Massachusetts Port Authority
Department of Aviation

Boston Logan Runway 33L RNAV Departure
Aviation Noise Survey Report
53 Louise Road
Town of Belmont

Prepared By: Noise Abatement Office

June 17, 2014

Summary of Findings

Massport's Noise Abatement Office conducted a noise survey at 53 Louise Road, Belmont from February 21, 2014 (set-up day) through March 21, 2014 (removal day) yielding 27 days of complete measurements. The site is located about 8 miles west northwest of Boston Logan International Airport (Boston Logan).

The purpose of the noise survey was to measure aviation noise related to a new RNAV departure procedure for Runway (R)33L (RNAV procedures are typically GPS based) implemented by the FAA in June 2013. The noise survey was conducted at the request of interested Belmont residents and community leadership.

Key Findings:

- Based on an analysis of radar data, during the study period Boston Logan handled about 22,500 jet takeoffs and landings of which 2,688 or 12% departed from R33L. Of the 2,688 departures about 1,600 passed within 1.6 nm of the survey area.
- The noise monitoring survey period reflects a peak use of R33L at 24.0% of all Boston Logan jet departures. This is at a higher rate than the annual usage, which ranged from 7% to 19% of departures for 2007 – 2013. During the survey period, R33L was the third busiest departure runway behind R9 (27% of jet departures) and R22R (28%).
- The average altitude of R33L departures over the site during the 27 day study period was 6,269 feet MSL.
- Based on the noise monitor data, Boston Logan related aviation noise events resulted in a noise exposure of (provided in partial DNL[1] dB) 44.1 from R33L departures, 44.5 from all Boston Logan flights and 45.0 from non-aviation noise (community based) events. These measurements are significantly lower than the FAA threshold for non-compatible residential land use and mitigation of DNL 65 dB or greater.

Measured DNL Compared to FAA Criteria	**DNL**
FAA Criteria	65
Non-Aviation Noise	45
All Boston Logan Airport Noise	44.5
R33L Departures Only	44.1

Figure 1: Summary of Results[2]

During the 27 day period of the survey, the temporary noise monitor captured 648 intervals of hourly noise information totaling just over 6,500 individual non-aviation and aviation noise events. Of the total noise events during this period, 2,071 were identified as Boston Logan aviation related. Of these, 1,534 noise events were related to R33L departures (note that some overflights did not register a noise event). The area is also overflown by other Boston

[1] Day Night Average Sound Level (DNL) is the standard Federal Aviation Administration (FAA) metric for determining cumulative exposure to noise and measured in decibels (dB). A partial DNL is the noise level associated with just the single source described and does not reflect all the noise sources of the environment or that an observer might hear.

[2] Note, measured values are based on noise events as measured by the monitor.

Logan related aircraft: 223 noise events correlated to R4L arrivals and 314 events to other Logan flights such as R22L arrivals, R22R departures and R27 departures. Note that overflights from multiple runways at this distance away from the airfield are common around Boston Logan[3].

Since the monitoring study was conducted, the FAA issued its six month re-evaluation of the new R33L procedure. In this review, the FAA compares flight tracks before and after the RNAV was in place. For context purposes we have attached the FAA Memorandum and it can also be downloaded from this link www.bostonrnavea.com.

Background

Belmont community representatives requested that Massport conduct a noise survey in response to FAA's implementation of a new RNAV departure procedure for Boston Logan's Runway (R33L). The new procedure was implemented by the FAA in June 2013. As a result, Massport's Noise Abatement Office (NAO) conducted a noise survey at 53 Louise Road, Belmont from February 22, 2014 through March 20, 2014, resulting in data for 27 complete days. Because R33L is typically utilized by the FAA when winds are northwesterly, the noise survey was timed to capture a busy period of use of this runway when northwesterly winds are generally more common, during the winter and early spring months.

Site Evaluation and Data Metric

The site was initially identified by the Belmont Community Advisory Committee representative. It is located in a suburban setting at the eastern edge of Belmont near the Cambridge border (see Figure 2). After an initial visit, staff determined that the site met Massport's selection criteria of:

1.) Capture the overflight impacts to the Town of Belmont as a result of the new FAA R33L RNAV departure

2.) Provide a safe, accessible location for staff and instruments with a cooperating land owner

3.) Limited external noise energy sources that may interfere with the collection of flight noise data.

The noise monitoring equipment was setup in the back yard area of the residence (see Figure 3). The instrumentation became operational on February 21, 2014. The survey site was visited twice a week until the conclusion of the survey on March 21, 2014. The goal of the survey was to conduct noise measurements during a period of high usage of R33L for departures and to collect operational information (altitude and flight information). There are

[3] The data collected represents the noise environment captured at the site during the measurement period and does not reflect an annual noise level. However, given the historic runway use and aircraft altitude for this area, it is expected that an annual measurement would be similar to the measurements presented in this study.

other Boston Logan procedures that overfly the area, including arrivals to Runway 4L (left) and to a lesser extent, arrivals to Runway 4R (Right) and R22R and departures from R22R.

The primary noise metrics that are used in this report are DNL and SEL. The day-night average sound level (DNL or L_{dn}) was developed to describe the average noise level over a 24 hour period. The DNL is the time average of all A-weighted sound levels for a 24-hour period with a 10 dB upward adjustment added to the nighttime levels (2200 to 0700, 10PM to 7 AM). This adjustment is applied to account for the increased human sensitivity to noise during that time period. The DNL noise metric is an international noise metric and has been adopted by multiple federal agencies including the Environmental Protection Agency (EPA), the Federal Transit Administration (FTA), the Federal Aviation Administration (FAA), and the Housing and Urban Development (HUD) to quantify human annoyance to environmental noise. The FAA uses a DNL of 65 dBA as the criterion for non-compatible residential land use with potential mitigation. The Sound Exposure Level (SEL) is the energy averaged A-weighted sound level of a single noise event referenced to a one-second duration. The SEL accounts for both the magnitude and the duration of the noise event; each SEL is included in the overall DNL. DNL can also be calculated using SEL data. All measurement information collected during the survey used the dBA scale.

The data collected represents the noise environment captured at the site during the measurement period and does not reflect an annual noise level. However, given the historic runway use and aircraft altitude for this area, it is expected that an annual measurement would be similar to the measurements presented in this study.

Data Collection

Continuous noise measurements were collected for four weeks or 27 complete days, at the survey location (Figures 2 and 3). The portable measurement equipment installed at that site consisted of a Bruel & Kjaer Model 2250 Precision Noise Analyzer and equipped with a Bruel & Kjaer Outdoor Microphone (both components will be referred to as the noise monitor). The noise monitor was time synchronized with Massport's Noise and Operations Monitoring System (NOMS) and was calibrated at the start and conclusion of the survey. The survey information could then be correlated with radar information to identify specific aircraft types and operations. Runway usage, radar, and weather information were obtained from the NOMS during the survey period. Data stored in the memory of the monitor during the survey period was downloaded to a computer (PC). Observations of noise sources and aircraft overflights at the survey site were made during regular visits to the site by NAO staff. In addition to aircraft overflight activity, observations were made of other noise sources including street traffic, animals, commuter rail traffic, a nearby furnace exhaust vent, and intermittent local construction.

