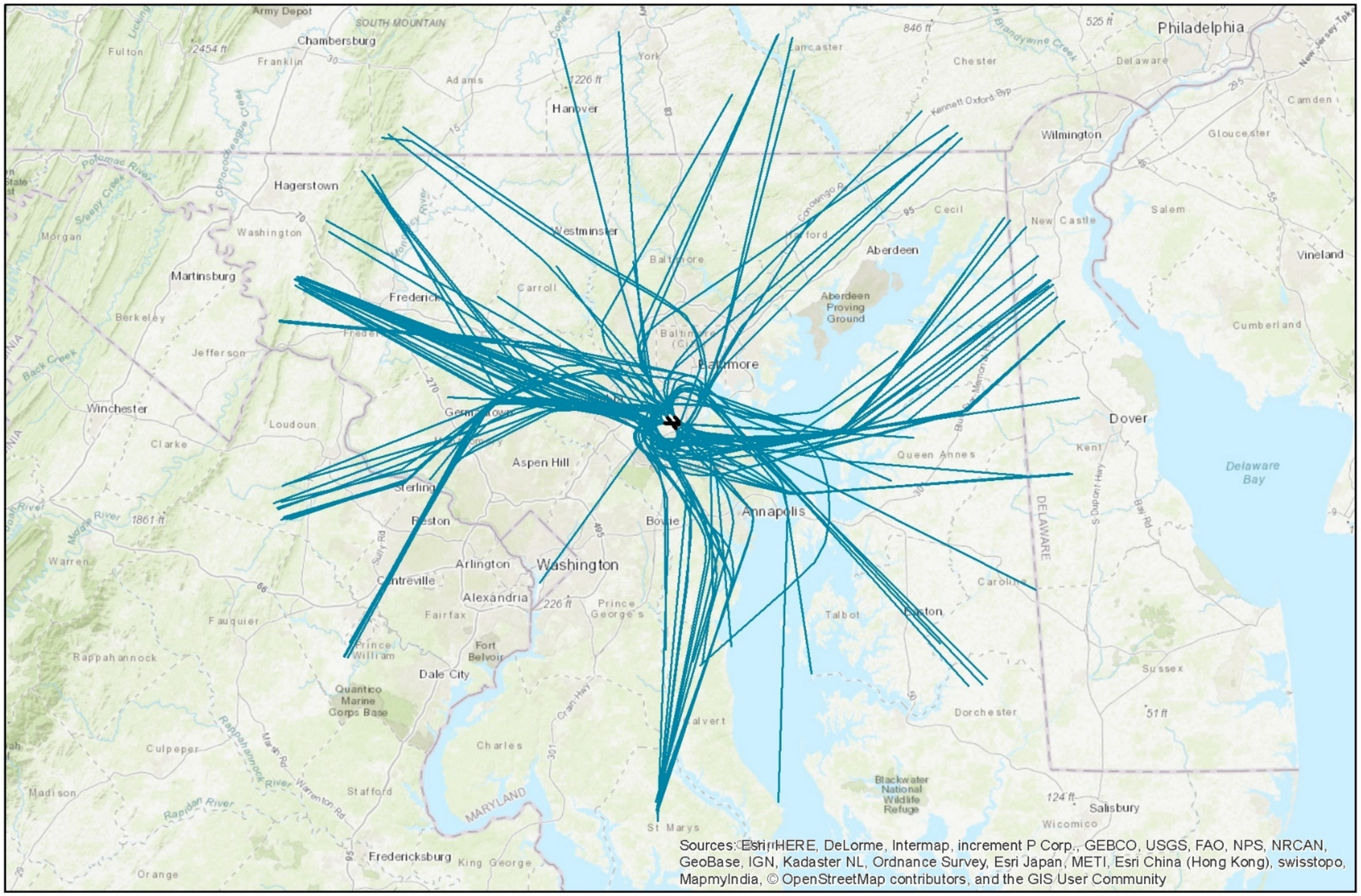
Figure K-2-1: Modeled Arrival Flight Tracks

N

0 2.5 5 10 Nautical Miles

BWI Marshall Airport Departure Flight Tracks

HNTB



LEGEND

Departure Flight Tracks
Runway

Figure K-2-2: Modeled Departure Flight Tracks

N

0 3.25 6.5 13 Nautical Miles

BWI Marshall Airport Noise Contour Comparison

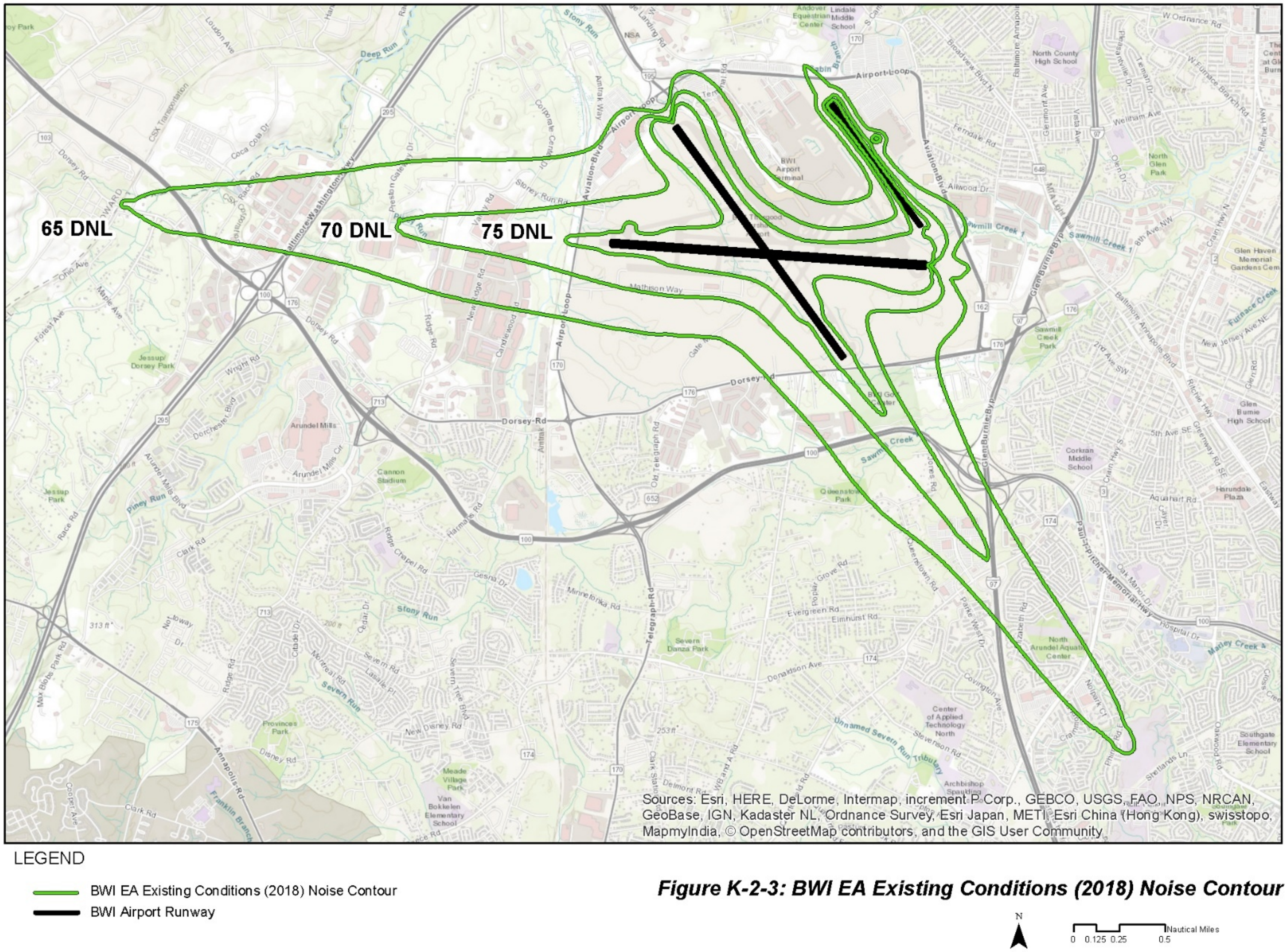
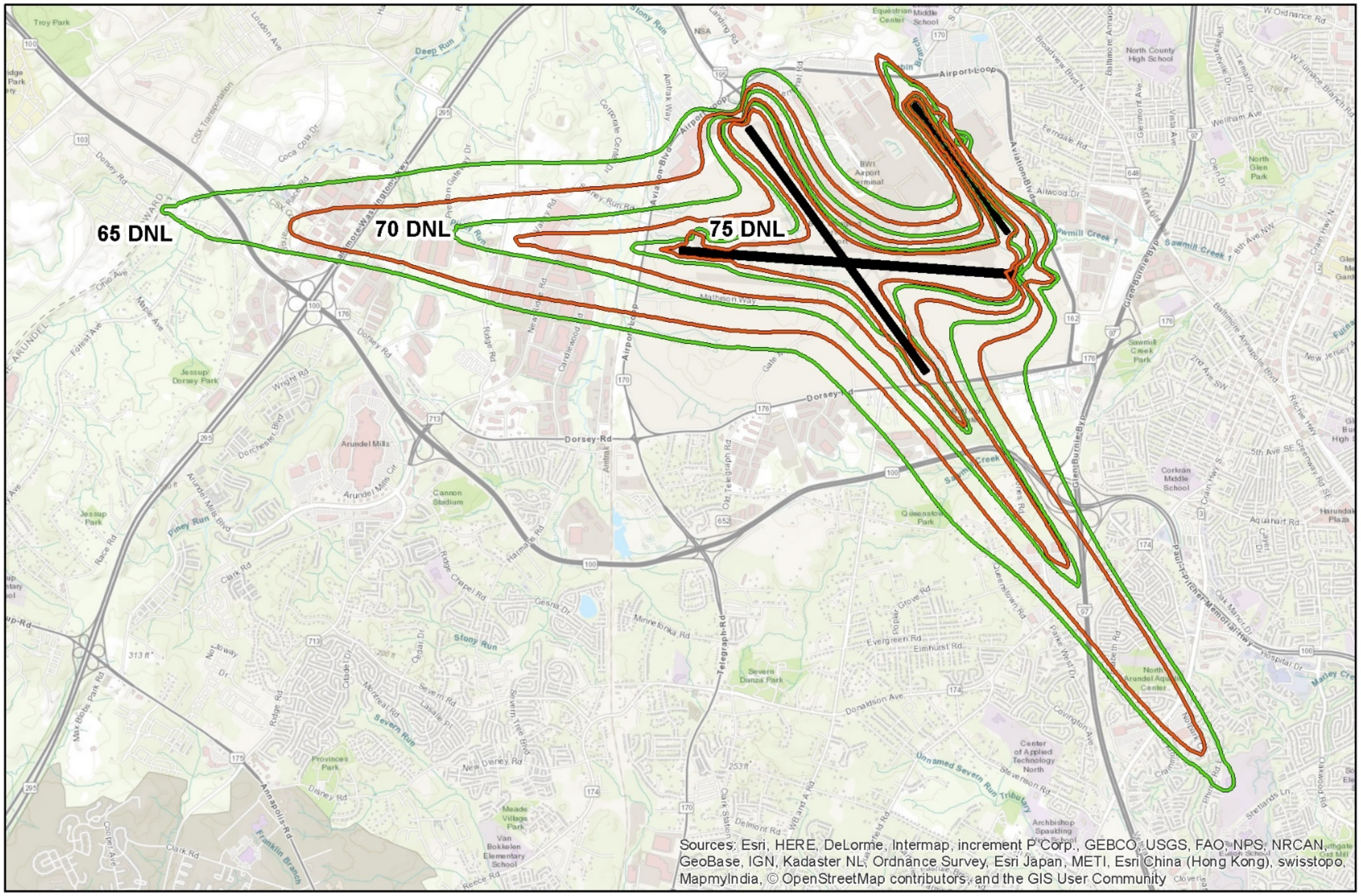


Figure K-2-3: BWI EA Existing Conditions (2018) Noise Contour

BWI Marshall Airport Noise Contour Comparison HNTB



LEGEND

- BWI EA Existing Conditions (2018) Noise Contour
- Part 150 Base Year (2014) Noise Contour
- BWI Airport Runway

Figure K-2-4: BWI EA Existing Conditions (2018) Noise Contour vs. Part 150 Study Base Year (2014) Noise Contour

N

0 0.125 0.25 0.5 Nautical Miles

Endnotes

[1] Federal Aviation Administration, Federal Register Vol. 81, No. 168, Noise Exposure Map Notice for Baltimore/Washington International Thurgood Marshall Airport, Anne Arundel County, Maryland, https://www.gpo.gov/fdsys/pkg/FR-2016-08-30/pdf/2016-20795.pdf.

[2] Baltimore/Washington International Thurgood Marshall Airport, Airport Noise Zone Update, December 2014.

[3] Federal Register Document Number 2015-11803, 14 CFR Chapter I Noise, Fuel Burn, and Emissions Modeling Using the Aviation Environmental Design Tool Version 2b, Policy Statement, May 15, 2015, Volume 80, Number 94, FAA, https://www.gpo.gov/fdsys/pkg/FR-2015-05-15/pdf/2015-11803.pdf.

[4] Guidance on Using the Aviation Environmental Design Tool (AEDT) to Conduct Environmental Modeling for FAA Actions Subject to NEPA, Section 5.3.2 User-defined profiles, FAA, September 12, 2016.

[5] MDOT MAA, Baltimore/Washington International Thurgood Marshall Airport Part 150 Update, Document of 2014 and 2019 Noise Exposure Maps, Section 4.2.9.

[6]U.S. Geological Survey, Multi-Resolution Land Characteristics Consortium (MRLC), National Land Cover Database (NLCD), U.S. Department of Interior, http://www.mrlc.gov/finddata.php.

[7] AEDT & Legacy Tools Comparisons, FAA, June 3rd, 2016.

Attachment 1:

FAA Non-Standard Noise Aircraft Substitution Letter

9/13/2016

U.S. Department of Transportation
Federal Aviation Administration

Office of Environment and Energy

800 Independence Ave., S.W.
Washington, D.C. 20591

9/13/2016

Andrew Brooks
Environmental Program Manager
Federal Aviation Administration
Eastern Regional Office
1 Aviation Plaza
Jamaica, NY 11434

Dear Andrew,

The Office of Environment and Energy (AEE) has received the memo dated August 24th, referencing the Environmental Assessment for Proposed Improvements 2016-2020 at Baltimore/Washington International Thurgood Marshall (BWI Marshall) Airport requesting approval for the user defined AEDT aircraft substitutions listed below.

Aircraft Type	Aircraft Code	Aircraft Description	Suggested AEDT ANP Substitution	AEE Requirement
Single Engine Prop (SEP)	C240	Cessna TTx Model T240	CNA20T	Concur
SEP	C77R	Cessna 177RG Cardinal	GASEPV	Concur
SEP	COL3	Cessna 350 Corvalis / Columbia 350	CNA206	Concur
SEP	COL4	Cessna 400 Corvalis / Columbia 400	CNA206	Concur
SEP	DA40	Diamond DA40 Diamond Star	GASEPV	Concur
SEP	EVOT	Lancair Evolution	GASEPV	Concur
SEP	PTS2	PITTS Special 2	GASEPV	Concur
SEP	S22T	Cirrus SR22 Turbo	COMSEP	Concur
SEP	Z42	Zlin Z42	GASEPV	Concur
Jet	CL35	Bombardier Challenger 350	CL600	Concur
Jet	**E50P**	**Embraer Phenom 100**	**CNA510**	**Use Default AEDT Aircraft Substitution**
Jet	**E55P**	**Embraer Phenom 300**	**CNA560E**	**Use Default AEDT Aircraft Substitution**
Jet	HDJT	Honda Jet	CNA510	Concur

AEE grants approval for all of the recommended substitutions **except** for the E50P and E55P, which are available as AEDT standard substitutions and do not require approval.

- The E50P is available as the Embraer 500 and is represented by the CNA510 ANP type.
- The E55P is available as the Embraer 550 and is represented by the CNA55B ANP type.

Please understand that this approval is limited to this particular Environmental Assessment for BWI Marshall Airport and that other non-standard AEDT inputs for additional projects at this or any other site will require separate approval.

Sincerely,

Natalia Sizov

for

Rebecca Cointin
Manager
AEE-100/Noise Division

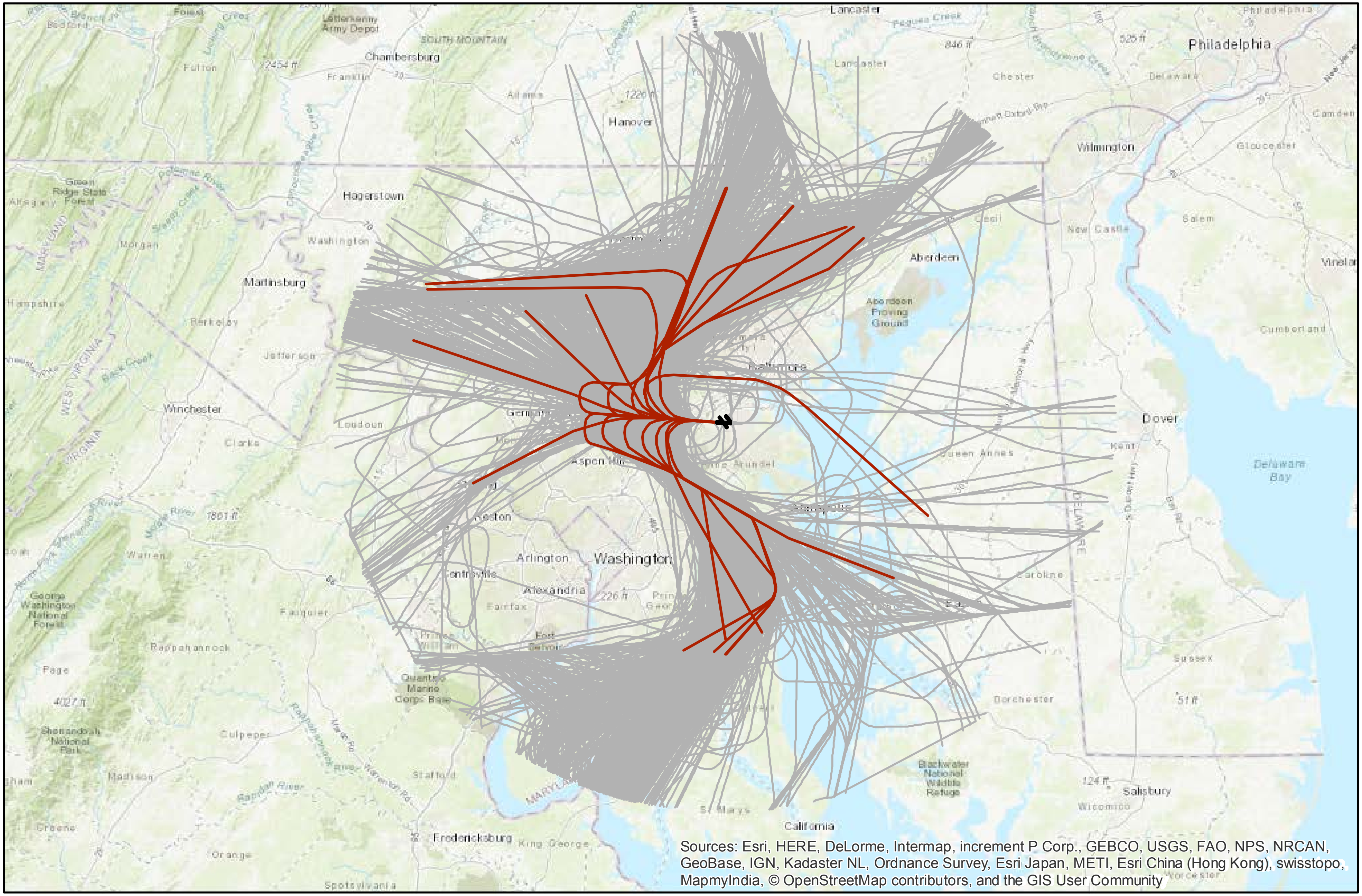
cc: Airports Contact (Jim Byers APP-400)

Attachment 2:

Flight Track Development Figures

BWI Marshall Airport Arrival Flight Tracks

HNTB



LEGEND

Radar Flight Tracks

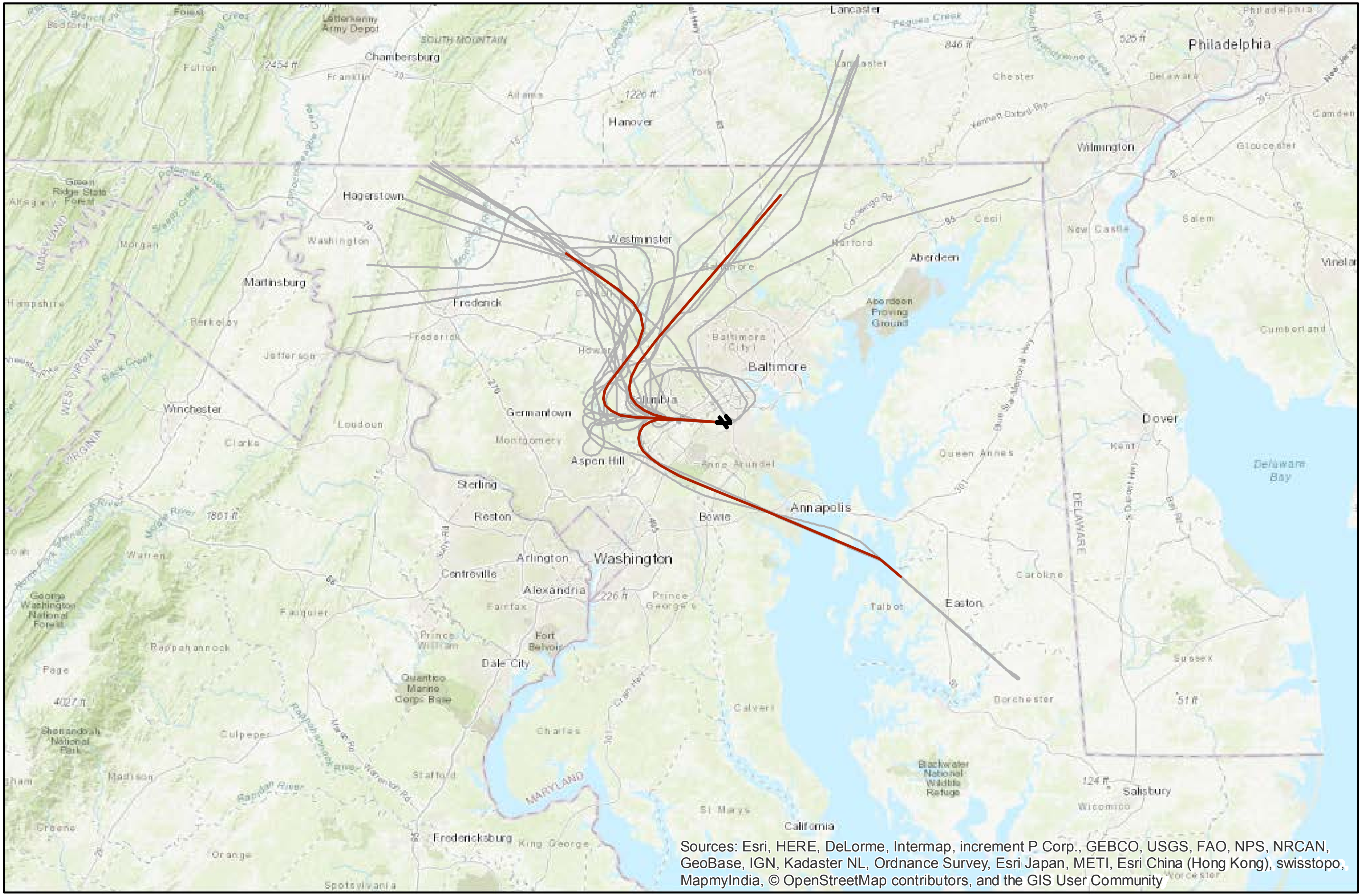
Modeled Flight Tracks

Arrival Flight Tracks

Figure 2-1: Commercial Jet Arrivals to Runway 10

N

0 3.5 7 14 Nautical Miles



LEGEND

Radar Flight Tracks

Modeled Flight Tracks

Arrival Flight Tracks

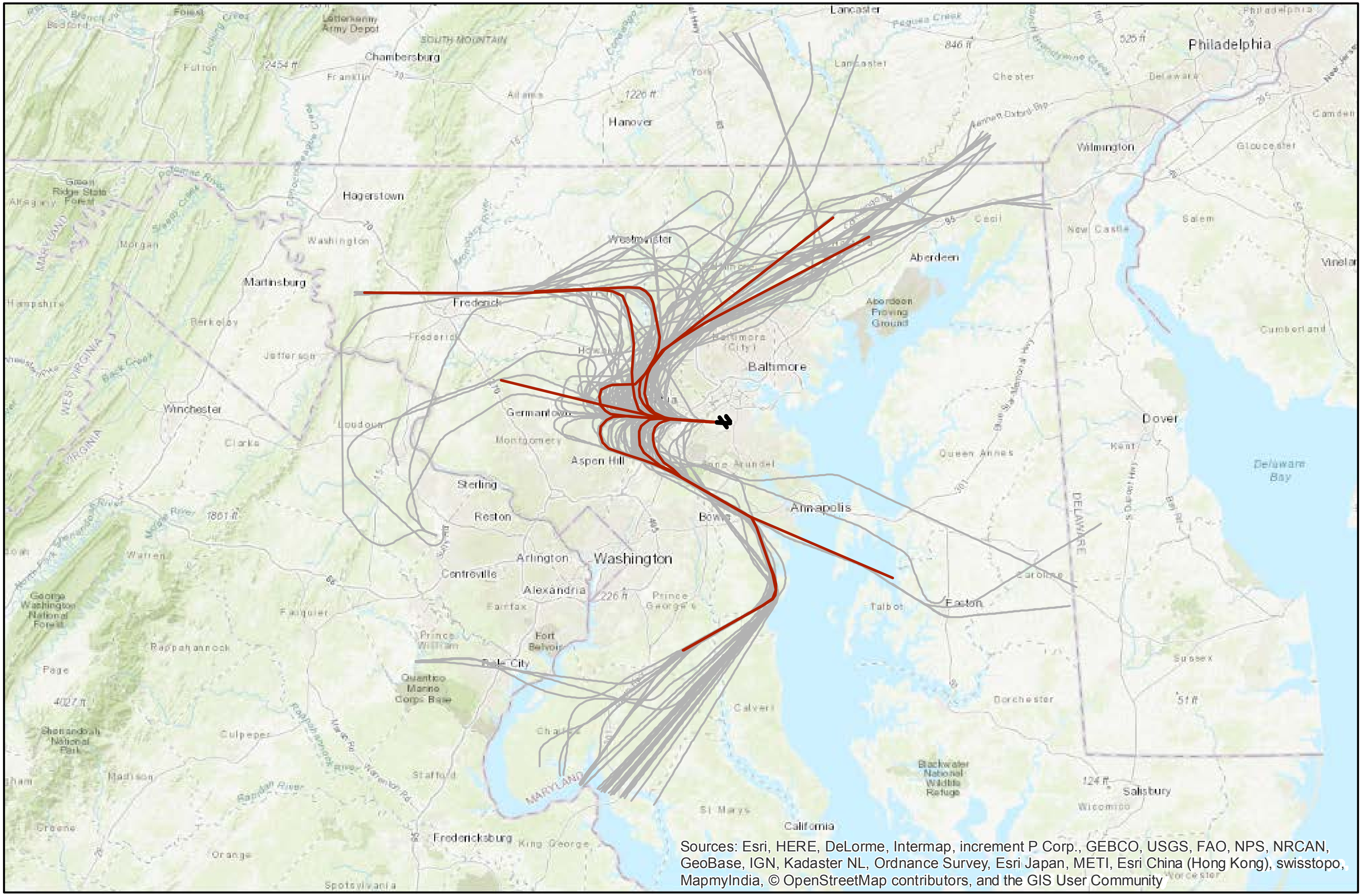
Figure 2-2: Commercial Propeller Arrivals to Runway 10

N

0 3.5 7 14 Nautical Miles

BWI Marshall Airport Arrival Flight Tracks

HNTB



LEGEND

Radar Flight Tracks

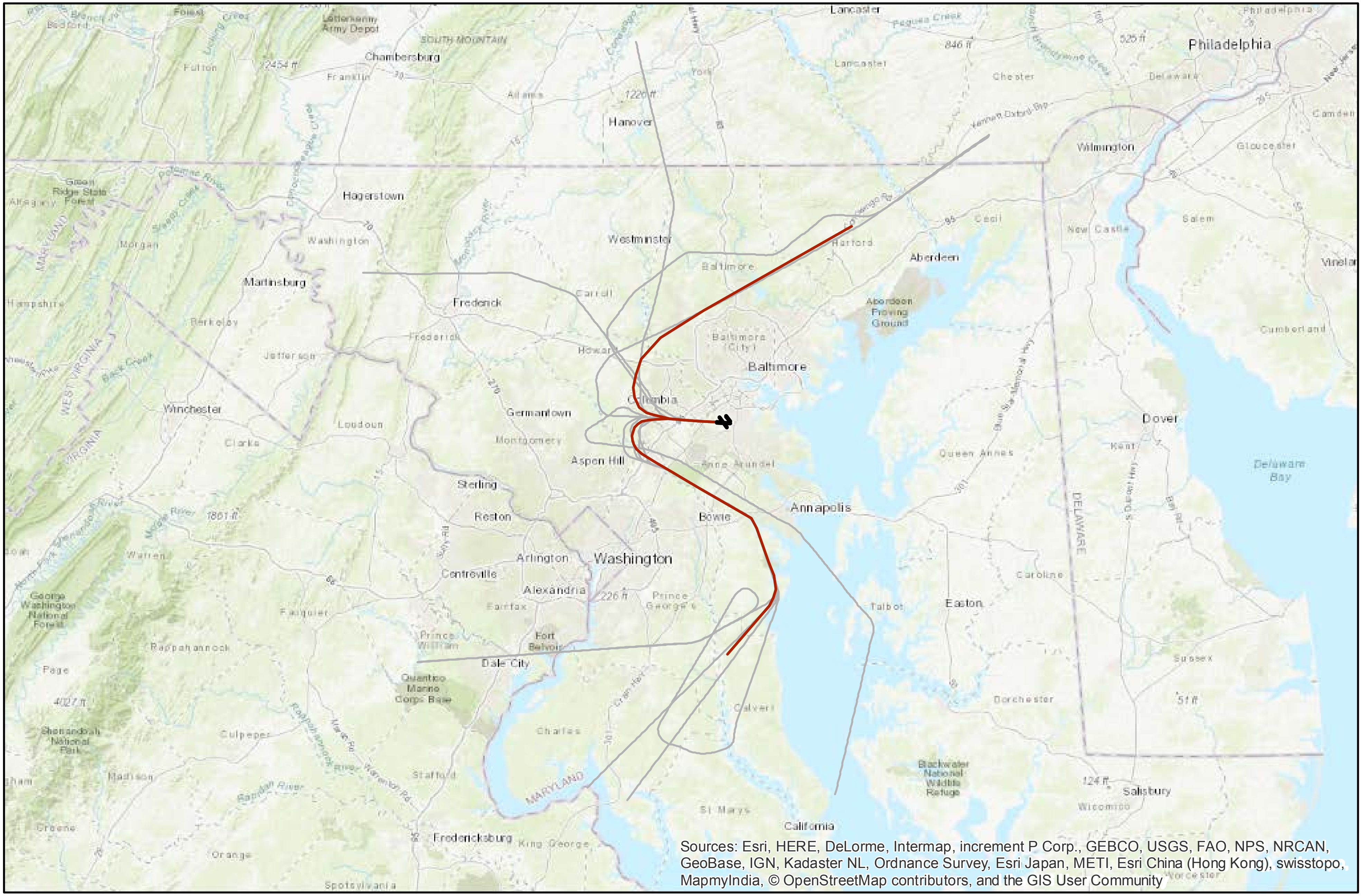
Modeled Flight Tracks

Arrival Flight Tracks

Figure 2-3: GA Jet Arrivals to Runway 10

N

0 3.5 7 14 Nautical Miles



LEGEND

Radar Flight Tracks

Modeled Flight Tracks

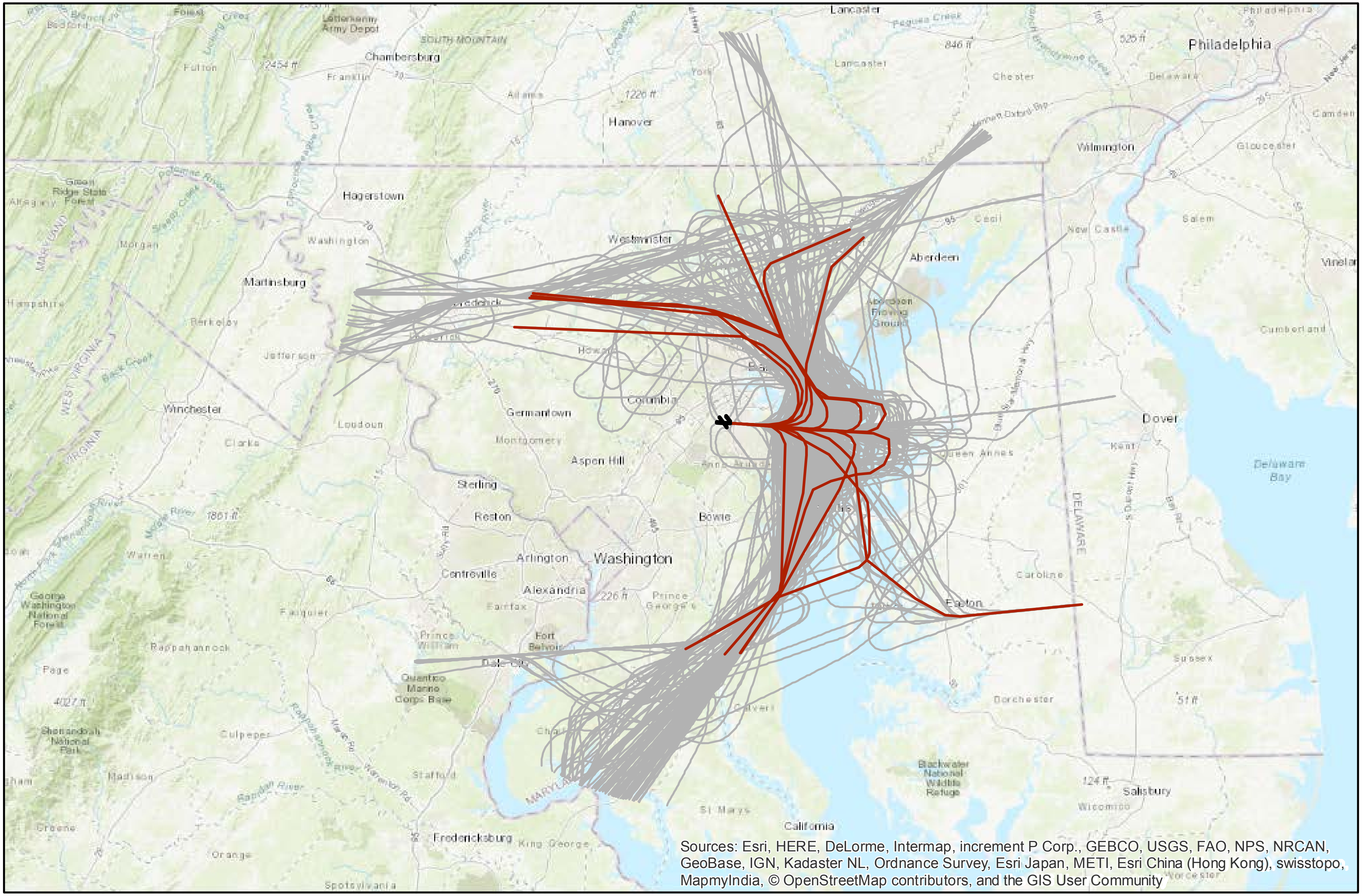
Arrival Flight Tracks

Figure 2-4: GA Propeller Arrivals to Runway 10

N

0 3.5 7 14 Nautical Miles

BWI Marshall Airport Arrival Flight Tracks



LEGEND

Radar Flight Tracks

Modeled Flight Tracks

Arrival Flight Tracks

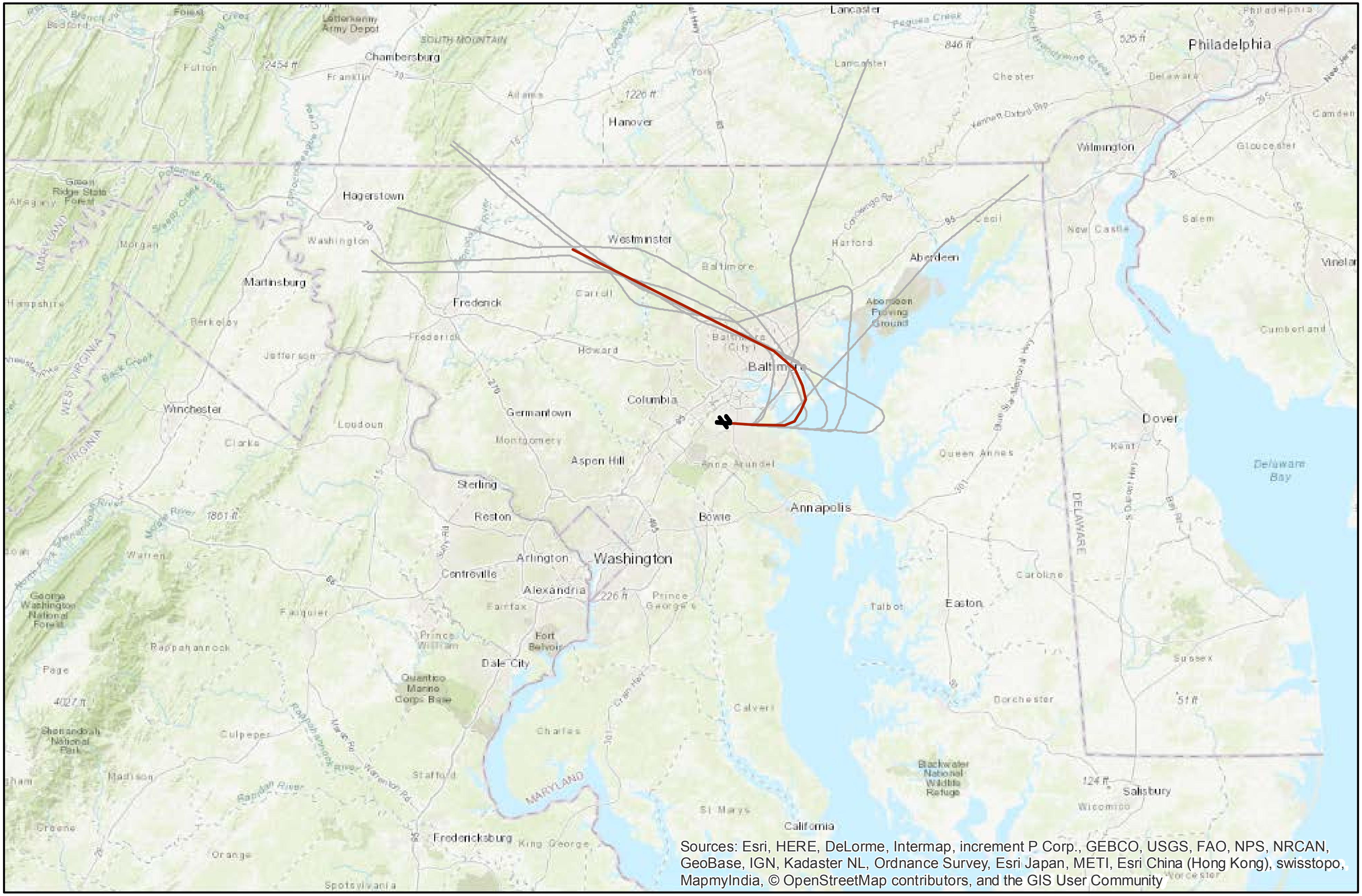
Figure 2-5: Commercial Jet Arrivals to Runway 28

