Seattle-Tacoma International Airport

Noise Abatement Departure Profile Noise Analysis

December 11, 2019

Work That Matters

Key Points

- Two Noise Abatement Departure Profiles (NADPs) are followed domestically and internationally: the ***Close-in*** and ***Distant*** departure profiles

- A Close-in NADP is more beneficial in abating noise in areas *closer* to the runway end; while a Distant NADP is more beneficial in abating noise in areas *farther* down the departure corridor

- A Distant NADP appears to provide the most benefits to the developed areas in the SEA environs

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Presentation Overview

- Introduction
- Background on Abatement Departure Profiles
- Review the SEA NADP Noise Analysis Results
- Recommendations
- Respond to Questions from StART Members

Introduction

- To determine the NADPs currently in use at Seattle-Tacoma International Airport (SEA), ESA surveyed five airlines operating Boeing 737-800s at SEA
- The existing NADPs were normalized to Stage Length 4 conditions and aircraft noise exposure was modeled using the Aviation Environmental Design Tool (AEDT)
- ESA compared the Sound Exposure Level (SEL) Contours and Grid Point values for the Close-In and Distant NADPs for four runway ends: 16L, 16C, 34R, and 34C
- The analysis identified a preferred NADP for use at SEA

Important Update

- After the technical work was completed and presented to the StART Working Group on October 14, 2019, Delta Air Lines conducted a internal review of its response to the NADP Survey
- As a result of that review, Delta Air Lines determined that its survey response incorrectly reflects the NADP that it is using at SEA
- Delta Air Lines has since indicated that it is using the Distant NADP (NADP 2) at SEA
- Therefore, Delta's SEL contours and grid point values would be similar to the Distant NADPs the other four surveyed airlines are flying at SEA
- However, the NADP Noise Analysis still provides a valuable comparison between the Close-In and Distant NADPs

Background on NADPs: Purpose

- NADPs serve as standard departure profiles for the minimization of aircraft noise in communities beneath departure corridors
- NADPs supplement the use of preferential departure runways and flight paths
- NADPs specify acceptable parameters for:
  - Speed
  - Altitude
  - Thrust settings
  - Aircraft configuration (flaps/slats)

Background on NADPs: Close-In vs. Distant

Close-In (NADP1)	Distant (NADP2)
Intended to provide noise reduction for noise sensitive areas near the departure end of the runway.	Intended to provide noise reduction for all other noise sensitive areas.
Thrust cutback initiated *prior to* initiation of flaps/slats retraction.	Thrust cutback initiated *after* initiation of flaps/slats retraction.
Climb power typically maintained to 1,500 feet above field elevation, then reduced.	Climb power may be reduced at 800 feet above field elevation
Speed and thrust criteria are maintained to 3,000 feet above field elevation or full transition to en route climb configuration.	
Standard departure internationally.	Standard departure in the U.S.

SOURCE: Federal Aviation Administration, July 1993; Aircraft Owners and Pilots Association, 2018.

Reduction of noise in one area results in a noise increase in another area.

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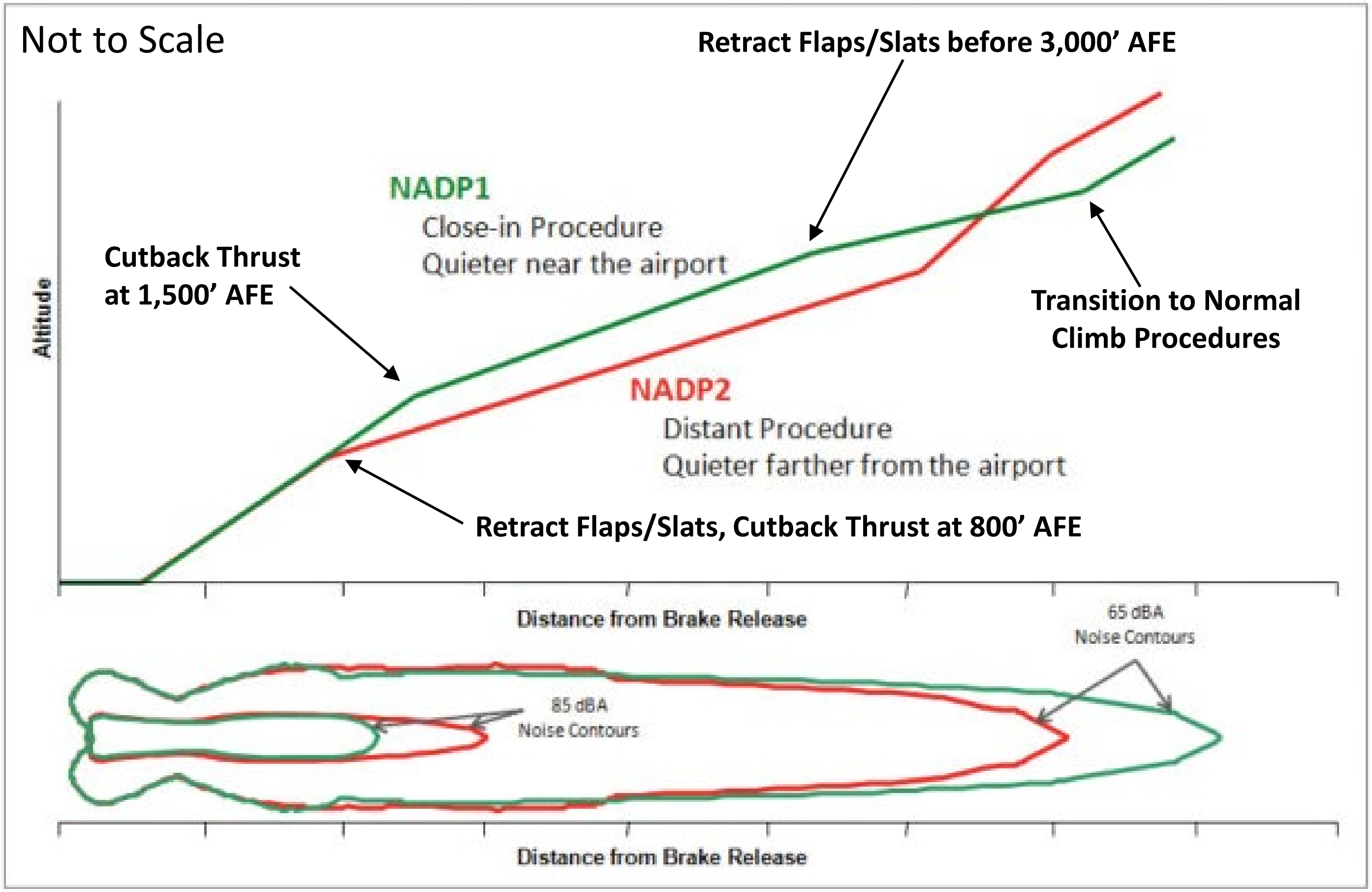
Background on NADPs:
Close-In vs. Distant