Figure 2: Map of the Belmont Site

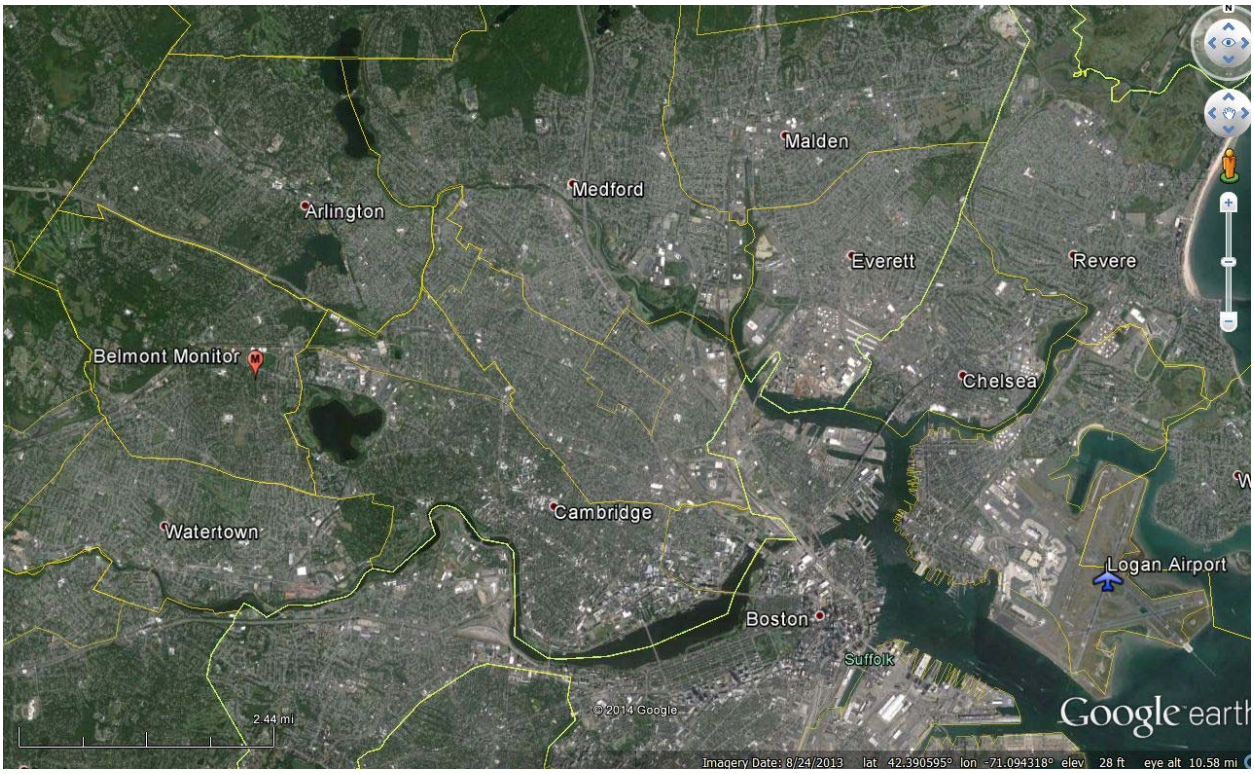


Figure 3. Two views from the Belmont Site

One-second noise measurements were conducted using the dBA scale. The measured data was used to generate continuous one-hour periods during the measurement survey. Measurement information was collected for all noise sources (both aircraft and community) and is represented in the daily (DNL) data. . The noise event data was derived from the measurement data by using the sound level when it exceeded a noise threshold level greater than 48 dBA and that also lasted for a minimum time period of five seconds above that level. This threshold level and time interval was selected based on the background noise level observed at the site by NAO staff and to exclude non-aviation related noise sources from the analysis[4].

In addition to the noise data that was collected at the survey monitoring site, radar data collected through the NOMS was used to identify all of the aircraft overflights from R33L that were within a 1.6 nautical mile (nmi) radius of the survey location during the survey period. An analysis was conducted that provided the altitude of the aircraft over the survey location, which was used to review all R33L departure operations during the survey period.

The runway usage during the period is shown below:

Table 1 Boston Logan Jet Runway Use during the Measurement Period

Runway Usage 2/22 - 3/20/2014 (Jet Only)

RW	OP	Total	Usage
27	A	3,410	30.1%
4R	A	2,744	24.2%
22L	A	2,162	19.1%
33L	A	1,966	17.4%
4L	A	756	6.7%
32	A	255	2.3%
15R	A	36	0.3%
22R	A	2	0.0%
Total		**11,331**	100%

RW	OP	Total	Usage
22R	D	3,112	27.8%
9	D	3,043	27.2%
33L	D	2,688	24.0%
27	D	1,400	12.5%
4R	D	466	4.2%
15R	D	371	3.3%
22L	D	122	1.1%
Total		**11,202**	100%

** Note – Percent's may not total to 100 due to rounding

[4] This is a standard industry practice when conducting a noise measurement survey and multiple sources of noise exist at the site.

The wind direction during the period is summarized in the table below. It was based on hourly observations using Boston Logan weather data as the source.

Table 2 Wind Direction during the Measurement Period

West	41%
North	30%
East	10%
South	16%
Calm	3%

Source: FAA ASPM data, accessed June 9, 2014 (https://aspm.faa.gov/Default.asp)

Data Analysis

During the survey, the temporary noise monitor captured 648 intervals of hourly noise information over the 27 day period with 2,071 identified as Boston Logan aviation related noise events. Of these, 1,534 were related to R33L departures. The area is also overflown by other Boston Logan related aircraft: 223 noise events correlated to R4L arrivals and 314 events to other Boston Logan flights such as R22L arrivals, R22R departures and R27 departures. Note that overflights from multiple runways at this distance away from the airfield are common around Boston Logan.

Massport staff provided the noise event data to Harris Miller Miller and Hanson Inc. (HMMH)[5]. HMMH analyzed the data and produced the results provided in this report.