N

0 3.5 7 14 Nautical Miles

BWI Marshall Airport Arrival Flight Tracks

HNTB



LEGEND

Radar Flight Tracks

Modeled Flight Tracks

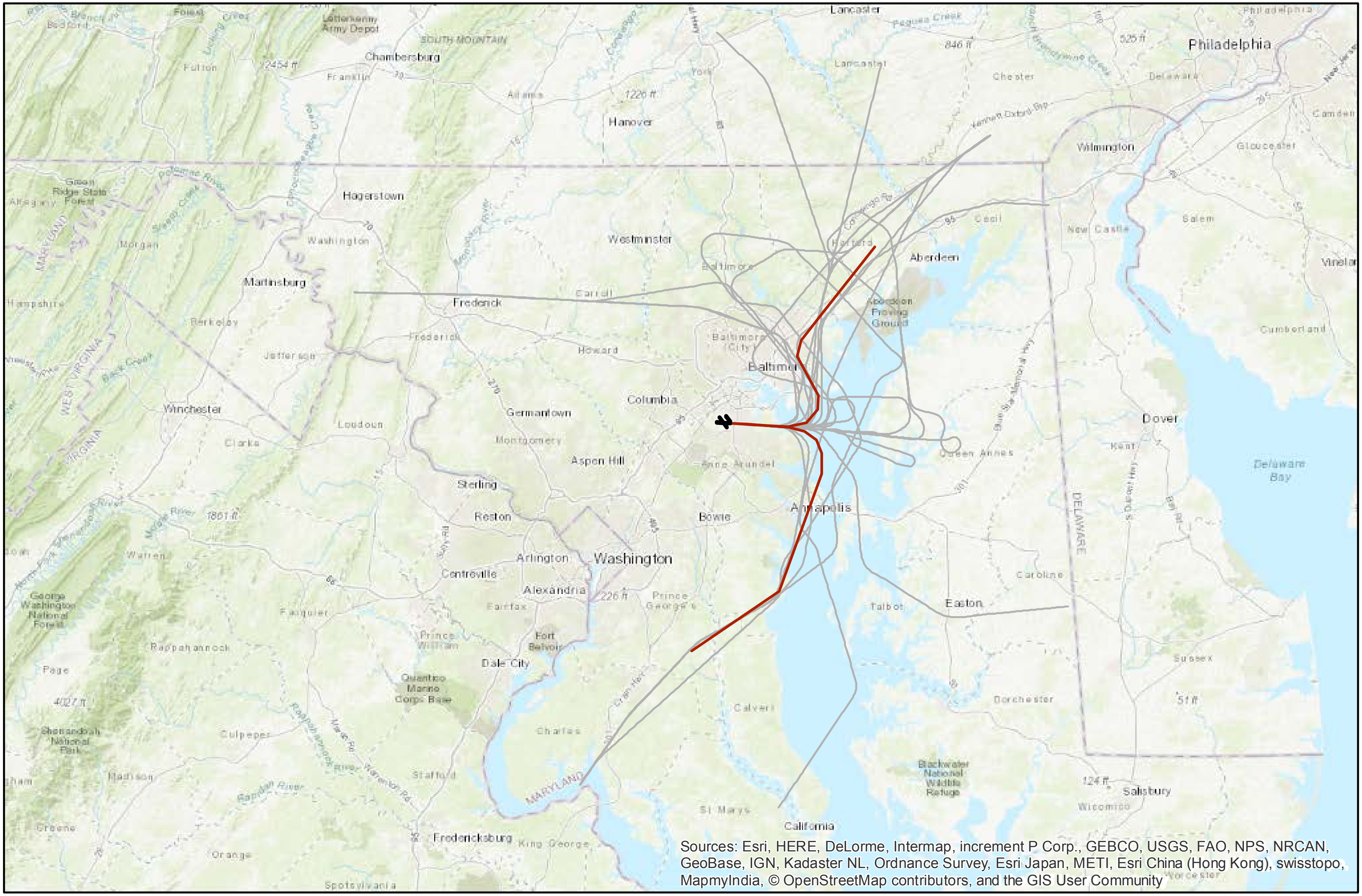
Arrival Flight Tracks

Figure 2-6: Commercial Propeller Arrivals to Runway 28

N

0 3.5 7 14 Nautical Miles

BWI Marshall Airport Arrival Flight Tracks



LEGEND

Radar Flight Tracks

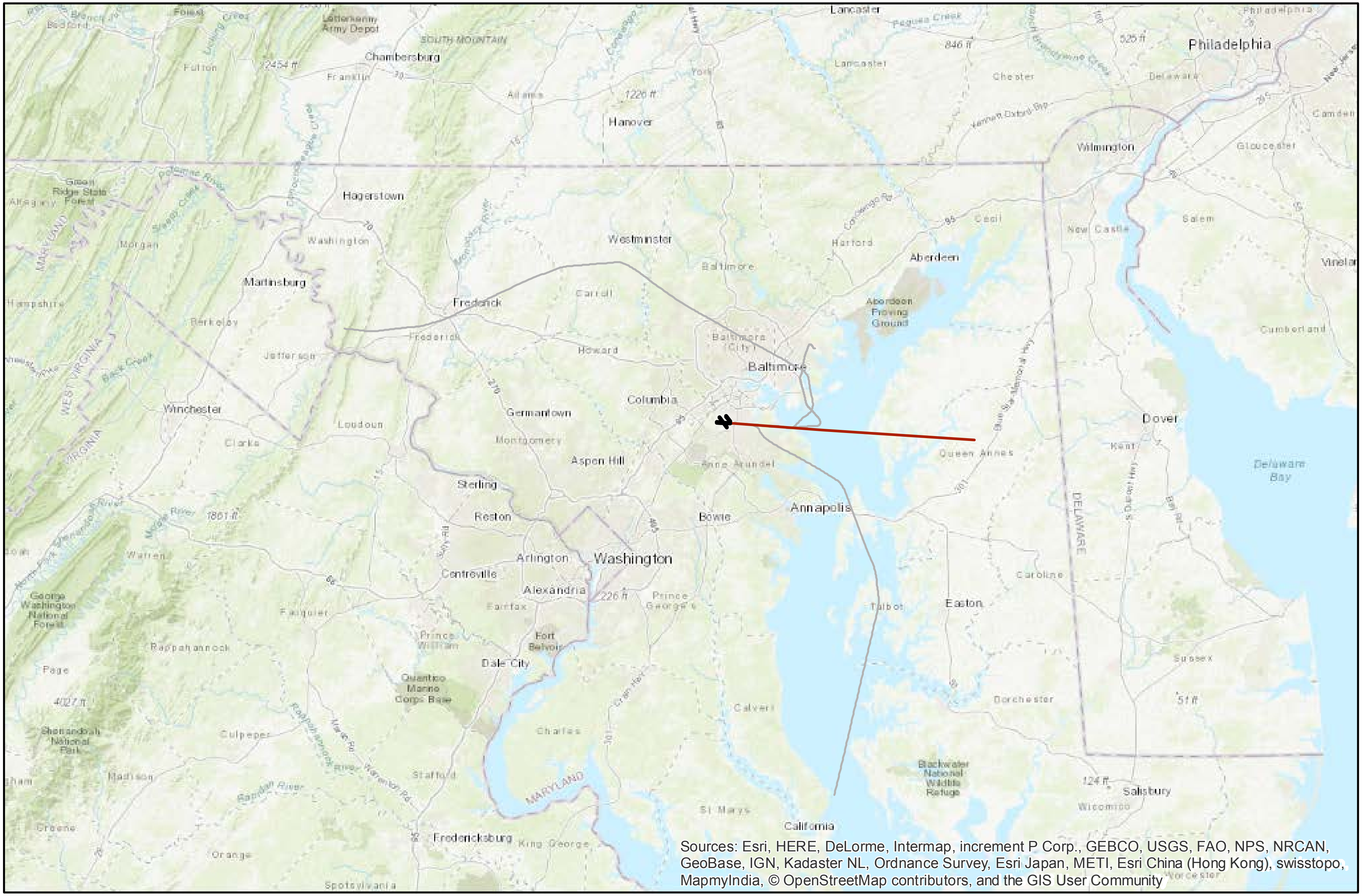
Modeled Flight Tracks

Arrival Flight Tracks

Figure 2-7: GA Jet Arrivals to Runway 28

N

0 3.5 7 14 Nautical Miles



LEGEND

Radar Flight Tracks

Modeled Flight Tracks

Arrival Flight Tracks

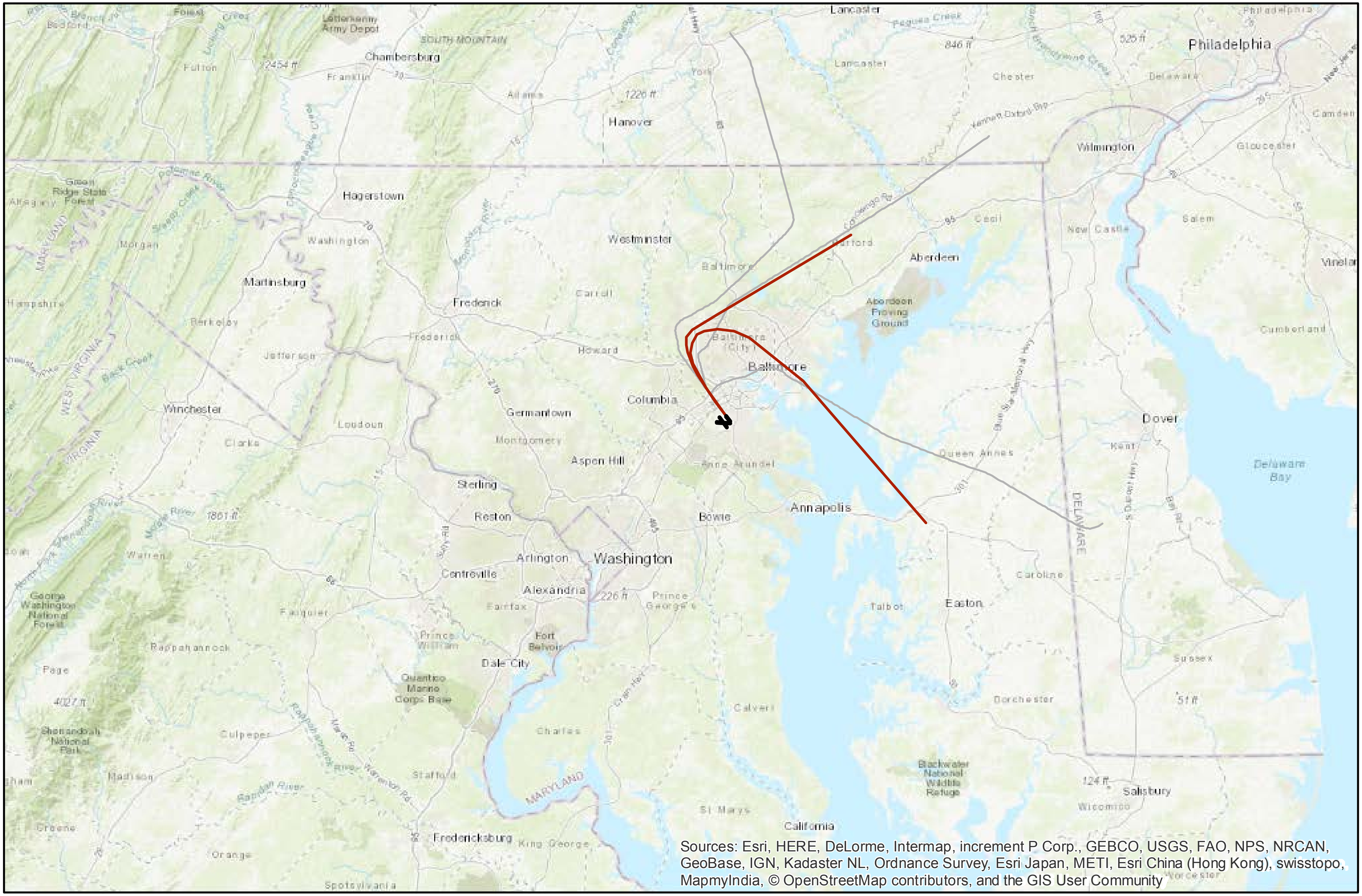
Figure 2-8: GA Propeller Arrivals to Runway 28

N

0 3.5 7 14 Nautical Miles

BWI Marshall Airport Arrival Flight Tracks

HNTB



LEGEND

Radar Flight Tracks

Modeled Flight Tracks

Arrival Flight Tracks

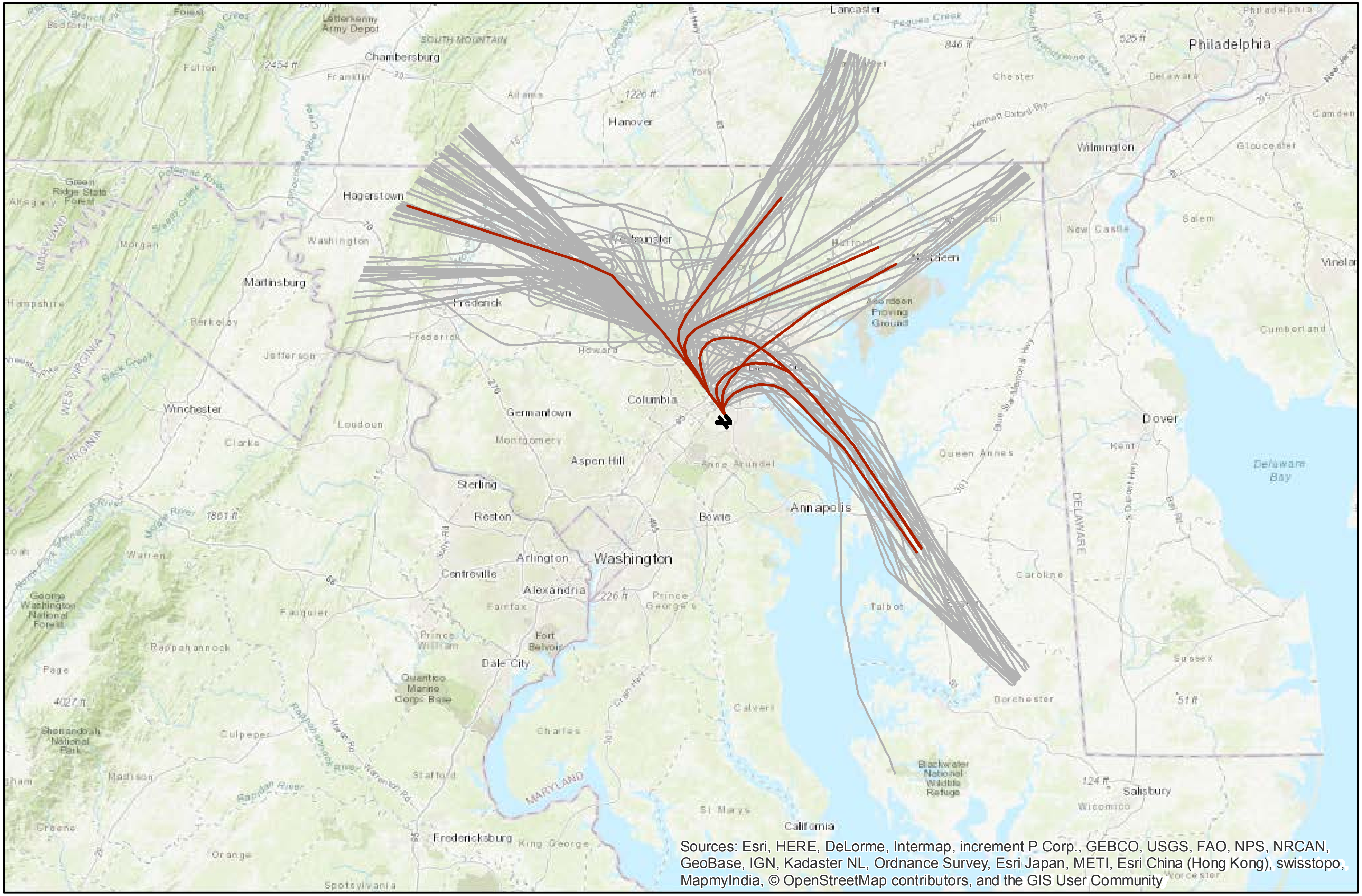
Figure 2-9: Commercial Jet Arrivals to Runway 15L

N

0 3.5 7 14 Nautical Miles

BWI Marshall Airport Arrival Flight Tracks

HNTB



LEGEND

- Radar Flight Tracks
- Modeled Flight Tracks

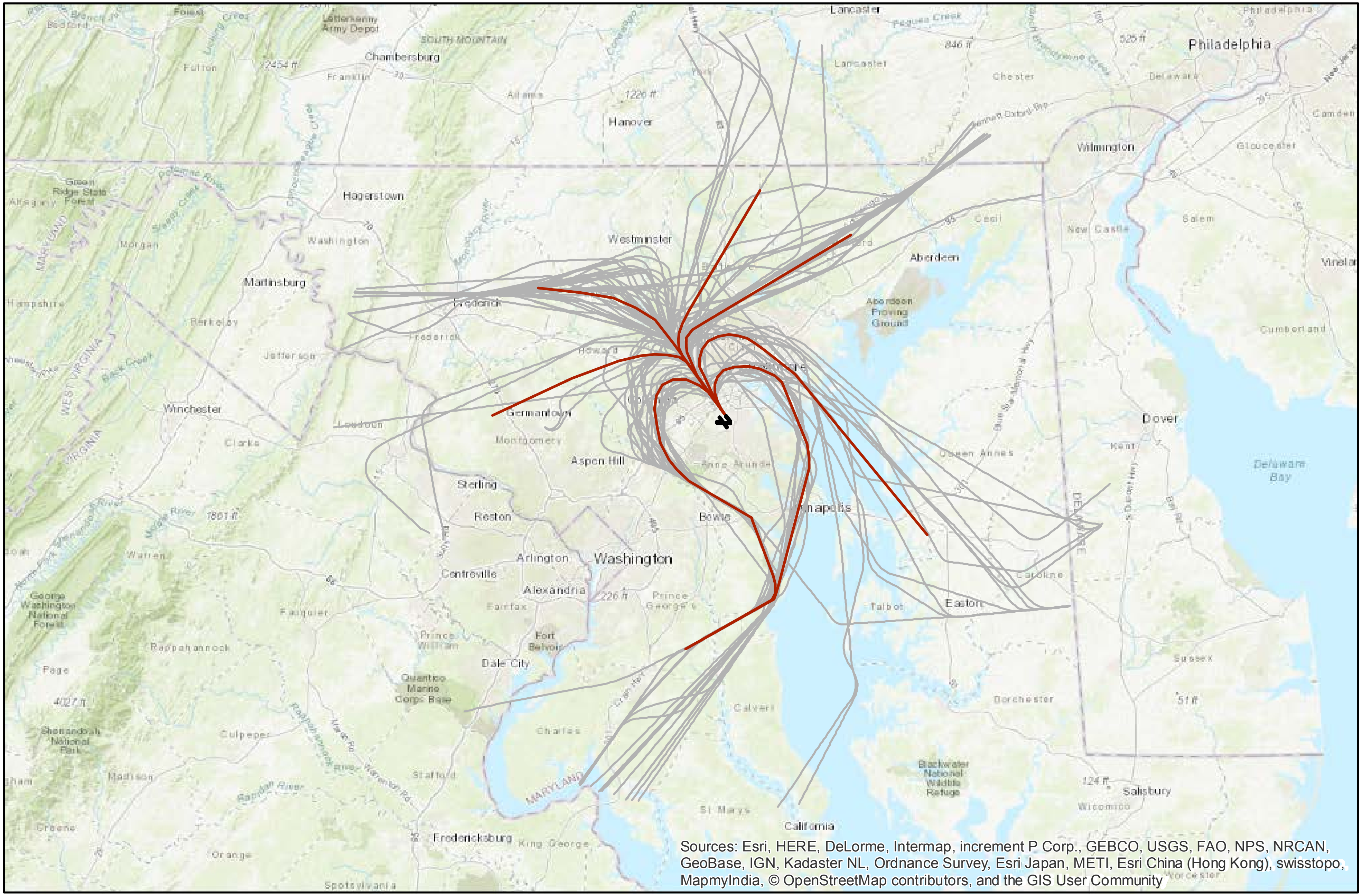
Arrival Flight Tracks

Figure 2-10: Commercial Propeller Arrivals to Runway 15L

N

0 3.5 7 14 Nautical Miles

HNTB



LEGEND

Radar Flight Tracks

Modeled Flight Tracks

Arrival Flight Tracks

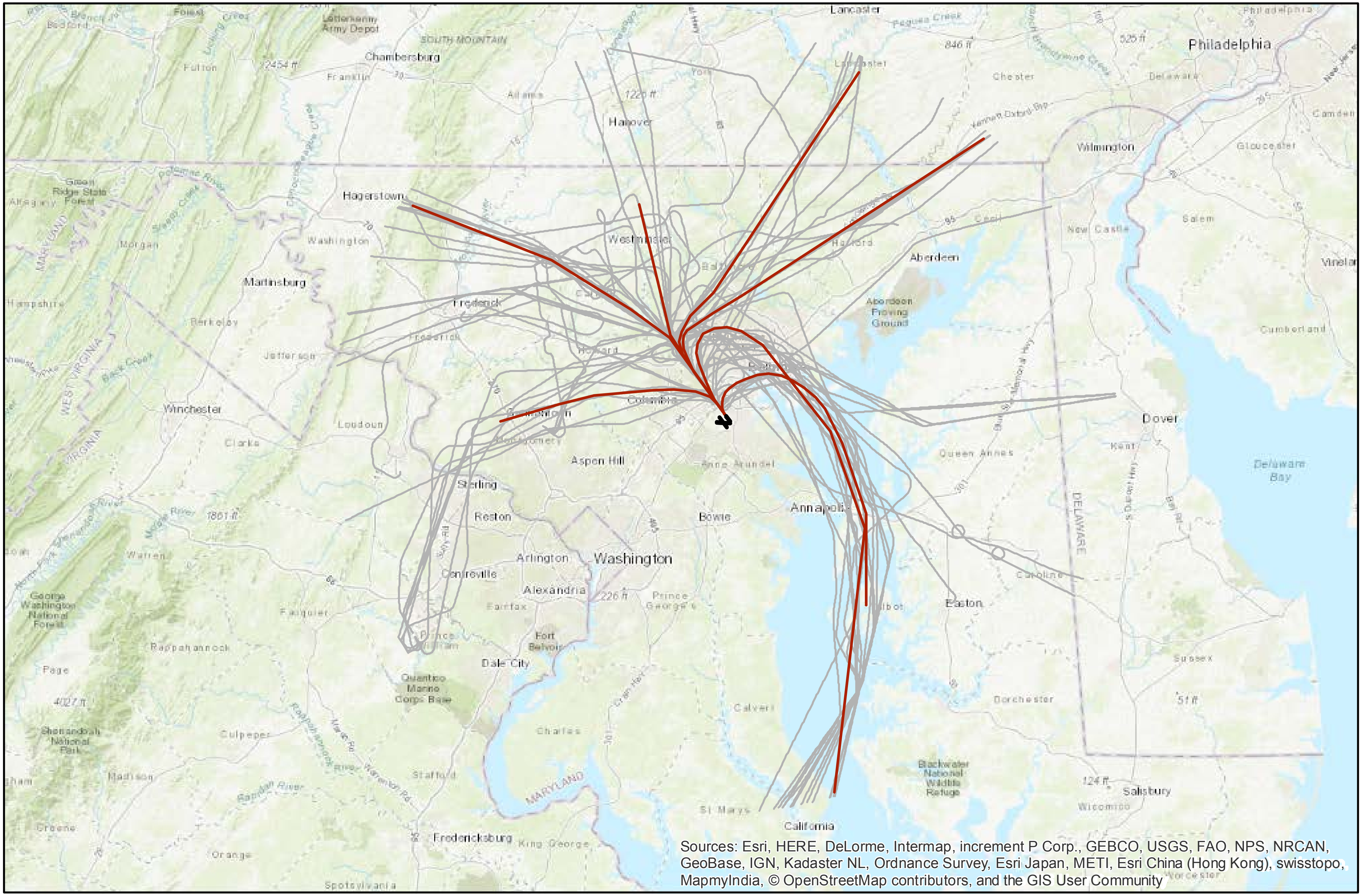
Figure 2-11: GA Jet Arrivals to Runway 15L

N

0 3.5 7 14 Nautical Miles

BWI Marshall Airport Arrival Flight Tracks

HNTB



LEGEND

- Radar Flight Tracks
- Modeled Flight Tracks

Arrival Flight Tracks

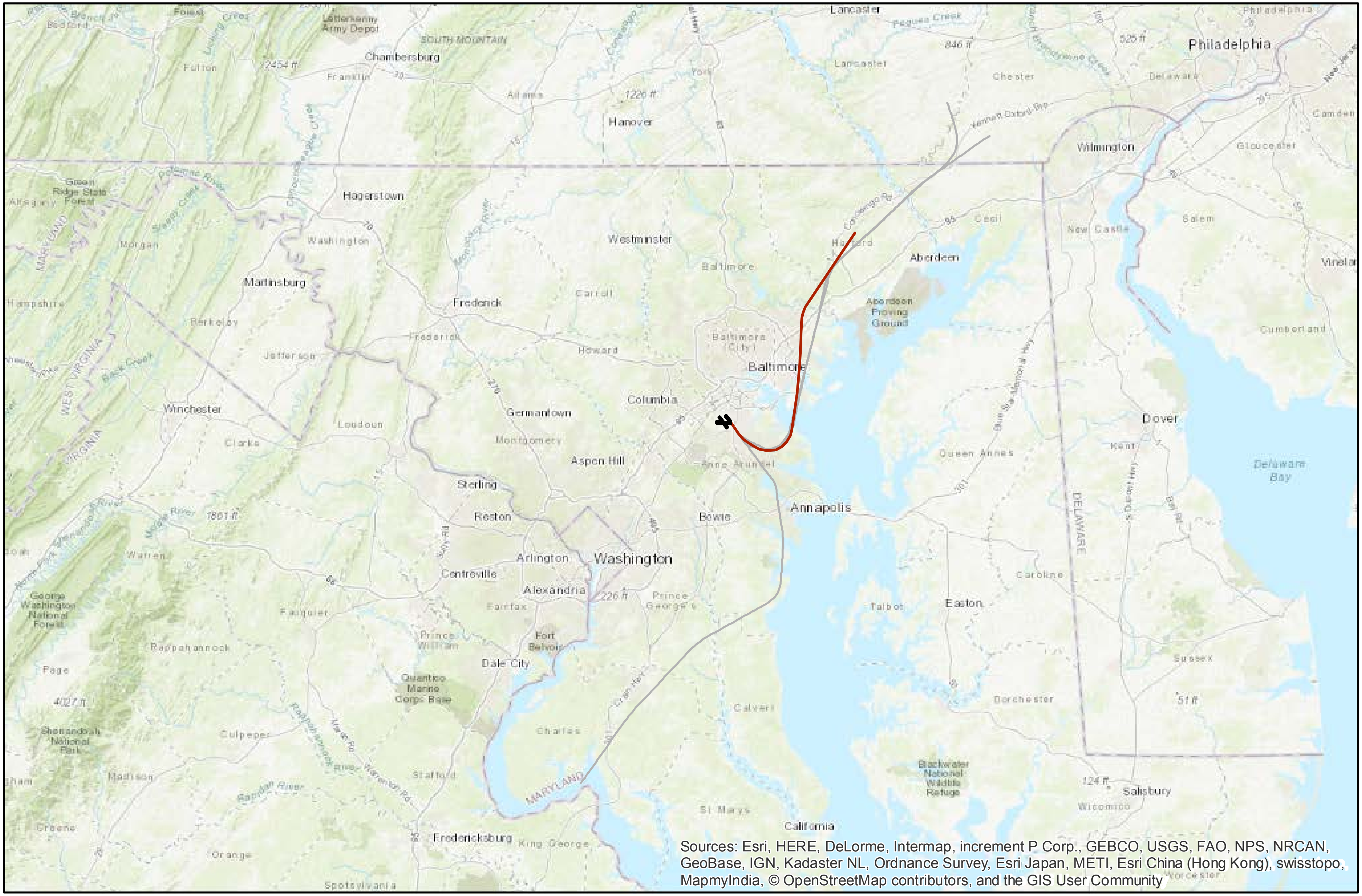
Figure 2-12: GA Propeller Arrivals to Runway 15L

N

0 3.5 7 14 Nautical Miles

BWI Marshall Airport Arrival Flight Tracks

HNTB



LEGEND

Radar Flight Tracks

Modeled Flight Tracks

Arrival Flight Tracks

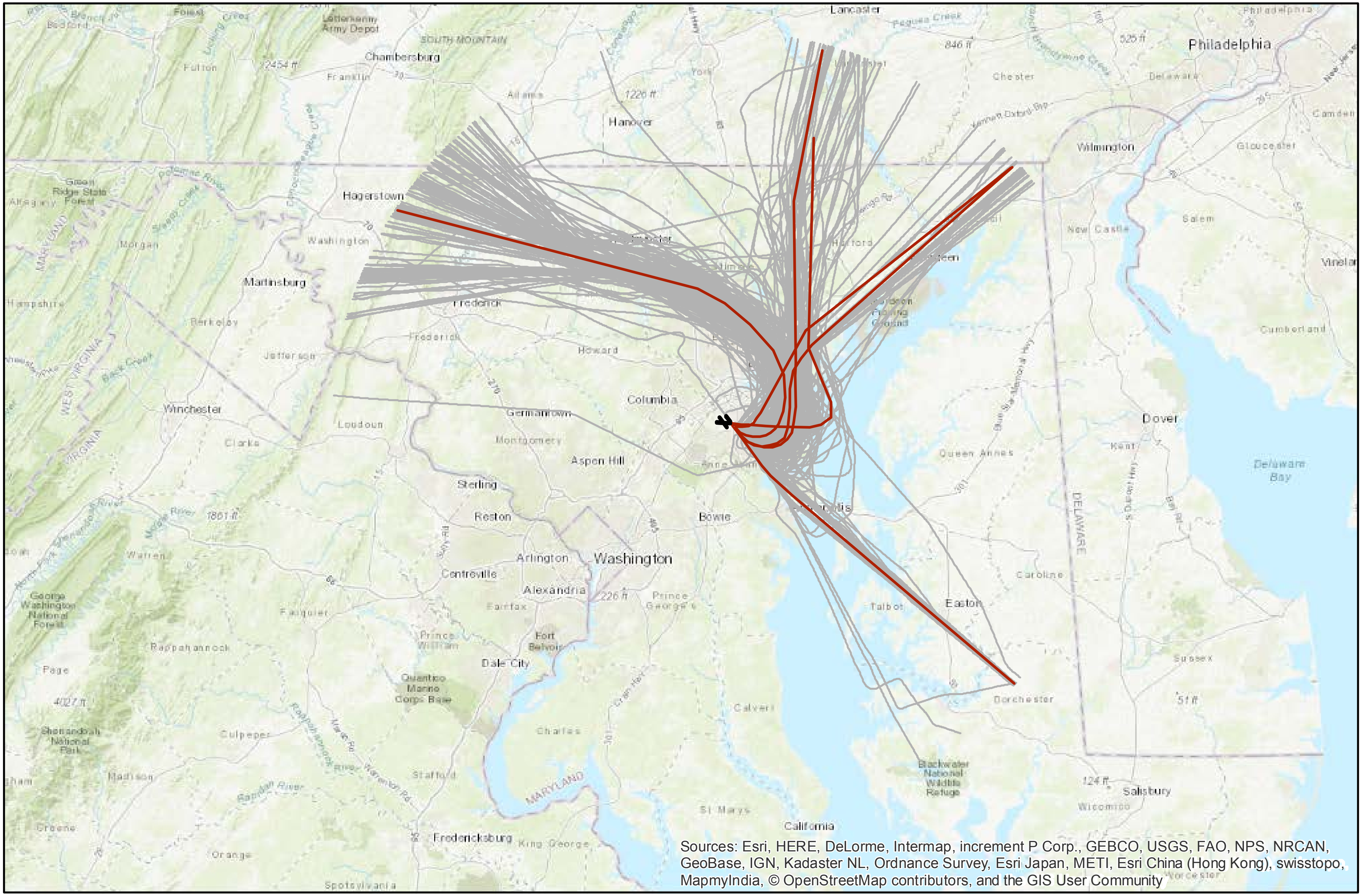
Figure 2-13: Commercial Jet Arrivals to Runway 33R

N

0 3.5 7 14 Nautical Miles

BWI Marshall Airport Arrival Flight Tracks

HNTB



LEGEND

Radar Flight Tracks

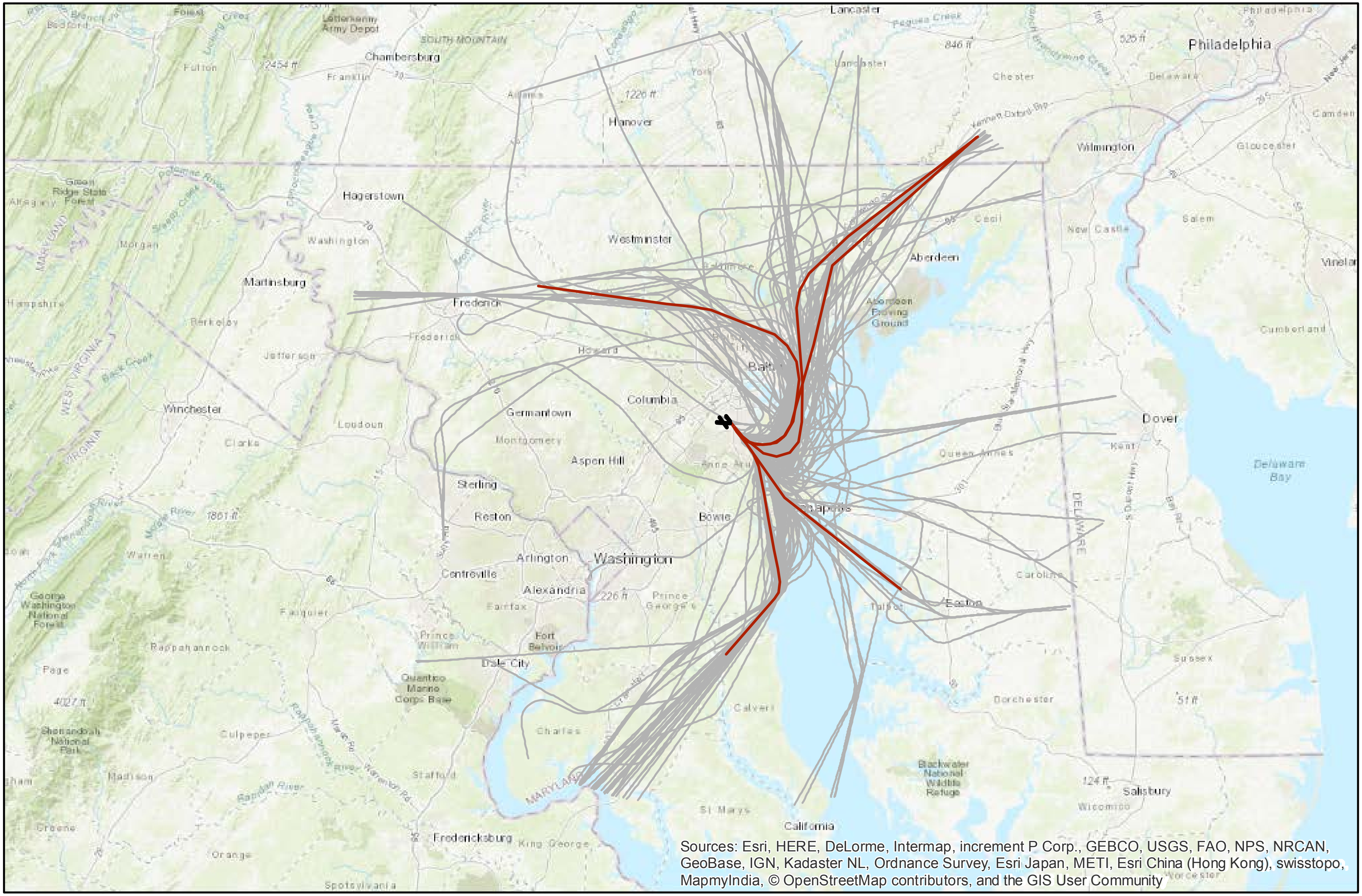
Modeled Flight Tracks

Arrival Flight Tracks

Figure 2-14: Commercial Propeller Arrivals to Runway 33R

N

0 3.5 7 14 Nautical Miles



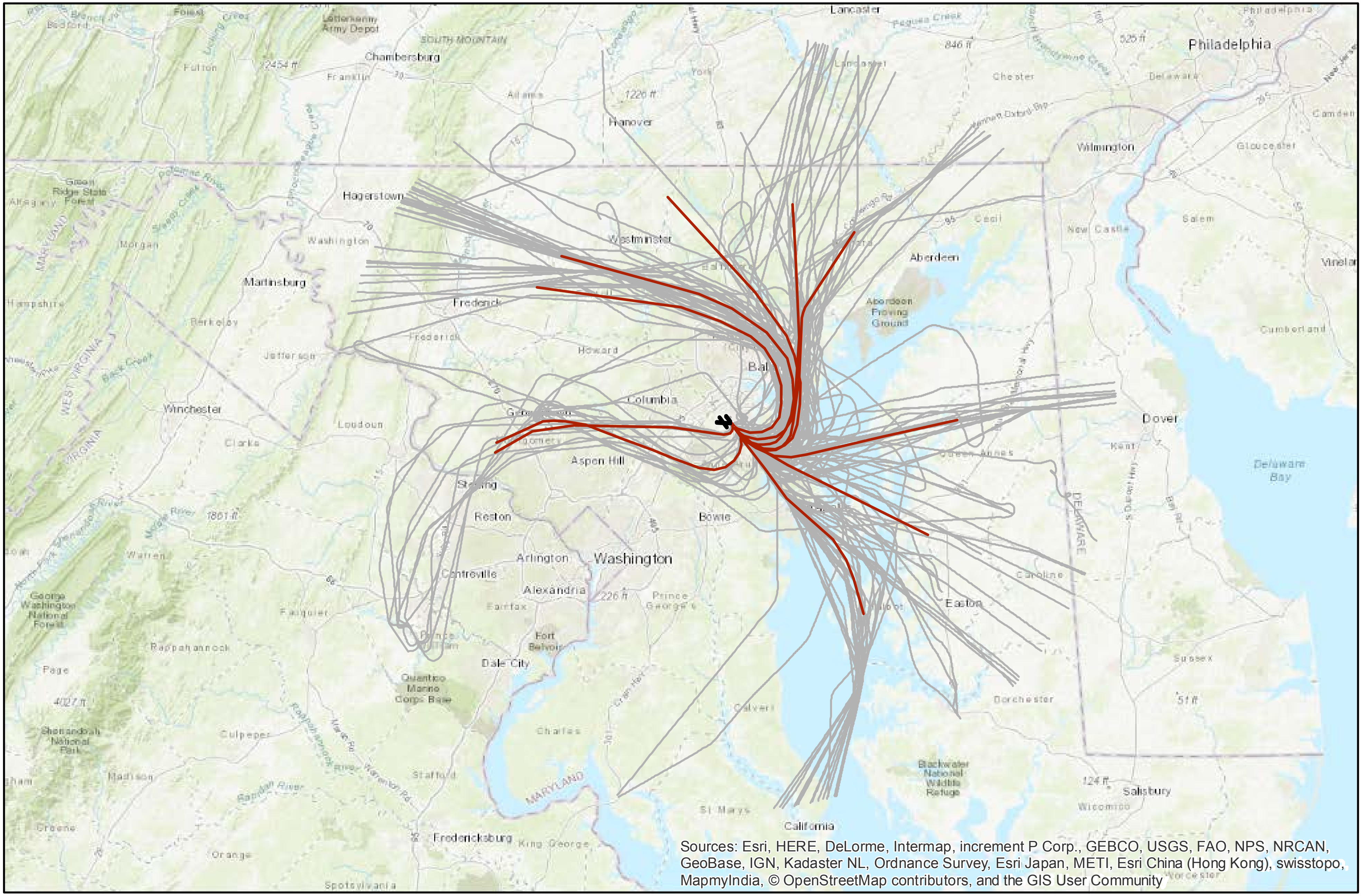
LEGEND

Radar Flight Tracks
Modeled Flight Tracks

Arrival Flight Tracks
Figure 2-15: GA Jet Arrivals to Runway 33R

BWI Marshall Airport Arrival Flight Tracks

HNTB



LEGEND

Radar Flight Tracks

Modeled Flight Tracks

Arrival Flight Tracks

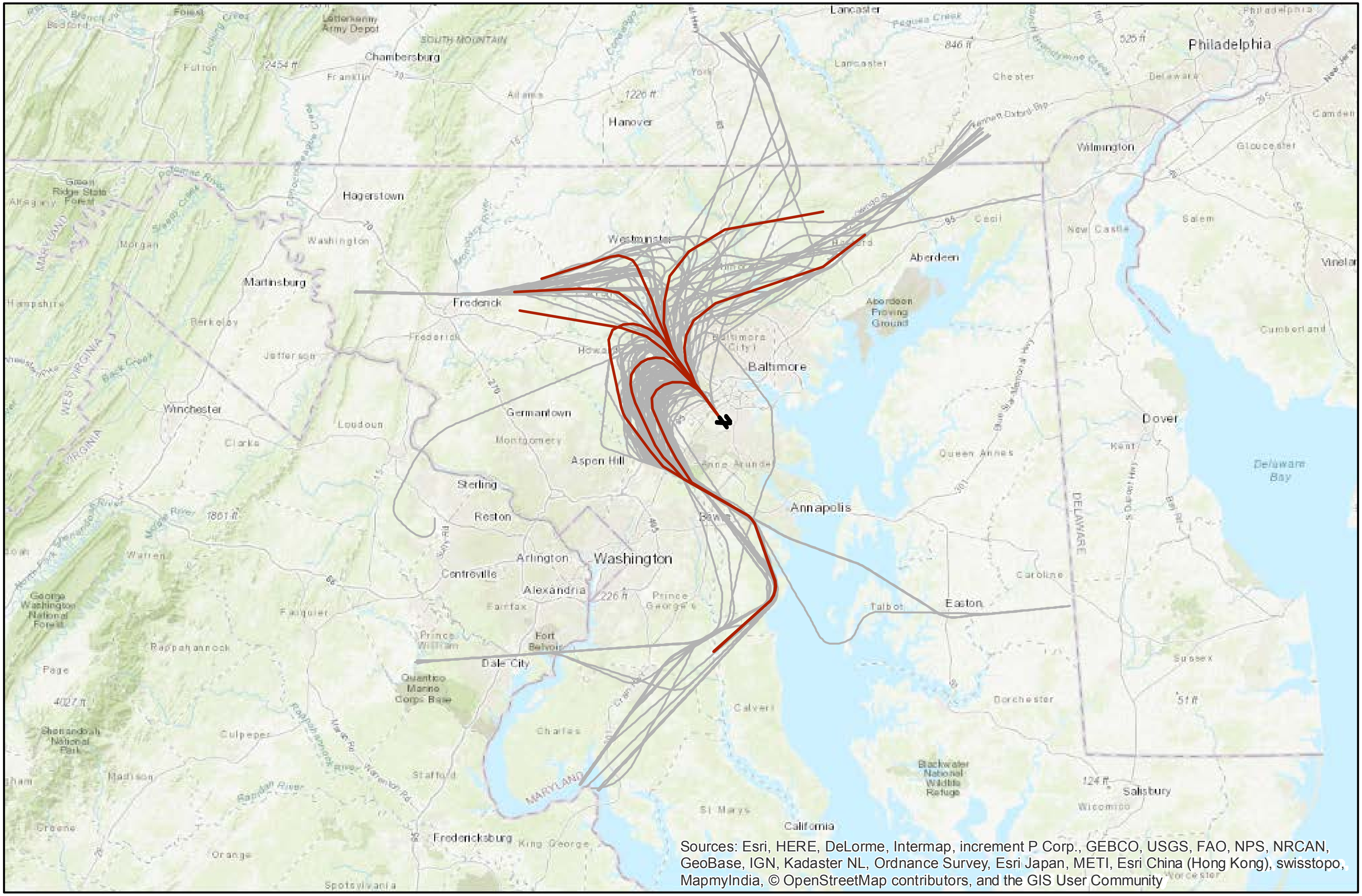
Figure 2-16: GA Propeller Arrivals to Runway 33R