Source: Boeing, ESA Annotations, October 2019
AFE = Above Field Elevation

Background on NADPs:
International Civil Aviation Organization (ICAO)

- In addition to the US NADPs recommended by the FAA, there are two NADPS that are used by international aircraft operators

- International Civil Aviation Organization (ICAO) Procedure A (Close-In)
  - The internationally accepted procedure
  - Consideration is given to areas closest to airports
  - If procedures are not followed, airlines can face penalties/fines (AOPA, 2018)

- ICAO Procedure B (Distant)
  - Can be used to meet single-engine performance requirements usually dictated by terrain
  - Also used for noise abatement when appropriate to specific communities

Background on NADPs

- Interpretation of NADPs may vary according to:
  - Airline
    - Based on standard operating procedures
    - Flight optimization practices/software utilized
  - Aircraft Type
    - Engine type
    - Noise footprint

SEA NADP Noise Analysis Results

- Noise Analysis Overview
  - Aviation Environmental Design Tool, Version 2d (AEDT)
    - FAA-approved software for modeling aircraft noise exposure
    - Allows for dynamic modeling of aircraft performance in space and time
    - Can calculate the noise exposure of single flights or multiple operations
  - Boeing 737-800 selected as representative aircraft
    - Prevalence throughout domestic fleets
    - Prevalence at SEA
    - Robust SEL footprint

SEA NADP Noise Analysis Results:
Existing Conditions

- Five airlines operating the Boeing 737-800 at SEA were surveyed to determine the NADPs currently in use

Airline	Reported NADP
Alaska Airlines	Distant
American Airlines	Distant
Delta Air Lines	Close-In*
Southwest Airlines	Distant (Equivalent)
United Airlines	Distant

SOURCE: ESA, September 2019.

*Delta Air Lines has indicated, post SEA NADP Noise Analysis, that it uses the Distant NADP at SEA

SEA NADP Noise Analysis Results: Existing Conditions

- The detailed survey responses were used to develop the AEDT inputs
- Modeling Assumptions
  - Annual average day temperature for SEA – 52 degrees F
  - Headwind – Turned on – 6.69 Knots
  - Terrain – Turned on
- The AEDT calculated the Sound Exposure Level (SEL) contours and SEL grid point values for existing NADP conditions

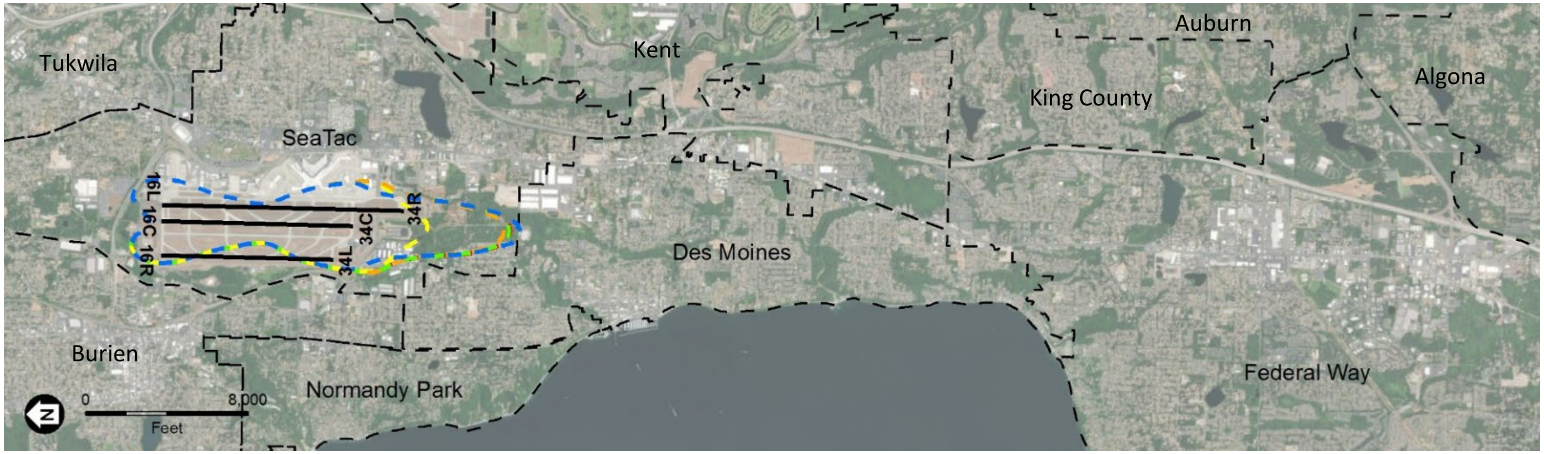
SEA NADP Noise Analysis Results:
Existing Conditions

- There are no federal standards for aircraft SELs
- Different SEL contour values yield different results
- Which SEL contours are most useful for comparing NADPs?

SEA NADP Noise Analysis Results

- Which SEL contours are most useful for comparing NADPs?