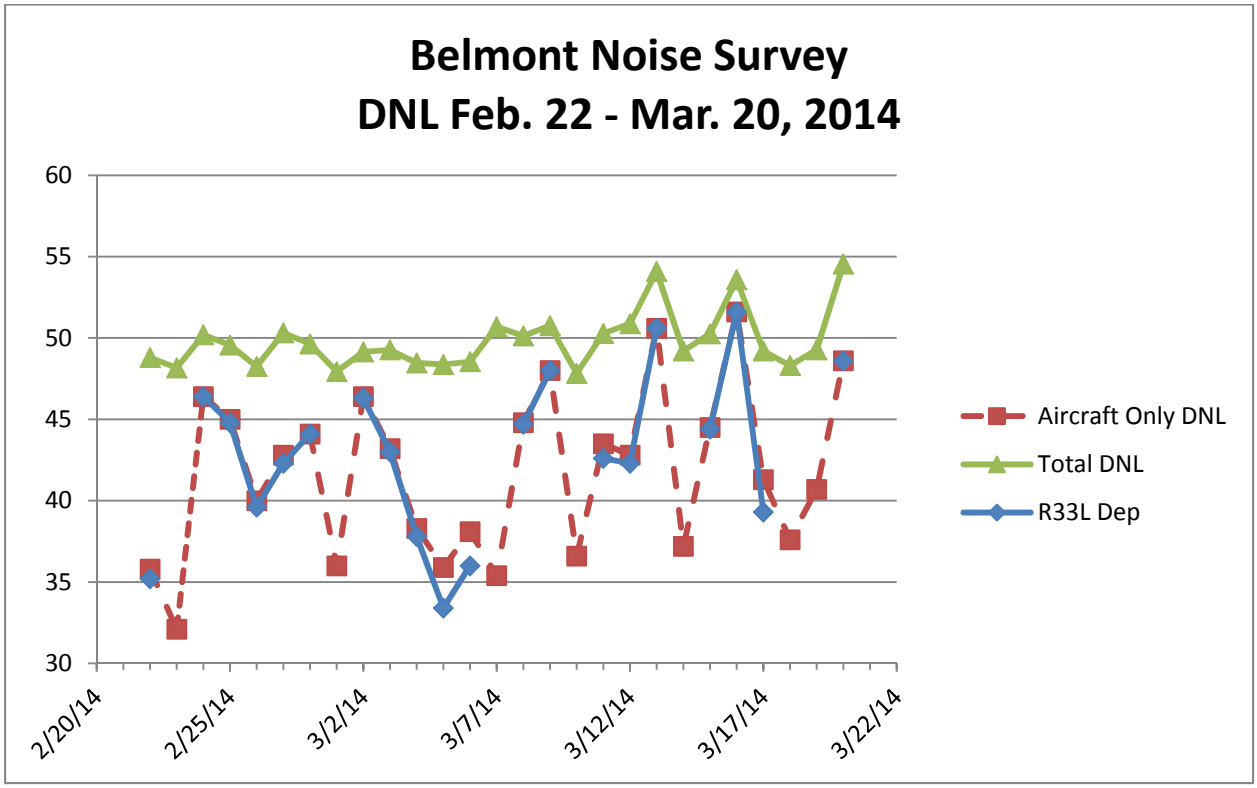
Analysis of the aviation related noise events during the survey period shows that the monitored location receives Logan related aviation noise exposure from R33L departures measured at a partial DNL of 44.1 dB; Boston Logan's R4L arrivals measured at a partial DNL of 29.4 dB; and, other overflights associated with Boston Logan were measured at a partial DNL of 31.5 dB. The overall DNL associated with Boston Logan flights was measured at a partial DNL of 44.5 dB. These measurements are significantly lower than the FAA criteria for non-compatible residential land use with potential mitigation (DNL 65 dB or greater). As noted, the RNAV procedure for R33L began in June 2013 and was in use during the survey period. The survey site also measured aviation related noise events not related to Boston Logan Airport such helicopters and flights from other airports.

The non-aviation noise (community based) events measured at a partial DNL of 45.0 dB.

The one-second data was used to calculate an average daily DNL (described above), at the site which is shown in Figure 4. The interval information in this figure contains the noise from all sources of noise (aviation and non-aviation related noise activities). The FAA requires that aircraft only DNL be included when determining aviation noise impacts and comparing to the FAA threshold of significance of DNL 65 dB. The aircraft only partial DNL for all Boston Logan related overflights computed at this site during the survey was 44.5 dB. Note that the data gaps in Figure 4 are as a result of no noise events from R33L were measured for that day.

[5] Aviation acoustical consultants.

Figure 4. Survey Daily DNL

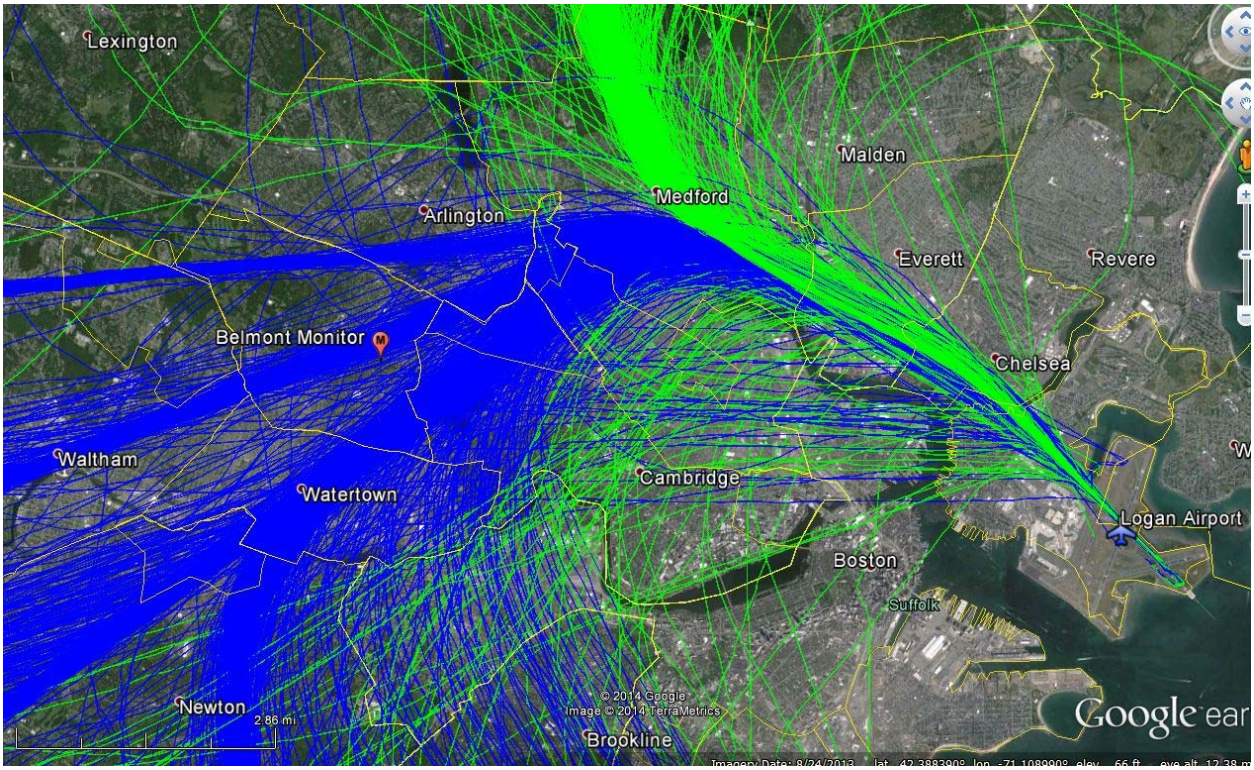


Note: DNL contribution below 25 dB is not shown on the graphic

Aircraft operational information, obtained from the FAA's radar system through the NOMS, was used to identify aircraft type, date and time information, operation and runway used, and altitude relative to the survey location. A display of the flight tracks departing from R33L during the 27 day survey period is shown in Figure 5. During the survey period, Boston Logan accommodated a total of 22,500 jet takeoffs and landings of which 2,688 or 12% departed from R33L. Of these flights 1,626 overflew within a 1.6 nautical miles, radius distance of the survey site[6]. Figure 5 displays the R33L jet departures in green and the R33L jet departures within the 1.6 nmi radius in blue. The flight track data for the period also shows that the survey location is less than one mile to the east of the main flight corridor of R33L departures. Based on the radar tracks analyzed for the survey, the flight corridor is splits over Medford with the southern branch passing over Cambridge and eastern Belmont, the middle branch passing through Belmont into Waltham and the northern branch passing over Arlington and the western section of Belmont.