N

0 3.5 7 14 Nautical Miles

BWI Marshall Airport Arrival Flight Tracks

HNTB



LEGEND

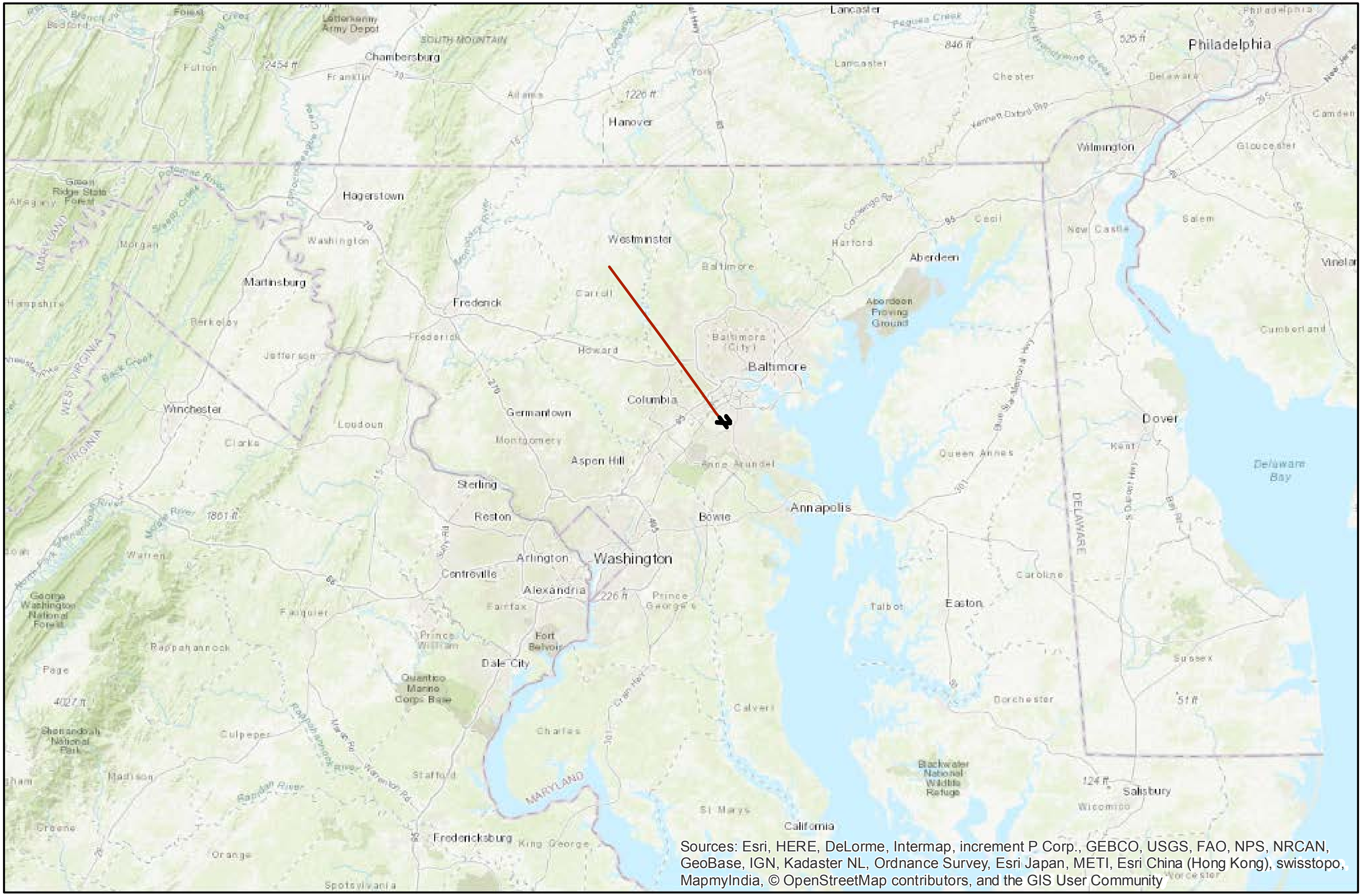
- Radar Flight Tracks
- Modeled Flight Tracks

Arrival Flight Tracks

Figure 2-17: Commercial Jet Arrivals to Runway 15R

N

0 3.5 7 14 Nautical Miles



LEGEND

Radar Flight Tracks

Modeled Flight Tracks

Arrival Flight Tracks

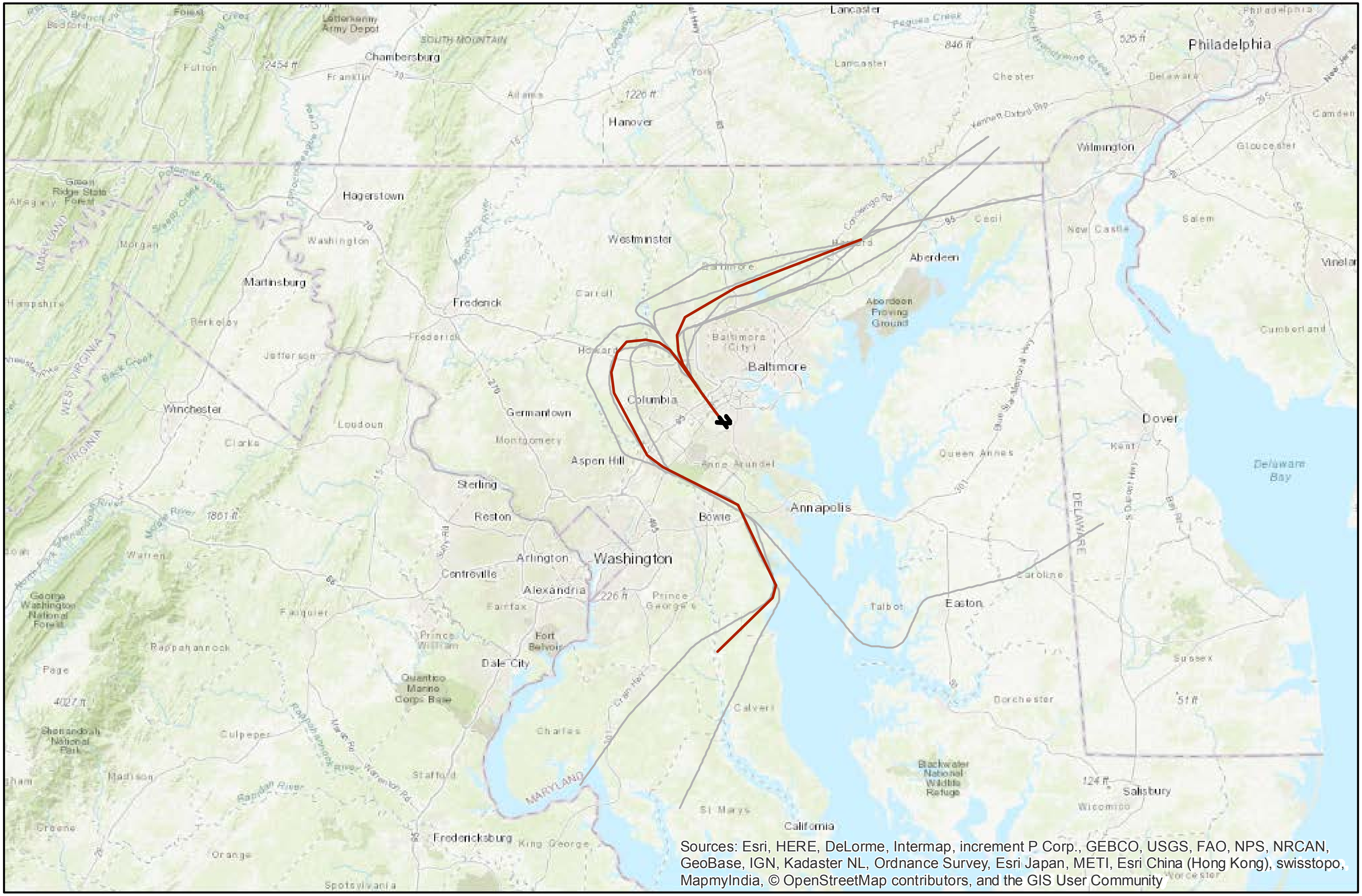
Figure 2-18: Commercial Propeller Arrivals to Runway 15R

N

Nautical Miles
0 3.5 7 14

BWI Marshall Airport Arrival Flight Tracks

HNTB



LEGEND

Radar Flight Tracks

Modeled Flight Tracks

Arrival Flight Tracks

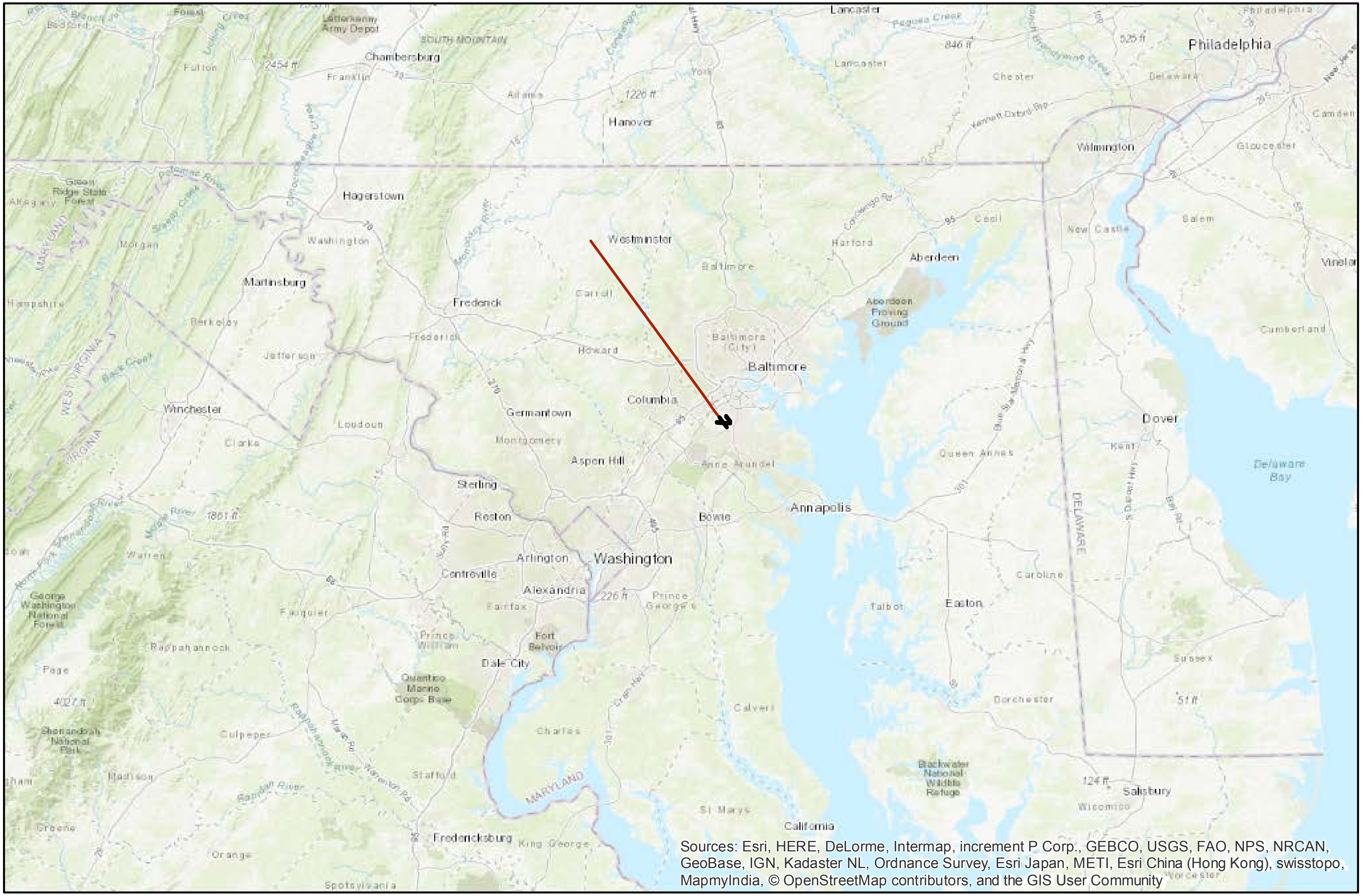
Figure 2-19: GA Jet Arrivals to Runway 15R

N

0 3.5 7 14 Nautical Miles

BWI Marshall Airport Arrival Flight Tracks

HNTB



LEGEND

Radar Flight Tracks

Modeled Flight Tracks

Arrival Flight Tracks

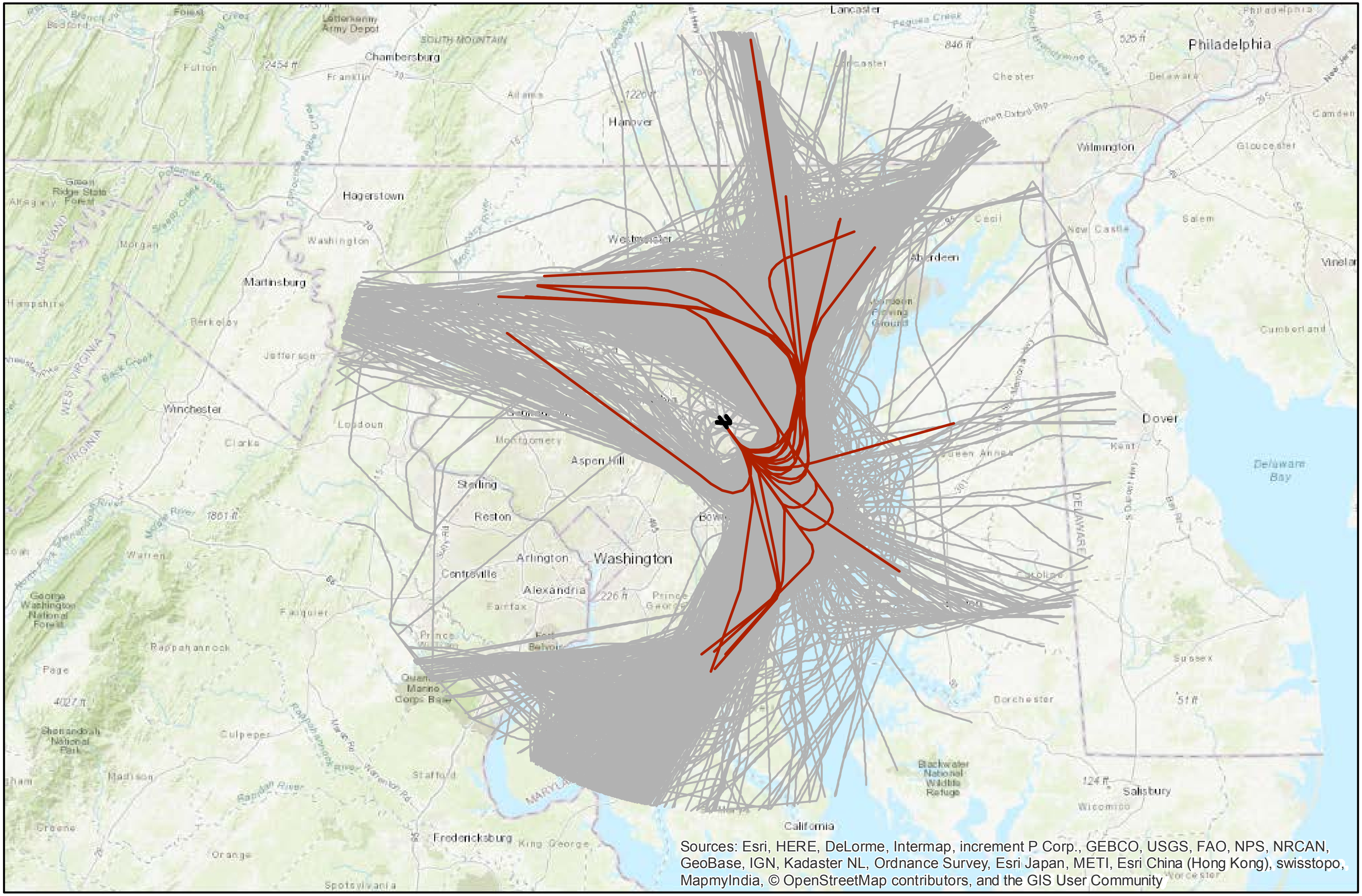
Figure 2-20: GA Propeller Arrivals to Runway 15R

N

0 3.5 7 14 Nautical Miles

BWI Marshall Airport Arrival Flight Tracks

HNTB



LEGEND

- Radar Flight Tracks
- Modeled Flight Tracks

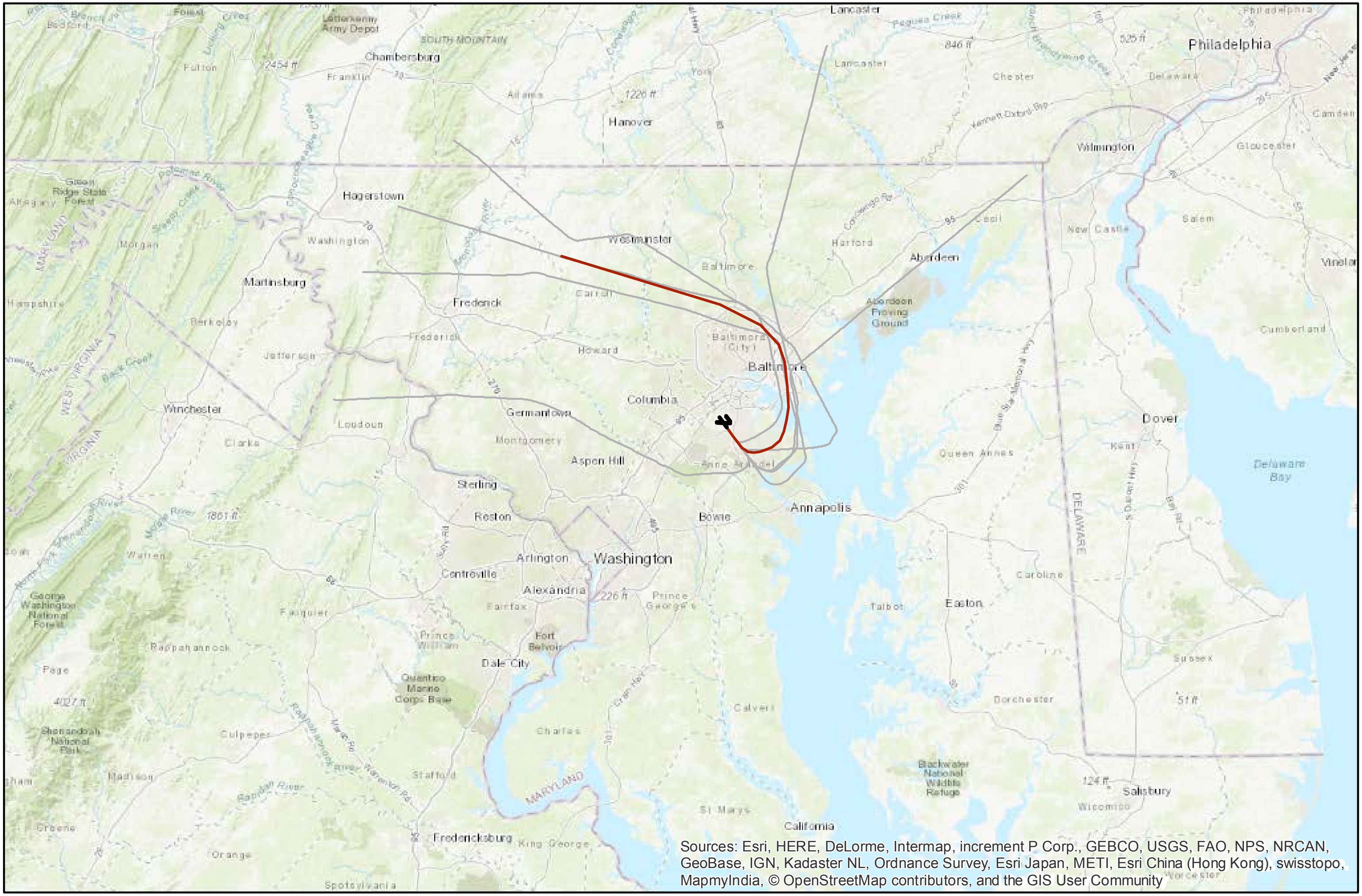
Arrival Flight Tracks
Figure 2-21: Commercial Jet Arrivals to Runway 33L

N

0 3.5 7 14 Nautical Miles

BWI Marshall Airport Arrival Flight Tracks

HNTB



LEGEND

- Radar Flight Tracks
- Modeled Flight Tracks

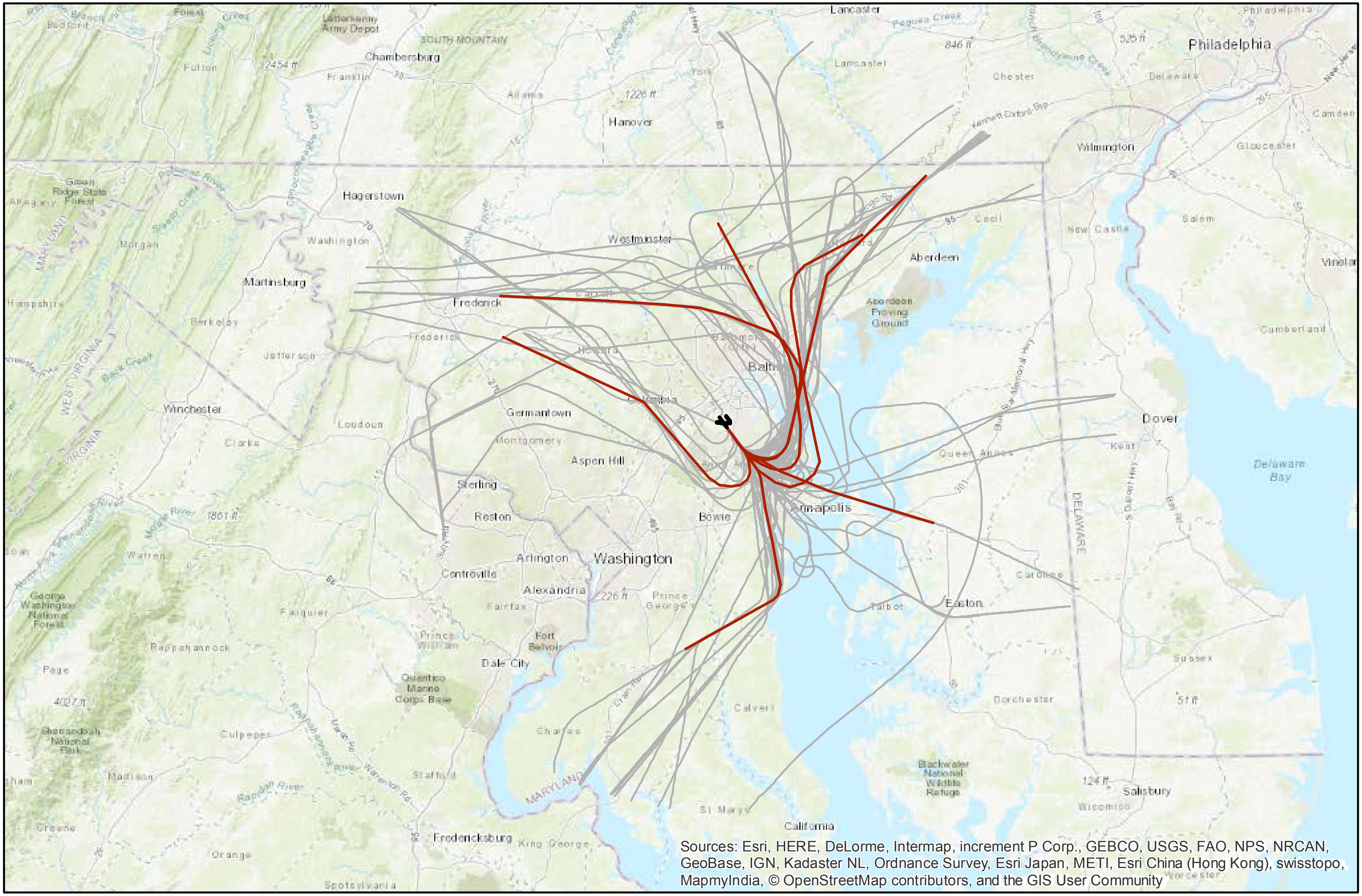
Arrival Flight Tracks

Figure 2-22: Commercial Propeller Arrivals to Runway 33L

N

Nautical Miles: 0, 3.5, 7, 14

BWI Marshall Airport Arrival Flight Tracks



LEGEND

Radar Flight Tracks

Modeled Flight Tracks

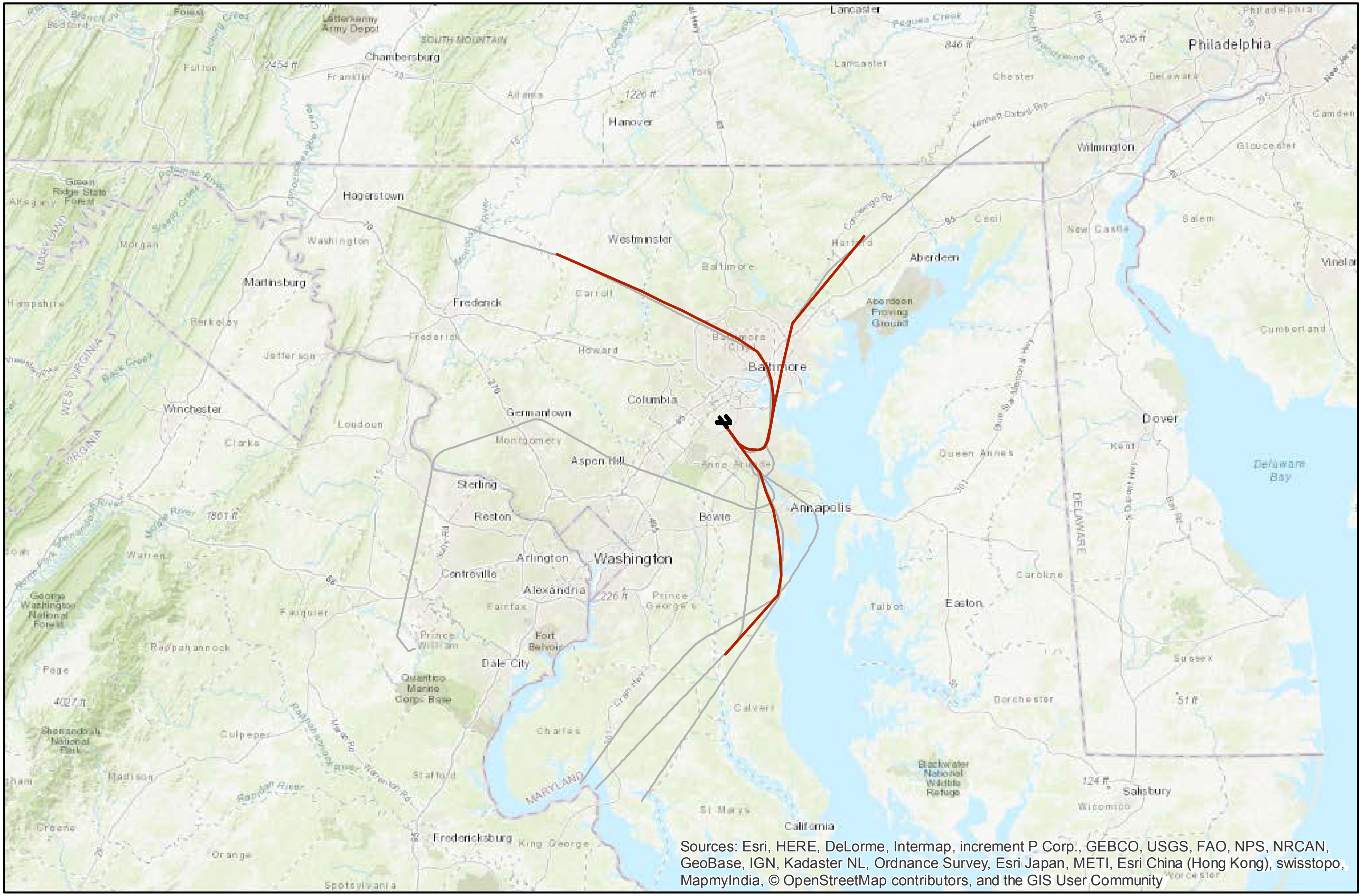
Arrival Flight Tracks

Figure 2-23: GA Jet Arrivals to Runway 33L

N

0 3.5 7 14 Nautical Miles

BWI Marshall Airport Arrival Flight Tracks



LEGEND

Radar Flight Tracks

Modeled Flight Tracks

Arrival Flight Tracks

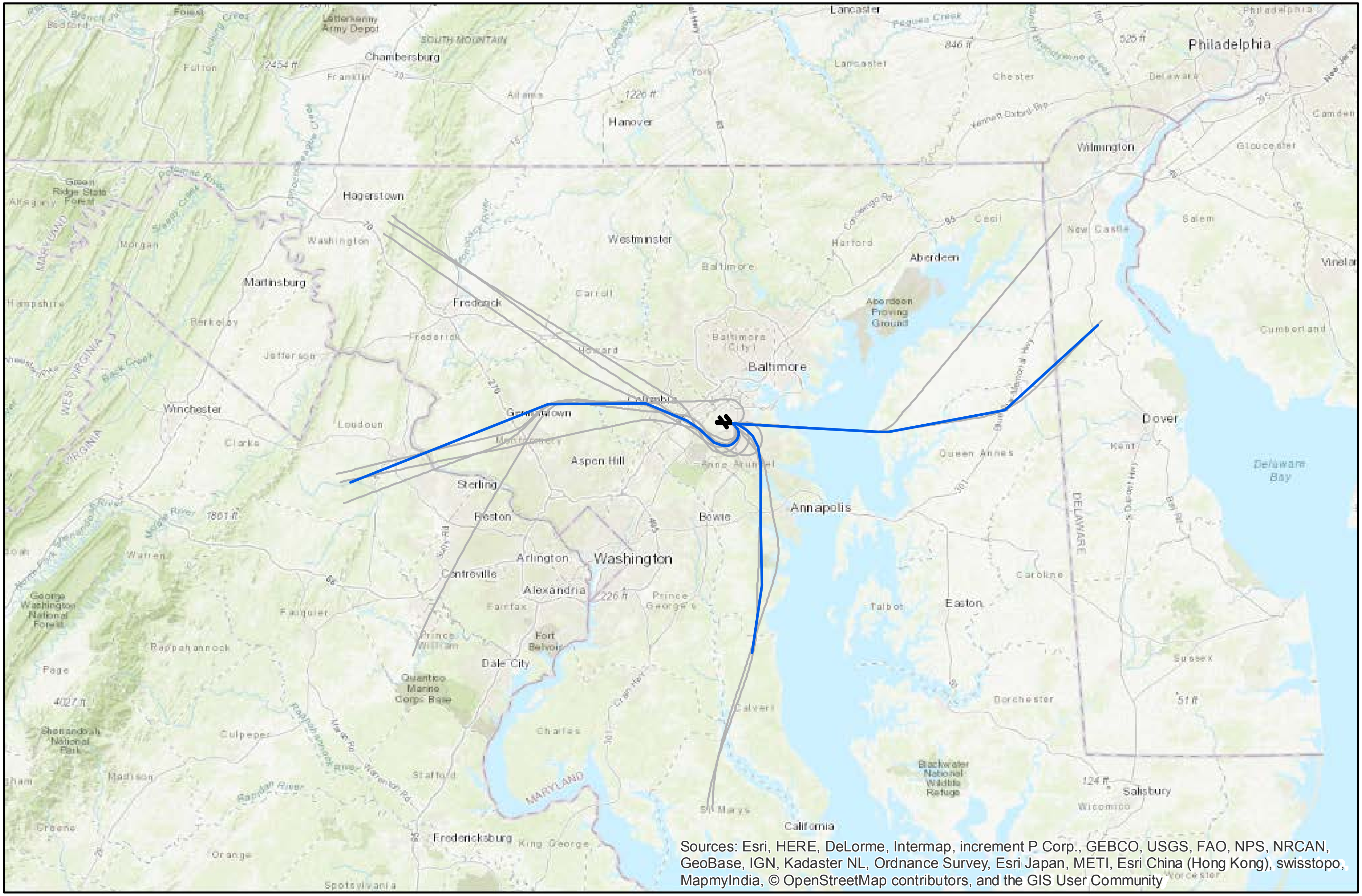
Figure 2-24: GA Propeller Arrivals to Runway 33L

N

0 3.5 7 14 Nautical Miles

BWI Marshall Airport Arrival Flight Tracks

HNTB



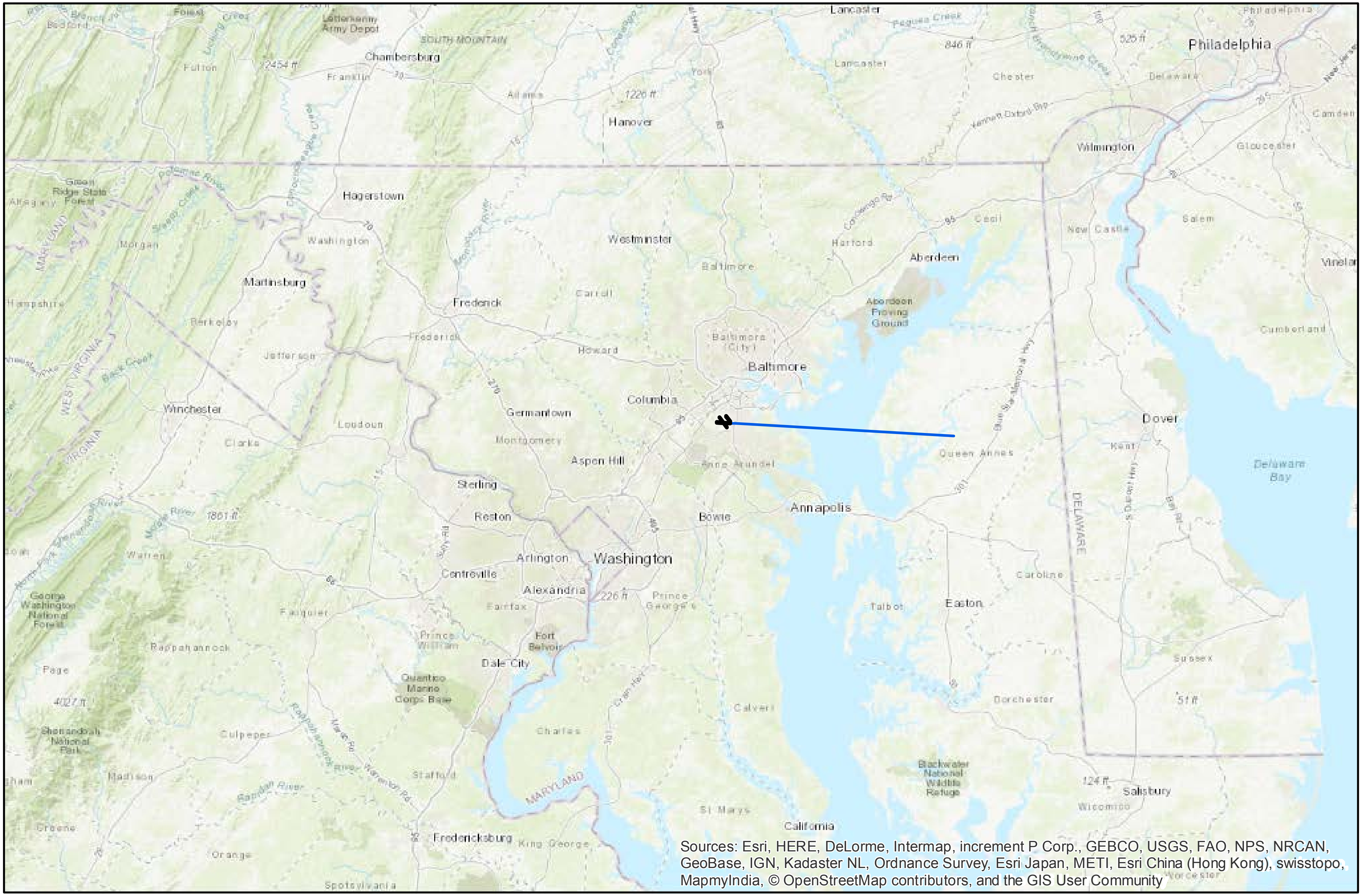
LEGEND

Radar Flight Tracks
Modeled Flight Tracks

Departure Flight Tracks
Figure 2-25: Commercial Jet Departures from Runway 10

N

0 3.5 7 14 Nautical Miles



LEGEND

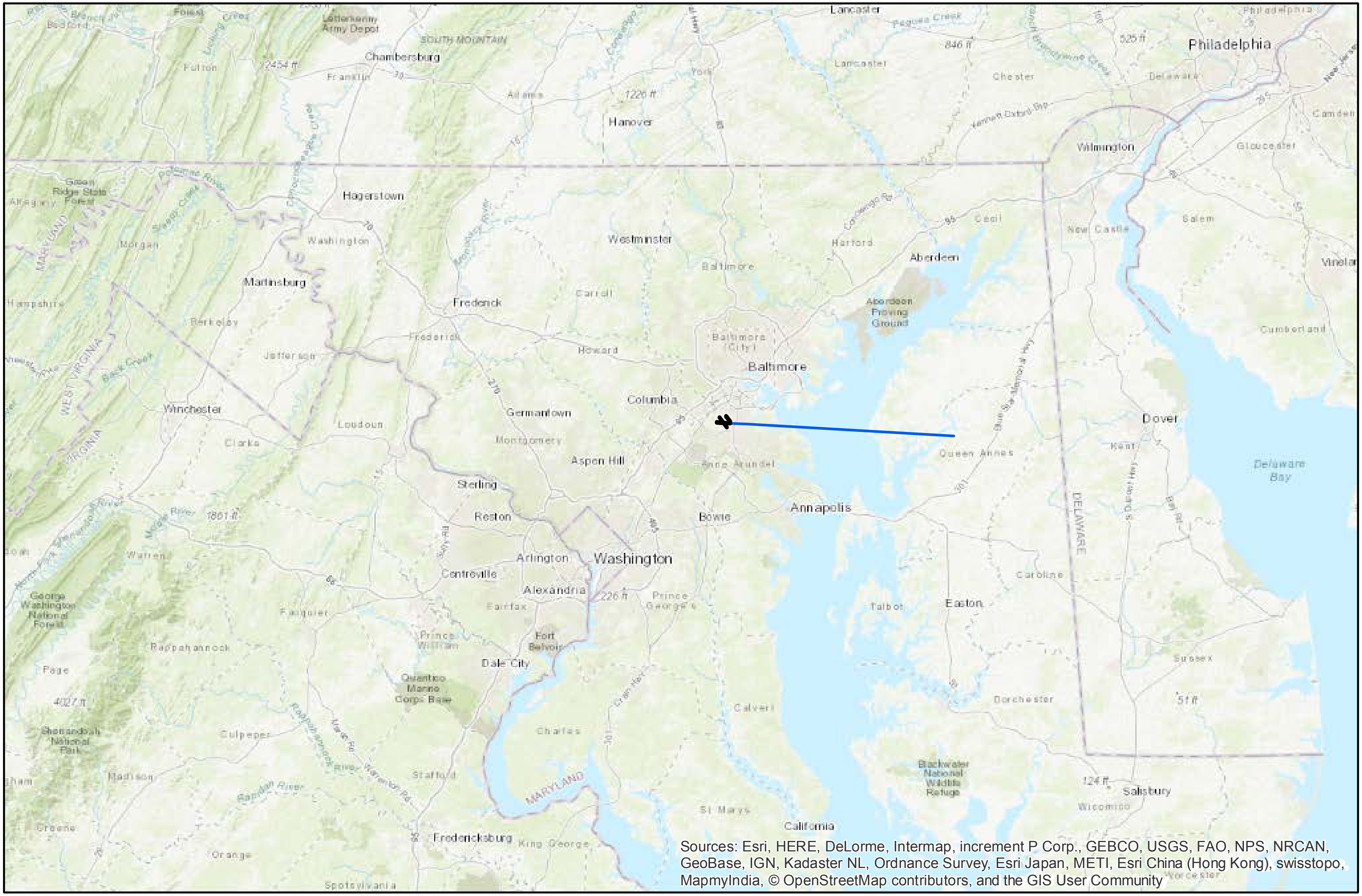
- Radar Flight Tracks
- Modeled Flight Tracks