SEL 90 dBA Contours



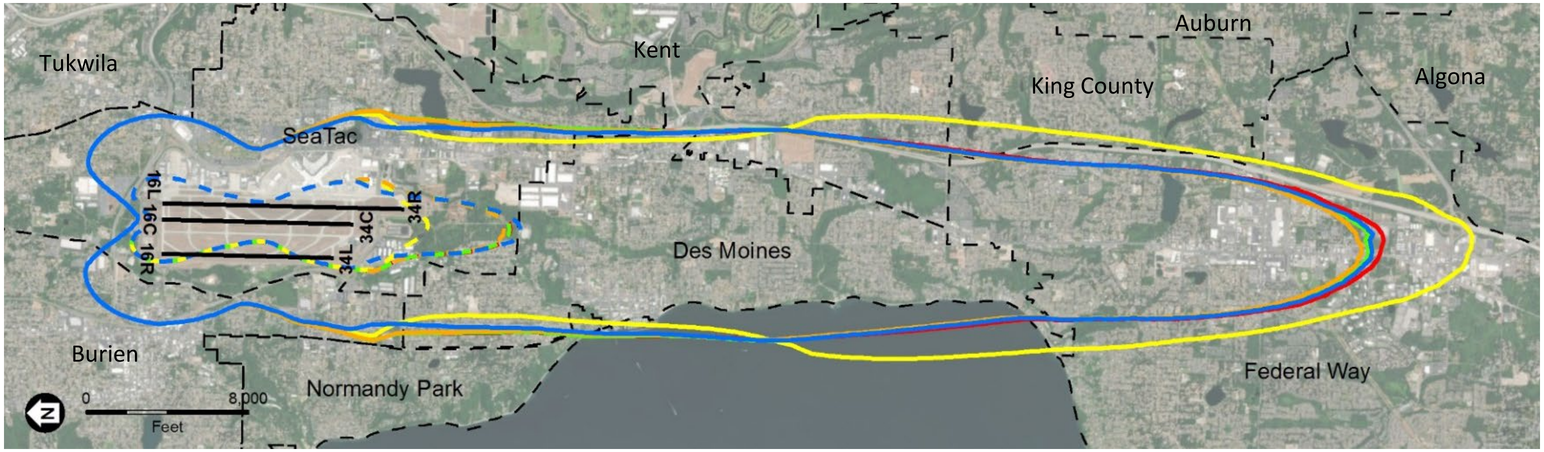
SOURCE: AEDT 2d, 2019; ESA, September 2019.

Note: SEL Contours represent the Stage Length 4 condition

SEA NADP Noise Analysis Results

- Which SEL contours are most useful for comparing NADPs?

SEL 90 dBA Contours and the SEL 80 dBA Contours



SOURCE: AEDT 2d, 2019; ESA, September 2019.

Note: SEL Contours represent the Stage Length 4 condition

SEA NADP Noise Analysis Results:
Close-In vs. Distant NADP Conditions

- The AEDT noise model associates a typical aircraft departure weight with a “stage length”

Stage Length	Distance to Destination
Stage Length 1	0 to 500 miles
Stage Length 2	500 to 1,000 miles
Stage Length 3	1,001 to 1,500 miles
Stage Length 4	1,501 to 2,500 miles
Stage Length 5	2,501 to 3,500 miles
Stage Length 6	3,501 to 4,500 miles
Stage Length 7	4,501 to 5,500 miles
Stage Length 8	5,501 to 6,500 miles
Stage Length 9	6,500+ miles

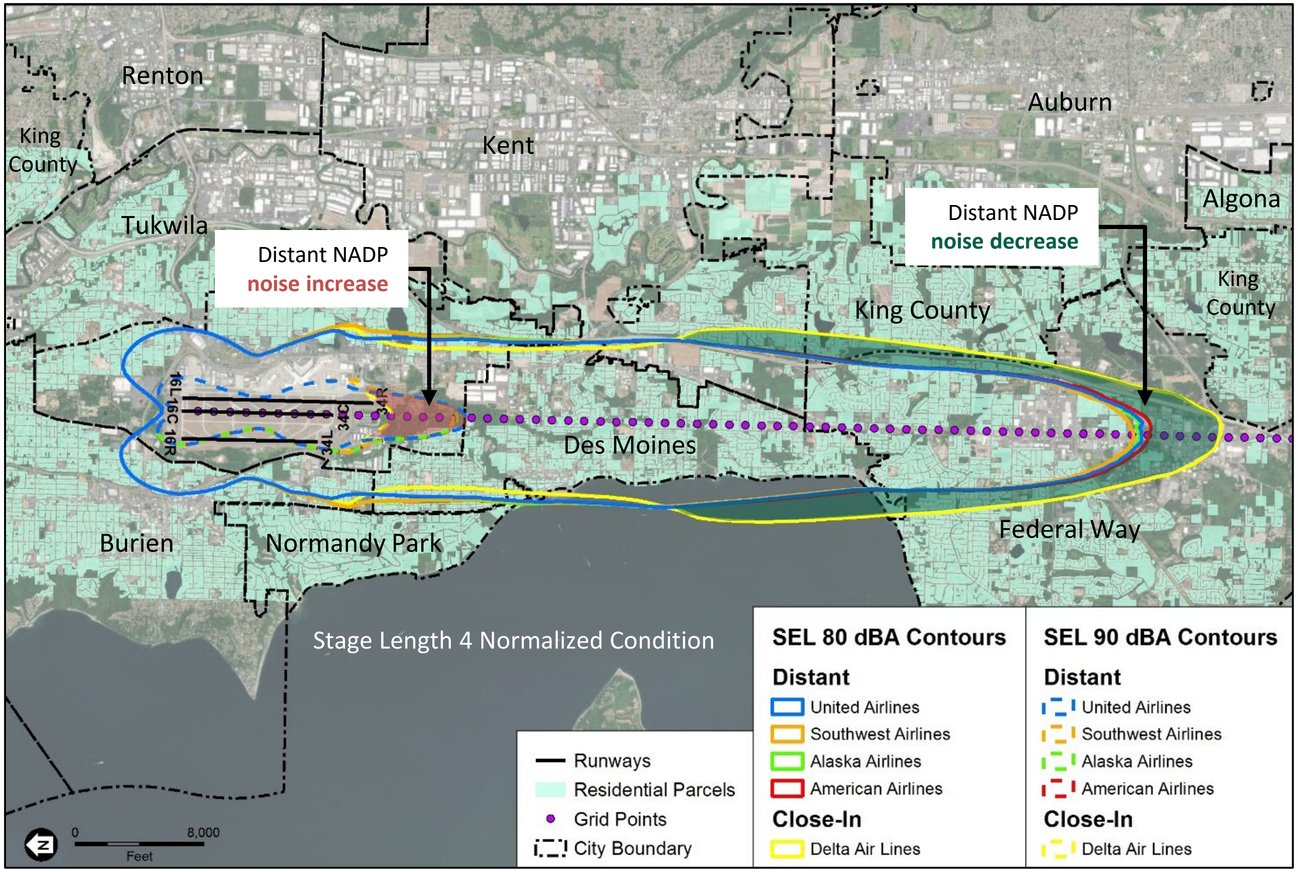
SOURCE: AEDT 2d, 2019; ESA, September 2019.