[6] Note that not all overflights generated a noise event at the survey site.

Figure 5. Boston Logan Runway 33L Jet Departures
1,626 flights of 2,688 Jet Departures within 1.6nm of site during the 27 day survey period



Runway 33L was in use for 24% for all of the jet departures from Boston Logan during the survey period. This was at a higher rate than the annual usage, which ranged from 7% to 19% for 2007 – 2013 (annual use). R33L was the third busiest departure runway (24% of departures) behind R9 (27%) and R22R (28%).

Conclusion

Based on the noise monitor data, Boston Logan related aviation noise events resulted in a noise exposure of (provided in partial DNL[7] dB) 44.1 from R33L departures, 44.5 from all Boston Logan flights and 45.0 from non-aviation noise (community based) events. These measurements are significantly lower than the FAA threshold for non-compatible residential land use and mitigation of DNL 65 dB or greater. The average altitude of R33L departures over the site during the study period was 6,269 feet MSL.

[7] Day Night Average Sound Level (DNL) is the standard Federal Aviation Administration (FAA) metric for determining cumulative exposure to noise and measured in decibels (dB). A partial DNL is the noise level associated with just the single source described and does not reflect all the noise sources of the environment or that an observer might hear.

Attachment, FAA Memorandum Dated April 24, 2014
Post-Implementation Review for the Boston (BOS) Runway 33L Area Navigation (RNAV) Standard Instrument Departure (SID) procedure

Federal Aviation Administration

Memorandum

Date: April 24, 2014

To: Sharon Abhalter, Acting Manager, Performance Based Navigation Group

From: John H. Belk II, Team Manager, Technical Support Team, AJV-1410

Prepared by: Jon T. Harris, Air Traffic Control Specialist, AJV-1410

Subject: Post-Implementation Review for the Boston (BOS) Runway 33L Area Navigation (RNAV) Standard Instrument Departure (SID) procedure

Background:

A new RNAV standard instrument departure procedure (SID) was developed for runway 33L at BOS and incorporated into the following (existing) SIDs at Boston: HYLND, LBSTA, CELTK, BRUWN, SSOXS, PATSS, BLZZR, and REVSS. The revised SIDs were published on March 07, 2013, and the runway 33L procedure became available for use on June 5, 2013.

A post-implementation review was completed on March 26, 2014. This review is a standard part of the Performance Based Navigation (PBN) 18-step RNAV procedure implementation process. The review determines aircraft track compliance by comparing historical flight track data against the published procedure. The review also provides a qualitative analysis opportunity to determine how the procedure satisfies air traffic control (ATC) operational requirements, including how aircraft using the procedure interact with arriving and departing aircraft utilizing other runways.

Post Implementation Review:

Since June 5, 2013 approximately 6,500 jet aircraft have flown the runway 33L SID. Since that time, there have been no negative comments provided by ATC regarding the runway 33L SID. The BOS Working Group representatives to include NATCA, provided the following feedback:

The Runway 33L RNAV SID is working as designed and accomplishes the following:

• Simplifies the BOS airport operations by allowing aircraft to depart from any runway using one SID assigned by ATC

• Enhances safety by eliminating possible pilot confusion on what SID to fly

• Reduces radio frequency congestion and workload for ATC and pilots during runway changes by not having to assign a new SID when the weather or winds changes

• Facilitates jets departing BOS to fly an advanced navigation RNAV SID from all runways

• Allows airlines and other operators to file standard RNAV routings from all runways

Evaluation of the aircraft flight tracks compared to the published SID profiles validates aircraft are flying the new procedure as designed. Due to ATC operational requirements, there are isolated aircraft tracks when ATC has removed an aircraft off a SID to ensure the safe and efficient flow of air traffic, e.g., to prevent faster climbing aircraft from overtaking slower climbing aircraft.

Additionally, work group participants representing industry were solicited for their comments regarding the new runway 33L SID. This feedback also validated the aircraft conformance for the SID. For example, Jet Blue Captain Joe DeVito reported that he "[has] not received any issues with its use."

Conclusions:

Based on the validation of flight tracks and feedback provided by Boston air traffic control and industry, the BOS Runway 33L RNAV SID is performing as designed with aircraft successfully flying within the confines of the procedure's design. Incorporating the runway 33L procedure into the existing RNAV SID infrastructure has served to enhance the air traffic operation and flow of aircraft at the Boston Logan airport.

FAA will conduct a 12 month post-implementation review of the runway 33L RNAV SID.