Departure Flight Tracks

Figure 2-26: Commercial Propeller Departures from Runway 10

N

0 3.5 7 14 Nautical Miles



LEGEND

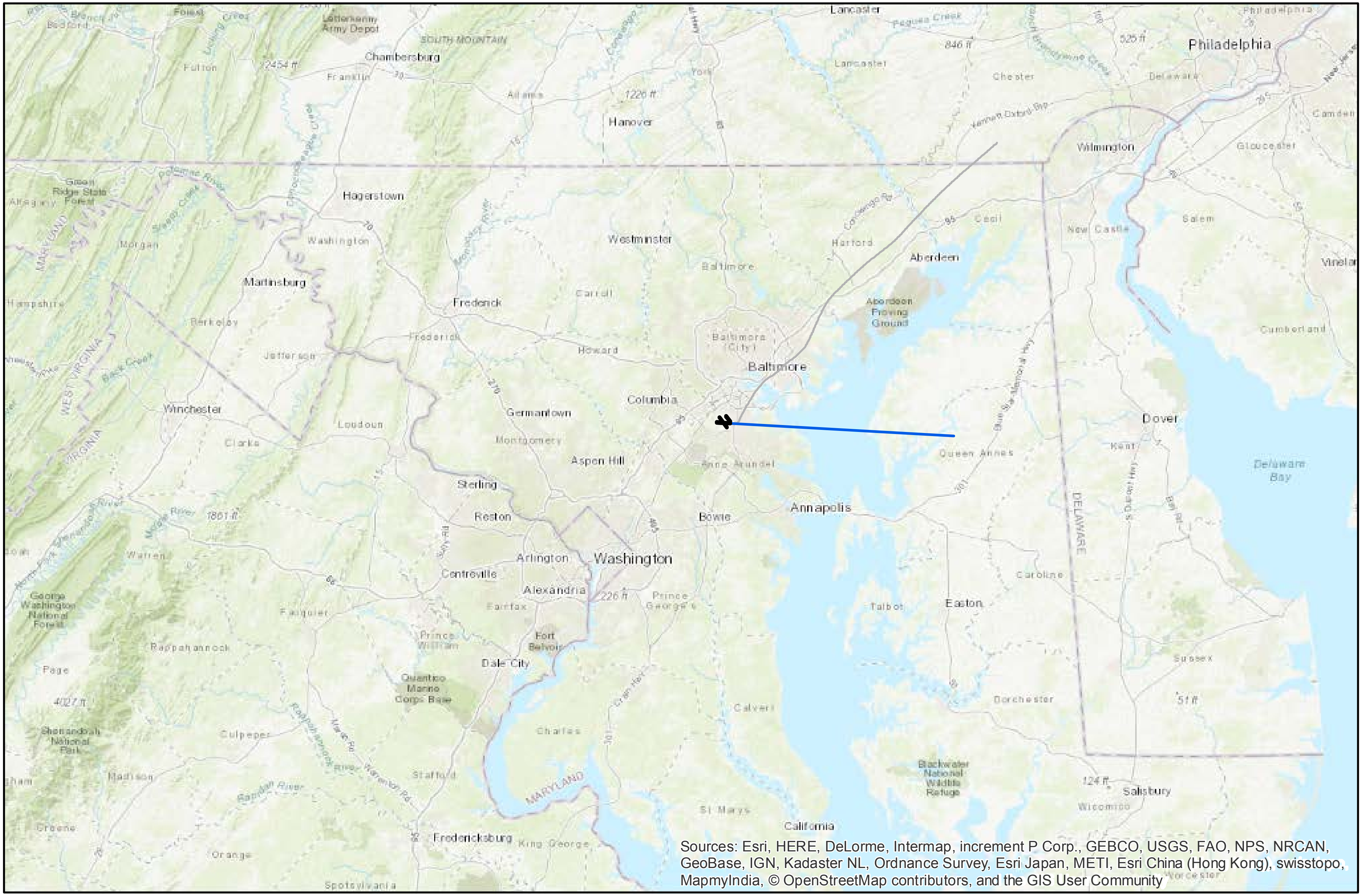
Radar Flight Tracks

Modeled Flight Tracks

Departure Flight Tracks
Figure 2-27: GA Jet Departures from Runway 10

N

0 3.5 7 14 Nautical Miles



LEGEND

Radar Flight Tracks

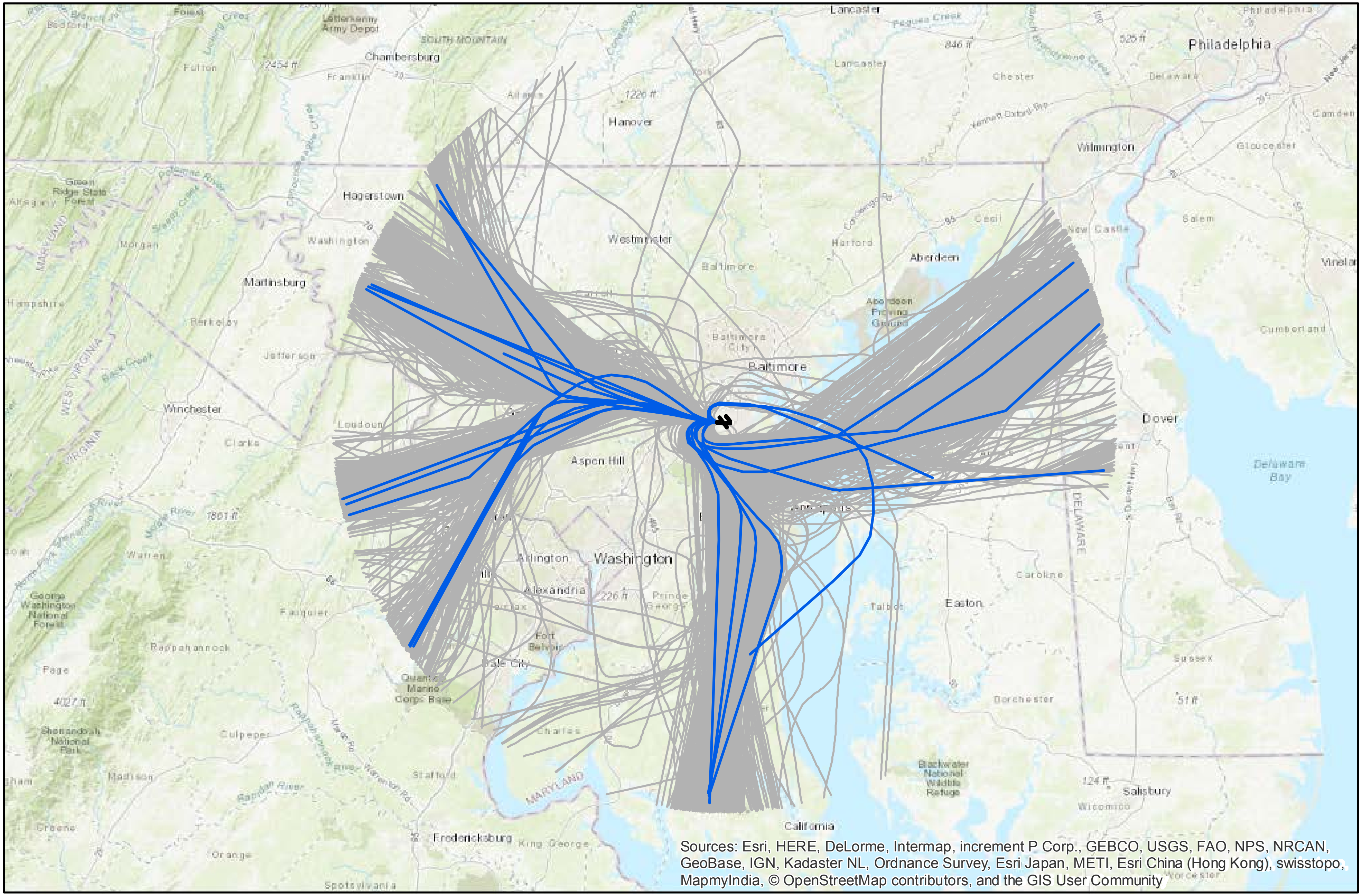
Modeled Flight Tracks

Departure Flight Tracks

Figure 2-28: GA Propeller Departures from Runway 10

N

Nautical Miles 0 3.5 7 14



LEGEND

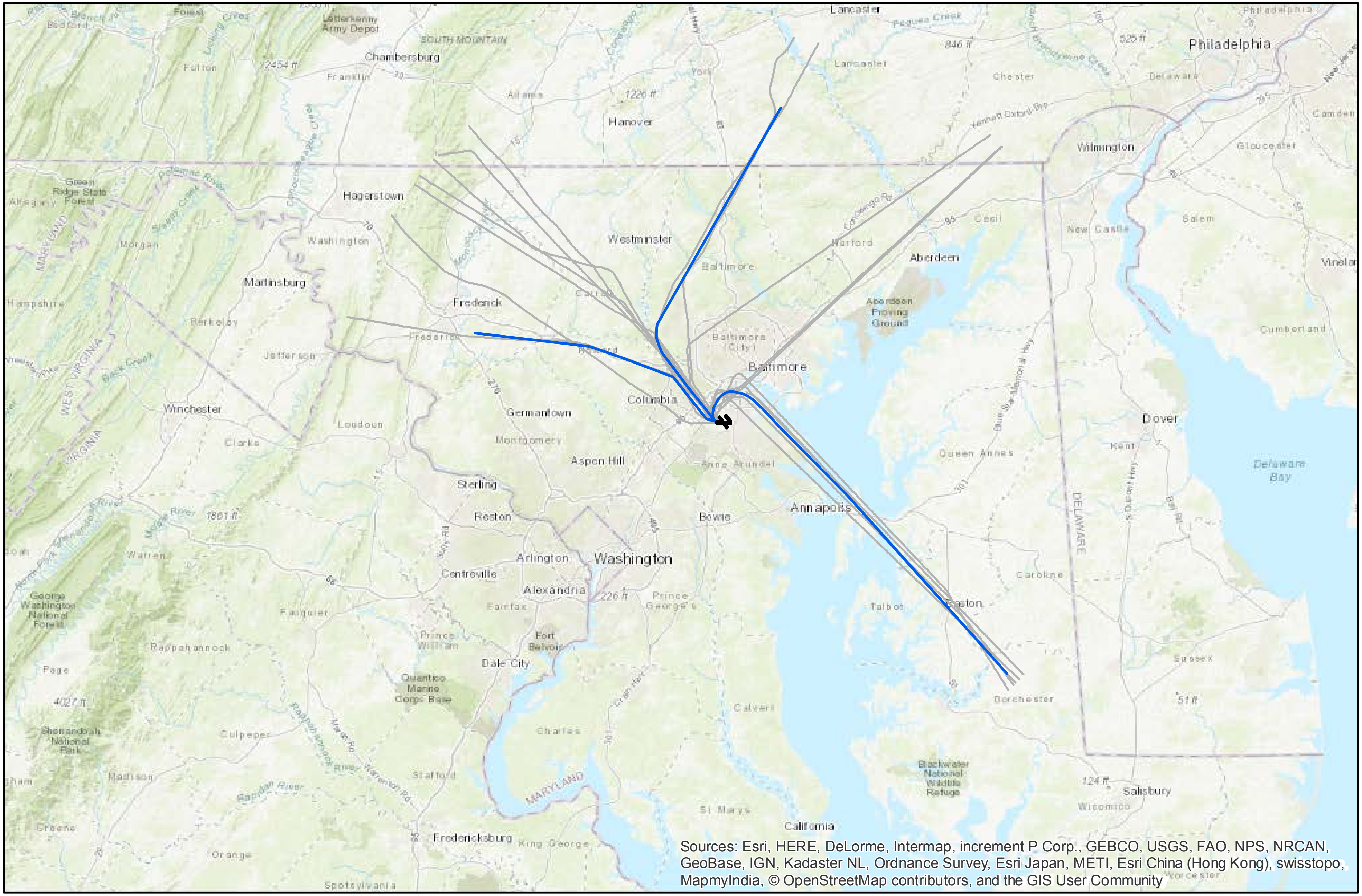
Radar Flight Tracks
Modeled Flight Tracks

Departure Flight Tracks
Figure 2-29: Commercial Jet Departures from Runway 28

N

0 3.5 7 14 Nautical Miles

HNTB



LEGEND

Radar Flight Tracks

Modeled Flight Tracks

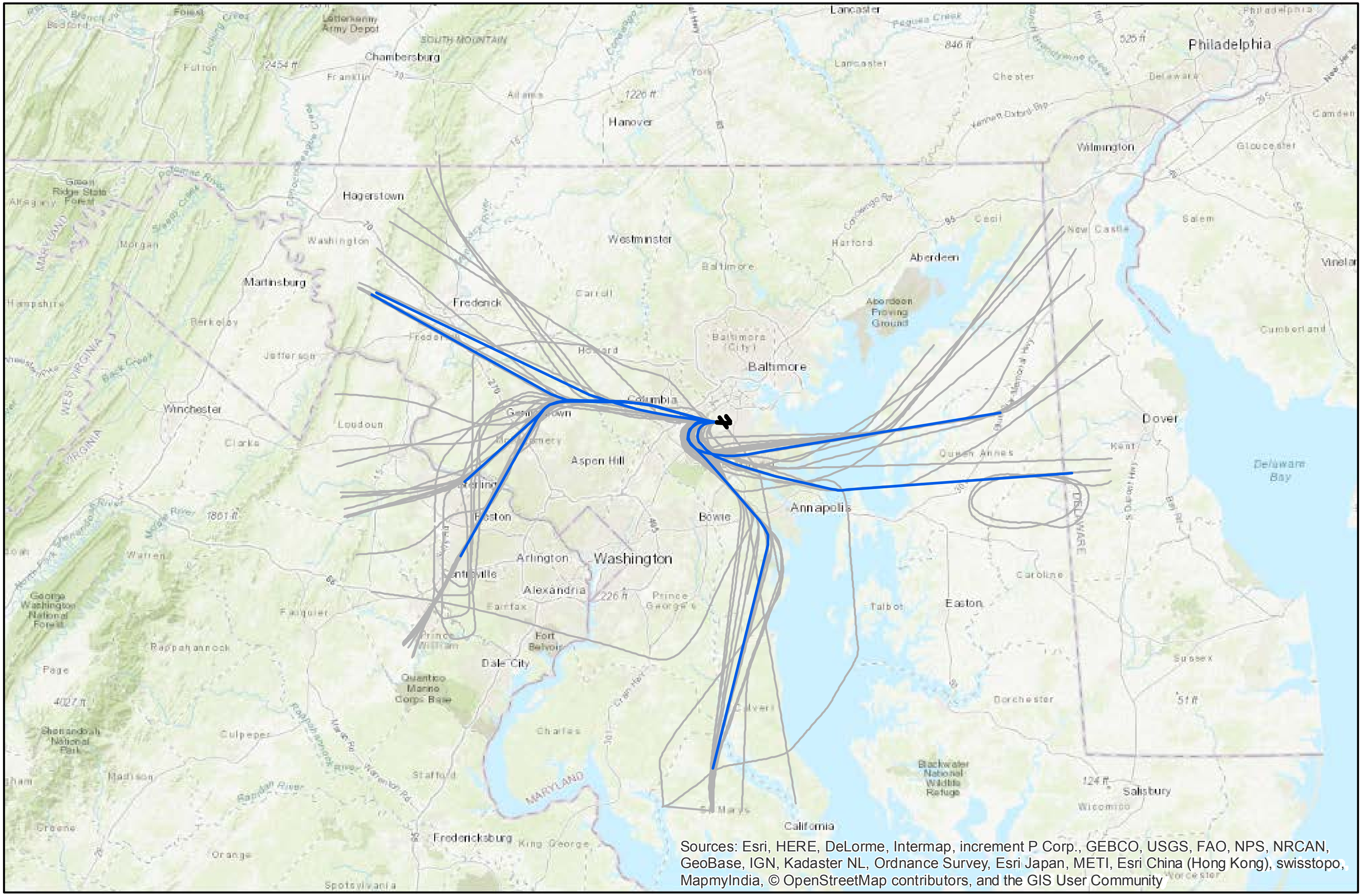
Departure Flight Tracks
Figure 2-30: Commercial Propeller Departures from Runway 28

N

0 3.5 7 14 Nautical Miles

BWI Marshall Airport Arrival Flight Tracks

HNTB



LEGEND

Radar Flight Tracks

Modeled Flight Tracks

Departure Flight Tracks

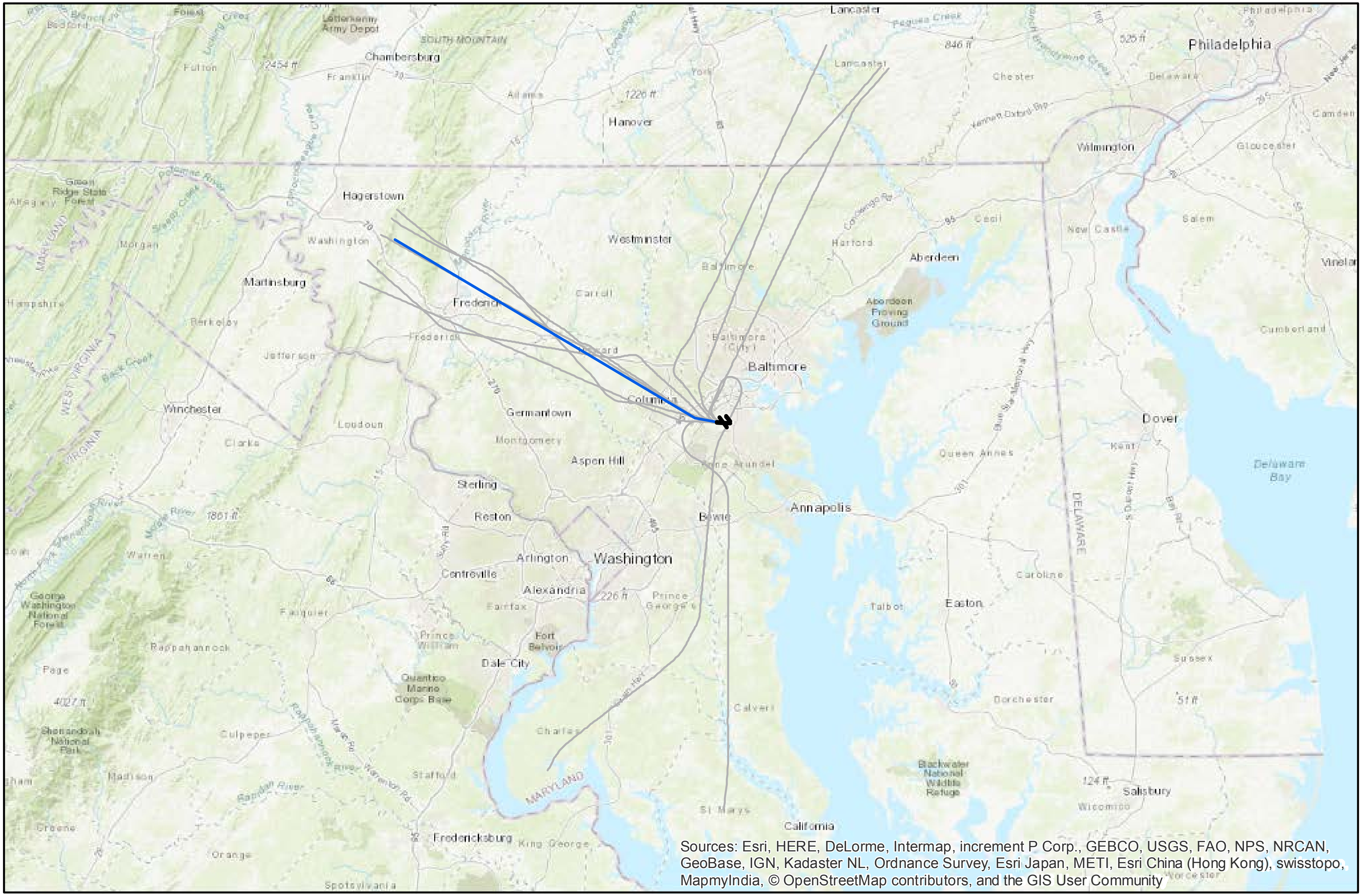
Figure 2-31: GA Jet Departures from Runway 28

N

0 3.5 7 14 Nautical Miles

BWI Marshall Airport Arrival Flight Tracks

HNTB



LEGEND

Radar Flight Tracks

Modeled Flight Tracks

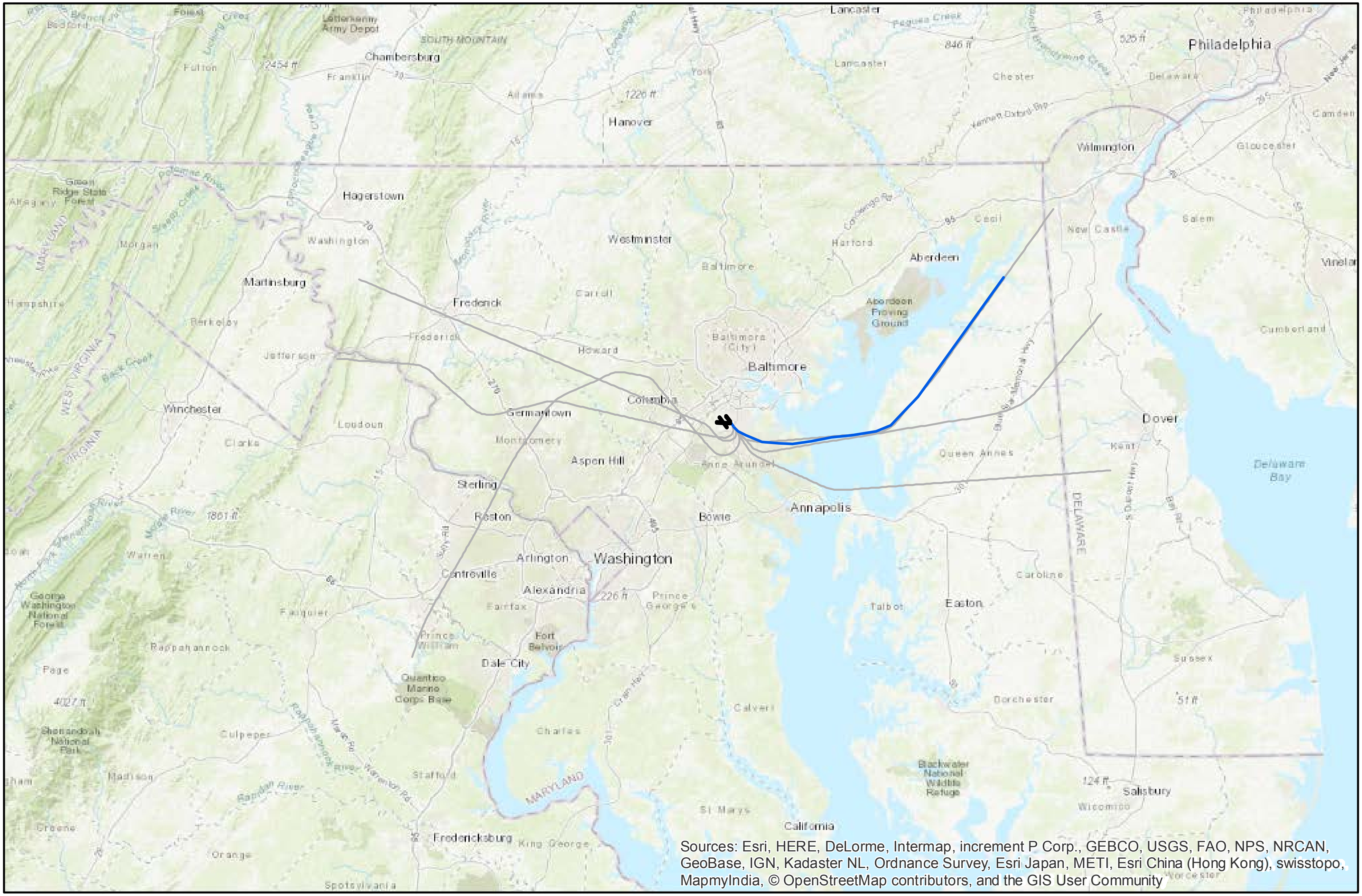
Departure Flight Tracks

Figure 2-32: GA Propeller Departures from Runway 28

N

0 3.5 7 14 Nautical Miles

HNTB



LEGEND

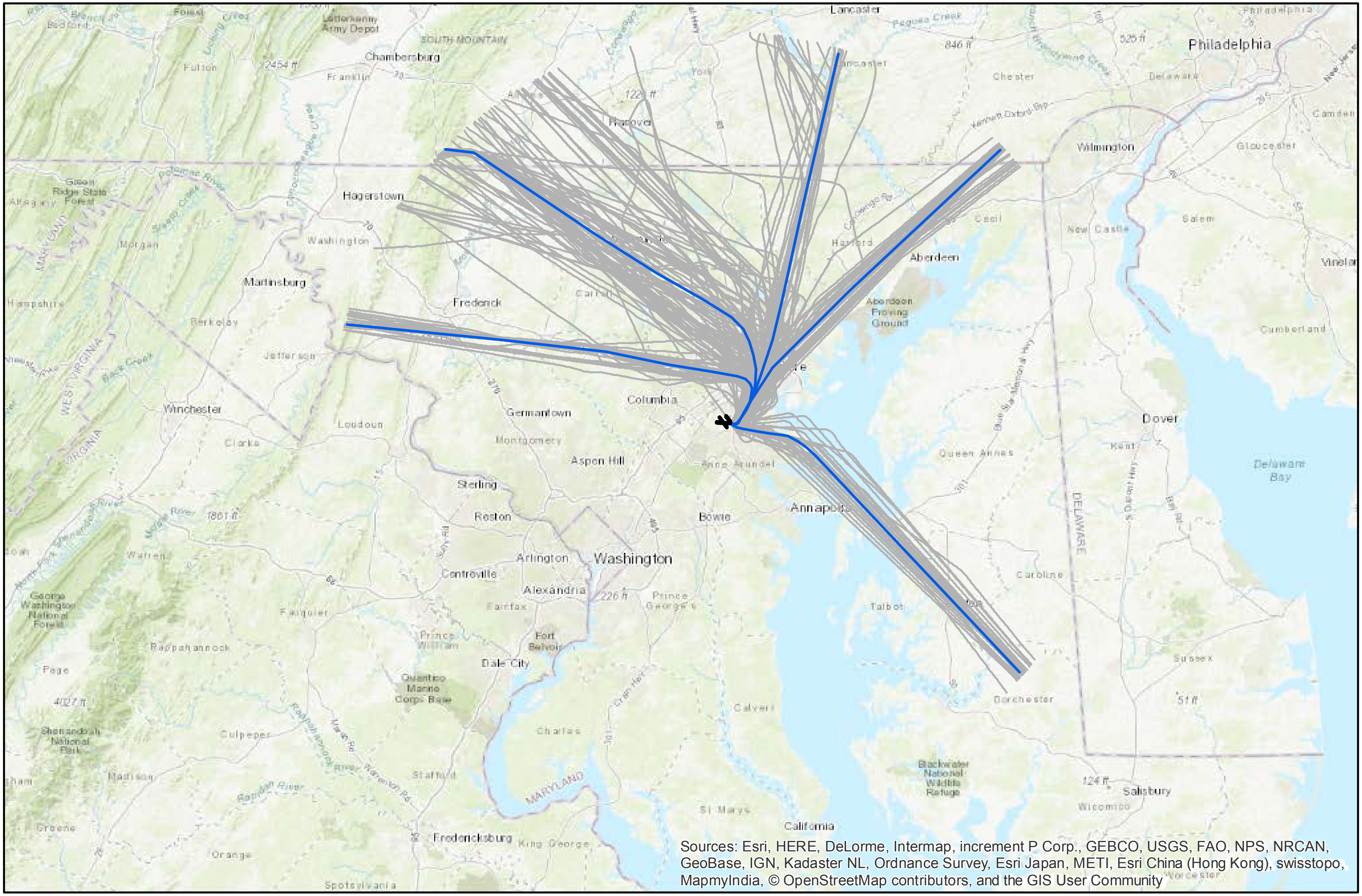
- Radar Flight Tracks
- Modeled Flight Tracks

Departure Flight Tracks

Figure 2-33: Commercial Jet Departures from Runway 15L

N

Nautical Miles: 0, 3.5, 7, 14



LEGEND

Radar Flight Tracks

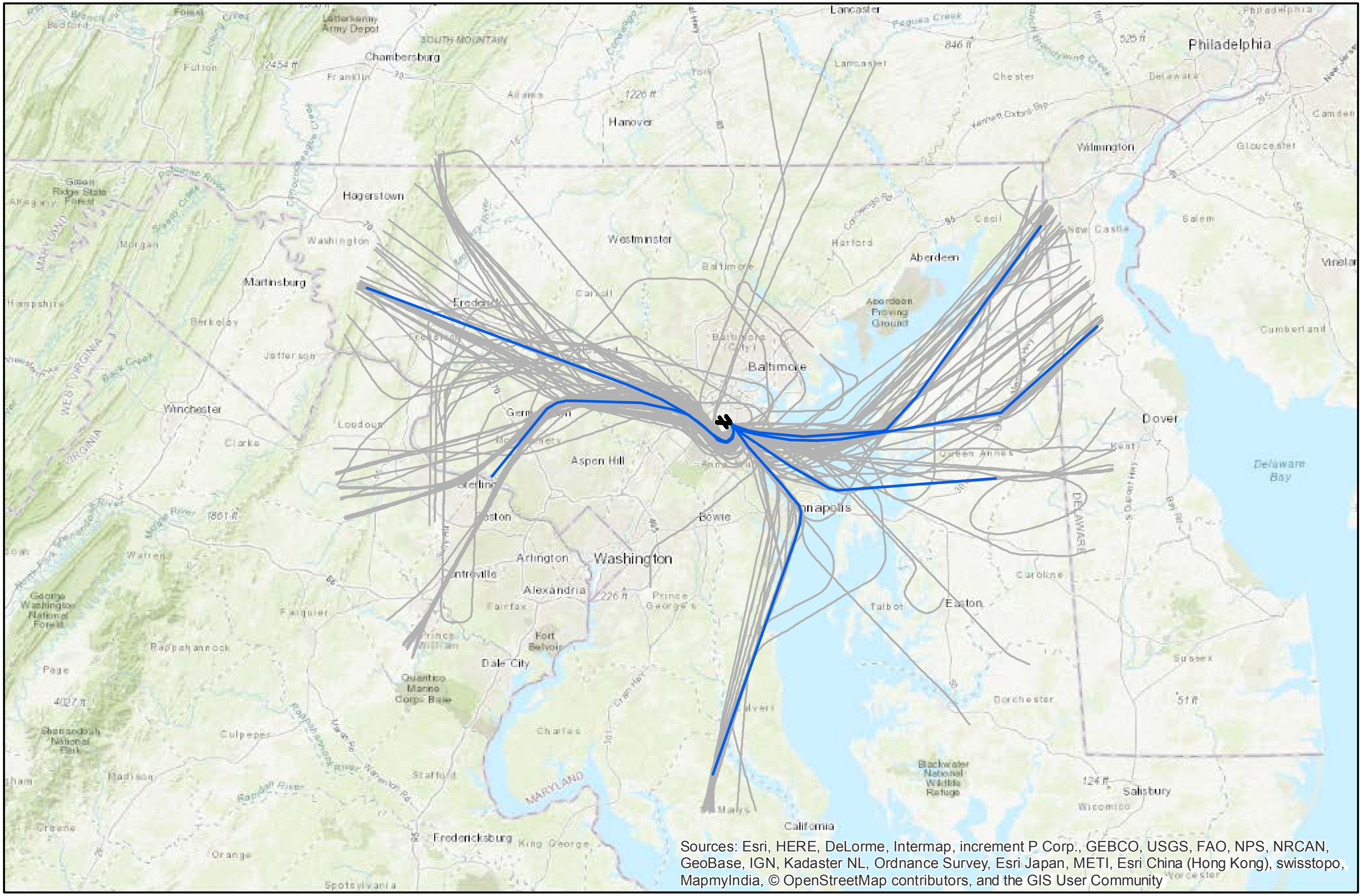
Modeled Flight Tracks

Departure Flight Tracks

Figure 2-34: Commercial Propeller Departures from Runway 15L

N

0 3.5 7 14 Nautical Miles



LEGEND

Radar Flight Tracks

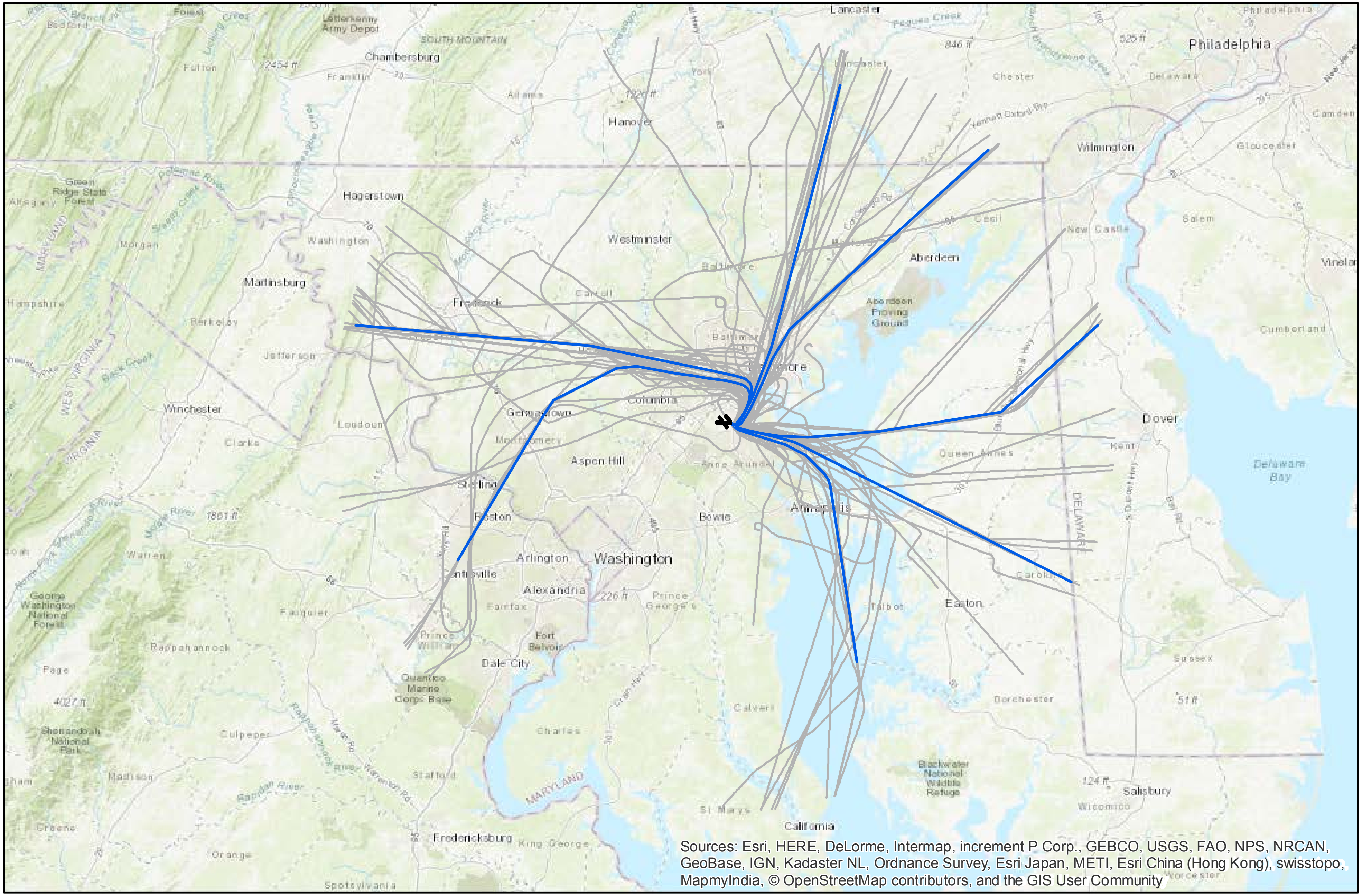
Modeled Flight Tracks

Departure Flight Tracks

Figure 2-35: GA Jet Departures from Runway 15L

N

0 3.5 7 14 Nautical Miles



LEGEND

Radar Flight Tracks

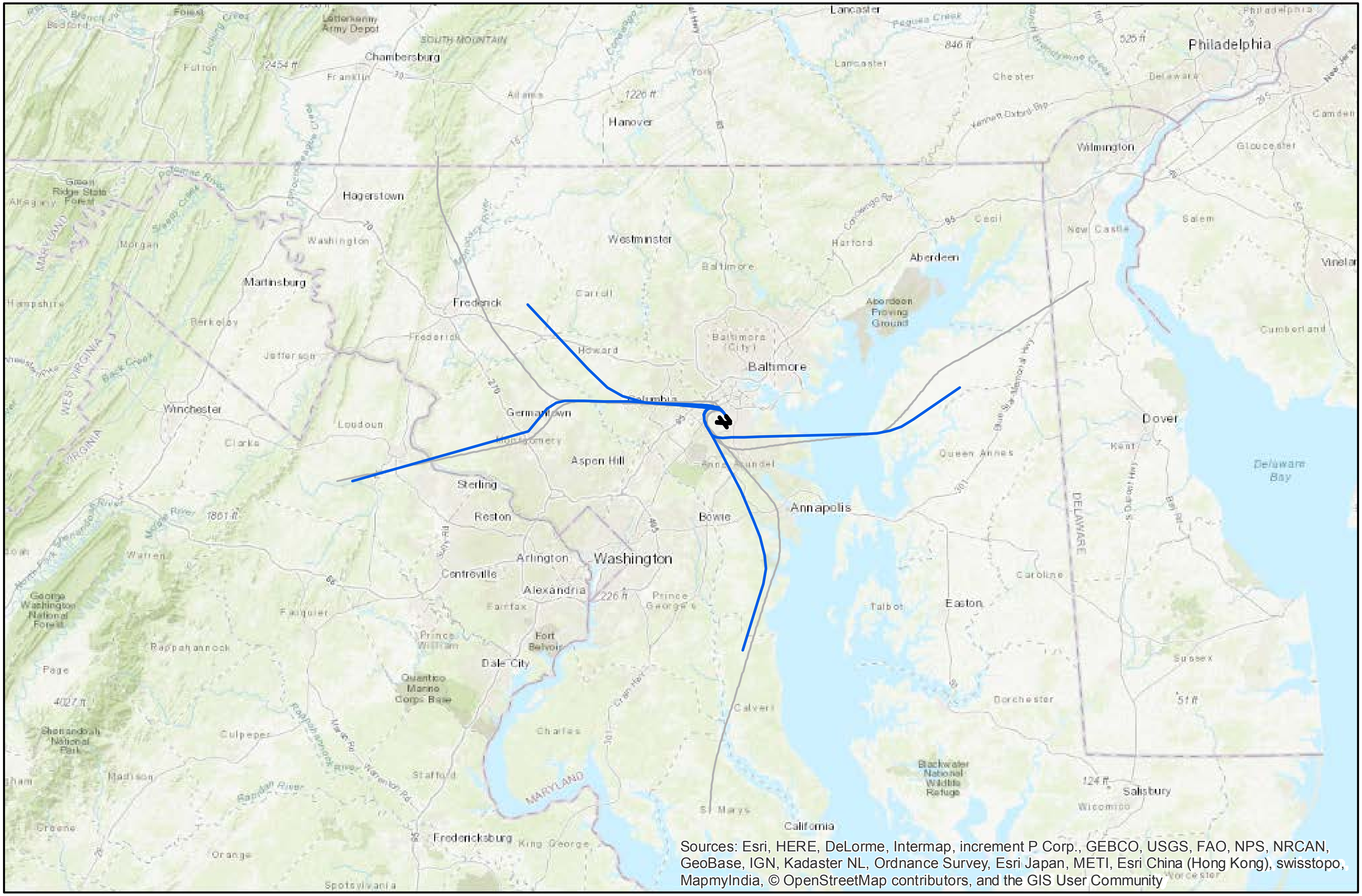
Modeled Flight Tracks

Departure Flight Tracks

Figure 2-36: GA Propeller Departures from Runway 15L

N

0 3.5 7 14 Nautical Miles



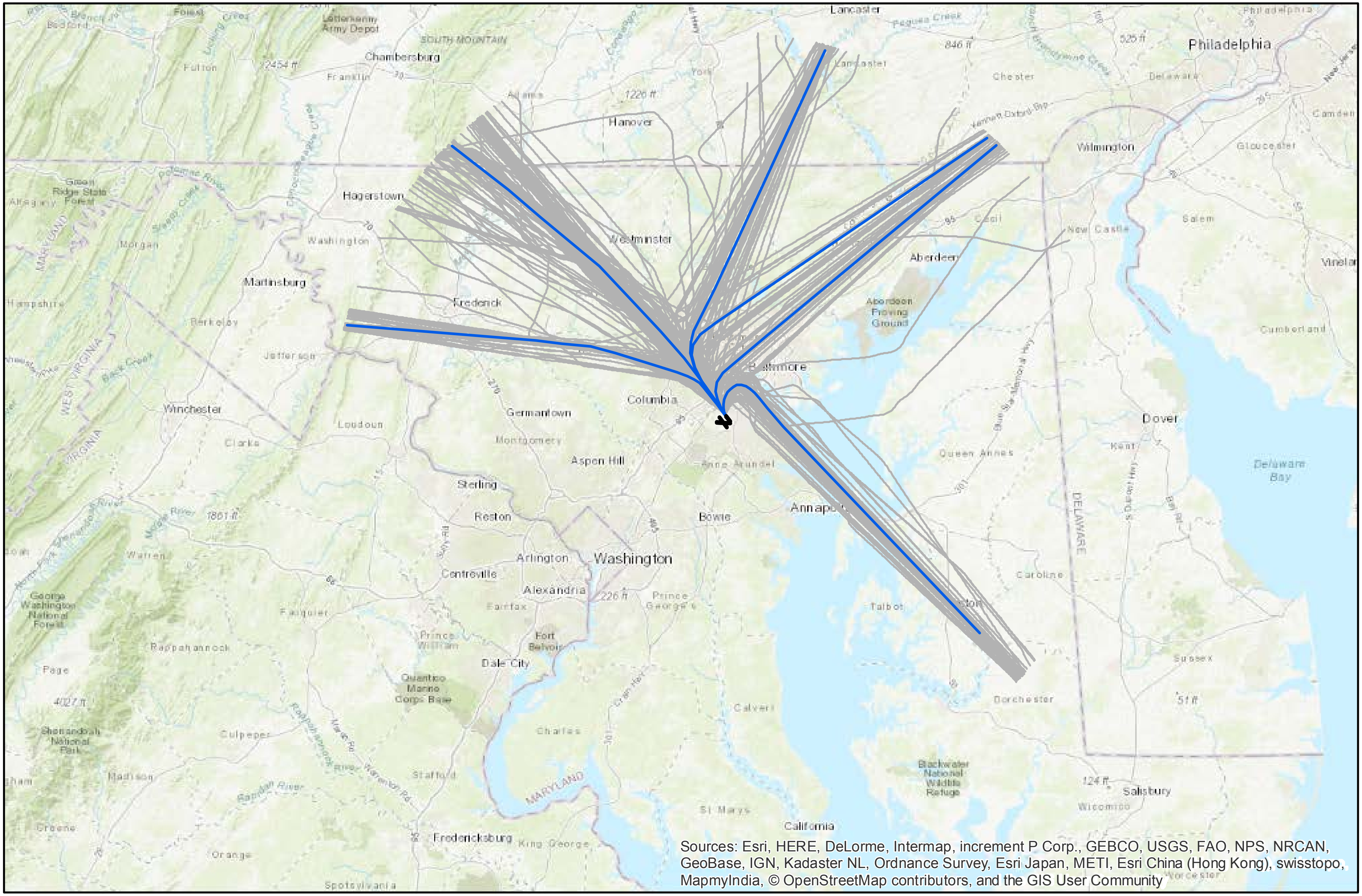
LEGEND

- Radar Flight Tracks
- Modeled Flight Tracks

Departure Flight Tracks
Figure 2-37: Commercial Jet Departures from Runway 33R

N

Nautical Miles 0 3.5 7 14



LEGEND

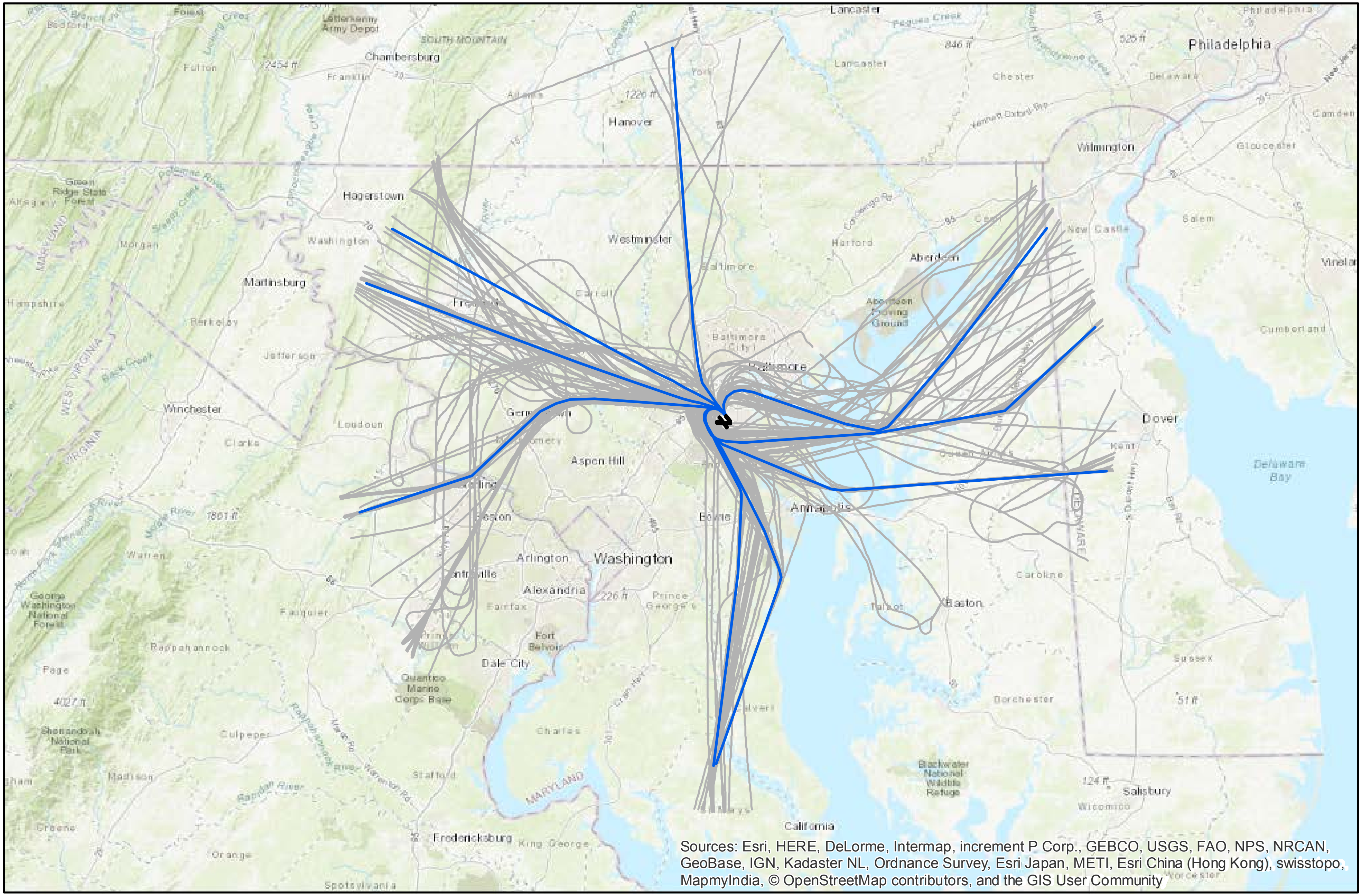
Radar Flight Tracks
Modeled Flight Tracks