SEA NADP Noise Analysis Results: Close-In vs. Distant NADP Conditions

- Variations among operators' reported typical departure weights resulted in the assignment of different stage lengths in the AEDT
  - Stage Length 3 – Southwest Airlines
  - Stage Length 4 – Alaska Airlines, American Airlines, and United Airlines
  - Stage Length 5 – Delta Air Lines
- In order to control for variations in typical aircraft departure weights, stage lengths assigned to the individual operators were normalized to Stage Length 4

SEA NADP Noise Analysis Results:
Close-In vs. Distant NADP Conditions

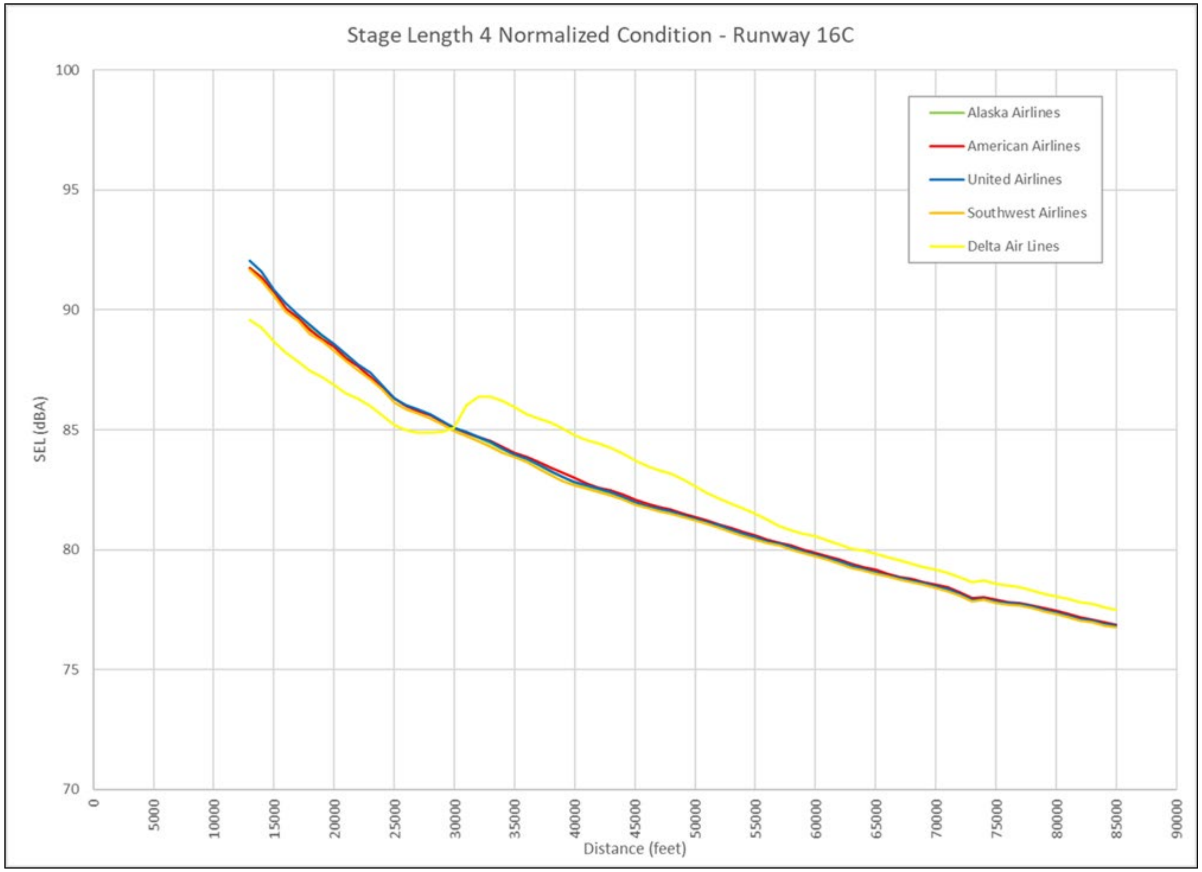
- SEL contours for **Runway 16C**



SOURCE: AEDT 2d, 2019; ESA, September 2019.