Boston Logan International Airport

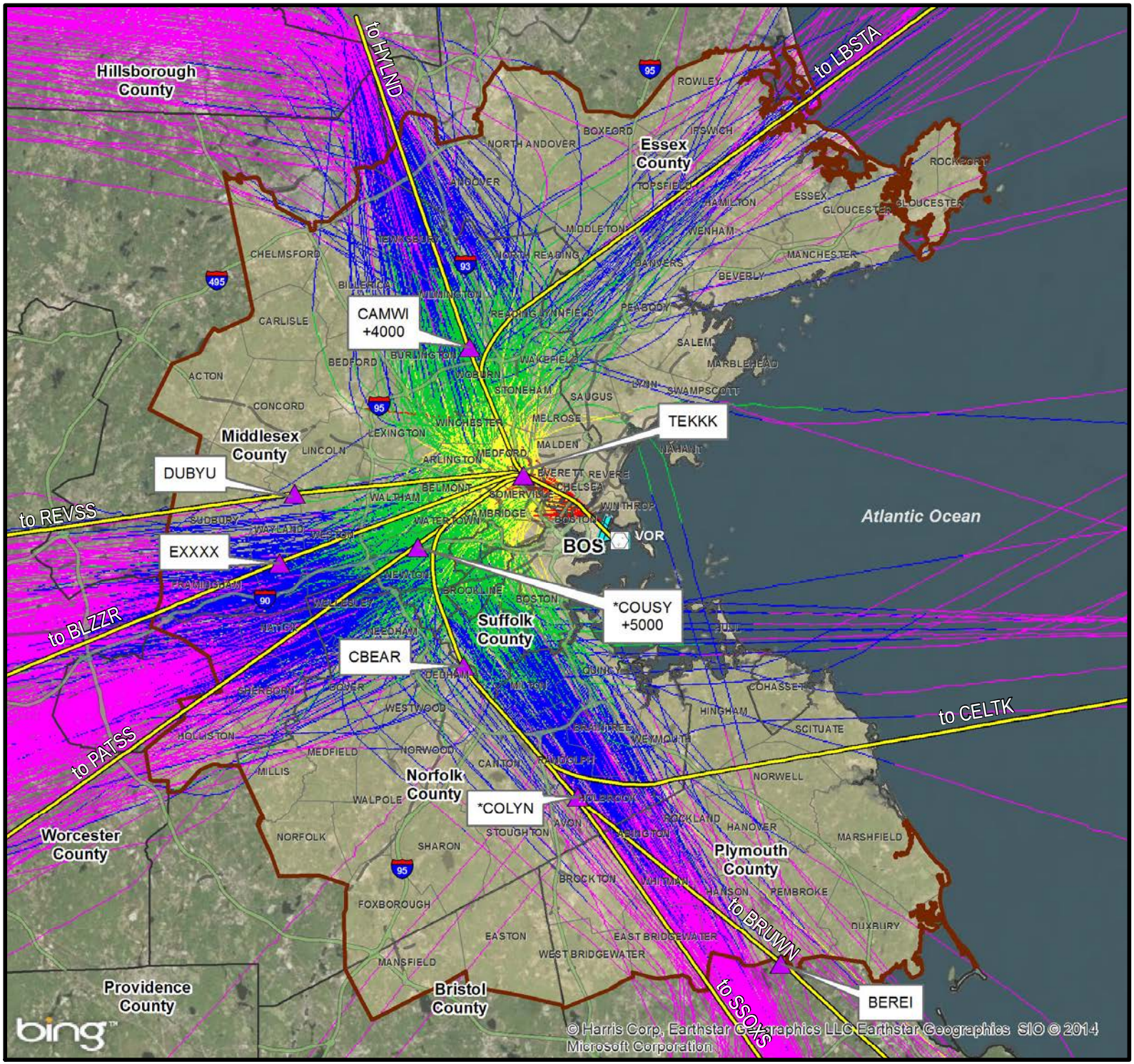


Figure 1
Runway 33L LOGAN SIX Jet Departures Compared with Proposed Action

(Final EA Figure 2-5, Revised 4/29/14)

LEGEND

- Runway 33L RNAV SID Noise Model Departure Flight Tracks (Expected Flyability Track)
- Waypoint
- Study Area
- Community within Study Area
- County Boundary
- BOS VOR/DME
- Interstate
- Highway

Existing (LOGAN SIX) Runway 33L Jet Departures

- 0 - 3,000 ft AGL
- 3,001 - 6,000 ft AGL
- 6,001 - 10,000 ft AGL
- 10,000 - 14,000 ft AGL
- 14,001+ ft AGL

Note: Procedure applies to RNAV-capable Jet aircraft. Turboprop and non-RNAV capable aircraft use LOGAN SIX Conventional SID.

Boston Logan International Airport Runway 33L RNAV SID

N

0 1 2 4 Nautical Miles

Source:
Radar Data: FAA PDARS (3/26/12, 3/30/12, 4/27/12, 4/30/12, 12/11/12, 12/12/12)
RNAV: TARGETS (FAA PBN Integration Office)
Office of Geographic Information (MassGIS), ESRI
*The COLYN and COUSY waypoints switched names in the final procedure design for the Runway 33L RNAV SID

Boston Logan International Airport

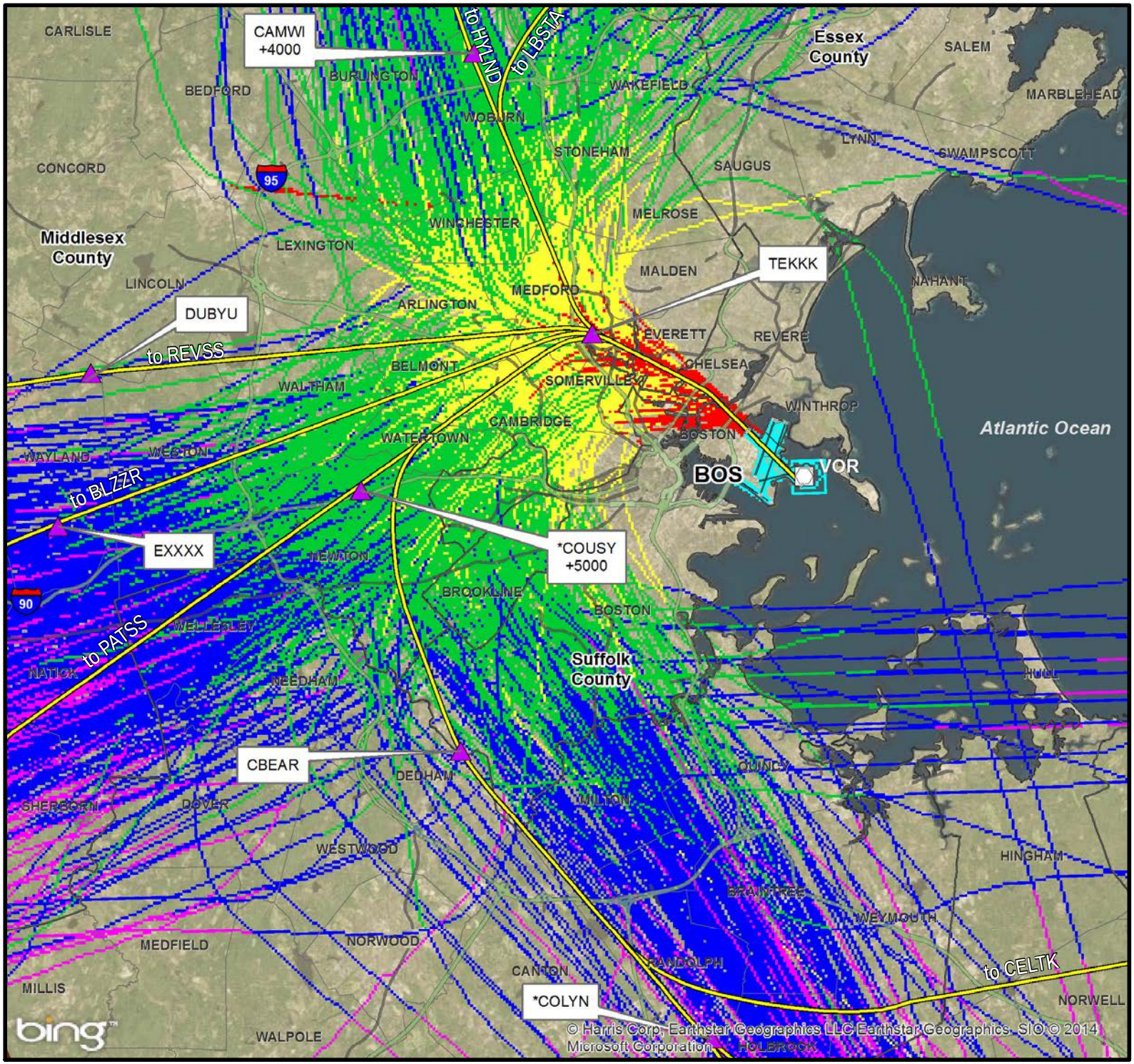


Figure 2
Runway 33L LOGAN SIX Jet Departures Compared with Proposed Action

(Final EA Figure 2-5, Revised 4/29/14)

LEGEND

- Runway 33L RNAV SID Noise Model Departure Flight Tracks (Expected Flyability Track)
- Waypoint
- Study Area
- Community within Study Area
- County Boundary
- BOS VOR/DME
- Interstate
- Highway

Existing (LOGAN SIX) Runway 33L Jet Departures

- 0 - 3,000 ft AGL
- 3,001 - 6,000 ft AGL
- 6,001 - 10,000 ft AGL
- 10,000 - 14,000 ft AGL
- 14,001+ ft AGL

Note: Procedure applies to RNAV-capable Jet aircraft. Turboprop and non-RNAV capable aircraft use LOGAN SIX Conventional SID.