Departure Flight Tracks

Figure 2-38: Commercial Propeller Departures from Runway 33R

N

0 3.5 7 14 Nautical Miles



LEGEND

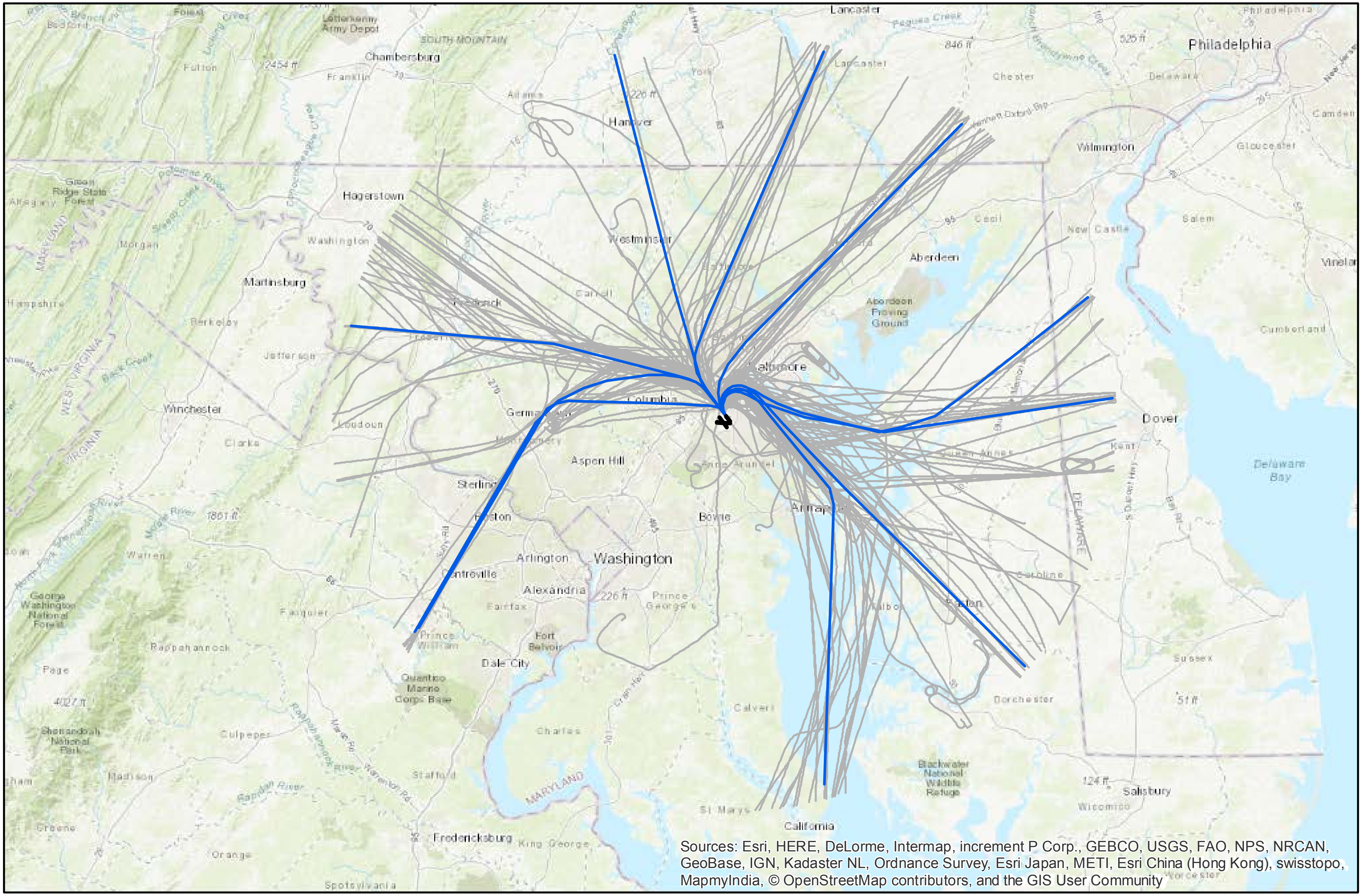
- Radar Flight Tracks
- Modeled Flight Tracks

Departure Flight Tracks

Figure 2-39: GA Jet Departures from Runway 33R

N

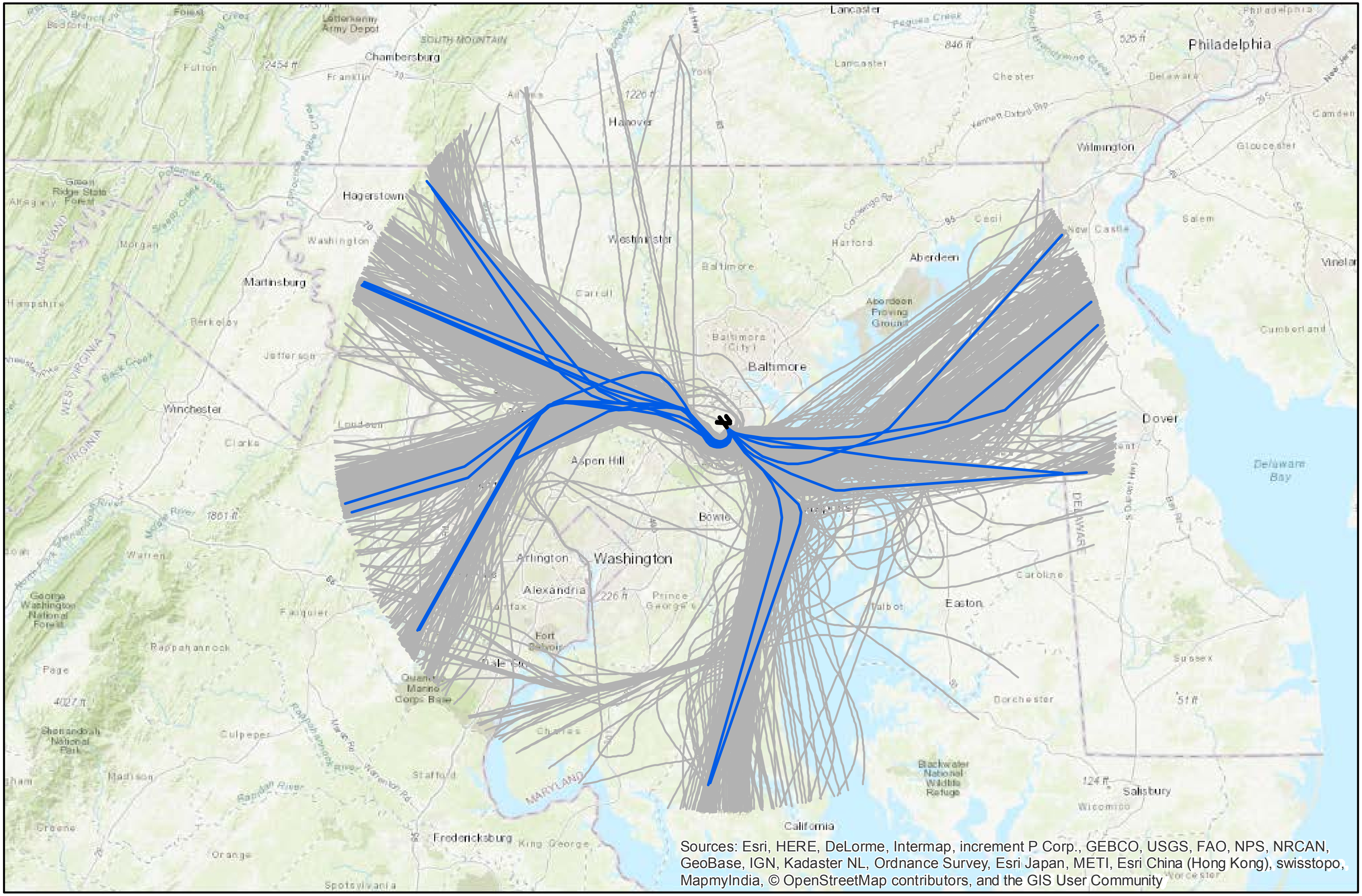
0 3.5 7 14 Nautical Miles



Departure Flight Tracks
Figure 2-40: GA Propeller Departures from Runway 33R

BWI Marshall Airport Arrival Flight Tracks

HNTB



LEGEND

Radar Flight Tracks

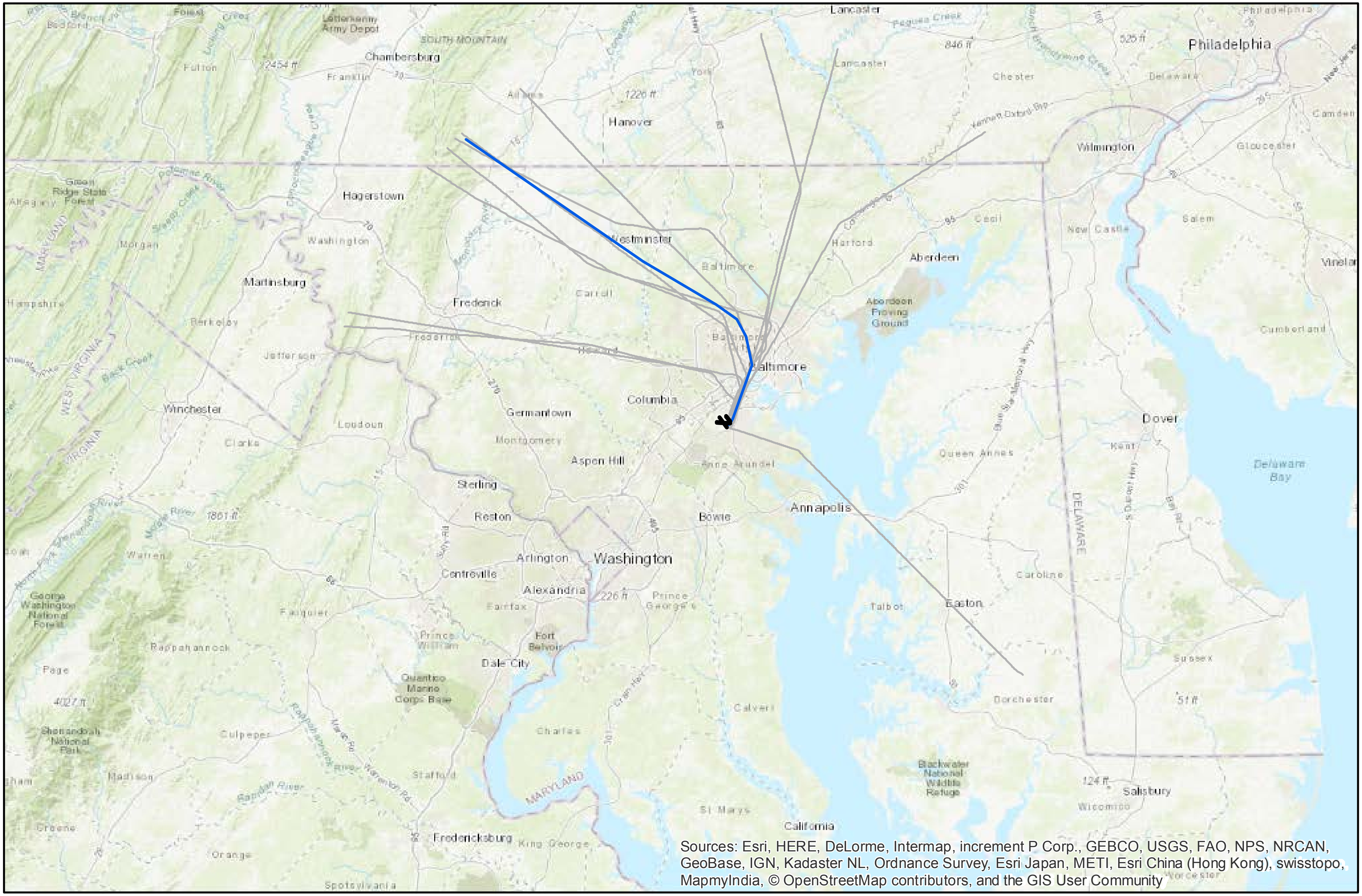
Modeled Flight Tracks

Departure Flight Tracks

Figure 2-41: Commercial Jet Departures from Runway 15R

N

0 3.5 7 14 Nautical Miles



LEGEND

Radar Flight Tracks

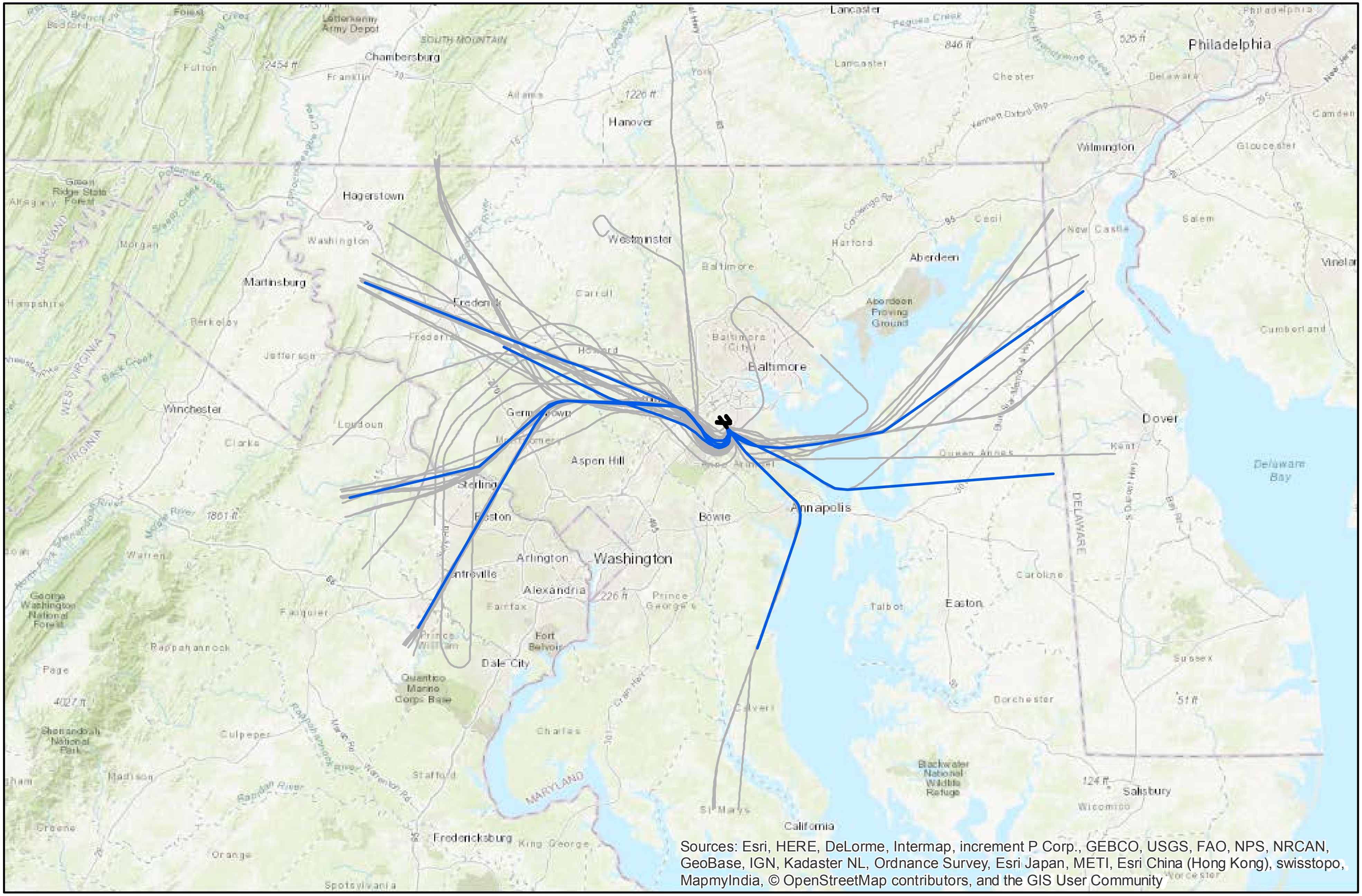
Modeled Flight Tracks

Departure Flight Tracks

Figure 2-42: Commercial Propeller Departures from Runway 15R

N

0 3.5 7 14 Nautical Miles



LEGEND

Radar Flight Tracks

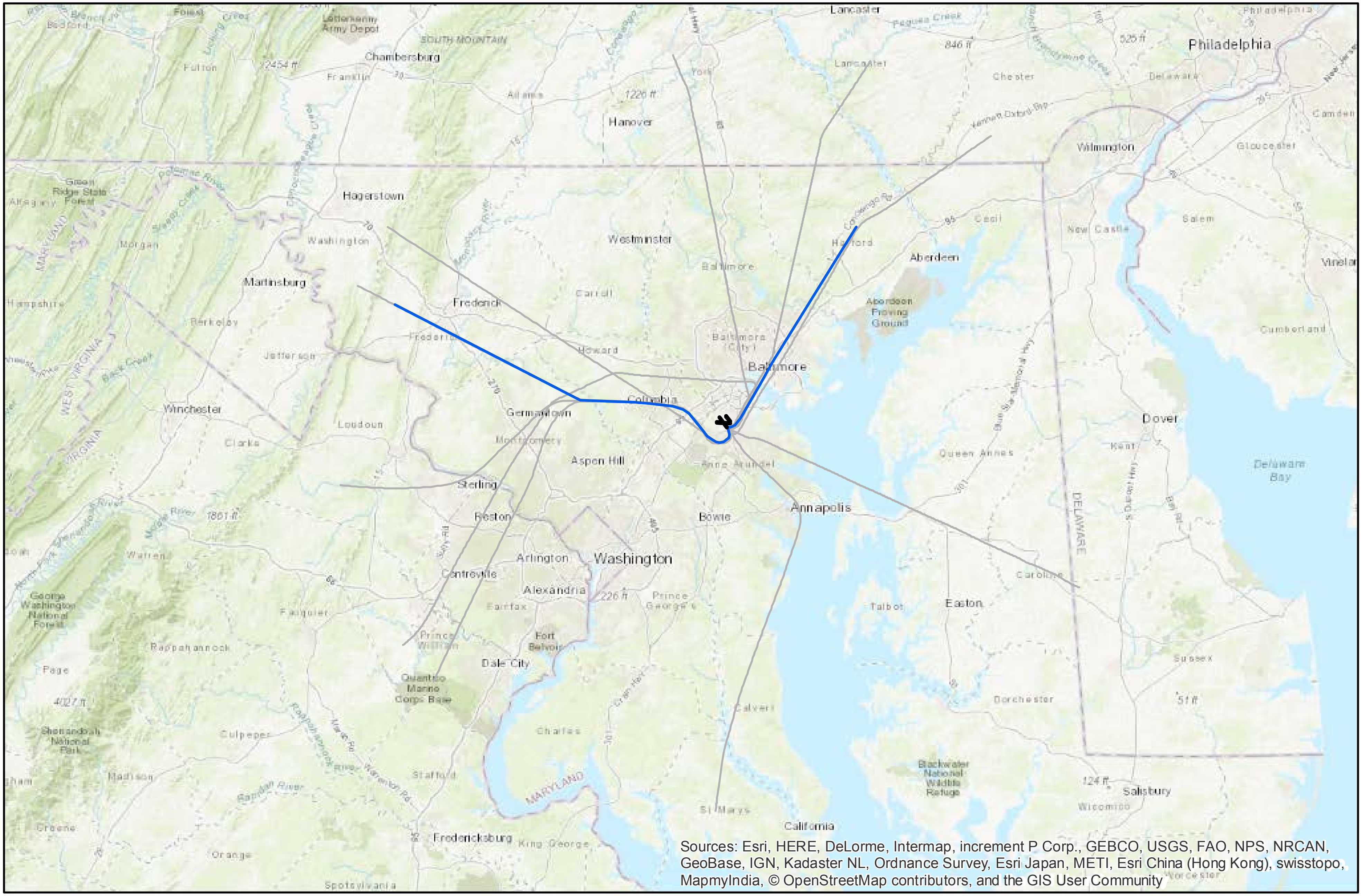
Modeled Flight Tracks

Departure Flight Tracks

Figure 2-43: GA Jet Departures from Runway 15R

N

0 3.5 7 14 Nautical Miles



LEGEND

Radar Flight Tracks

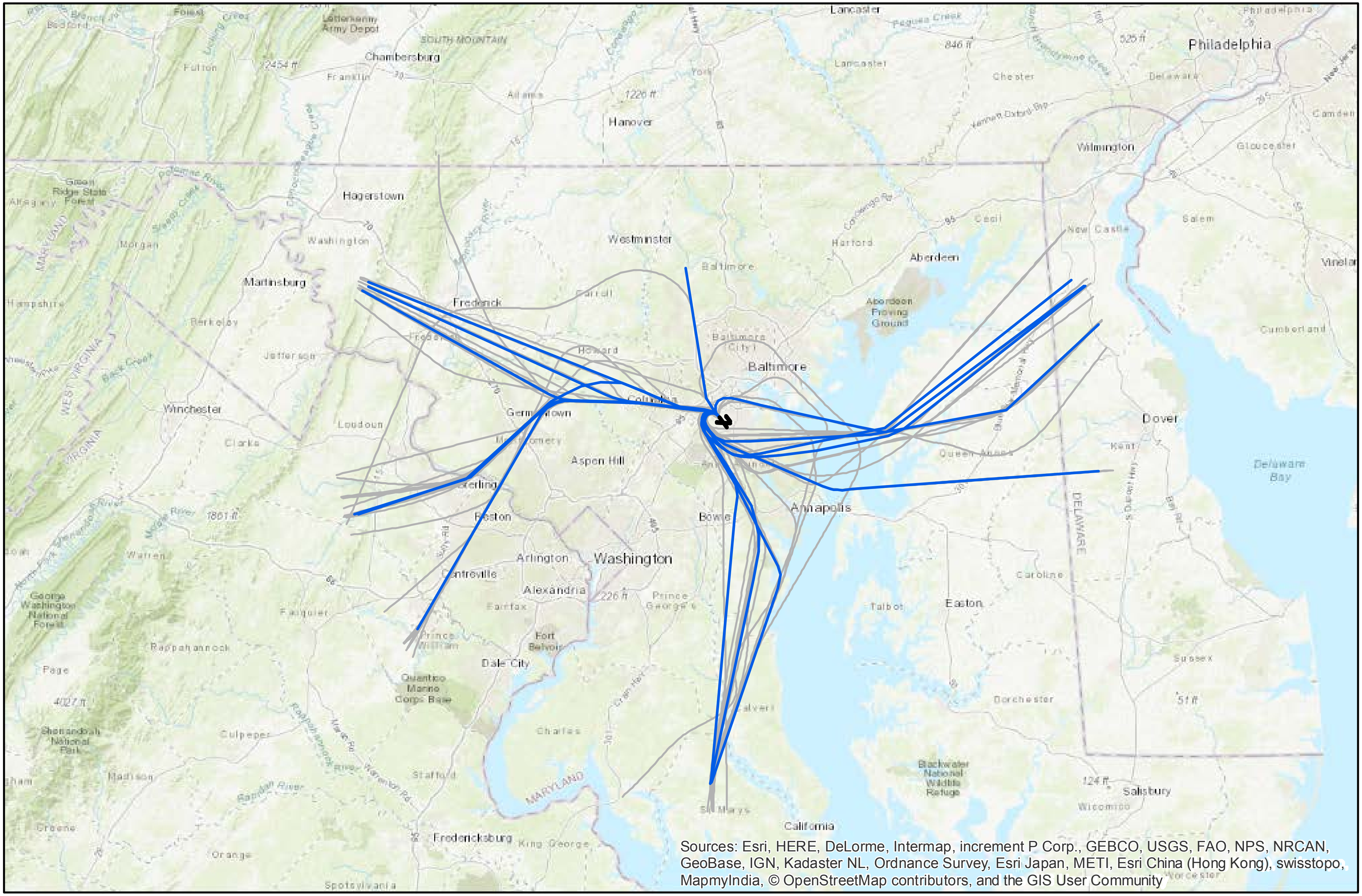
Modeled Flight Tracks

Departure Flight Tracks

Figure 2-44: GA Propeller Departures from Runway 15R

N

0 3.5 7 14 Nautical Miles



LEGEND

Radar Flight Tracks

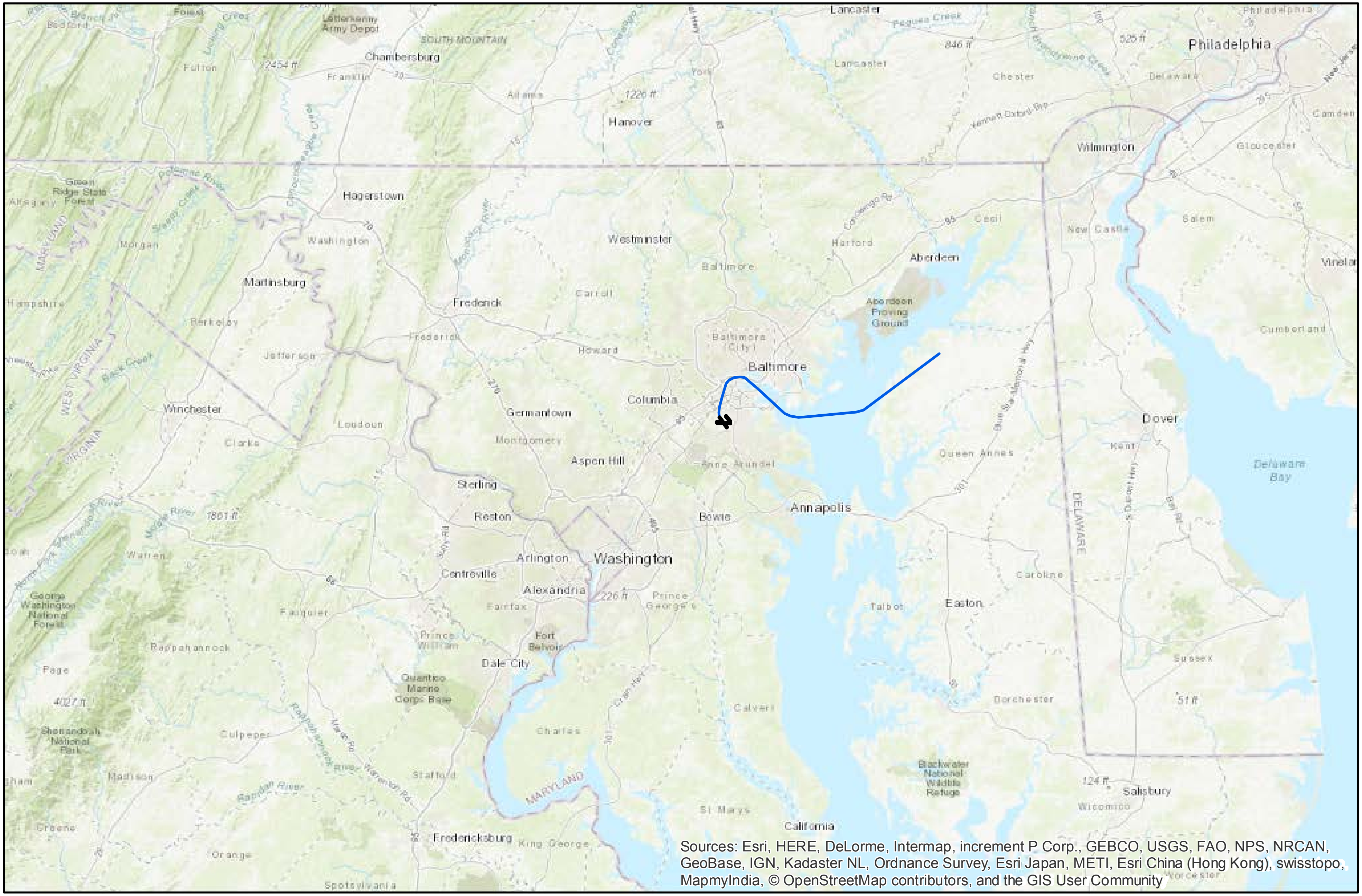
Modeled Flight Tracks

N

0 3.5 7 14 Nautical Miles

Departure Flight Tracks

Figure 2-45: Commercial Jet Departures from Runway 33L



LEGEND

- Radar Flight Tracks
- Modeled Flight Tracks

Departure Flight Tracks

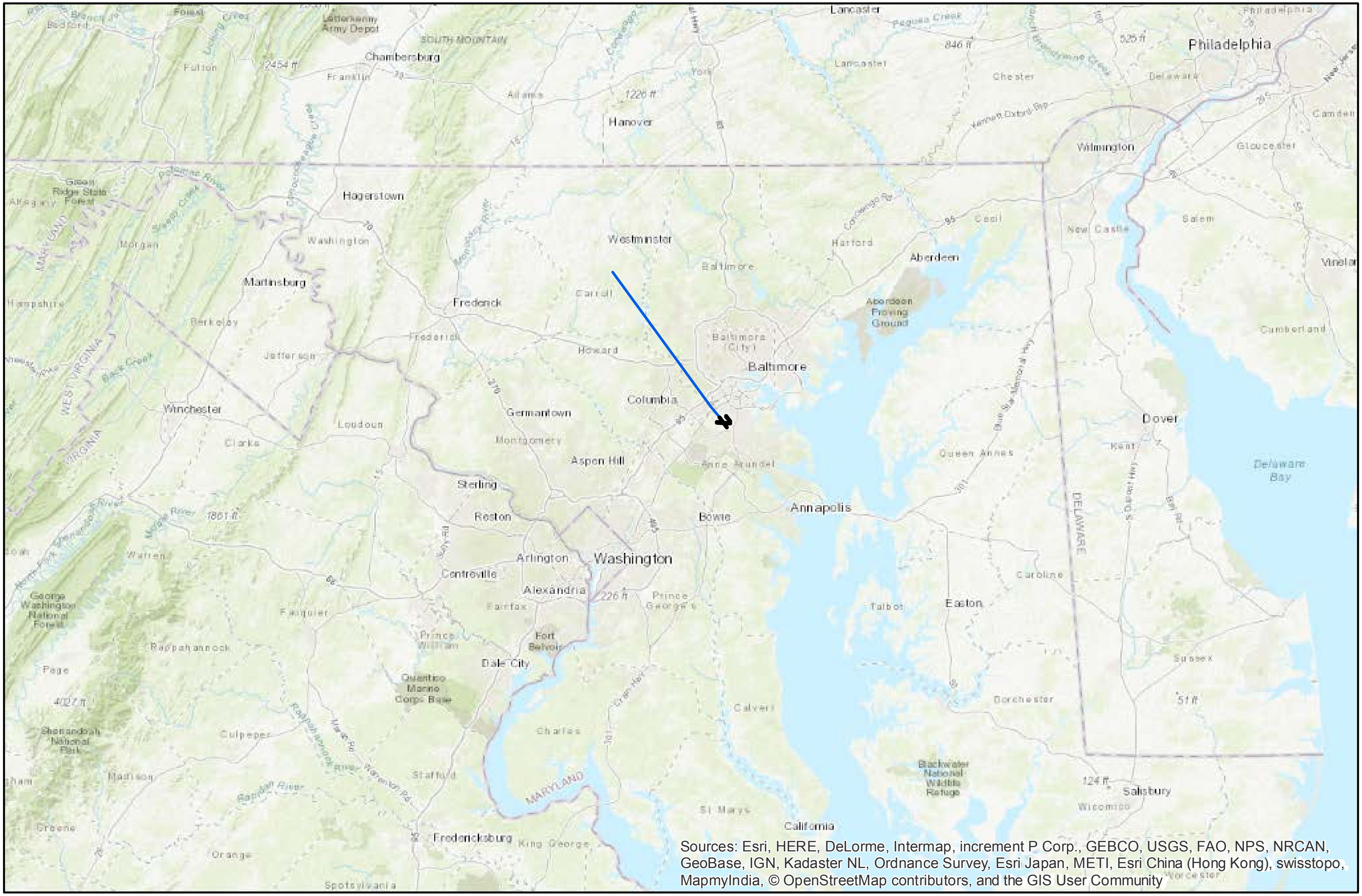
Figure 2-46: Commercial Propeller Departures from Runway 33L

N

0 3.5 7 14 Nautical Miles

BWI Marshall Airport Arrival Flight Tracks

HNTB



LEGEND

Radar Flight Tracks

Modeled Flight Tracks

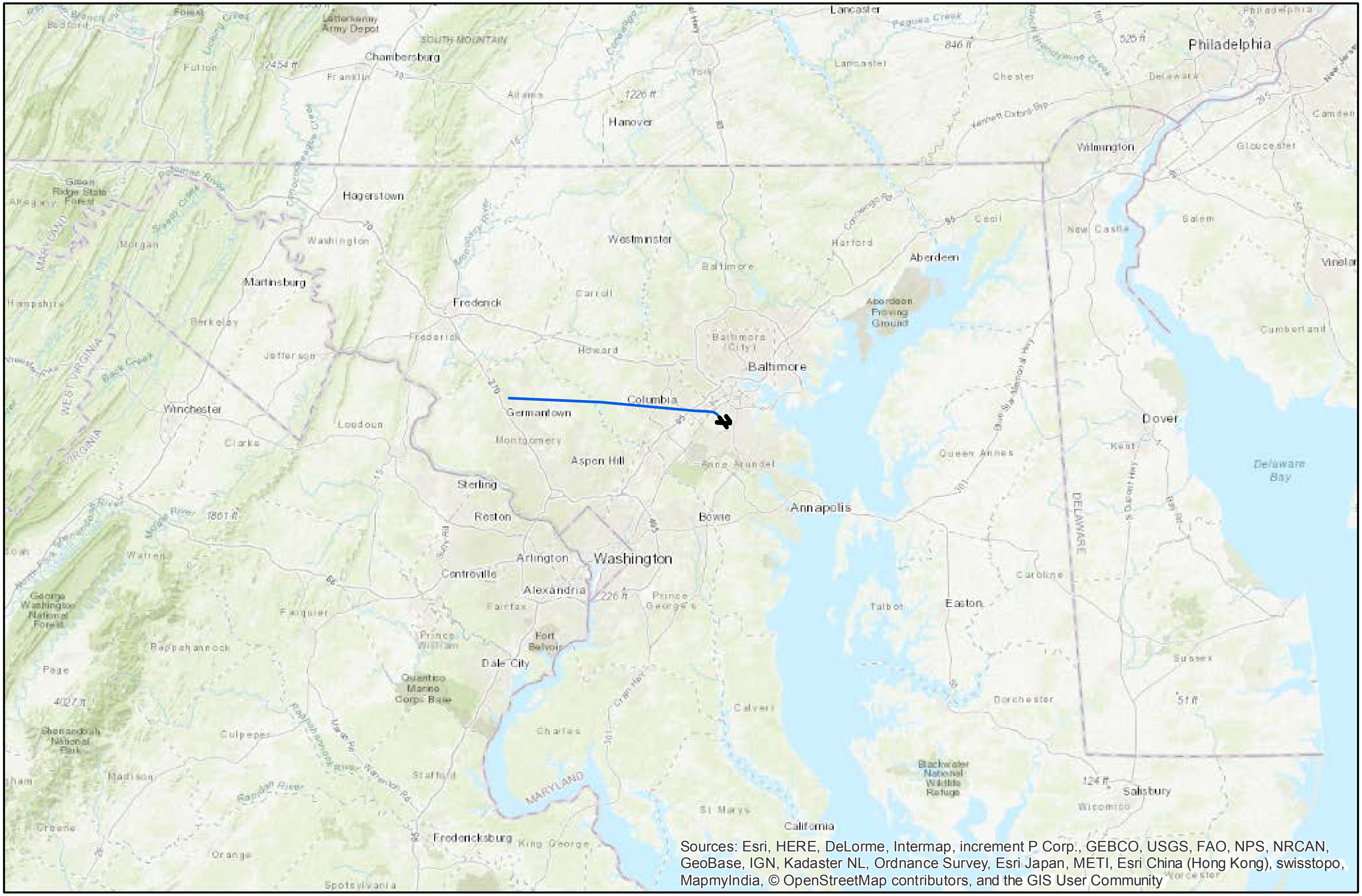
Departure Flight Tracks

Figure 2-47: GA Jet Departures from Runway 33L

N

Nautical Miles

0 3.5 7 14



LEGEND

Radar Flight Tracks
Modeled Flight Tracks

Departure Flight Tracks
Figure 2-48: GA Propeller Departures from Runway 33L

N

0 3.5 7 14 Nautical Miles

Appendix K-3

Future Scenarios Noise Analysis Technical Report

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ATTACHMENTS

APPENDIX K-3: Future Scenarios Noise Analysis

This appendix summarizes the data sources, assumptions and methodologies used to develop the Future Scenarios (2022 and 2027) noise contours for BWI Marshall Airport. The Future Scenarios include the Proposed Actions and No Action scenarios.

Initially, the future years of the EA were determined to be 2020 and 2025. However, after the 2017 Re-Evaluation and the 2018 Written Re-Evaluation/Record of Decision (WR/ROD) for the Midfield Cargo Facility Improvements were completed, it was necessary to incorporate the additional impacts associated with the 2017 Re-Evaluation and the 2018 WR/ROD for the Midfield Cargo Facility Improvements. Additionally, the timeline for construction of projects included as the Proposed Action within the EA have moved further into the future. Therefore, the future years were updated to reflect conditions in the years of 2022 and 2027. Appendix C, Attachment 2 provides additional detail regarding the Midfield Cargo Operations and additional updates to the fleet mix.

K-3.1 BWI Marshall Airport Facilities

BWI Marshall Airport currently has 3 runways including Runway 10-28, Runway 15L-33R, and Runway 15R-33L. Helicopter operations are currently directed to hover taxi to the GA ramp as the helipad was eliminated in 2017. Therefore, the helipad is modeled close to the GA ramp.. There are no proposed changes to the physical characteristics of the runways and helipad in the Future Scenarios. Displaced thresholds at Runway 10-28 and 15R-33L and departure procedures at Runway 28 are consistent with the Existing Conditions. The Proposed Actions scenario includes an airline maintenance facility and the majority of the fleet are expected to perform engine maintenance run-ups in proximity to the new facility. Run-up operations will also be allowed at the Runway 33L holding block and Runway 28 de-ice pad. The Runway 10 holding block, where the current engine maintenance run-up operations are being performed, is expected to be eliminated as part of the Proposed Actions scenario. See Table K-2.1 in Appendix K-2 for the runway and helipad characteristics.