SEA NADP Noise Analysis Results:
Close-In vs. Distant NADP Conditions

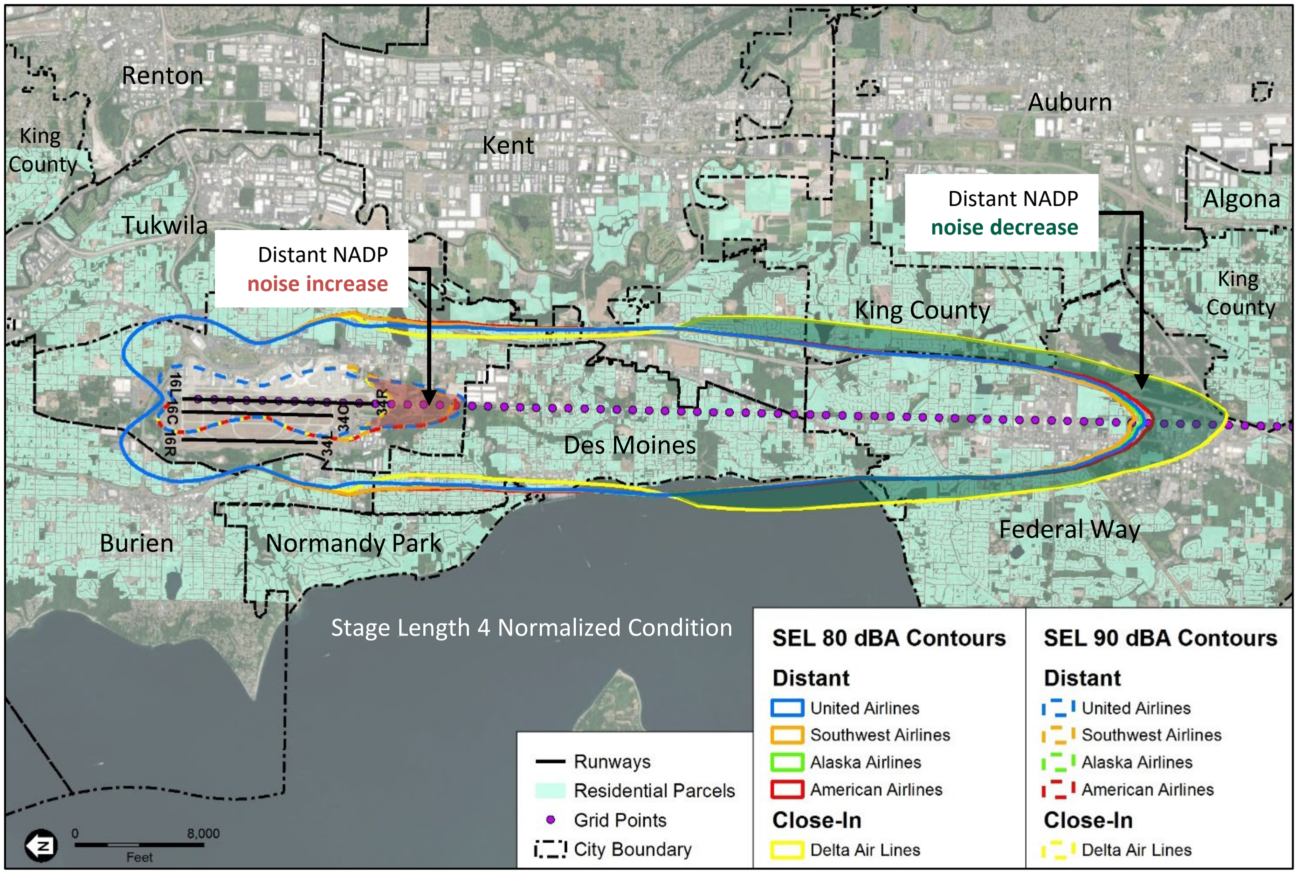
- Plotted SEL grid point values for **Runway 16C**



SOURCE: AEDT 2d, 2019; ESA, September 2019.