Boston Logan International Airport Runway 33L RNAV SID

0 0.75 1.5 3 Nautical Miles

N

Source:
Radar Data: FAA PDARS (3/26/12, 3/30/12, 4/27/12, 4/30/12, 12/11/12, 12/12/12)
RNAV: TARGETS (FAA PBN Integration Office)
Office of Geographic Information (MassGIS), ESRI
*The COLYN and COUSY waypoints switched names in the final procedure design for the Runway 33L RNAV SID

Boston Logan International Airport

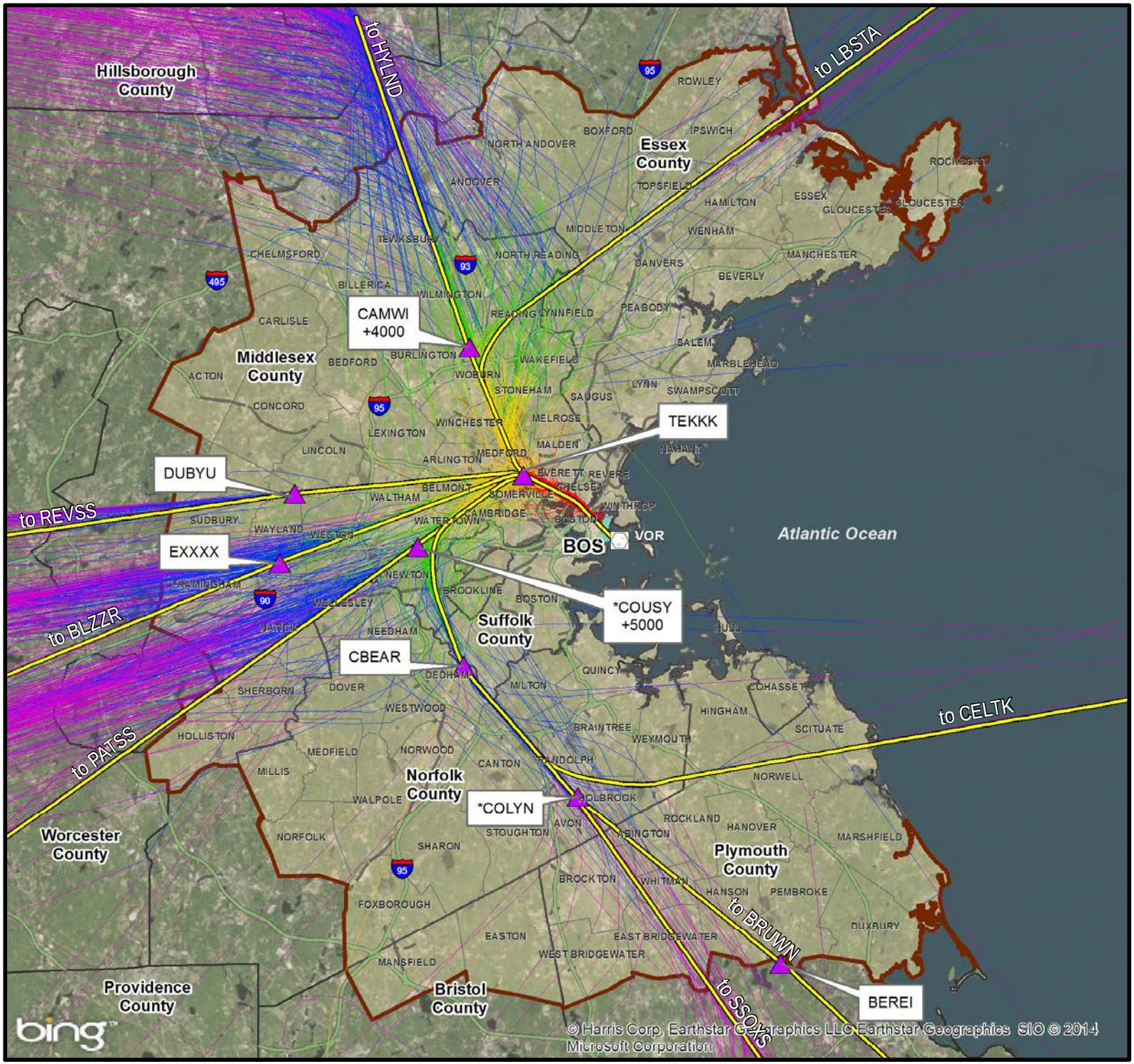


Figure 3
Runway 33L RNAV Flight Tracks with Altitudes

LEGEND

- Runway 33L RNAV SID Noise Model Departure Flight Tracks (Expected Flyability Track)
- Waypoint
- Study Area
- Community within Study Area
- County Boundary
- BOS VOR/DME
- Interstate
- Highway

Post Implementation RNAV Runway 33L Jet Departures

- 0 - 3,000 ft AGL
- 3,001 - 6,000 ft AGL
- 6,001 - 10,000 ft AGL
- 10,000 - 14,000 ft AGL
- 14,001+ ft AGL

Note: Procedure applies to RNAV-capable Jet aircraft. Turboprop and non-RNAV capable aircraft use LOGAN SIX Conventional SID.

Boston Logan International Airport Runway 33L RNAV SID

0 1 2 4 Nautical Miles

N

Source:
Radar Data: RNAV: Two representative days per month, June through December 2013
RNAV: TARGETS (FAA PBN Integration Office)
Office of Geographic Information (MassGIS), ESRI
*The COLYN and COUSY waypoints switched names in the final procedure design for the Runway 33L RNAV SID