K-3.2 Future Scenarios Noise Model Inputs

There are no physical changes to runway ends and helipad locations. The Proposed Actions scenario includes an airline maintenance facility and the majority of the fleet are expected to perform engine maintenance run-ups in proximity to the new facility. The No Action scenario assumes the engine maintenance run-up operations will continue to occur at the current run-up location. The noise contours for 2022 and 2027 were modeled using the fleet mixes developed as part this EA process. The fleet mixes were provided to the FAA for review on July 11th, 2019. Attachment 2 in *Appendix C, Fleet Mix* provides the updated fleet mix technical memorandum. The Future Scenarios noise contours in 2022 and 2027 were modeled using AEDT version 2d. This section describes the assumptions and methodologies applied in the noise modeling.

K-3.2.1 Fleet Mix

The Future Scenarios fleet mixes were developed as part of the EA process. The Proposed Actions and No Action fleet mixes were assumed to be identical. Operations were categorized into Air Carrier, Air Taxi, General Aviation, and Military. On an Average Annual Day (AAD) basis, the total number of operations is projected to increase from 719.06 in 2018 to 743.20 in 2022 and 791.56 in 2027. **Table K-3.1** summarizes the number of operations by operating categories.

Table K-3.1
Existing and Future Scenarios Fleet Mix by Operating Category

Operating Category	2018		2022		2027	
	Day	Night	Day	Night	Day	Night
Air Carrier	547.4	113.1	562.5	123.4	601.1	131.2
Air Taxi	21.0	1.3	21.1	1.3	22.7	1.4
General Aviation	29.6	3.6	28.8	3.5	29.1	3.5
Military	2.9	0.1	2.5	0.1	2.5	0.1
Total	601.0	118.1	615.0	128.2	655.4	136.2

Sources: Radar Data, FAA, and HNTB Analysis,2019.

In general, daytime operations were projected to increase by 3.3 percent between 2018 and 2022 and by 10.1 percent between 2018 and 2027. Nighttime operations were projected to increase by 8.6 percent in 2022 and by 15.3 percent in 2027, as compared to 2018 operations. Nighttime operations were projected to increase by a greater percentage than daytime operations because a large number of the cargo operations associated with the Midfield Cargo Area occur at night.

Aircraft in the fleet mix were converted into representative noise aircraft in AEDT using standard and non-standard aircraft substitutions. The non-standard AEDT aircraft substitutions were reviewed and approved by the FAA Office of Environmental and Energy (AEE) on September 13th, 2016. The coordination letter is included in Attachment 1 of *Appendix K-2, Existing Conditions Noise Analysis.* Although the coordination letter was developed before the future years and the fleet mixes were changed to reflect 2022/2027 conditions, no new aircraft requiring the AEE coordination were identified in the 2022 or 2027 fleet mixes. Therefore, the current AEE coordination effort is still valid.

The detailed number of AAD operations, by arrivals, departures and touch-and-goes, by operation category, and by day and night, for each noise aircraft in the fleet mix for 2022 and 2027 are shown in Tables K.1 and K.2 in **Attachment 1** of this **Appendix**.

K-3.2.2 Stage Length

Departure stage lengths for Future Scenarios were assumed to be consistent with the Existing Conditions by aircraft type. It was assumed that the same aircraft would have the same stage lengths as in the Existing Conditions. For aircraft that were not in the Existing Conditions fleet mix, a similar aircraft stage length distribution was applied. For example, for the projected Boeing

737 MAX 7 operations, the departure stage length distribution of Boeing 737-700 as determined for Existing Conditions was applied. **Table K-3.2** shows the distribution of the departure stage lengths in 2022 and 2027. The distribution of departure stage lengths changed slightly because of changes in the fleet mixes. Departures with stage length 8 in 2027 reflect projected new international markets served by wide-body aircraft.

Table K-3.2
Distribution of Departure Stage Lengths

Stage Length	**Distance Bracket (nm)**	**2022**			**2027**		
		Day	**Night**	**Total**	**Day**	**Night**	**Total**
1	0-500	39.5%	47.8%	40.8%	37.9%	46.7%	39.3%
2	501-1,000	34.6%	33.1%	34.4%	35.2%	32.7%	34.8%
3	1,001-1,500	13.1%	8.2%	12.3%	13.5%	9.1%	12.8%
4	1,501-2,500	12.3%	10.0%	11.9%	12.8%	10.7%	12.5%
5	2,501-3,500	0.4%	0.7%	0.4%	0.3%	0.6%	0.4%
6	3,501-4,500	0.1%	0.2%	0.1%	0.0%	0.2%	0.1%
7	4,501-5,500	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
8	5,501 – 6,500	0.2%	0.0%	0.2%	0.2%	0.0%	0.1%

Source: MAA Radar Data and HNTB Analysis, 2019.

K-3.2.3 Day and Night Operations

For all non-midfield cargo operations, the day and night split by aircraft type was also assumed to be consistent with the Existing Conditions. It was assumed that the same aircraft type would fly the same percentage of time during the daytime hours and nighttime hours as the Existing Conditions. In most instances, the existing day/night and stage length distributions of each aircraft type were assumed to carry over into the 2022 and 2027 forecasts. Exceptions were made when an airline was anticipated to experience a major turnover in aircraft types. In those cases, the new aircraft type was assumed to take on the day/night and stage length characteristics of the aircraft it was replacing. Changes in the future fleet mixes and additional operations by the Midfield Cargo Operator, as shown in Table K-3.1 and Tables K.1 and K.2 in **Attachment 1** of this Appendix, would change the overall distribution of day and night operations. The Future Scenarios analysis indicates that approximately 82.8% of all operations would occur during the daytime and approximately 17.2% of all operations would occur during the night time. **Table K-3.3** shows the projected distribution of daytime and night time operations in 2022 and 2027.

Table K-3.3
Distribution of Day and Night Operations

Operation Type	2022		2027	
	Daytime	Nighttime	Daytime	Nighttime
Arrival	81.2%	18.8%	81.3%	18.7%
Departure	84.3%	15.7%	84.3%	15.7%
Total	82.8%	17.2%	82.8%	17.2%

Sources: MAA Radar Data and HNTB Analysis 2019.

K-3.2.4 Aircraft Maintenance Engine Run-ups

Currently at BWI Marshall Airport, engine run-up operations are permitted at the holding block of Runway 10, with the aircraft nose positioned between 190^0 to 220^0 to the magnetic north [1]. In Future Scenarios with the Proposed Actions, the Runway 10 holding block is expected to be demolished. An airline maintenance facility is proposed where most of the fleet are expected to perform engine maintenance run-ups. Additional run-up operations will also be allowed at the Runway 33L holding block and Runway 28 de-ice pad. To account for additional run-up operations, the proposed airline maintenance facility was compared with another maintenance facility with similar functionality and capacity. Projected aircraft maintenance engine run-up operations in 2022 and 2027 were estimated based on a comparison of the fleet mixes and frequencies between the two facilities. **Table K-3.4** shows the projected number of engine run-up operations in 2022 and 2027 by aircraft on an AAD basis. **Table K-3.5** identifies the projected number of engine run-up operations in 2022 and 2027 by daytime and nighttime.

Table K-3.4
Proposed Actions Engine Maintenance Run-up Operations by Aircraft Type

Aircraft Description	2022	2027
	AAD Operations	AAD Operations
Boeing 737-700 and MAX 7	3.932	3.598
Boeing 737-800 and MAX 8	2.956	4.019
Boeing MD90	0.003	-
Total	**6.891**	**7.617**

Sources: MAA and HNTB Analysis 2019.

[1] MAA, Baltimore/Washington International Thurgood Marshall Airport Part 150 Update, Document of 2014 and 2019 Noise Exposure Maps, Section 4.2.9.

Table K-3.5
Proposed Actions Engine Maintenance Run-up Operations by Day/Night

Day/Night	2022	2027
Daytime (7 AM – 9:59 PM)	4.133	4.570
Nighttime (10 PM – 6:59 AM)	2.758	3.047
Total	**6.891**	**7.617**

Sources: MAA and HNTB Analysis 2019.

In the No Action scenarios, it was assumed that no additional engine maintenance run-ups would be introduced without the airline maintenance center. The number of run-up operations was estimated based on the growth factors by aircraft developed in the fleet mix development task. **Table K-3.6** shows the modeled engine maintenance run-up operations in the No Action scenario.

Table K-3.6
No Action Engine Maintenance Run-up Operations

Aircraft Description	2022	2027
	AAD Operations	AAD Operations
Boeing 737-700 and MAX 7	0.002	0.002
Boeing 737-800 and MAX 8	0.007	0.009
Boeing MD90	0.003	-
Total	0.012	0.012

Sources: MAA and HNTB Analysis 2019.

K-3.2.5 Meteorological Conditions

For the Future Scenarios, parameters in **Table K-3.7** were applied based on default AEDT 2c meteorological conditions at BWI Marshall Airport, same as the Existing Conditions

Table K-3.7
Future Scenarios Meteorological Parameters

Parameters	Units	Value
Temperature	Fahrenheit	54.0
Pressure	Millibar	1010.9
Relative Humidity	Percentage	67.9
Headwind Speed	Knot	6.1

Source: AEDT 2c default meteorological parameters.

K-3.2.6 Terrain

Terrain data was obtained from the National Land Cover Database (NLCD) developed by the U.S. Department of the Interior[2].

K-3.2.7 Runway Utilization

Runway utilization percentages were assumed to be consistent by aircraft type with the runway utilization of the Existing Conditions. The runway utilization in Future Scenarios changed slightly from the Existing Conditions because of changes in the fleet mixes. For example, as shown in Table K-3.1, the percentage of GA operations was projected to decline. GA aircraft operating at BWI Marshall Airport primarily utilize Runway 15L-33R whose utilization percentage was projected to decline slightly as a result. It was assumed that the runway utilization would not change between the Proposed Actions and No Action scenarios. **Tables K-3.8** shows the runway utilization for 2022 and 2027.

Table K-3.8
Runway Utilization in 2022 and 2027

Runway	2022				2027			
	Arrivals		Departures		Arrivals		Departures	
	Day	Night	Day	Night	Day	Night	Day	Night
10	32.8%	36.5%	0.5%	1.1%	32.3%	35.9%	0.5%	1.0%
28	3.3%	2.7%	56.9%	57.6%	3.2%	2.7%	57.4%	58.2%
15L	2.7%	1.4%	3.5%	2.2%	2.7%	1.4%	3.4%	2.1%
33R	6.1%	3.3%	6.2%	3.9%	6.0%	3.1%	6.1%	3.8%
15R	1.2%	1.5%	32.2%	34.3%	1.2%	1.5%	31.9%	34.1%
33L	53.7%	54.5%	0.5%	0.8%	54.5%	55.2%	0.5%	0.8%
H01	0.2%	0.1%	0.2%	0.1%	0.2%	0.1%	0.2%	0.1%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Sources: Radar Data and HNTB Analysis 2019.

K-3.2.8 Track Geometry and Utilization

Track geometry and utilization were consistent with the Existing Conditions.

K-3.3 Noise Contours and Comparison

The 2022 and 2027 noise contours were modeled using the noise inputs described in the previous sections. **Figures K-3-1** and **K-3-2** show the 2022 Proposed Actions and No Action noise contours. **Figure K-3-3** compares the 2022 Proposed Actions and No Action noise contours with

[2] U.S. Geological Survey, Multi-Resolution Land Characteristics Consortium (MRLC), National Land Cover Database (NLCD), U.S. Department of Interior, http://www.mrlc.gov/finddata.php.

the 2018 Existing Conditions noise contours. **Figures K-3-4** and **K-3-5** show the 2027 Proposed Actions and No Action noise contours. **Figure K-3-6** compares the 2027 Proposed Actions and No Action noise contours with the 2018 Existing Conditions noise contours.

Compared with the 2018 Existing Conditions, the areas within 65+ DNL are projected to increase by 10.5% in 2022 and 11.6% in 2027 under the Proposed Actions scenarios. Under the No Action scenarios, the areas within 65+ DNL are projected to increase by 9.7% in 2022 and 10.7% in 2027. A direct comparison between the No Action and Proposed Action 65+ DNL contour areas indicates that the Proposed Action is expected to increase the contour area by less than 1.0% in both 2022 and 2027. **Table K-3.9** shows the areas within 65+ DNL for the Existing Conditions, No Action, and Proposed Actions scenarios.

Table K-3.9
65+ DNL Areas

Scenarios	65+ DNL Area (acres)	% Increase vs. Existing Conditions	% Increase vs. No Action
2018 Existing Conditions	4,119.6	N/A	N/A
2022 No Action	4,520.1	9.7%	N/A
2027 No Action	4,561.4	10.7%	N/A
2022 Proposed Actions	4,552.1	10.5%	0.7%
2027 Proposed Actions	4,595.4	11.6%	0.8%

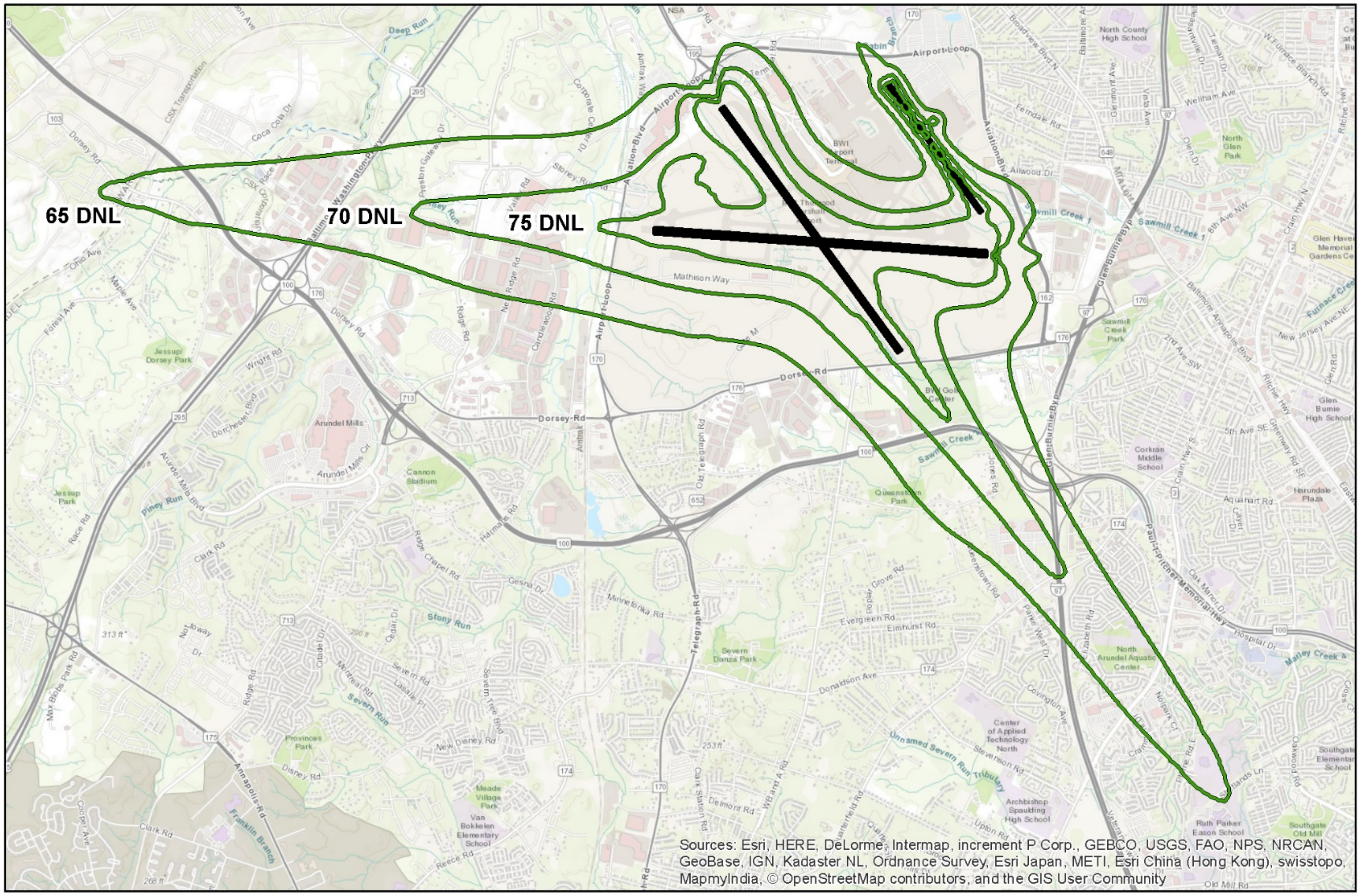
Sources: HNTB Analysis 2019.

The increase of the contour area was primarily driven by the increase in operations projected between the Existing Conditions and Future Scenarios, additional run-up operations projected due to the proposed airline maintenance facility, and changes in the fleet mixes. More specifically, the increases of the contour area along runway centerlines were primarily due to the increase in operations and changes in the fleet mixes. The increase of the contour area between Runways 10 and 15R was primary driven by the engine maintenance run-up operations that would occur at the proposed airline maintenance center.

The BWI EA 2022 Proposed Action noise contours were also compared with the Part 150 Study 2019 noise contours, which is shown in **Figure K-3-7**. Compared with the Part 150 Study 2019 noise contours, the areas within the 65+DNL of the BWI EA 2022 Proposed Action noise contours are projected to increase by 27.6%. The most significant increase is expected to occur to the northwest of the airport between Runway 10 and Runway 15R. Areas to the southeast of the airport along the Runway 15R/33L extended centerline are also expected to experience an increase of noise level. The differences between the BWI EA 2022 and Part 150 Study 2019 noise contours can be attributed to various factors including differences in fleet mixes and operations, day/night split, stage lengths, runway and track utilization, procedure changes, engine maintenance location and frequency, approach and departure procedures, and meteorological conditions.

BWI Marshall Airport Noise Contour Comparison

HNTB



LEGEND

- 2022 Proposed Action Noise Contour
- BWI Airport Runway

Figure K-3-1: BWI EA (2022) Proposed Actions Noise Contour

N

0 0.125 0.25 0.5 Nautical Miles

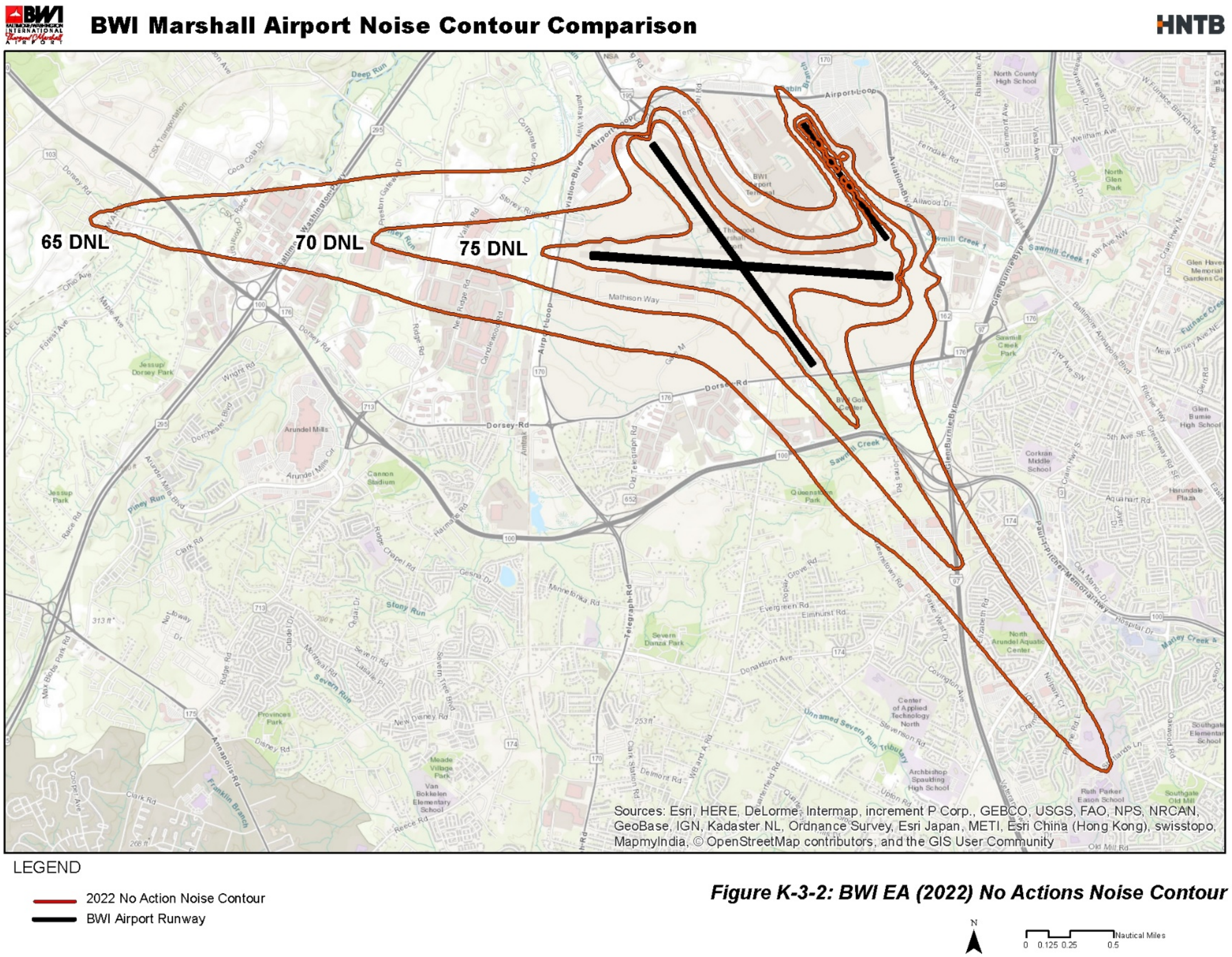
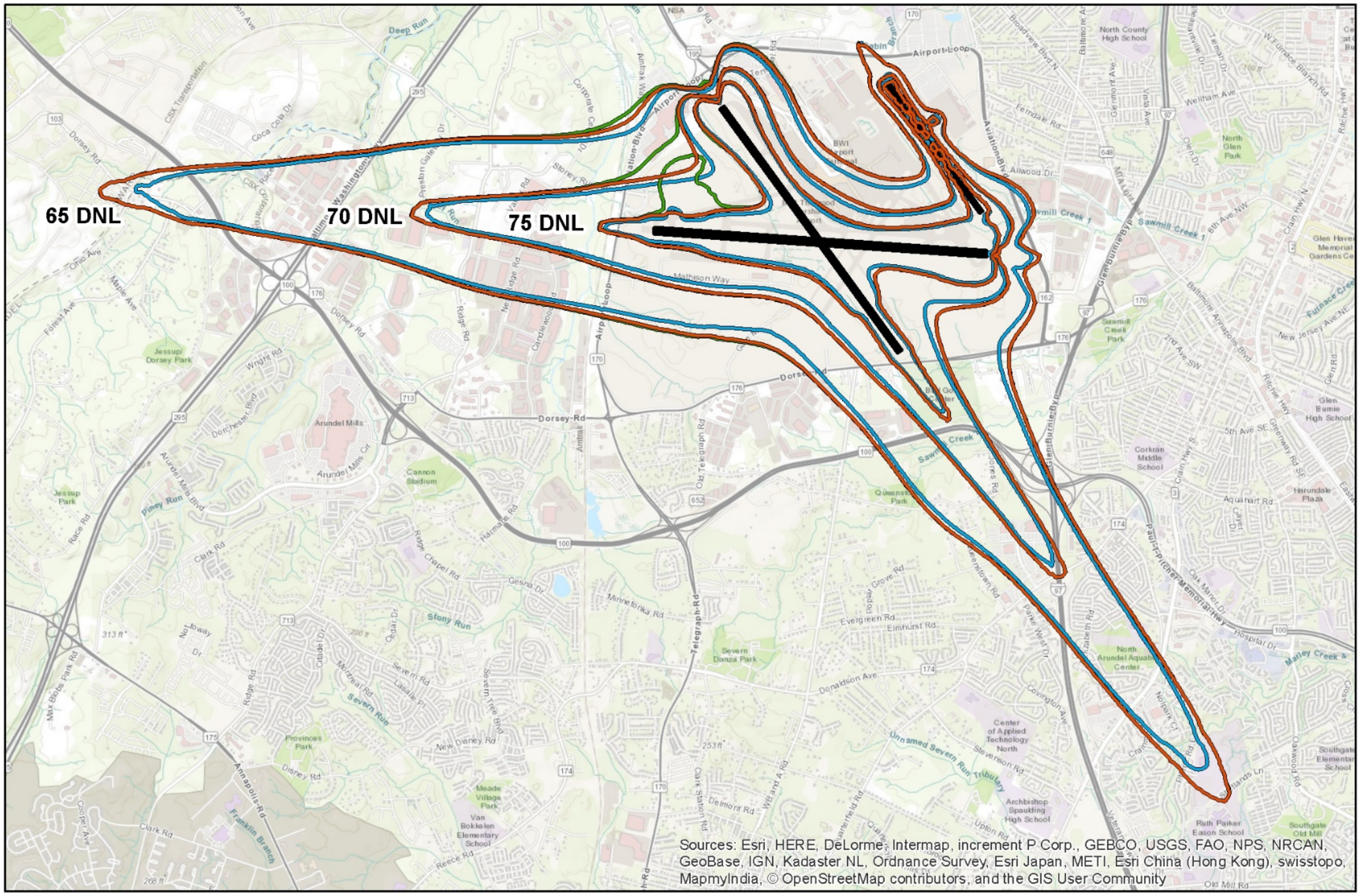


Figure K-3-2: BWI EA (2022) No Actions Noise Contour

BWI Marshall Airport Noise Contour Comparison

HNTB



LEGEND

- 2022 Proposed Action Noise Contour
- 2022 No Action Noise Contour
- 2018 Existing Conditions Noise Contour
- BWI Airport Runway

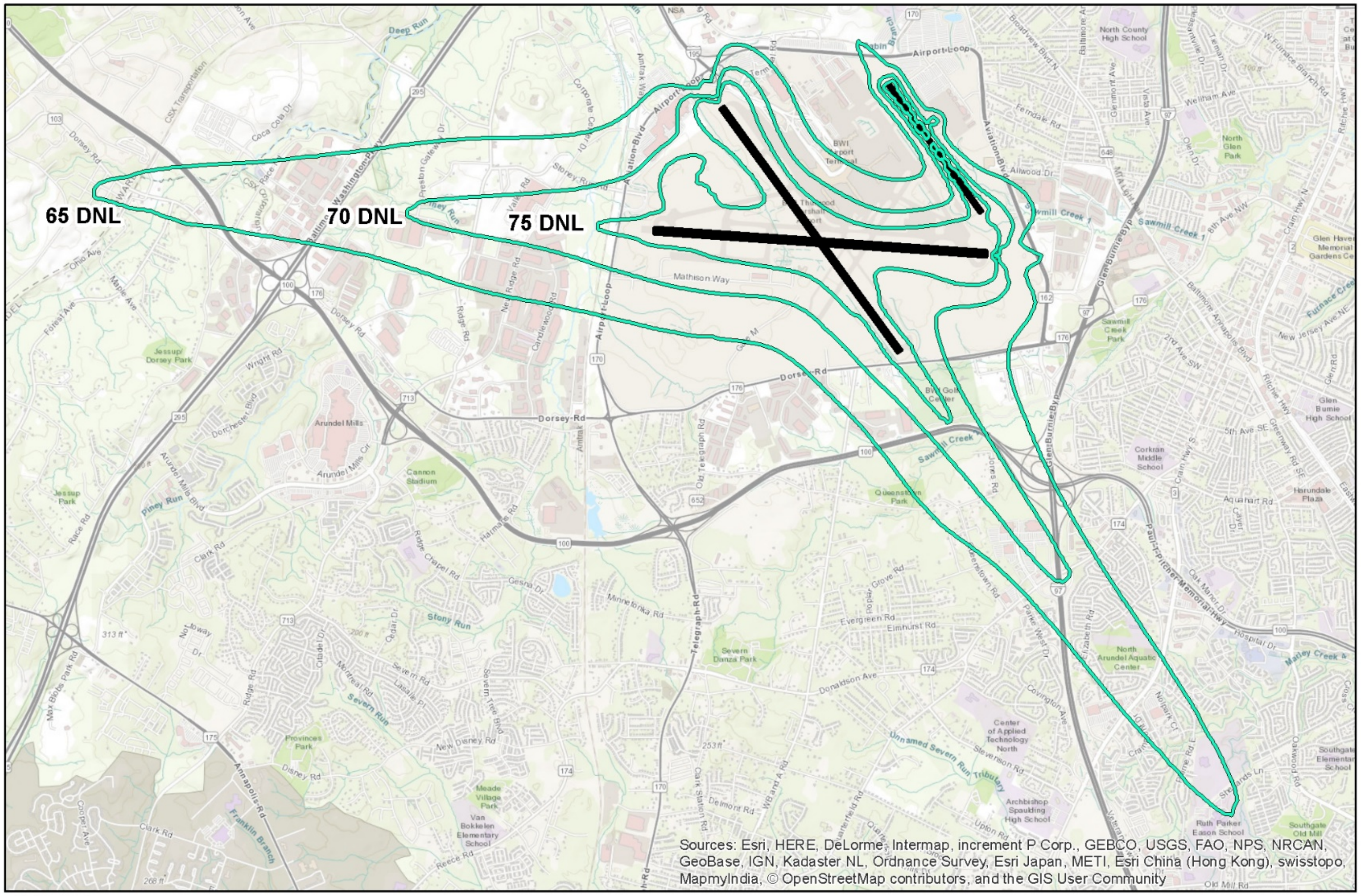
Figure K-3-3: BWI EA (2022) Proposed Action and No Action vs. Existing Conditions

N

0 0.125 0.25 0.5 Nautical Miles

BWI Marshall Airport Noise Contour Comparison

HNTB



LEGEND

- 2027 Proposed Action Noise Contour
- BWI Airport Runway

Figure K-3-4: BWI EA (2027) Proposed Actions Noise Contour

N

0 0.125 0.25 0.5 Nautical Miles

BWI Marshall Airport Noise Contour Comparison

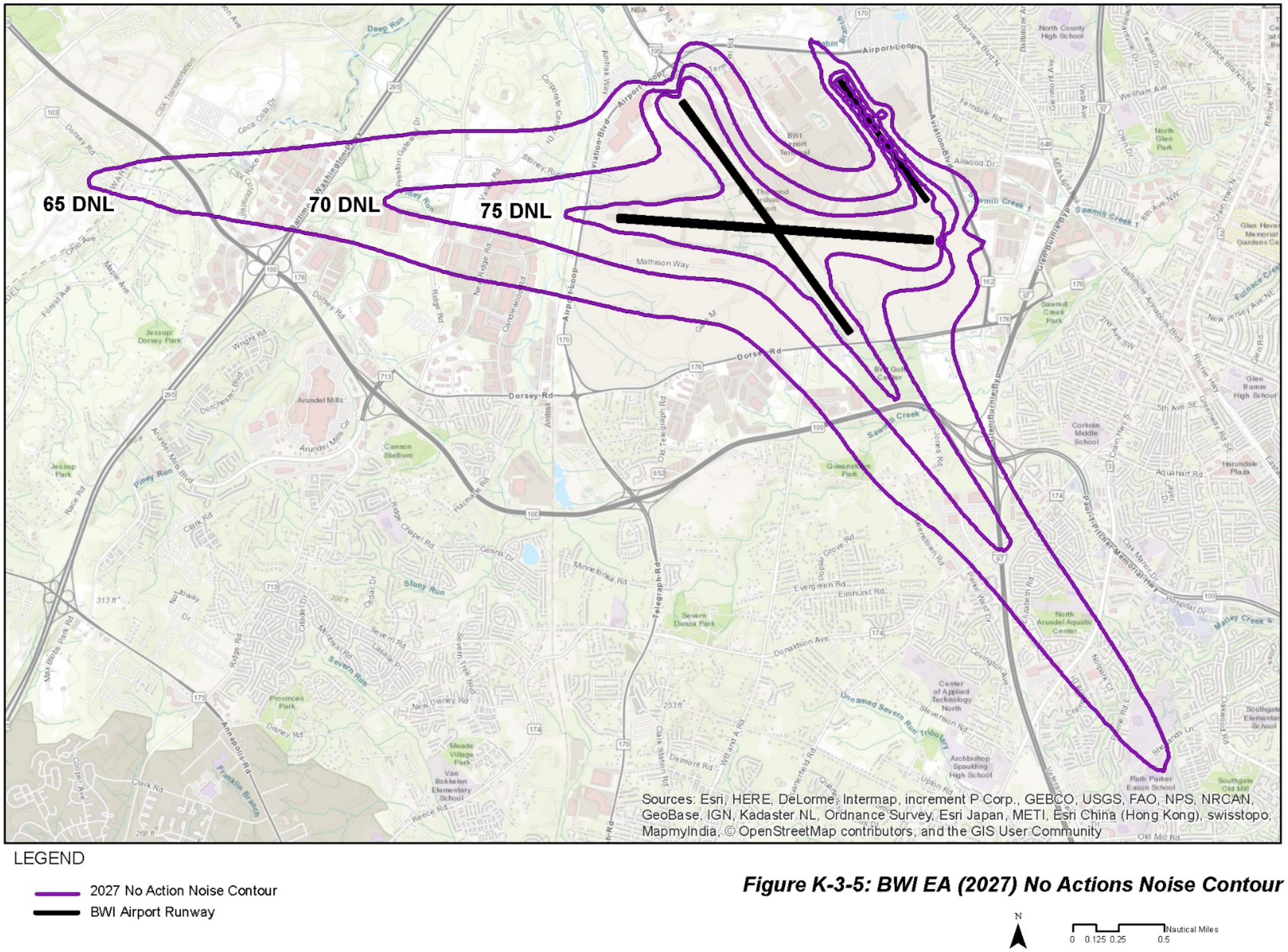


Figure K-3-5: BWI EA (2027) No Actions Noise Contour

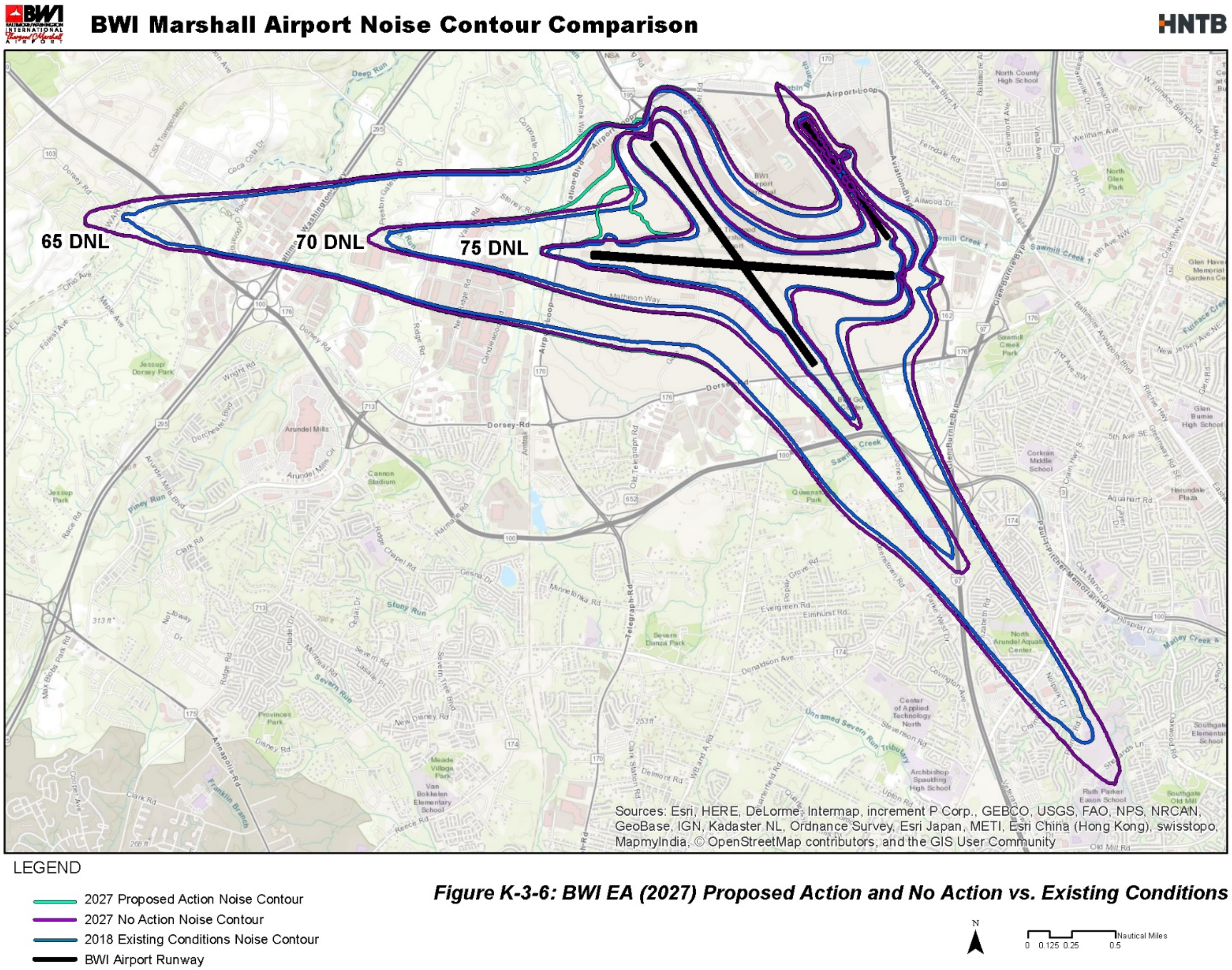


Figure K-3-6: BWI EA (2027) Proposed Action and No Action vs. Existing Conditions

BWI Marshall Airport Noise Contour Comparison

HNTB

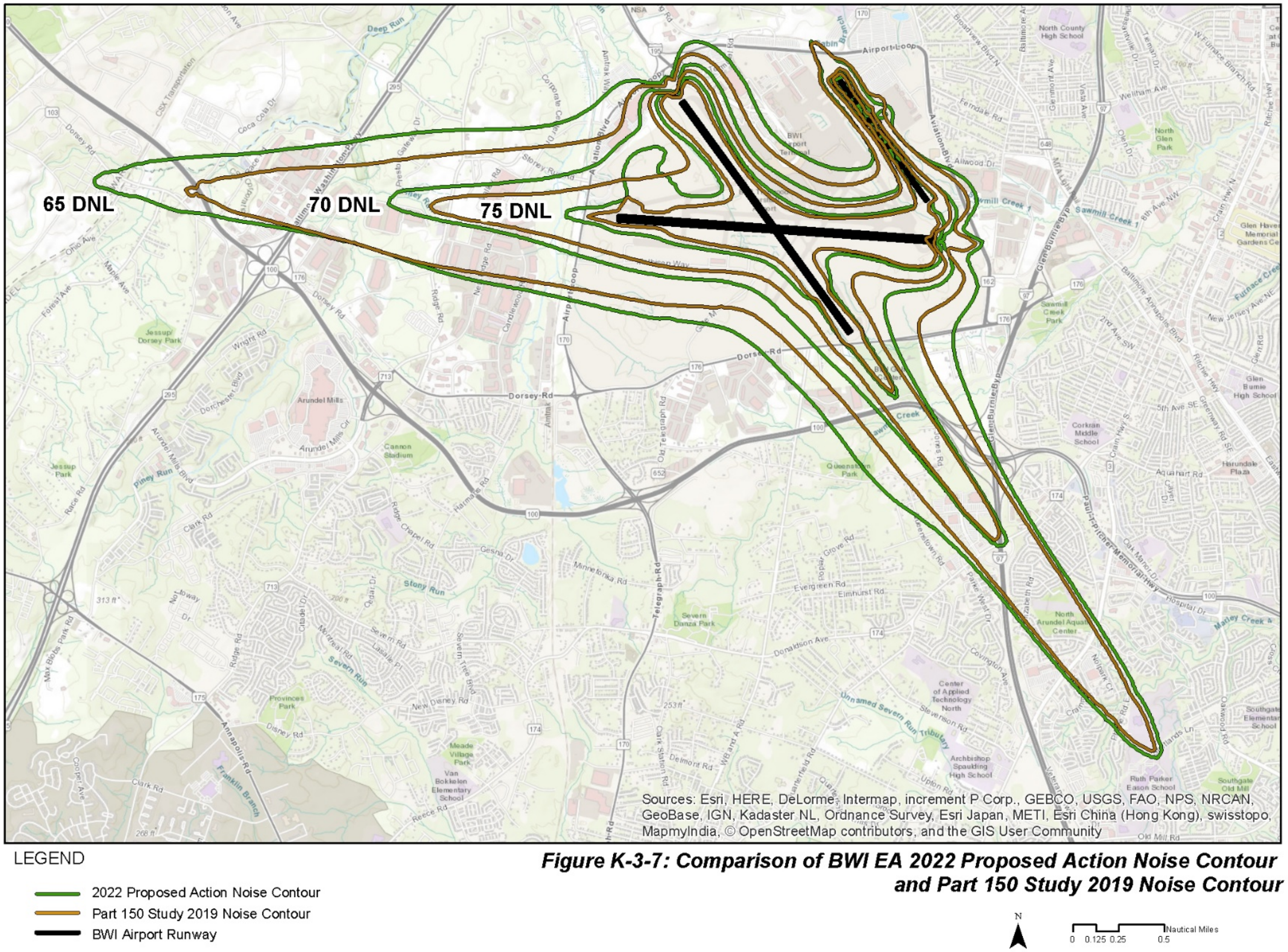


Figure K-3-7: Comparison of BWI EA 2022 Proposed Action Noise Contour and Part 150 Study 2019 Noise Contour

Attachment 1:

Future Scenarios Fleet Mix Tables

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Table K.1

Fleet Mix in 2022

Aircraft Category	AEDT Aircraft ID	Arrivals		Departures		Total
		Day	Night	Day	Night	
Air Carrier	727EM2	0.01	0.00	0.01	0.00	0.03
	737400	0.12	0.02	0.12	0.02	0.27
	737500	0.01	0.00	0.01	0.00	0.01
	737700	99.29	16.36	97.21	18.43	231.29
	737800	57.40	17.17	62.80	11.78	149.16
	7378MAX	30.81	4.65	31.76	3.69	70.92
	737N17	0.00	0.00	0.00	0.00	0.00
	737N9	0.00	0.00	0.00	0.00	0.00
	74720B	0.01	0.00	0.01	0.01	0.02
	747400	0.12	0.11	0.13	0.11	0.47
	757PW	0.06	0.50	0.47	0.09	1.12
	757RR	0.13	0.54	0.56	0.11	1.34
	767300	10.44	10.13	11.71	8.86	41.14
	767CF6	0.03	0.01	0.02	0.02	0.09
	767JT9	0.02	0.00	0.02	0.00	0.05
	777200	0.11	0.06	0.10	0.06	0.33
	7878R	0.89	0.01	0.73	0.17	1.80
	A300-622R	0.41	0.49	0.50	0.40	1.81
	A319-131	6.56	2.31	7.96	0.91	17.75
	A320-211	5.00	0.42	5.09	0.33	10.85
	A320-232	13.42	5.30	15.95	2.76	37.43
	A321-232	17.55	5.13	18.23	4.46	45.37
	A330-301	0.00	0.00	0.00	0.00	0.01
	A330-343	0.58	0.00	0.57	0.01	1.17
	CL600	3.66	0.21	3.58	0.29	7.75
	CNA208	10.95	1.83	11.15	1.63	25.57
	CRJ9-ER	2.61	0.20	2.70	0.11	5.62
	DHC6	0.01	0.00	0.01	0.00	0.01
	DHC830	0.04	0.03	0.04	0.02	0.14
	EMB145	7.18	0.05	7.17	0.06	14.46
	EMB170	2.10	0.61	1.96	0.75	5.44
	EMB175	1.95	0.01	1.95	0.01	3.91
	EMB190	0.88	0.22	0.87	0.23	2.20
	FAL20	0.00	0.01	0.00	0.00	0.01
	LEAR35	0.07	0.04	0.07	0.04	0.22
	MD11GE	0.02	0.32	0.21	0.14	0.69
	MD11PW	0.01	0.14	0.09	0.06	0.29

Table K.1
Fleet Mix in 2022

Aircraft Category	AEDT Aircraft ID	Arrivals		Departures		Total
		Day	Night	Day	Night	
	MD9025	1.49	0.20	1.46	0.22	3.36
	MD9028	1.66	0.22	1.63	0.25	3.76
Air Carrier Total		275.60	67.32	286.87	56.05	685.84
Air Taxi	1900D	0.01	0.00	0.01	0.00	0.01
	737700	0.03	0.00	0.01	0.01	0.05
	A109	0.00	0.00	0.00	0.00	0.00
	B206L	0.00	0.00	0.00	0.00	0.00
	B407	0.00	0.00	0.00	0.00	0.01
	B427	0.00	0.00	0.00	0.00	0.00
	B429	0.00	0.00	0.00	0.00	0.01
	B430	0.00	0.00	0.00	0.00	0.00
	BD-700-1A10	0.07	0.01	0.08	0.00	0.16
	BD-700-1A11	0.08	0.00	0.07	0.01	0.15
	BEC58P	0.04	0.01	0.05	0.01	0.11
	C12	0.02	0.01	0.02	0.01	0.07
	CIT3	0.01	0.00	0.01	0.00	0.01
	CL600	1.25	0.09	1.28	0.06	2.70
	CL601	0.25	0.02	0.24	0.02	0.52
	CNA172	0.01	0.00	0.01	0.00	0.02
	CNA182	0.00	0.00	0.00	0.00	0.01
	CNA208	0.41	0.02	0.40	0.03	0.85
	CNA441	0.02	0.01	0.03	0.00	0.05
	CNA500	0.22	0.01	0.21	0.02	0.46
	CNA510	0.14	0.00	0.14	0.00	0.27
	CNA525C	0.03	0.00	0.03	0.00	0.07
	CNA55B	1.18	0.06	1.19	0.05	2.48
	CNA560E	0.11	0.01	0.11	0.01	0.23
	CNA560U	0.11	0.01	0.11	0.01	0.23
	CNA560XL	1.30	0.06	1.30	0.06	2.72
	CNA680	1.22	0.07	1.24	0.04	2.57
	CNA750	1.09	0.08	1.11	0.06	2.34
	COMSEP	0.02	0.00	0.02	0.00	0.05
	CRJ9-ER	0.01	0.00	0.01	0.00	0.03
	DC93LW	0.00	0.00	0.00	0.00	0.01
	DHC6	0.36	0.04	0.37	0.02	0.80
	EC130	0.00	0.00	0.00	0.00	0.00
	EMB120	0.00	0.00	0.00	0.00	0.01

Table K.1
Fleet Mix in 2022

Aircraft Category	AEDT Aircraft ID	Arrivals		Departures		Total
		Day	Night	Day	Night	
	EMB145	0.06	0.03	0.08	0.01	0.17
	FAL20	0.01	0.00	0.01	0.00	0.02
	GASEPF	0.01	0.00	0.01	0.00	0.03
	GASEPV	0.04	0.00	0.04	0.00	0.07
	GII	0.00	0.00	0.00	0.00	0.01
	GIV	0.55	0.04	0.57	0.03	1.18
	GV	0.14	0.01	0.14	0.01	0.30
	H500D	0.00	0.00	0.00	0.00	0.00
	IA1125	0.15	0.02	0.15	0.01	0.32
	LEAR25	0.00	0.00	0.00	0.00	0.01
	LEAR35	0.67	0.06	0.66	0.07	1.47
	MU3001	0.51	0.03	0.52	0.02	1.07
	PA28	0.00	0.00	0.00	0.00	0.00
	PA42	0.31	0.02	0.32	0.01	0.67
	R44	0.00	0.00	0.00	0.00	0.00
	S70	0.00	0.00	0.00	0.00	0.00
	S76	0.02	0.00	0.02	0.00	0.04
	SA330J	0.04	0.01	0.04	0.00	0.08
	SA350D	0.00	0.00	0.00	0.00	0.01
	SA365N	0.00	0.00	0.00	0.00	0.00
	SF340	0.00	0.00	0.00	0.00	0.01
Air Taxi Total		10.51	0.71	10.64	0.58	22.43
General Aviation	1900D	0.01	0.00	0.01	0.00	0.02
	737700	0.01	0.00	0.01	0.00	0.03
	737N17	0.00	0.00	0.00	0.00	0.00
	737N9	0.00	0.00	0.00	0.00	0.00
	A109	0.00	0.00	0.00	0.00	0.01
	B206L	0.05	0.01	0.06	0.00	0.12
	B407	0.03	0.00	0.02	0.01	0.06
	B427	0.01	0.00	0.01	0.00	0.03
	B429	0.14	0.01	0.14	0.00	0.30
	B430	0.04	0.01	0.04	0.01	0.11
	BD-700-1A10	0.17	0.01	0.17	0.01	0.36
	BD-700-1A11	0.05	0.00	0.05	0.00	0.10
	BEC58P	0.49	0.02	0.50	0.01	1.02
	C12	0.21	0.01	0.21	0.01	0.45
	CIT3	0.23	0.02	0.23	0.02	0.49

Table K.1
Fleet Mix in 2022

Aircraft Category	AEDT Aircraft ID	Arrivals		Departures		Total
		Day	Night	Day	Night	
	CL600	0.67	0.04	0.67	0.03	1.41
	CL601	0.25	0.02	0.26	0.01	0.55
	CNA172	0.53	0.01	0.53	0.00	1.07
	CNA182	0.13	0.00	0.12	0.01	0.26
	CNA206	0.17	0.00	0.17	0.00	0.35
	CNA208	0.58	0.75	0.51	0.82	2.67
	CNA20T	0.01	0.00	0.01	0.00	0.01
	CNA441	0.32	0.02	0.33	0.01	0.67
	CNA500	0.75	0.04	0.76	0.03	1.58
	CNA510	0.16	0.02	0.16	0.02	0.36
	CNA525C	0.15	0.02	0.17	0.00	0.34
	CNA55B	0.35	0.03	0.34	0.05	0.77
	CNA560E	0.13	0.01	0.12	0.02	0.28
	CNA560U	0.13	0.01	0.12	0.02	0.28
	CNA560XL	0.68	0.02	0.67	0.02	1.39
	CNA680	0.38	0.01	0.38	0.01	0.78
	CNA750	1.85	0.17	1.90	0.12	4.03
	COMSEP	1.16	0.02	1.08	0.11	2.37
	DC3	0.00	0.00	0.00	0.00	0.01
	DHC6	0.44	0.03	0.43	0.04	0.94
	DO328	0.00	0.00	0.00	0.00	0.01
	EC130	0.03	0.01	0.04	0.00	0.09
	ECLIPSE500	0.09	0.00	0.08	0.01	0.18
	EMB145	0.04	0.02	0.05	0.01	0.12
	EMB170	0.00	0.00	0.00	0.00	0.01
	EMB190	0.03	0.00	0.02	0.00	0.05
	FAL20	0.04	0.00	0.04	0.00	0.07
	GASEPF	0.07	0.01	0.08	0.01	0.17
	GASEPV	0.53	0.01	0.52	0.02	1.07
	GII	0.01	0.00	0.01	0.00	0.02
	GIV	0.48	0.05	0.47	0.06	1.07
	GV	0.52	0.08	0.56	0.03	1.20
	H500D	0.00	0.00	0.00	0.00	0.01
	HS748A	0.01	0.00	0.01	0.00	0.01
	IA1125	0.34	0.03	0.34	0.02	0.73
	LEAR35	1.34	0.14	1.36	0.12	2.96
	MU3001	0.31	0.03	0.32	0.01	0.67

Table K.1

Fleet Mix in 2022

Aircraft Category	AEDT Aircraft ID	Arrivals		Departures		Total
		Day	Night	Day	Night	
	PA28	0.04	0.01	0.04	0.00	0.09
	PA30	0.01	0.00	0.01	0.00	0.01
	PA42	0.09	0.00	0.09	0.01	0.19
	R44	0.01	0.00	0.01	0.00	0.03
	S70	0.01	0.00	0.01	0.00	0.01
	S76	0.10	0.01	0.10	0.01	0.23
	SA330J	0.02	0.01	0.03	0.00	0.06
	SA350D	0.00	0.00	0.01	0.00	0.01
	SA365N	0.00	0.00	0.00	0.00	0.00
	SF340	0.00	0.00	0.00	0.00	0.01
	T33A	0.00	0.00	0.00	0.00	0.01
General Aviation Total		14.43	1.72	14.41	1.74	32.30
Military	737700	0.01	0.00	0.01	0.00	0.02
	A321-232	0.00	0.00	0.00	0.00	0.01
	B429	0.00	0.00	0.00	0.00	0.01
	BAC111	0.12	0.00	0.12	0.00	0.24
	BD-700-1A10	0.00	0.00	0.00	0.00	0.01
	BD-700-1A11	0.00	0.00	0.00	0.00	0.01
	BEC58P	0.01	0.00	0.01	0.00	0.02
	C12	0.16	0.01	0.16	0.01	0.34
	C-130E	0.01	0.00	0.01	0.00	0.02
	C130HP	0.00	0.00	0.00	0.00	0.01
	CL600	0.01	0.00	0.01	0.00	0.02
	CL601	0.00	0.00	0.00	0.00	0.00
	CNA172	0.01	0.00	0.01	0.00	0.02
	CNA182	0.03	0.00	0.03	0.00	0.06
	CNA206	0.00	0.00	0.00	0.00	0.01
	CNA208	0.00	0.00	0.00	0.00	0.01
	CNA55B	0.01	0.00	0.01	0.00	0.02
	CNA560E	0.01	0.00	0.01	0.00	0.02
	CNA560U	0.01	0.00	0.01	0.00	0.02
	CNA680	0.01	0.00	0.01	0.00	0.02
	CNA750	0.01	0.00	0.01	0.00	0.02
	COMSEP	0.00	0.00	0.00	0.00	0.01
	CRJ9-ER	0.45	0.02	0.45	0.01	0.93
	DHC6	0.01	0.00	0.01	0.00	0.02
	DHC6QP	0.00	0.00	0.00	0.00	0.01

Table K.1

Fleet Mix in 2022

Aircraft Category	AEDT Aircraft ID	Arrivals		Departures		Total
		Day	Night	Day	Night	
	DHC8	0.13	0.01	0.13	0.00	0.27
	DHC830	0.00	0.00	0.00	0.00	0.00
	DO328	0.01	0.00	0.01	0.00	0.02
	F-18	0.01	0.00	0.01	0.00	0.02
	GASEPV	0.02	0.00	0.02	0.00	0.05
	GII	0.03	0.00	0.03	0.00	0.05
	GIV	0.04	0.00	0.04	0.00	0.08
	GV	0.04	0.00	0.04	0.00	0.09
	KC135R	0.00	0.00	0.00	0.00	0.01
	LEAR25	0.00	0.00	0.00	0.00	0.01
	LEAR35	0.01	0.00	0.01	0.00	0.02
	MU3001	0.01	0.00	0.01	0.00	0.02
	S70	0.01	0.00	0.01	0.00	0.03
	S76	0.00	0.00	0.00	0.00	0.01
	SA365N	0.00	0.00	0.00	0.00	0.01
	SABR80	0.06	0.00	0.07	0.00	0.14
	T-38A	0.00	0.00	0.00	0.00	0.01
Military Total		1.26	0.05	1.28	0.04	2.63
Grand Total		301.80	69.80	313.20	58.40	743.20

Sources: HNTB Fleet Mix Forecast for BWI EA, 2019

Table K.2

Fleet Mix in 2027

Aircraft Category	AEDT Aircraft ID	Arrivals		Departures		Total
		Day	Night	Day	Night	
Air Carrier	737400	0.05	0.01	0.05	0.01	0.11
	737700	90.33	15.12	88.90	16.55	210.90
	737800	54.44	16.07	59.48	11.03	141.02
	7378MAX	60.16	10.13	59.50	10.79	140.58
	74720B	0.01	0.00	0.01	0.01	0.02
	747400	0.13	0.12	0.13	0.11	0.49
	757PW	0.02	0.48	0.42	0.08	1.01
	757RR	0.02	0.54	0.47	0.09	1.12
	767300	10.92	10.58	12.21	9.28	42.98
	767JT9	0.01	0.00	0.01	0.00	0.01

Table K.2
Fleet Mix in 2027

Aircraft Category	AEDT Aircraft ID	Arrivals		Departures		Total
		Day	Night	Day	Night	
	777200	0.11	0.06	0.10	0.06	0.33
	7878R	0.89	0.01	0.73	0.17	1.80
	A300-622R	0.21	0.27	0.27	0.21	0.96
	A319-131	6.45	2.31	7.85	0.91	17.51
	A320-211	4.65	0.34	4.71	0.28	9.98
	A320-232	12.63	4.83	14.87	2.59	34.92
	A321-232	19.47	6.87	22.64	3.70	52.66
	A330-301	0.00	0.00	0.00	0.00	0.01
	A330-343	0.58	0.00	0.57	0.01	1.17
	CL600	3.20	0.19	3.13	0.27	6.78
	CNA208	11.87	1.84	12.07	1.64	27.42
	CRJ9-ER	3.41	0.25	3.52	0.14	7.32
	DHC6	0.01	0.00	0.01	0.00	0.01
	DHC830	0.16	0.11	0.17	0.10	0.53
	EMB145	10.39	0.40	10.22	0.56	21.57
	EMB170	2.11	0.61	1.97	0.75	5.44
	EMB175	2.22	0.01	2.22	0.01	4.46
	EMB190	0.01	0.00	0.01	0.00	0.01
	FAL20	0.00	0.01	0.00	0.00	0.01
	LEAR35	0.07	0.04	0.07	0.04	0.22
	MD11GE	0.02	0.32	0.21	0.14	0.69
	MD11PW	0.01	0.14	0.09	0.06	0.29
Air Carrier Total		294.52	71.66	306.59	59.58	732.35
Air Taxi	1900D	0.01	0.00	0.01	0.00	0.01
	737700	0.03	0.00	0.02	0.01	0.05
	A109	0.00	0.00	0.00	0.00	0.00
	B206L	0.00	0.00	0.00	0.00	0.00
	B407	0.00	0.00	0.00	0.00	0.01
	B427	0.00	0.00	0.00	0.00	0.00
	B429	0.00	0.00	0.00	0.00	0.01
	B430	0.00	0.00	0.00	0.00	0.00
	BD-700-1A10	0.08	0.01	0.08	0.00	0.17
	BD-700-1A11	0.08	0.00	0.08	0.01	0.16
	BEC58P	0.04	0.01	0.04	0.00	0.10
	C12	0.02	0.01	0.02	0.01	0.07
	CIT3	0.01	0.00	0.01	0.00	0.01
	CL600	1.36	0.10	1.40	0.07	2.93

Table K.2

Fleet Mix in 2027

Aircraft Category	AEDT Aircraft ID	Arrivals		Departures		Total
		Day	Night	Day	Night	
	CL601	0.27	0.02	0.26	0.02	0.57
	CNA172	0.01	0.00	0.01	0.00	0.02
	CNA182	0.00	0.00	0.00	0.00	0.01
	CNA208	0.40	0.02	0.39	0.03	0.83
	CNA441	0.02	0.01	0.03	0.00	0.05
	CNA500	0.24	0.01	0.23	0.02	0.50
	CNA510	0.15	0.00	0.15	0.00	0.30
	CNA525C	0.04	0.00	0.03	0.00	0.07
	CNA55B	1.29	0.06	1.29	0.05	2.69
	CNA560E	0.12	0.01	0.12	0.01	0.25
	CNA560U	0.12	0.01	0.12	0.01	0.25
	CNA560XL	1.41	0.06	1.42	0.06	2.95
	CNA680	1.32	0.08	1.35	0.05	2.80
	CNA750	1.18	0.09	1.20	0.07	2.54
	COMSEP	0.02	0.00	0.02	0.00	0.04
	CRJ9-ER	0.02	0.00	0.01	0.00	0.03
	DC93LW	0.00	0.00	0.00	0.00	0.01
	DHC6	0.35	0.04	0.37	0.02	0.78
	EC130	0.00	0.00	0.00	0.00	0.00
	EMB120	0.00	0.00	0.00	0.00	0.01
	EMB145	0.06	0.03	0.08	0.01	0.18
	FAL20	0.01	0.00	0.01	0.00	0.02
	GASEPF	0.01	0.00	0.01	0.00	0.03
	GASEPV	0.03	0.00	0.03	0.00	0.06
	GII	0.00	0.00	0.00	0.00	0.01
	GIV	0.60	0.04	0.61	0.03	1.28
	GV	0.15	0.01	0.15	0.01	0.32
	H500D	0.00	0.00	0.00	0.00	0.00
	IA1125	0.16	0.02	0.17	0.01	0.35
	LEAR25	0.00	0.00	0.00	0.00	0.01
	LEAR35	0.73	0.07	0.72	0.07	1.59
	MU3001	0.55	0.03	0.56	0.02	1.16
	PA28	0.00	0.00	0.00	0.00	0.00
	PA42	0.30	0.02	0.31	0.01	0.66
	R44	0.00	0.00	0.00	0.00	0.00
	S70	0.00	0.00	0.00	0.00	0.00
	S76	0.02	0.00	0.02	0.00	0.04

Table K.2

Fleet Mix in 2027

Aircraft Category	AEDT Aircraft ID	Arrivals		Departures		Total
		Day	Night	Day	Night	
	SA330J	0.04	0.01	0.04	0.00	0.08
	SA350D	0.00	0.00	0.00	0.00	0.01
	SA365N	0.00	0.00	0.00	0.00	0.00
	SF340	0.00	0.00	0.00	0.00	0.01
Air Taxi Total		11.26	0.76	11.40	0.61	24.04
General Aviation	1900D	0.01	0.00	0.01	0.00	0.02
	737700	0.01	0.00	0.01	0.00	0.03
	737N17	0.00	0.00	0.00	0.00	0.00
	737N9	0.00	0.00	0.00	0.00	0.00
	A109	0.00	0.00	0.00	0.00	0.01
	B206L	0.05	0.01	0.06	0.00	0.12
	B407	0.03	0.00	0.02	0.01	0.06
	B427	0.01	0.00	0.01	0.00	0.03
	B429	0.14	0.01	0.14	0.00	0.30
	B430	0.04	0.01	0.04	0.01	0.11
	BD-700-1A10	0.18	0.01	0.18	0.01	0.39
	BD-700-1A11	0.05	0.00	0.05	0.00	0.11
	BEC58P	0.44	0.02	0.45	0.01	0.92
	C12	0.21	0.01	0.20	0.01	0.44
	CIT3	0.24	0.02	0.25	0.02	0.53
	CL600	0.72	0.04	0.72	0.03	1.51
	CL601	0.27	0.02	0.28	0.02	0.58
	CNA172	0.44	0.01	0.45	0.00	0.90
	CNA182	0.11	0.00	0.10	0.00	0.22
	CNA206	0.14	0.00	0.14	0.00	0.29
	CNA208	0.55	0.73	0.48	0.80	2.55
	CNA20T	0.00	0.00	0.00	0.00	0.01
	CNA441	0.31	0.02	0.31	0.01	0.65
	CNA500	0.80	0.04	0.81	0.03	1.69
	CNA510	0.18	0.02	0.18	0.02	0.39
	CNA525C	0.16	0.02	0.18	0.00	0.37
	CNA55B	0.38	0.03	0.36	0.05	0.82
	CNA560E	0.14	0.01	0.13	0.02	0.30
	CNA560U	0.14	0.01	0.13	0.02	0.30
	CNA560XL	0.72	0.02	0.72	0.02	1.48
	CNA680	0.41	0.01	0.41	0.01	0.84
	CNA750	1.97	0.18	2.03	0.13	4.31

Table K.2

Fleet Mix in 2027

Aircraft Category	AEDT Aircraft ID	Arrivals		Departures		Total
		Day	Night	Day	Night	
	COMSEP	0.98	0.02	0.91	0.09	2.00
	DC3	0.00	0.00	0.00	0.00	0.01
	DHC6	0.42	0.03	0.42	0.04	0.91
	DO328	0.00	0.00	0.00	0.00	0.01
	EC130	0.03	0.01	0.04	0.00	0.09
	ECLIPSE500	0.09	0.00	0.08	0.01	0.20
	EMB145	0.04	0.02	0.05	0.01	0.13
	EMB170	0.00	0.00	0.00	0.00	0.01
	EMB190	0.03	0.00	0.02	0.00	0.06
	FAL20	0.04	0.00	0.04	0.00	0.08
	GASEPF	0.07	0.01	0.07	0.01	0.15
	GASEPV	0.45	0.01	0.44	0.02	0.92
	GII	0.01	0.00	0.01	0.00	0.02
	GIV	0.51	0.06	0.51	0.06	1.14
	GV	0.56	0.08	0.60	0.04	1.28
	H500D	0.00	0.00	0.00	0.00	0.01
	HS748A	0.01	0.00	0.01	0.00	0.01
	IA1125	0.36	0.03	0.37	0.02	0.78
	LEAR35	1.43	0.15	1.46	0.13	3.17
	MU3001	0.33	0.03	0.34	0.02	0.71
	PA28	0.03	0.01	0.03	0.00	0.08
	PA30	0.01	0.00	0.01	0.00	0.01
	PA42	0.09	0.00	0.08	0.01	0.18
	R44	0.01	0.00	0.01	0.00	0.03
	S70	0.01	0.00	0.01	0.00	0.01
	S76	0.10	0.01	0.10	0.01	0.23
	SA330J	0.02	0.01	0.03	0.00	0.06
	SA350D	0.00	0.00	0.01	0.00	0.01
	SA365N	0.00	0.00	0.00	0.00	0.00
	SF340	0.00	0.00	0.00	0.00	0.01
	T33A	0.00	0.00	0.00	0.00	0.01
General Aviation Total		14.54	1.73	14.55	1.73	32.55
Military	737700	0.01	0.00	0.01	0.00	0.02
	A321-232	0.00	0.00	0.00	0.00	0.01
	B429	0.00	0.00	0.00	0.00	0.01

Table K.2

Fleet Mix in 2027

Aircraft Category	AEDT Aircraft ID	Arrivals		Departures		Total
		Day	Night	Day	Night	
	BAC111	0.12	0.00	0.12	0.00	0.24
	BD-700-1A10	0.00	0.00	0.00	0.00	0.01
	BD-700-1A11	0.00	0.00	0.00	0.00	0.01
	BEC58P	0.01	0.00	0.01	0.00	0.02
	C12	0.16	0.01	0.16	0.01	0.34
	C-130E	0.01	0.00	0.01	0.00	0.02
	C130HP	0.00	0.00	0.00	0.00	0.01
	CL600	0.01	0.00	0.01	0.00	0.02
	CL601	0.00	0.00	0.00	0.00	0.00
	CNA172	0.01	0.00	0.01	0.00	0.02
	CNA182	0.03	0.00	0.03	0.00	0.06
	CNA206	0.00	0.00	0.00	0.00	0.01
	CNA208	0.00	0.00	0.00	0.00	0.01
	CNA55B	0.01	0.00	0.01	0.00	0.02
	CNA560E	0.01	0.00	0.01	0.00	0.02
	CNA560U	0.01	0.00	0.01	0.00	0.02
	CNA680	0.01	0.00	0.01	0.00	0.02
	CNA750	0.01	0.00	0.01	0.00	0.02
	COMSEP	0.00	0.00	0.00	0.00	0.01
	CRJ9-ER	0.45	0.02	0.45	0.01	0.93
	DHC6	0.01	0.00	0.01	0.00	0.02
	DHC6QP	0.00	0.00	0.00	0.00	0.01
	DHC8	0.13	0.01	0.13	0.00	0.27
	DHC830	0.00	0.00	0.00	0.00	0.00
	DO328	0.01	0.00	0.01	0.00	0.02
	F-18	0.01	0.00	0.01	0.00	0.02
	GASEPV	0.02	0.00	0.02	0.00	0.05
	GII	0.03	0.00	0.03	0.00	0.05
	GIV	0.04	0.00	0.04	0.00	0.08
	GV	0.04	0.00	0.04	0.00	0.09
	KC135R	0.00	0.00	0.00	0.00	0.01
	LEAR25	0.00	0.00	0.00	0.00	0.01
	LEAR35	0.01	0.00	0.01	0.00	0.02
	MU3001	0.01	0.00	0.01	0.00	0.02
	S70	0.01	0.00	0.01	0.00	0.03
	S76	0.00	0.00	0.00	0.00	0.01
	SA365N	0.00	0.00	0.00	0.00	0.01

Table K.2

Fleet Mix in 2027

Aircraft Category	AEDT Aircraft ID	Arrivals		Departures		Total
		Day	Night	Day	Night	
	SABR80	0.06	0.00	0.07	0.00	0.14
	T-38A	0.00	0.00	0.00	0.00	0.01
Military Total		1.26	0.05	1.28	0.04	2.63
Grand Total		321.58	74.20	333.82	61.96	791.56

Sources: HNTB Fleet Mix Forecast for BWI EA, 2019

Appendix K-4

NextGen DC Metroplex Post-Implementation Revisions and Potential Impacts on BWI Marshall EA Noise Contours

(Appendix K-4 was created in response to comments on the January 2018 publication of the Draft EA and Draft Section 4(f) Determination. The public comment response matrix provided in Appendix N, Attachment 1, references Appendix K-4. The existing year fleet mix and noise contours were since updated using radar data from 2018-2019.)

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APPENDIX K-4: NextGen DC Metroplex Post-Implementation Revisions and Potential Impacts on BWI Marshall EA Noise Contours

K-4.1 Introduction

In December of 2013, the FAA approved a number of new Next Generation Air Transportation System (NextGen) procedures throughout the D.C. area, including at BWI Marshall (DC Metroplex). Those original Metroplex procedures were fully implemented by June 2015, and therefore were captured in the five weeks of radar data used for noise contour developments in **Appendix K-2 and K-3**. However, the FAA made a number of post-implementation revisions to procedures after June 2015 which may not have been fully captured in the five weeks of radar data analyzed. The post-implementation revisions were made at various points between October 2015 and March 2016. This appendix analyzes these post-implementation revisions and their potential impacts on the BWI Marshall EA noise contours.

K-4.2 NextGen Post-Implementation Revisions

For the noise analysis in the BWI EA, radar data was selected from five representative weeks between 2015-2016 after the implementation of the original DC Metroplex NextGen procedures, as follows:

- July 26, 2015 – August 1, 2015
- September 20, 2015 – September 26, 2015
- November 29, 2015 – December 5, 2015
- May 22, 2016 – May 28, 2016
- June 12, 2016 – June 18, 2016

The FAA made the following NextGen post-implementation revisions between October 2015 and March 2016[1]:

- October 15, 2015 – ANTHM2 replaced ANTHM1; TRISH1 replaced TROYZ2; and CONLE2 replaced CONLE1.
- December 10, 2015 – RAVNN6 replaced RAVNN5; RIPKN2 replaced RIPKN1; and MIIDY2 replaced MIIDY1.

- February 4, 2016 – CONLE3 replaced CONLE2; FIXET2 replaced FIXET1; and TERPZ6 replaced TERPZ5.
- March 31, 2016 – ANTHM3 replaced ANTHM2; TRISH2 replaced TRISH1.

Therefore, the first three weeks of the radar data analyzed in the BWI EA noise analysis did not fully capture the post-implementation revisions. To analyze the potential impacts to the noise contours, the post-implementation revisions were assessed in detail and were graphically compared with the noise contours.

K-4.3 Potential Impacts on BWI EA Noise Contours due to Post-Implementation Revisions

K-4.3.1 ANTHM2 Replaced ANTHM1

On October 15, 2015, the ANTHM1 Area Navigation (RNAV) Standard Terminal Arrivals (STAR) was refined and became the ANTHM2 RNAV STAR. The following revisions were implemented:

- An additional waypoint, SHEPH, was added between the BUBBI and EAGLL Waypoints with an "At or Below" 15,000 feet constraint.
- The altitudes on the en route transitions were modified to provide a more optimized descent.
- Runway transitions serving Runways 10/28, 15L/33R, and 15R/33L were modified. The runway transition serving Runways 10, 15L, and 15R was extended on the ANTHM2 STAR to turn west on a downwind to Runway 10. The runway transition serving Runways 33L and 33R was modified on the ANTHM2 STAR to provide additional space for BWI departures off Runways 33L and 33R that turn east. A new waypoint, OLBAY, was added and the CRABZ Waypoint was moved northeast to enable this space. The JABBR Waypoint was moved southeast and the HOIST Waypoint was removed to provide a more direct routing from ANTHM to OLBAY. The RUTHE Waypoint was replaced by the FINNZ Waypoint, just east of the previous routing, in order to provide a direct routing for arrivals on the TRISH1 RNAV STAR.
- The routing serving Martin State Airport (MTN) were revised.

Figure K-4-1 reflects the procedure revisions and the BWI Marshall EA 2025 Future Scenario Proposed Action noise contours (PA Noise Contours). Although there were small lateral and vertical procedure path revisions, these revisions occurred numerous miles beyond the 65 DNL contour.

K-4.3.2 ANTHM3 Replaced ANTHM2

On March 31, 2016, the ANTHM2 RNAV STAR was replaced by the ANTHM3 RNAV STAR. The following revisions were implemented:

- The RAAYY Waypoint was added to arrivals to MTN. There were no lateral path revisions.
- A chart note was removed.

Figure K-4-2 reflects the procedure revisions and the PA Noise Contours. There were no lateral path revisions and therefore there would be no impact to the 65 DNL contour.

K-4.3.3 CONLE2 Replaced CONLE1

On October 15, 2015, the CONLE1 RNAV Standard Instrument Departure (SID) was replaced by the CONLE2 RNAV SID. The following revision was implemented:

- The DIXXE Waypoint was renamed to the BOOCK Waypoint.

Figure K-4-3 reflects the procedure revision and the PA Noise Contours. There were no lateral path revisions or reduction in altitudes and therefore there would be no impact to the 65 DNL contour.

K-4.3.4 CONLE3 Replaced CONLE2

On February 4, 2016, the CONLE2 RNAV SID was replaced by the CONLE3 RNAV SID. The following revisions were implemented:

- A Top Altitude crossing restriction was raised from 4,000 ft to 14,000 ft to comply with the FAAO 8260.46F procedure design criteria, which may allow aircraft to climb to a higher altitude sooner.
- The DEKMN Waypoint was renamed to the RAISN Waypoint.

Figure K-4-4 reflects the procedure revisions and the PA Noise Contours. There were no lateral path revisions or reduction in altitudes. Therefore, there would be no impact to the 65 DNL contour.

K-4.3.5 FIXET2 Replaced FIXET1

On February 4, 2016, the FIXET1 RNAV SID was replaced by the FIXET2 RNAV SID. The following revisions were implemented:

- A Top Altitude restriction was raised from 4,000 ft to 14,000 ft to comply with the FAAO 8260.46F procedure design criteria, which may allow aircraft to climb to a higher altitude sooner.
- The DEKMN Waypoint was renamed to the RAISN Waypoint.

Figure K-4-5 reflects the procedure revisions and the PA Noise Contours. There were no lateral path revisions or reduction in altitudes. Therefore, there would be no impact to the 65 DNL contour.

K-4.3.6 MIIDY2 Replaced MIIDY1

On December 10, 2015, the MIIDY2 RNAV STAR was replaced by the MIIDY1 RNAV STAR. The following revisions were implemented:

- Two new runway transitions were added for approaches to Runways 28 and 33R.

- A speed constraint was removed.
- An altitude crossing restriction was added to the JUMGO transition.

Figure K-4-6 reflects the procedure revisions and the PA Noise Contours. There were minor lateral and vertical path revisions with the lower attitude at JUMGO and the new runway transitions. These runway transition additions for Runways 28 and 33R would potentially affect the noise contour. The new runway transitions may affect contours to the east of BWI Marshall, along Runways 28 and 33R. However, the impacts to the 65 DNL noise contour would be minimal because aircraft would still align along the same final approach segment where the noise contours would be impacted. Therefore, the noise impacts would be minimal.

K-4.3.7 RAVNN6 Replaced RAVNN5

On December 10, 2015, the RAVNN5 RNAV STAR was refined and became the RAVNN6 RNAV STAR. The following revisions were implemented:

- The current holding pattern at CAPKO was replaced by two holding patterns at JAYOH and RAVNN.
- An additional en route transition was added.
- The lateral paths of the HBUDA and THHMP were altered.
- Several altitude crossing restrictions were revised to allow aircraft to remain higher and provide segregation from other traffic.

Figure K-4-7 reflects the procedure revisions and the PA Noise Contours. There were lateral and vertical revisions to the procedure but these revisions occurred numerous miles beyond the 65 DNL contour.

K-4.3.8 RIPKN2 Replaced RIPKN1

On December 10, 2015, the RIPKN1 Conventional STAR was refined and became RIPKN2 Conventional STAR. The refinements to the RAVNN5 were carried over to the RIPKN2, including:

- The current holding pattern was replaced by two holding patterns at JAYOH and RAVNN.
- An additional en route transition was added.
- The lateral paths of RIC en route transition was altered.
- A speed restriction of the CSN en route transition was removed.

Figure K-4-8 reflects the procedure revisions and the PA Noise Contours. There were lateral and vertical revisions to the procedure but these revisions occurred numerous miles beyond the 65 DNL contour.

K-4.3.9 TERPZ6 Replaced TERPZ5

On February 4, 2016, the TERPZ5 RNAV SID was replaced by the TERPZ6 RNAV SID. The following revisions were implemented:

- A Top Altitude crossing restriction was raised to a higher altitude to comply with procedure design criteria.
- The WONCE Waypoint was laterally repositioned to a 296⁰ track to provide a 10⁰ departure divergence between the CONLE and TERPZ departure procedures facilitating the use of FAAO 7110.65 5-8-3 (a) Equivalent Lateral Spacing Operations (ELSO) .
- The PIRCH Waypoint was renamed to the SARLY Waypoint.
- Two waypoints, HIRCK, and FOXHL, were added. The Minimum En Route Altitude (MEA) between the HIRCK and FOXHL Waypoints was lowered from 20,000 ft to 17,000 ft.
- The LINSE Waypoint altitude was raised from 13,000 ft to an "At or Above" crossing restriction of 14,000 ft, which may allow aircraft to climb to a higher altitude sooner.
- The LITME Waypoint was moved slightly southeast.
- A chart note was revised.

Figure K-4-9 reflects the procedure revisions and the PA Noise Contours. There were lateral and vertical arrival path procedure revisions that may impact the noise contours. However, these revisions were reflected in the noise model as demonstrated in **Figure K-3-1** in **Appendix K-3**. Therefore, the noise contours depicted in BWI Marshall EA noise analysis reflect the implementation of the TERPZ 6 RNAV SID.

K-4.3.10 TRISH1 Replaced TROYZ1

On October 15, 2015, the TROYZ1 RNAV STAR was refined and became the TRISH1 RNAV STAR. The following revisions were implemented:

- Three additional en route transitions were added to the original NUGGY en route transition.
- Runway transitions to Runways 10/28, 15L/33R, and 15R/33L were revised.
- The routing serving MTN was revised.

Figure K-4-10 reflects the procedure revisions and the PA Noise Contours. There were lateral and vertical path revisions to the procedure but these revisions occurred numerous miles beyond the 65 DNL contour.

K-4.3.11 TRISH2 Replaced TRISH1

On March 31, 2016, the TRISH2 RNAV STAR replaced the TRISH1 RNAV STAR. The following revisions were implemented:

- The RAAYY Waypoint was added with a 4,000 ft crossing restriction on the KMTN transition in order to comply with procedure design criteria.
- The FINNZ Waypoint was revised from a flyover waypoint to a flyby waypoint in order to comply with criteria.
- An altitude crossing restriction of 12,000 ft. was added to the TROYZ Waypoint.
- The aircraft holding pattern leg at the DRRES Waypoint was reduced from ten nautical miles legs to seven nautical miles legs.

- A chart note stating, "Maintain Last Assigned Altitude Until Cleared to Descend via the TRISH STAR" was removed. Speed note reference Mach number was also deleted.

Figure K-4-11 reflects the procedure revisions and the PA Noise Contours. There were lateral and vertical path revisions on the procedure which lower the aircraft arrivals on the TRISH2 RNAV STAR to MTN. However, the revisions had little impacts on the vertical approach paths into BWI. In addition, these revisions occurred numerous miles beyond the 65 DNL contour. Therefore, there would be no impact to the 65 DNL contour.

K-4.4 Summary

This appendix analyzes the 11 post-implementation procedure revisions after the original DC Metroplex OAPM procedures were implemented. The majority of the revisions occurred numerous miles beyond the 65 DNL contour and therefore it is highly unlikely they would introduce any noticeable change to the PA noise contours. In addition, the impacts of STARs on the noise contour would normally occur after the Initial Approach Fixes which were not affected in most of the post-implementation revisions. There were two revisions that would potentially influence the noise contour. The first revision, from MIIDY1 to MIIDY2, would have minimal changes to the east of the airport since aircraft would still align along the same final approach segment where the noise contours would be impacted. The second revision, from TERPZ5 to TERPZ6, was captured in the BWI Marshall EA noise analysis. **Table K-4-1** summarizes the procedure revisions and their potential influence on the PA noise contours.

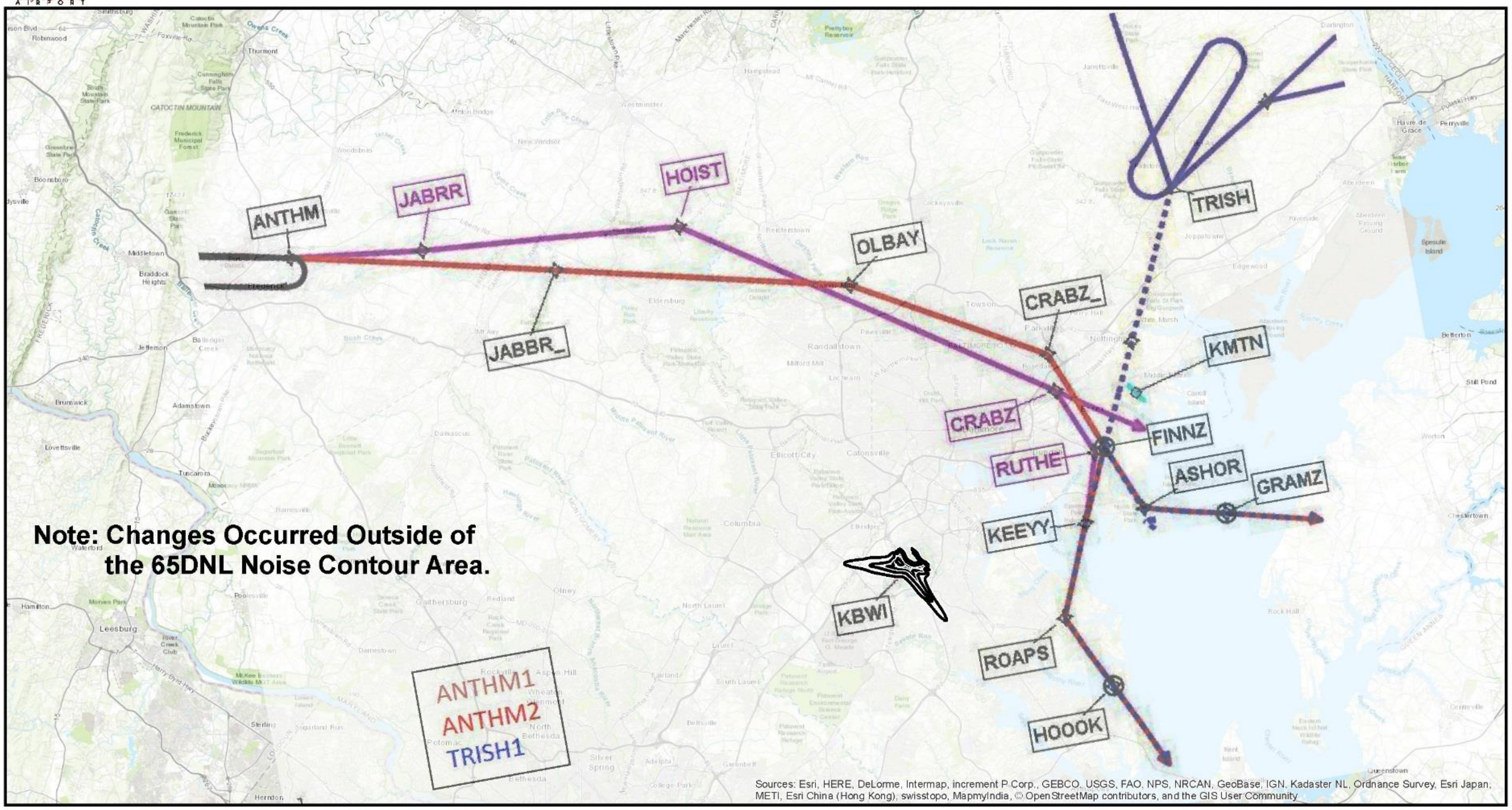
Table K-4.1

Summary of Procedure Revisions and Potential Impacts to PA Noise Contours

Old Procedure	New Procedure	Date	Potential Impact
ANTHM1	ANTHM2	15-Oct-15	Revisions occurred many miles beyond the 65 DNL contour
ANTHM2	ANTHM3	31-Mar-16	No lateral revisions and therefore no impacts on the contour
CONLE1	CONLE2	15-Oct-15	No lateral revisions and therefore no impacts on the contour
CONLE2	CONLE3	4-Feb-16	No lateral revisions and therefore no impacts on the contour
FIXET1	FIXET2	4-Feb-16	No lateral revisions and therefore no impacts on the contour
MIIDY1	MIIDY2	10-Dec-15	Minimal revisions to the contour to the east
RAVNN5	RAVNN6	10-Dec-15	Revisions occurred many miles beyond the 65 DNL contour
RIPKN1	RIPKN2	10-Dec-15	Revisions occurred many miles beyond the 65 DNL contour
TERPZ5	TERPZ6	4-Feb-16	Revisions captured in the noise analysis
TROYZ1	TRISH1	15-Oct-15	Revisions occurred many miles beyond the 65 DNL contour
TRISH1	TRISH2	31-Mar-16	Revisions occurred many miles beyond the 65 DNL contour

Sources: FAA Record of Changes and HNTB Analysis, 2018.