SEA NADP Noise Analysis Results:
Close-In vs. Distant NADP Conditions

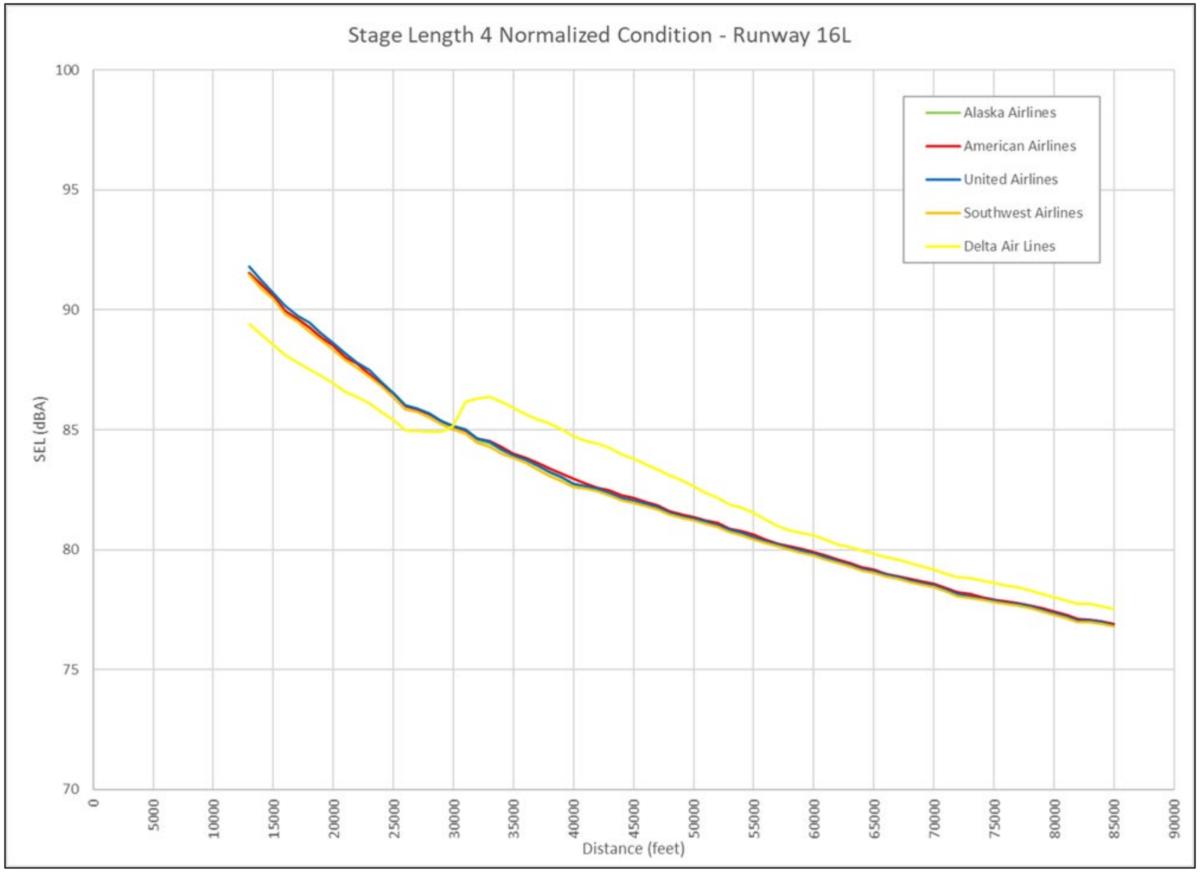
- SEL contours for **Runway 16L**



SOURCE: AEDT 2d, 2019; ESA, September 2019.

SEA NADP Noise Analysis Results:
Close-In vs. Distant NADP Conditions

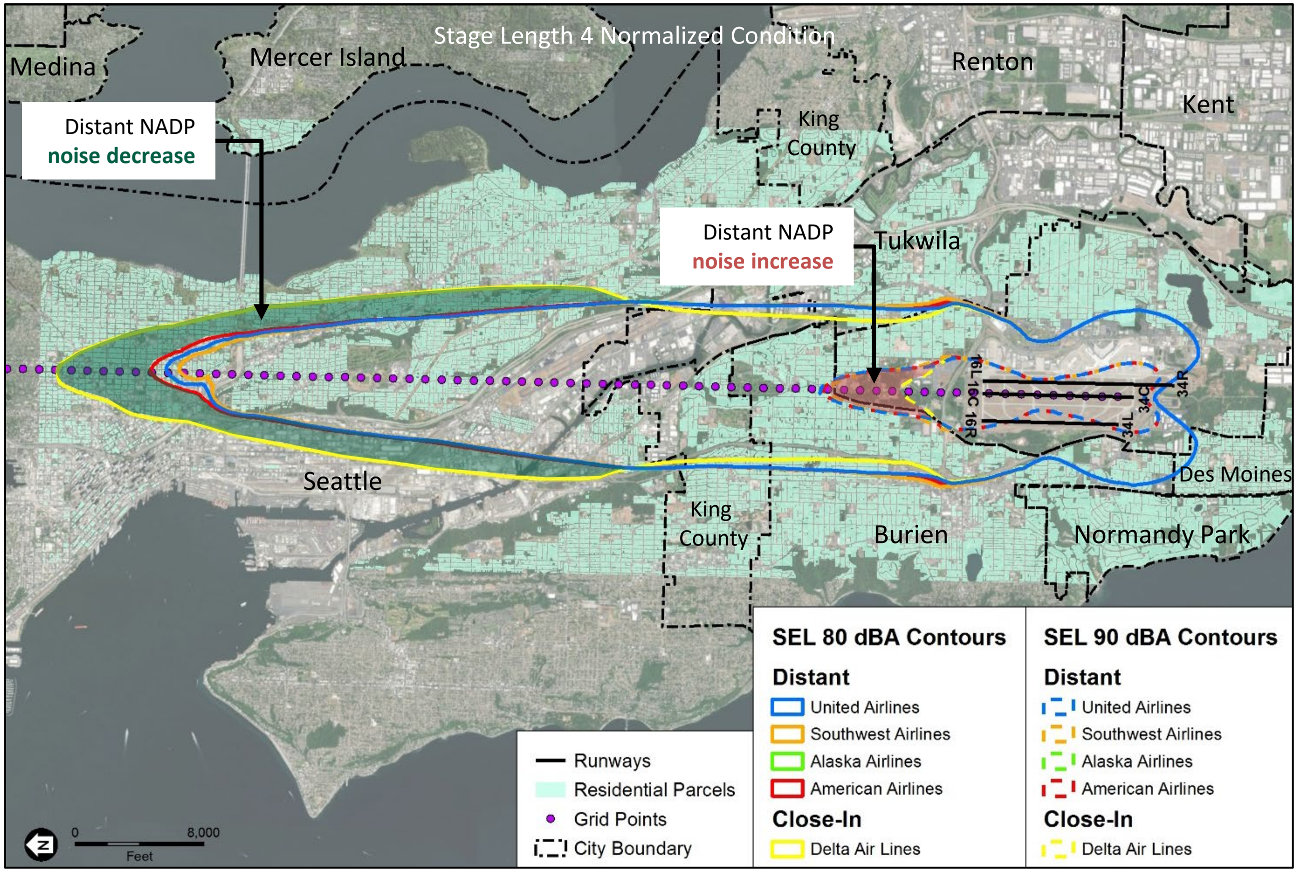
- Plotted SEL grid point values for **Runway 16L**



SOURCE: AEDT 2d, 2019; ESA, September 2019.