Boston Logan International Airport

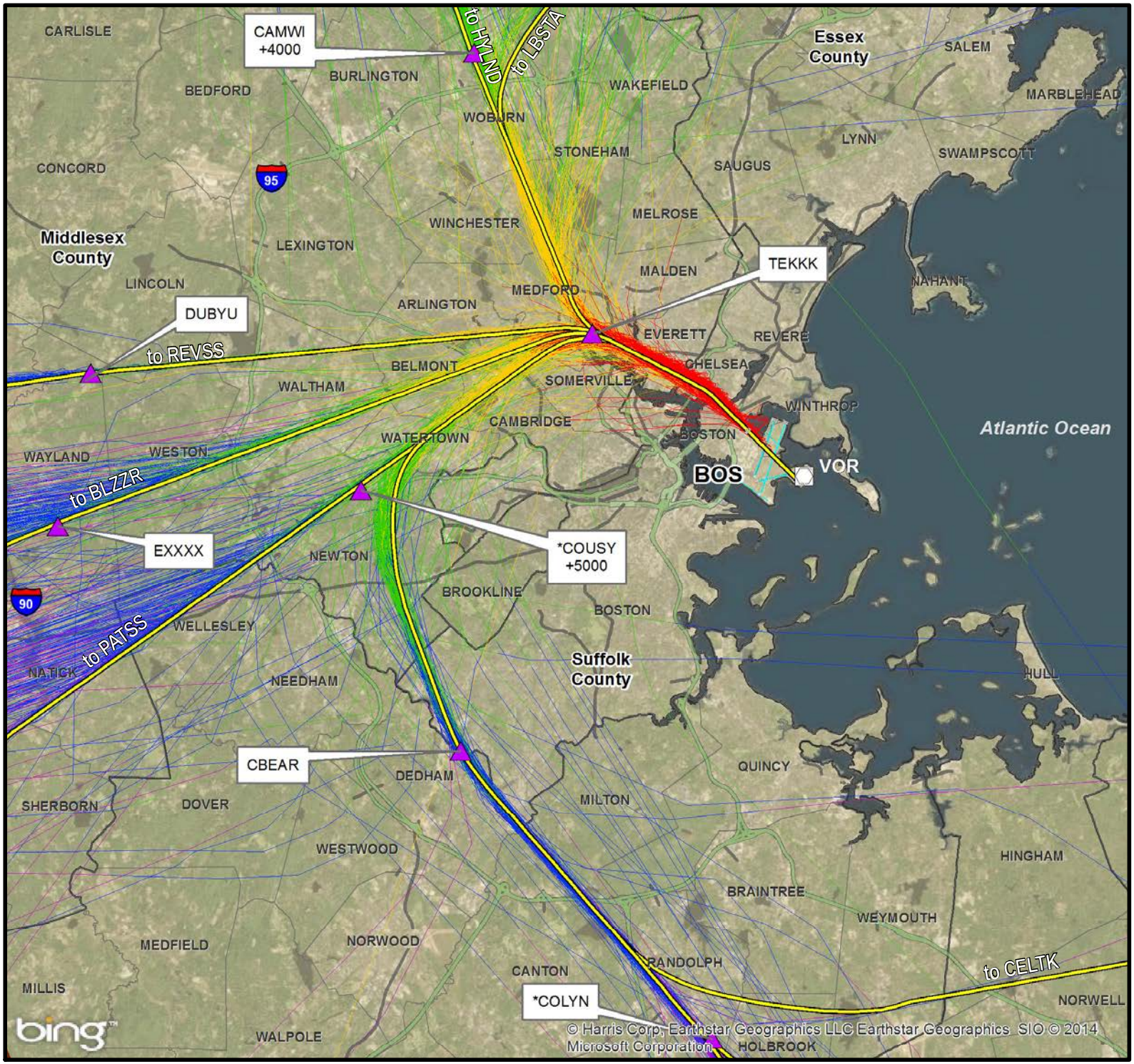


Figure 4
Runway 33L RNAV Flight Tracks with Altitudes

LEGEND

- Runway 33L RNAV SID Noise Model Departure Flight Tracks (Expected Flyability Track)
- Waypoint
- Study Area
- Community within Study Area
- County Boundary
- BOS VOR/DME
- Interstate
- Highway

Post Implementation RNAV Runway 33L Jet Departures

- 0 - 3,000 ft AGL
- 3,001 - 6,000 ft AGL
- 6,001 - 10,000 ft AGL
- 10,000 - 14,000 ft AGL
- 14,001+ ft AGL

Note: Procedure applies to RNAV-capable Jet aircraft. Turboprop and non-RNAV capable aircraft use LOGAN SIX Conventional SID.

Boston Logan International Airport Runway 33L RNAV SID

0 0.75 1.5 3 Nautical Miles

N

Source:
Radar Data: RNAV: Two representative days per month, June through December 2013
RNAV: TARGETS (FAA PBN Integration Office)
Office of Geographic Information (MassGIS), ESRI
***The COLYN and COUSY waypoints switched names in the final procedure design for the Runway 33L RNAV SID**