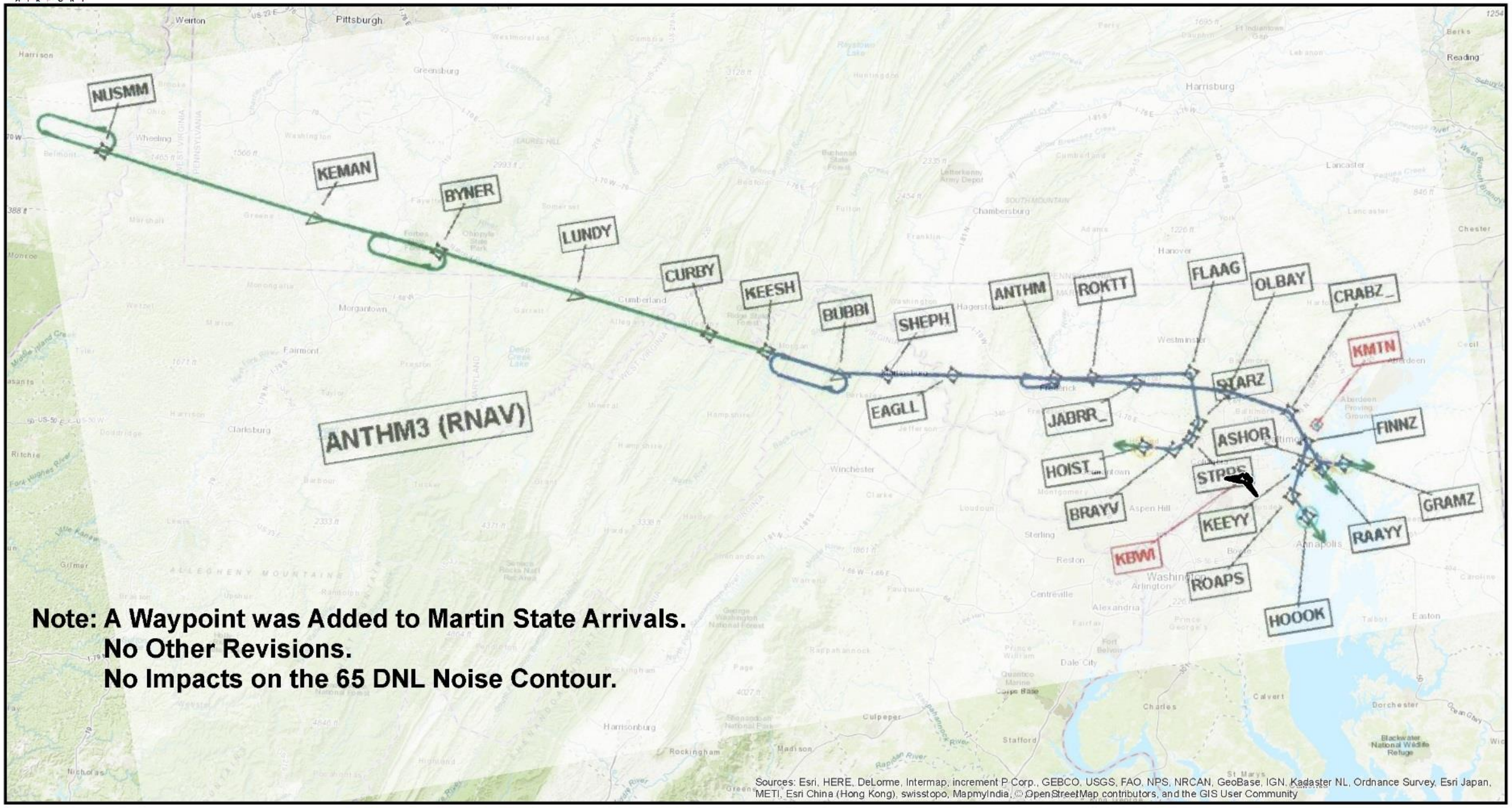
EA and Section 4(f) Determination for Proposed Improvements 2016-2020 at BWI Marshall Airport



LEGEND
2025 Proposed Action DNL Noise Contour

Figure K-4-1
ANTHM2

EA and Section 4(f) Determination for Proposed Improvements 2016-2020 at BWI Marshall Airport



LEGEND

2025 Proposed Action DNL Noise Contour

Figure K-4-2
ANTHM3

N

0 48,500 97,000 194,000 Feet

EA and Section 4(f) Determination for Proposed Improvements 2016-2020 at BWI Marshall Airport

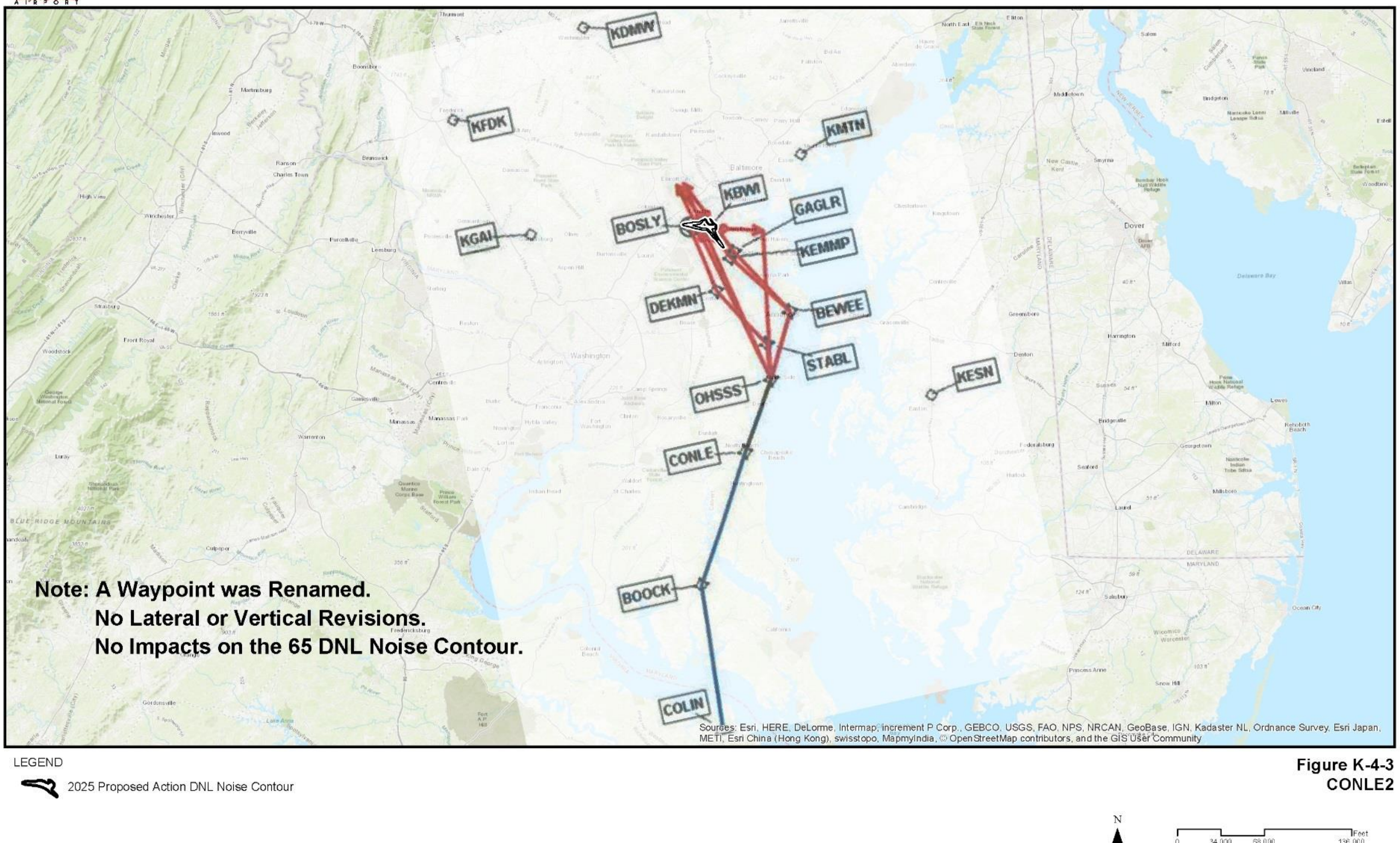


Figure K-4-3
CONLE2

EA and Section 4(f) Determination for Proposed Improvements 2016-2020 at BWI Marshall Airport

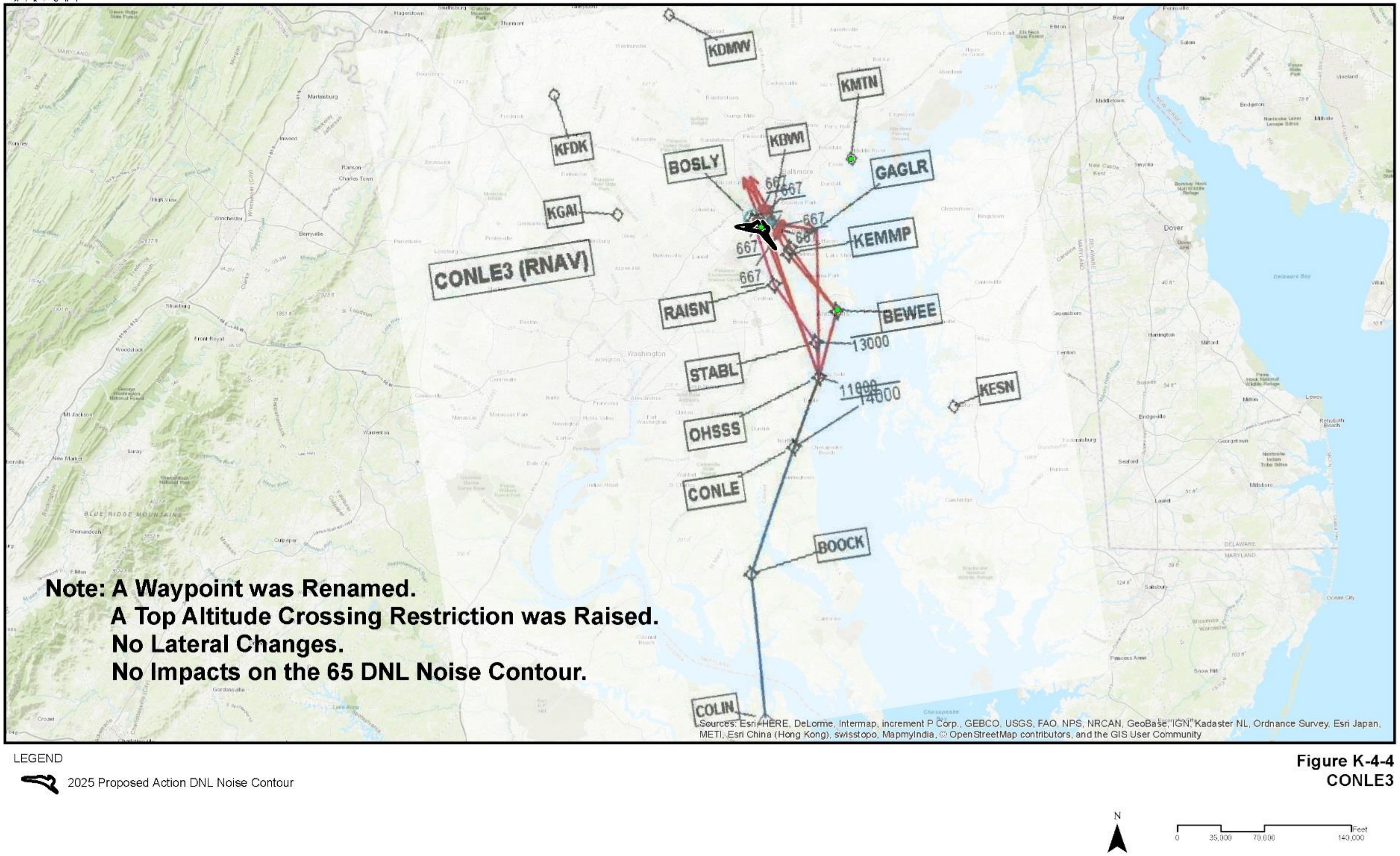
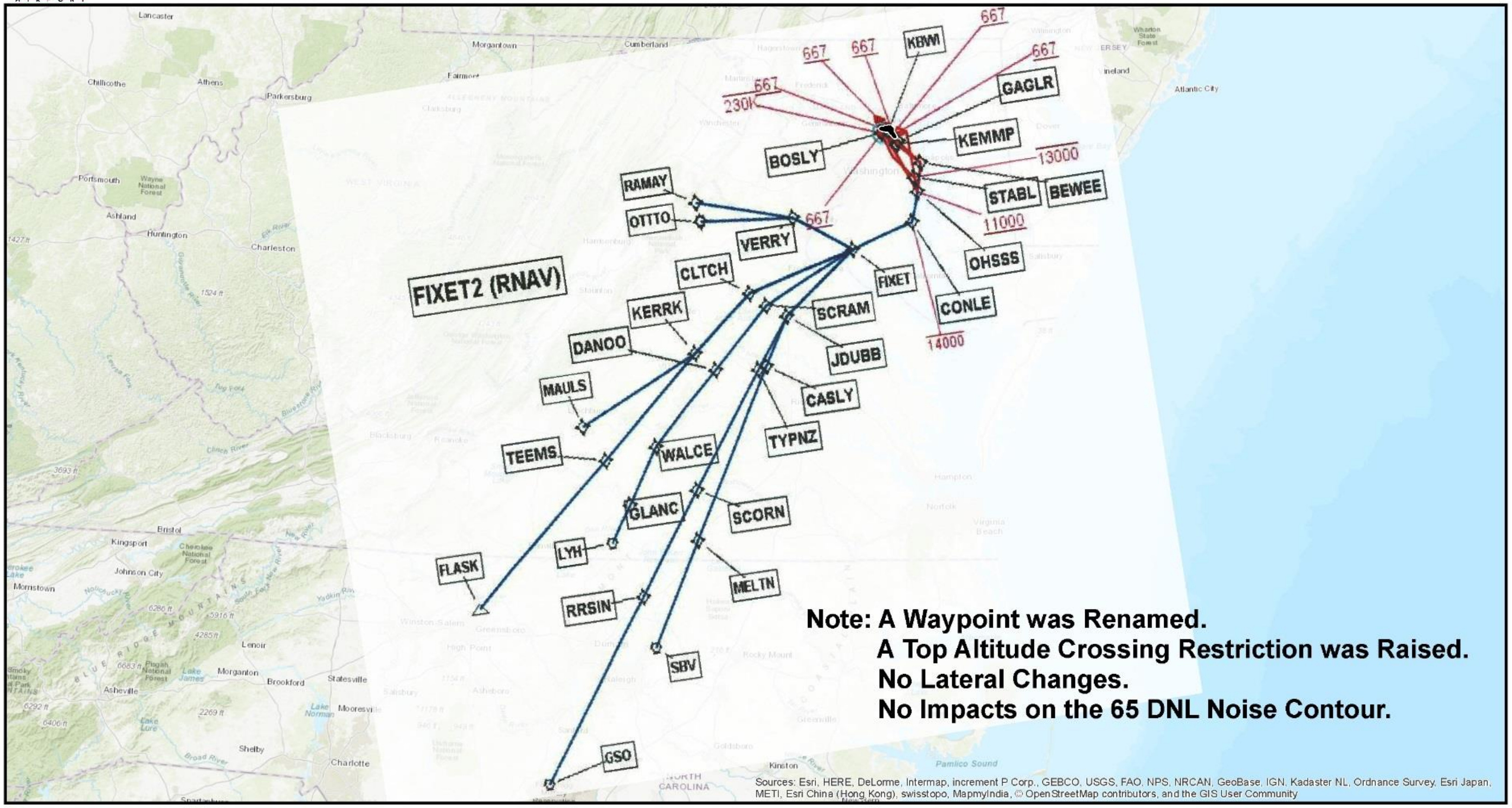


Figure K-4-4
CONLE3

EA and Section 4(f) Determination for Proposed Improvements 2016-2020 at BWI Marshall Airport

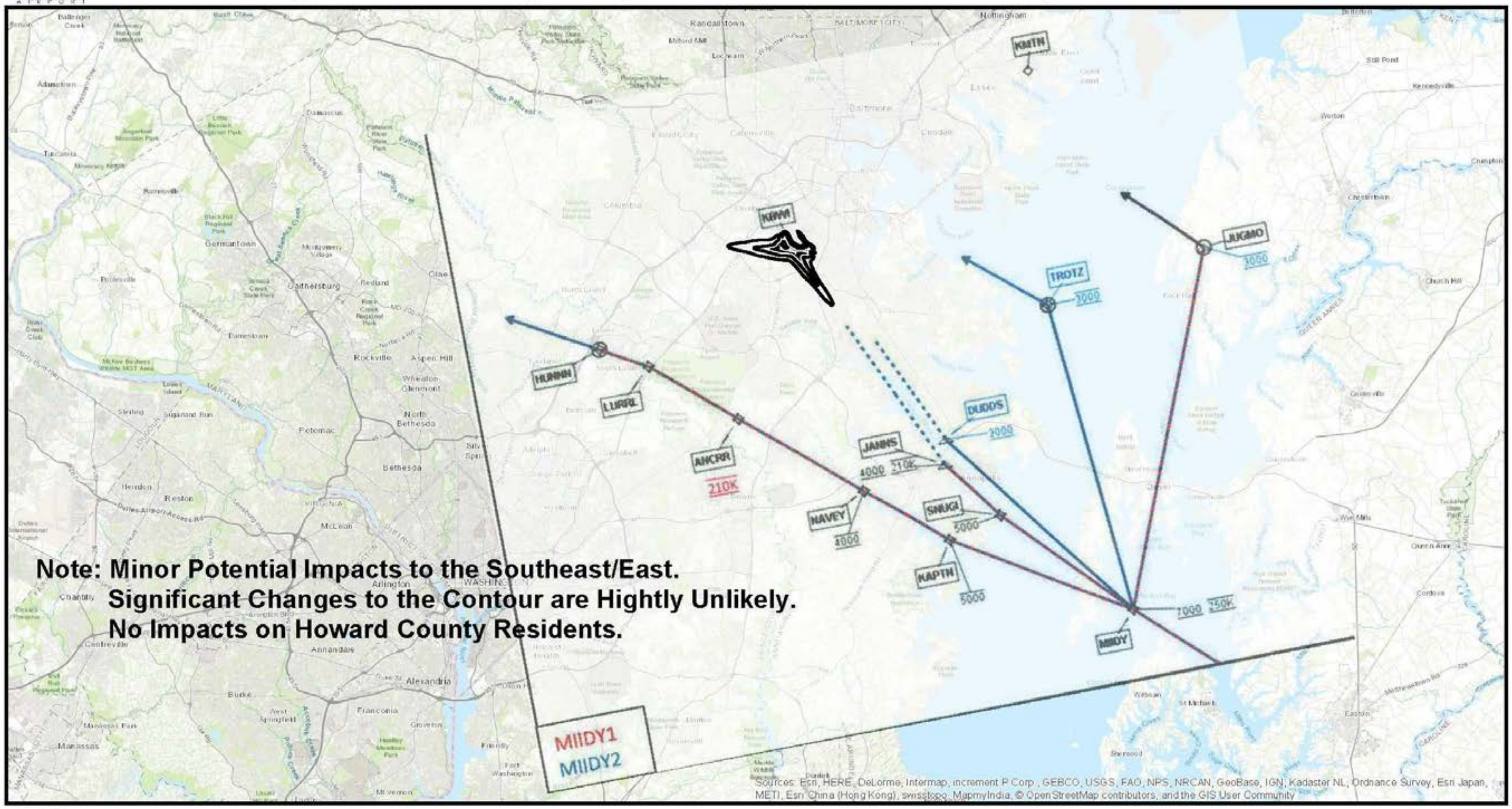


LEGEND

2025 Proposed Action DNL Noise Contour

Figure K-4-5
FIXET2

EA and Section 4(f) Determination for Proposed Improvements 2016-2020 at BWI Marshall Airport



LEGEND

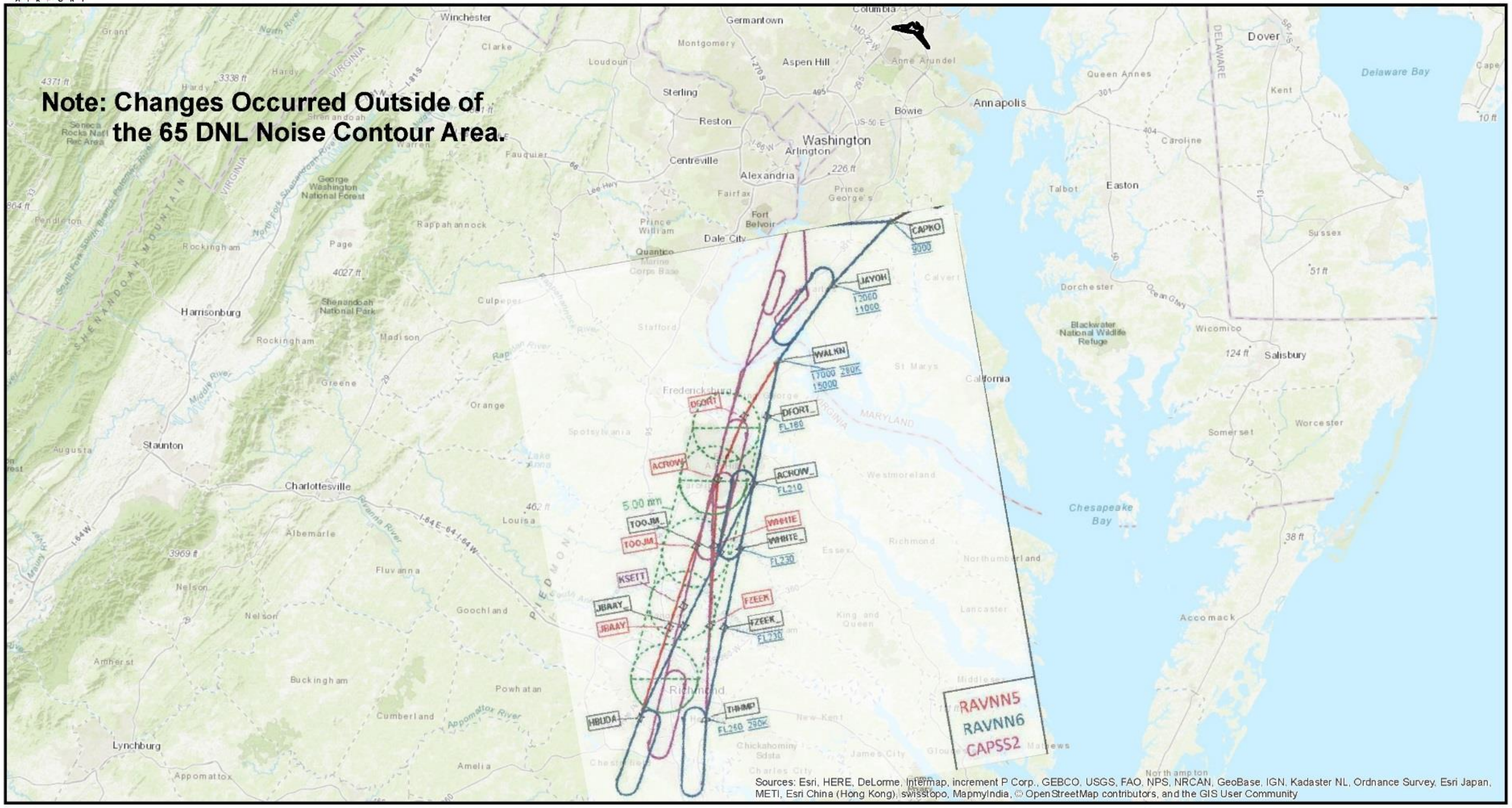
2025 Proposed Action DNL Noise Contour

Figure K-4-6
MIIDY2

N

0 14,500 29,000 58,000 Feet

EA and Section 4(f) Determination for Proposed Improvements 2016-2020 at BWI Marshall Airport



LEGEND

2025 Proposed Action DNL Noise Contour

Figure K-4-7
RAVNN6

N

0 42,000 84,000 168,000 Feet

EA and Section 4(f) Determination for Proposed Improvements 2016-2020 at BWI Marshall Airport

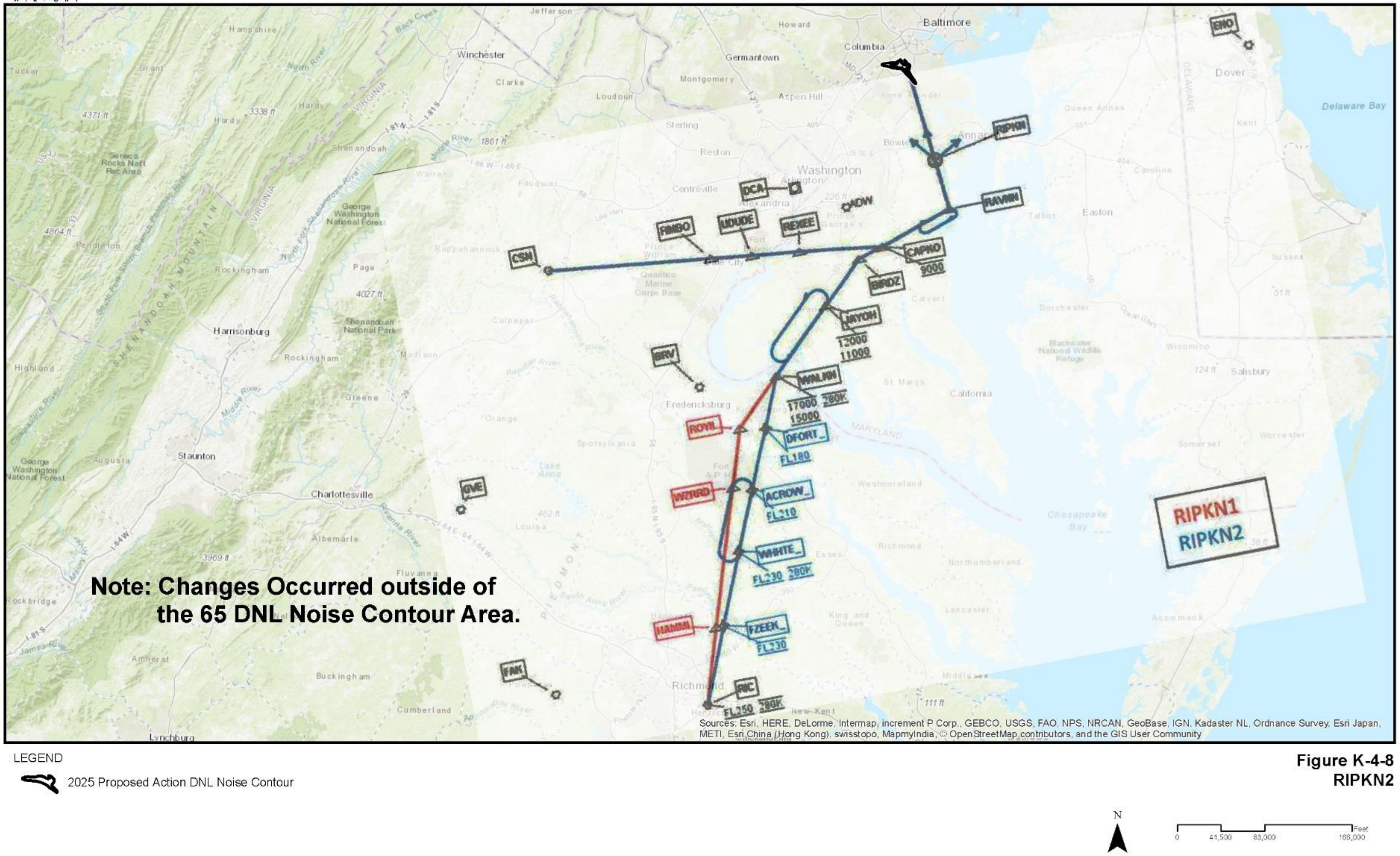


Figure K-4-8
RIPKN2

EA and Section 4(f) Determination for Proposed Improvements 2016-2020 at BWI Marshall Airport

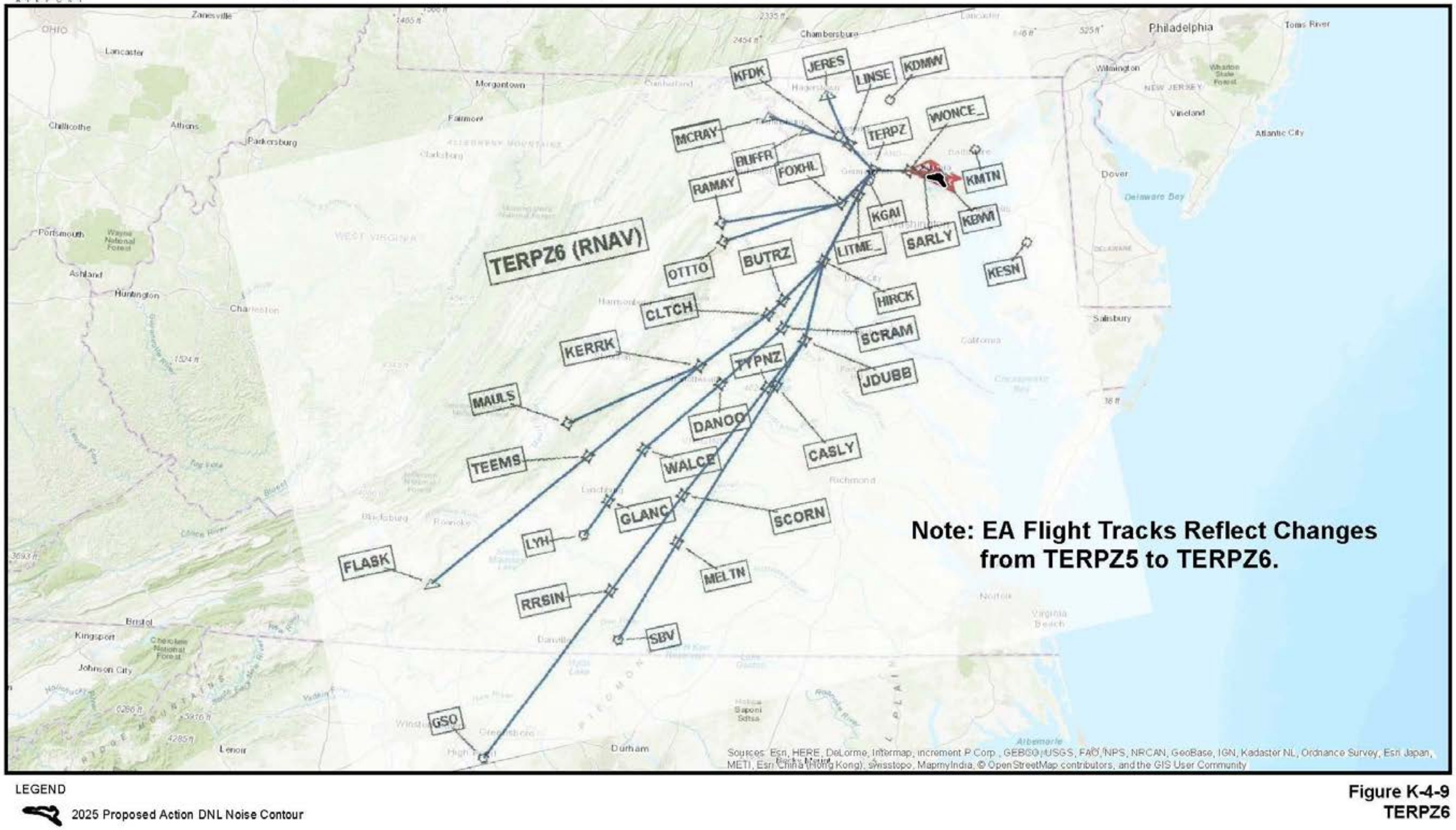
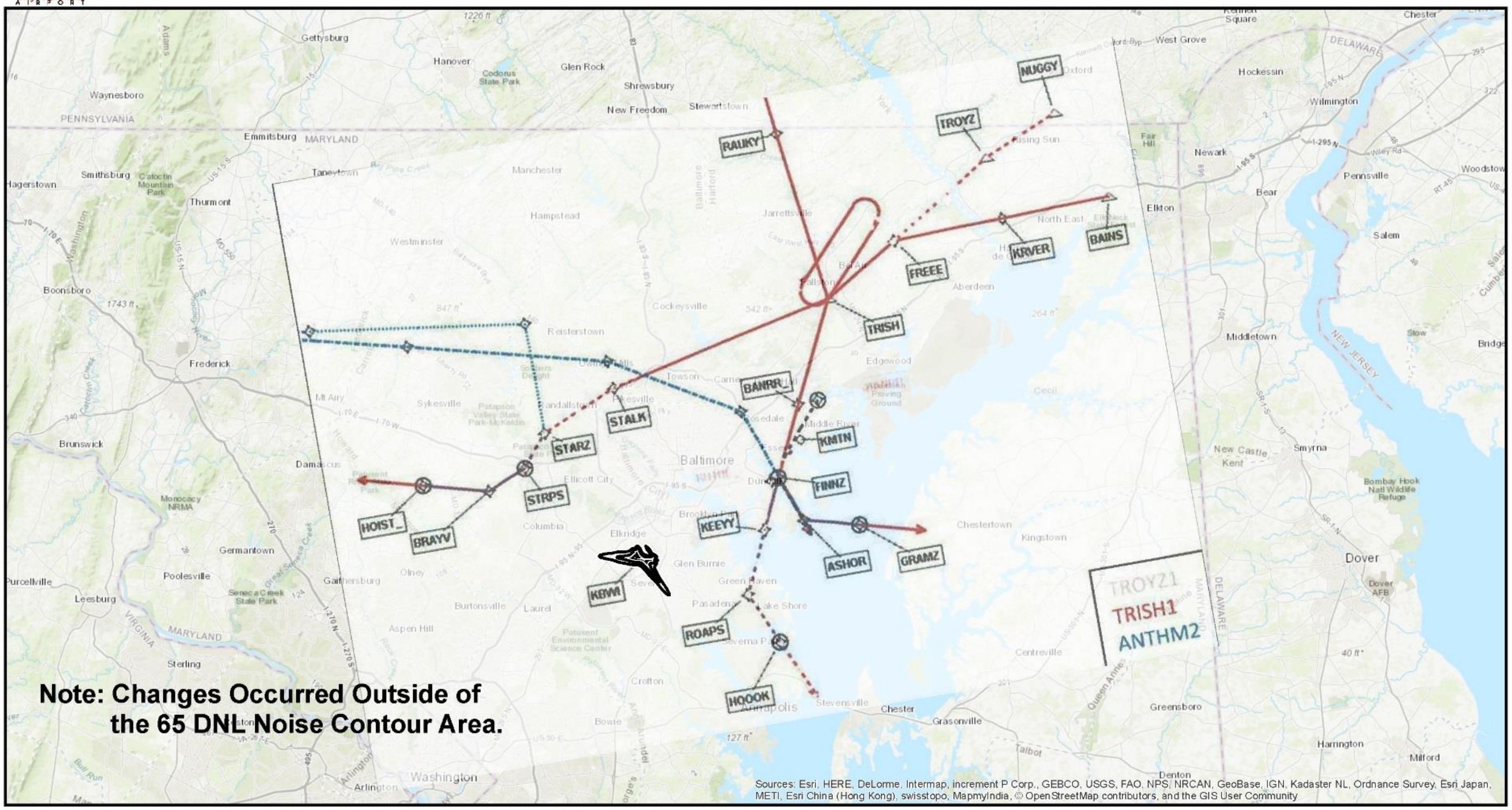


Figure K-4-9
TERPZ6

EA and Section 4(f) Determination for Proposed Improvements 2016-2020 at BWI Marshall Airport



LEGEND

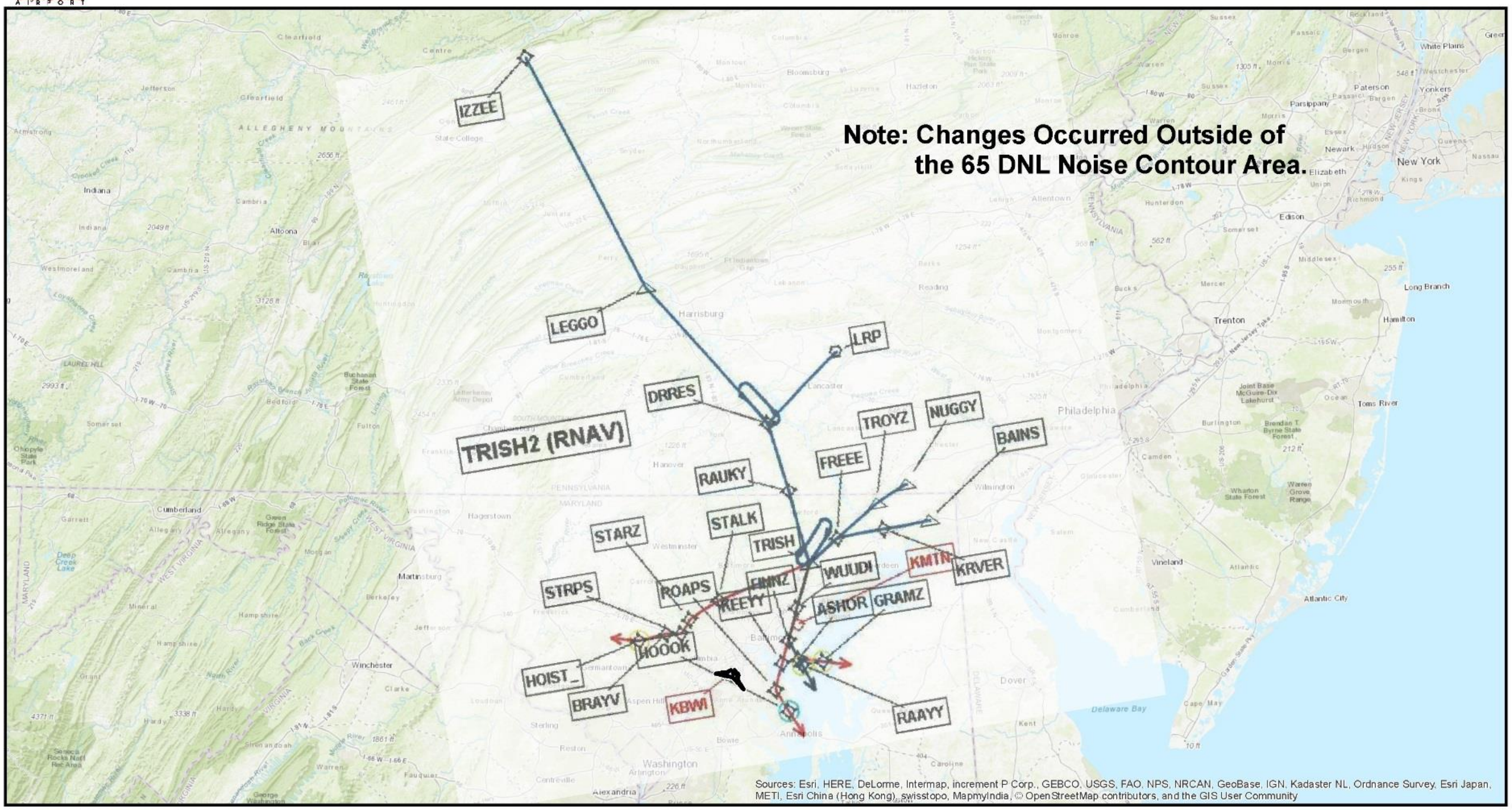
2025 Proposed Action DNL Noise Contour

Figure K-4-10
TRISH1

N

0 22,000 44,000 88,000 Feet

EA and Section 4(f) Determination for Proposed Improvements 2016-2020 at BWI Marshall Airport



LEGEND

2025 Proposed Action DNL Noise Contour

Figure K-4-11
TRISH2

N

0 50,000 100,000 200,000 Feet

Endnotes

[1] OAPM Submission: Washington Metroplex, Record of Change Control Sheet, FAA.