SEA NADP Noise Analysis Results:
Close-In vs. Distant NADP Conditions

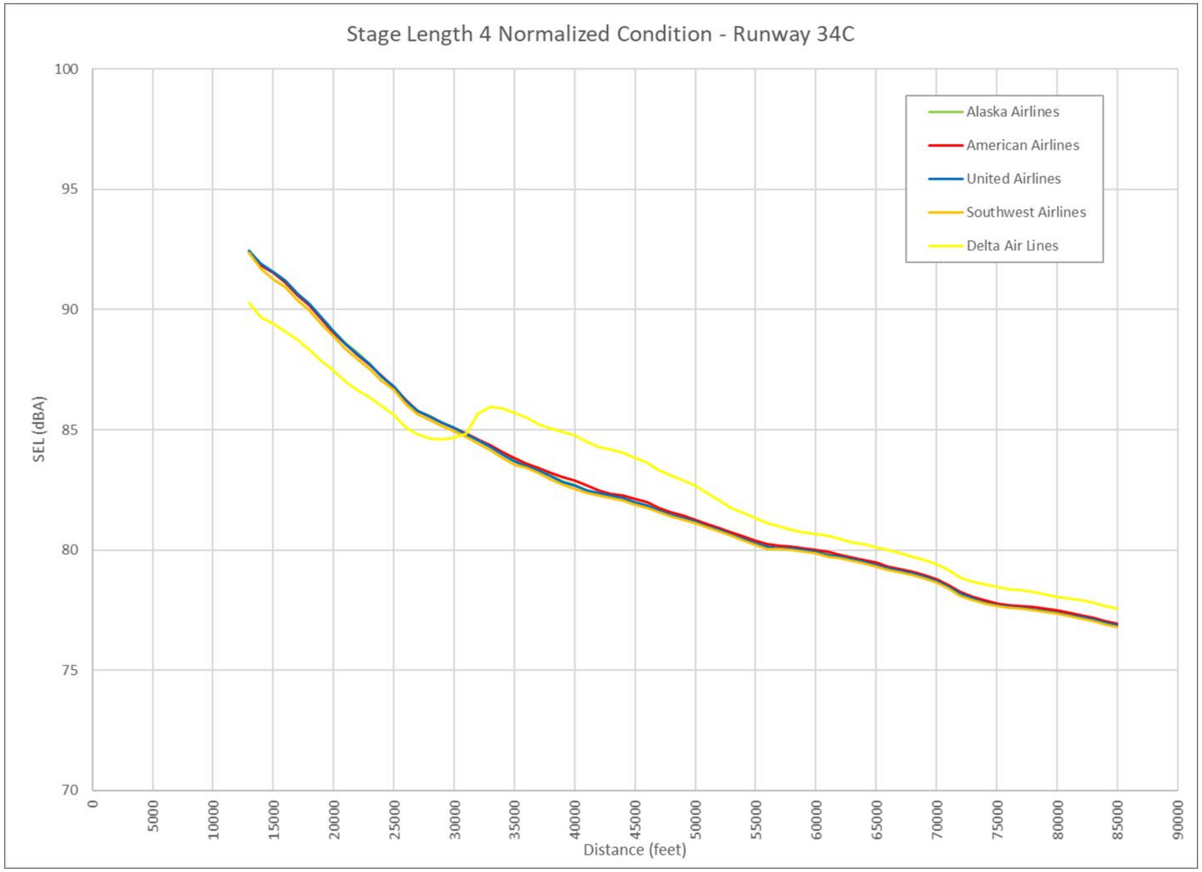
- SEL contours for **Runway 34C**



SOURCE: AEDT 2d, 2019; ESA, September 2019.

SEA NADP Noise Analysis Results:
Close-In vs. Distant NADP Conditions

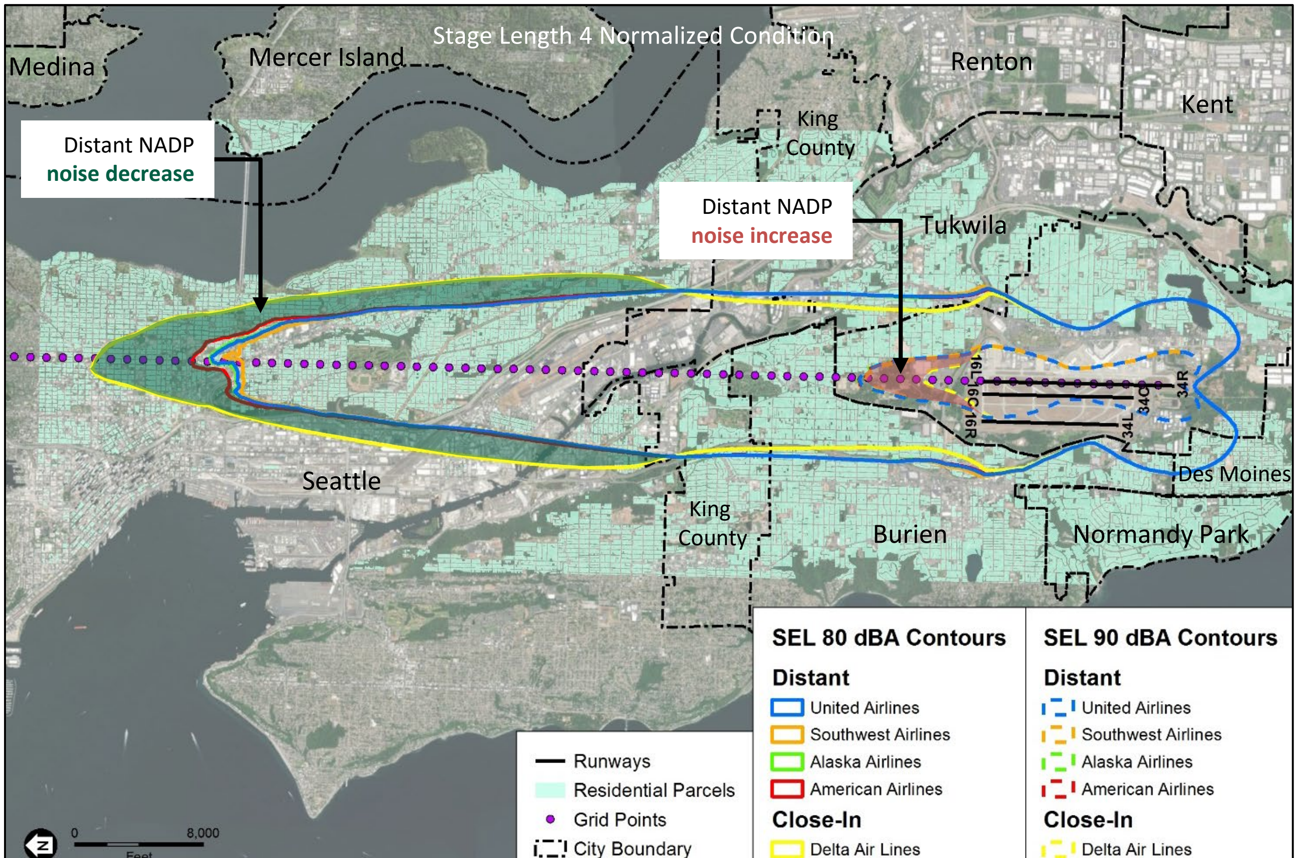
- Plotted SEL grid point values for **Runway 34C**



SOURCE: AEDT 2d, 2019; ESA, September 2019.