Boston Logan International Airport

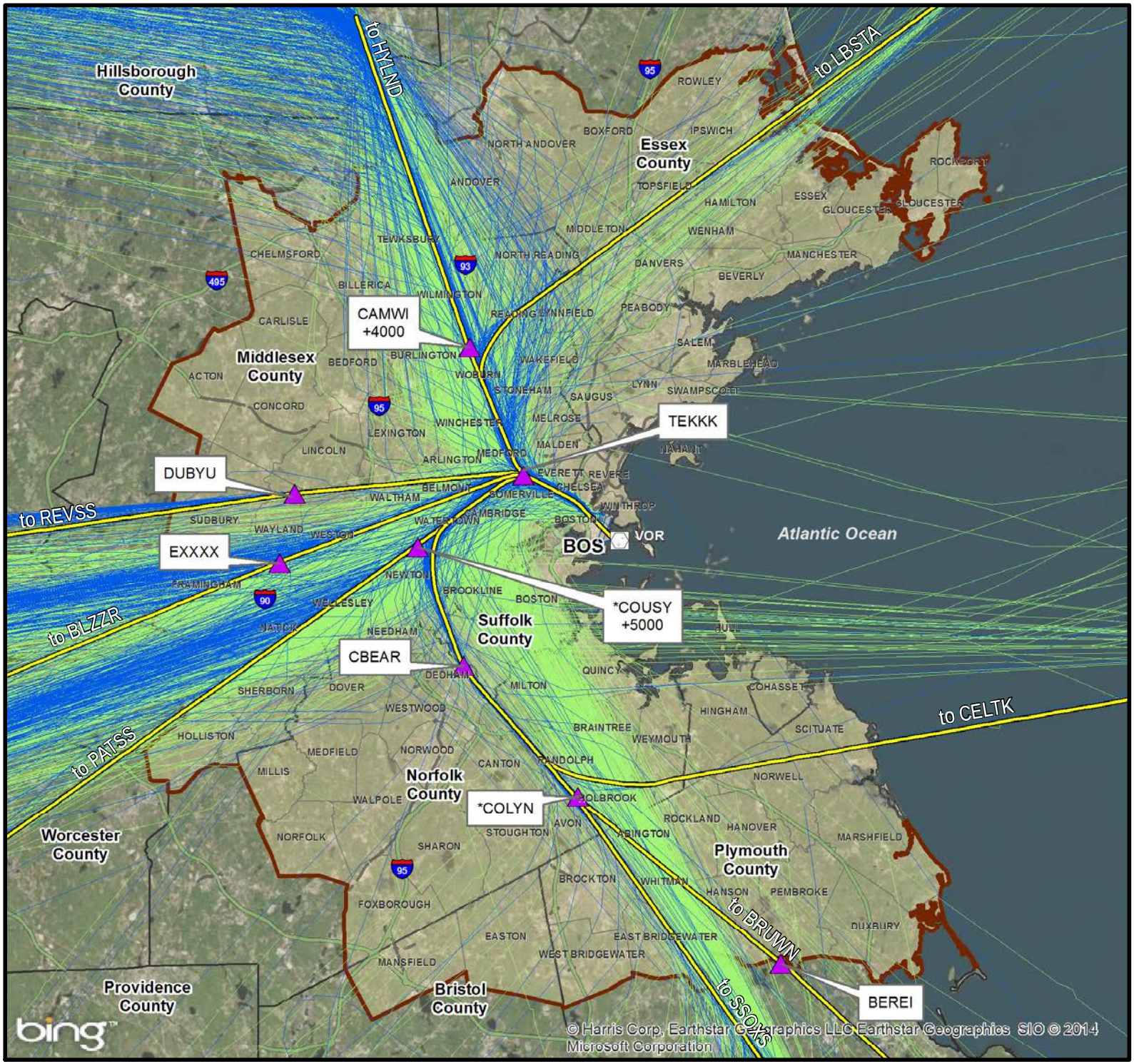


Figure 5
Runway 33L Flight Track Dispersion Comparison

LEGEND

- Runway 33L RNAV SID Noise Model Departure Flight Tracks (Expected Flyability Track)
- Post Implementation RNAV Runway 33L Departures
- Pre Implementation Runway 33L Departures
- Waypoint
- Study Area
- Community within Study Area
- County Boundary
- BOS VOR/DME
- Interstate
- Highway

Note: Procedure applies to RNAV-capable Jet aircraft. Turboprop and non-RNAV capable aircraft use LOGAN SIX Conventional SID.

Boston Logan International Airport Runway 33L RNAV SID

N

0 1 2 4 Nautical Miles

Source:
Radar Data: RNAV: Two representative days per month, June through December 2013
Non RNAV: Two representative days per month between November 2012 and March 2013
RNAV: TARGETS (FAA PBN Integration Office)
Office of Geographic Information (MassGIS), ESRI
*The COLYN and COUSY waypoints switched names in the final procedure design for the Runway 33L RNAV SID

Boston Logan International Airport

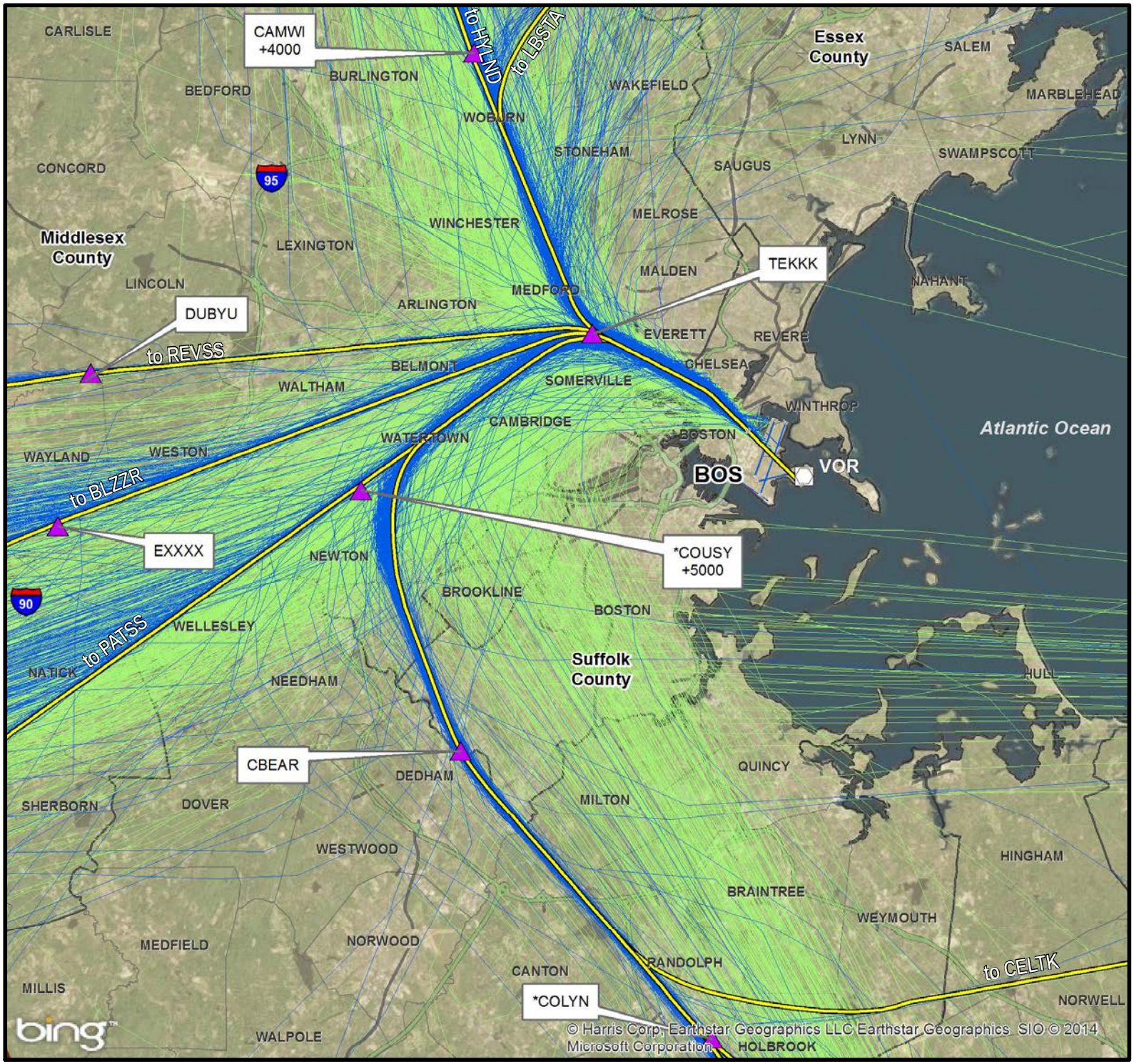


Figure 6
Runway 33L Flight Track Dispersion Comparison

LEGEND

- Runway 33L RNAV SID Noise Model Departure Flight Tracks (Expected Flyability Track)
- Post Implementation RNAV Runway 33L Departures
- Pre Implementation Runway 33L Departures
- Waypoint
- Study Area
- Community within Study Area
- County Boundary
- BOS VOR/DME
- Interstate
- Highway

Note: Procedure applies to RNAV-capable Jet aircraft. Turboprop and non-RNAV capable aircraft use LOGAN SIX Conventional SID.

Boston Logan International Airport Runway 33L RNAV SID

N

0 0.75 1.5 3 Nautical Miles

Source:
Radar Data: RNAV: Two representative days per month, June through December 2013
Non RNAV: Two representative days per month between November 2012 and March 2013
RNAV: TARGETS (FAA PBN Integration Office)
Office of Geographic Information (MassGIS), ESRI
*The COLYN and COUSY waypoints switched names in the final procedure design for the Runway 33L RNAV SID