SEA NADP Noise Analysis Results:
Close-In vs. Distant NADP Conditions

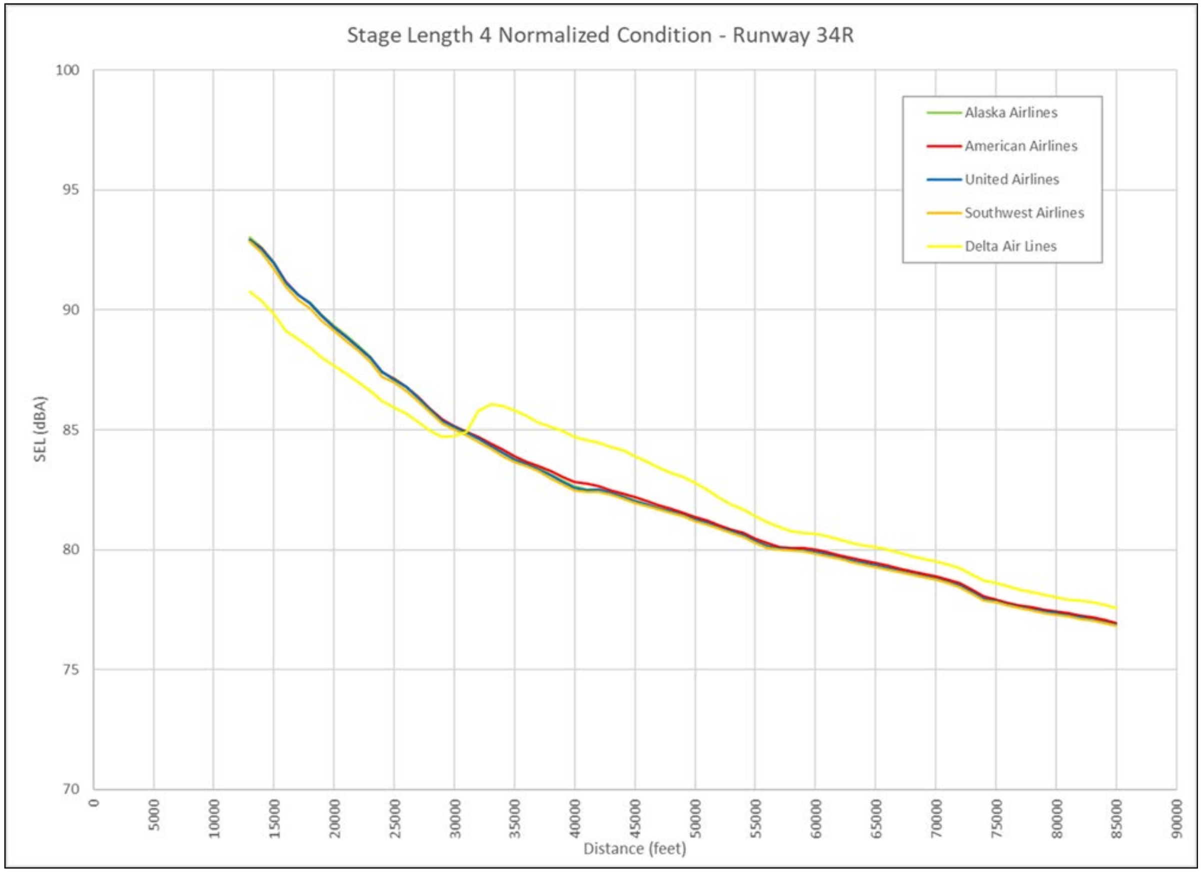
- SEL contours for **Runway 34R**



SOURCE: AEDT 2d, 2019; ESA, September 2019.

SEA NADP Noise Analysis Results:
Close-In vs. Distant NADP Conditions

- Plotted SEL grid point values for **Runway 34R**



SOURCE: AEDT 2d, 2019; ESA, September 2019.

SEA NADP Noise Analysis Results:
People Exposed to SEL 80 dBA and Higher

NADP	16C	16L	34C	34R
SEL 80 dBA				
Close-In	76,200	79,435	94,905	89,987
Distant	73,088	75,781	68,551	68,698
Difference	**3,111**	**3,655**	**26,353**	**21,288**
SEL 90 dBA				
Close-In	4	1	7	3
Distant	171	141	528	119
Difference	**-167**	**-140**	**-521**	**-116**

SOURCE: AEDT 2d, 2019; ESA, September 2019.

- For this analysis, the American Airlines NADP represented the Distant NADP and was compared to the Delta Air Lines Close-In NADP
- The Distant NADP exposes fewer people within the SEL 80 dBA contour, while the Close-In NADP exposes fewer people within the SEL 90 dBA contour
- These results are consistent with expectations regarding the benefits and drawbacks of the Close-In and Distant NADPs

SEA NADP Noise Analysis Results: Conclusions and Recommendations

- Based on the B737-800 results, ESA recommends that the Port of Seattle request all aircraft operators implement the **Distant NADP (NADP 2) or its ICAO equivalent (Procedure B) at SEA**

- The Port's implementation process may benefit from direct meetings with the airlines

- The Port should track and report on airline adoption and use of the Distant NADP

- The Port should evaluate and report on the change in aircraft noise exposure levels over time due to the Distant NADP

Questions from StART Members?