A Measured, Reproducible Methodology for Community Aircraft-Noise Burden Assessment Under a Proposed Departure Procedure

From residential parcels and addresses through geocoding, flight-path reconstruction, and empirically calibrated propagation to FAA DNL significance

BWI Runway 15R Departure Corridor · Severn, Anne Arundel County, Maryland

Abstract

This report documents a reproducible method for estimating the residential noise burden of a proposed RNAV departure procedure (the "BRGHT" straight-leg departure) over communities beneath the Baltimore/Washington International Thurgood Marshall Airport (BWI) Runway 15R corridor. The method proceeds from authoritative parcel and address data, through flight-path reconstruction from recorded track data, to a propagation model calibrated on field measurements from a community-operated IEC 61672 Class 2 instrument [4]. Single-event levels are integrated to Sound Exposure Level (SEL) and aggregated to the FAA Day-Night Average Sound Level (DNL). We report both the regulatory metric and the single-event evidence it omits, and present the full distribution of change over the no-action baseline rather than a single summary value. Two central empirical results — an energy-attenuation coefficient K ≈ 1.2 fit across 687 measured departures, and the finding that even the loudest measured geometry reaches only ~57 DNL — are offered as measured evidence, not as a substitute for the FAA Aviation Environmental Design Tool (AEDT). Every external standard, dataset, and threshold is cited to a primary source.

Contents

1 Introduction and scope

Communities beneath modern RNAV departure corridors frequently report that the loudness and frequency of individual overflights are not reflected in the noise contours that govern federal significance. The governing metric, DNL, is a 24-hour, annually-averaged, energy-based measure. Its 65 dB regulatory threshold traces to a dosage-response synthesis first published by Schultz in 1978 [1], expanded by Finegold et al. in 1994 [5], and institutionalized through FICON in 1992 [2]. Its limitations for single-event disturbance are long-documented [3].

This report does not relitigate the threshold. Its purpose is to document, step by step and with citations, how community-measured data become a defensible estimate of who bears what burden under a proposed procedure — reporting relief, no-change, and increase alike. The method is designed to be reproduced by a third party from public data plus the measurement record.

Scope. The analysis covers the residential parcels swept by the proposed straight-leg departure relative to the current procedure, the addresses and populations within them, and modeled single-event and cumulative noise at each. It is an independent measured screening; it is not an AEDT model, produces no official contours, and treats the post-turn segment of the proposed track as notional because no flown examples exist.

2 Data sources and provenance

All inputs are authoritative public data or calibrated field measurement. Table 1 summarizes each source and role; subsequent sections detail their use.

Input	Source	Role
Zoning parcels	Anne Arundel County adopted zoning (OpenArundel GIS)	Identify residential parcels; zoning class → housing type
Addresses	Anne Arundel County Structure Address Points	Actual residence count via point-in-polygon
Census geography	U.S. Census Bureau Geocoder API	Assign each address to a 2020 block group
Demographics	ACS 2019–2023 5-year estimates, block group	Income, tenure, race/ethnicity
Flight tracks	Recorded ADS-B track logs (KML)	Reconstruct current and proposed paths
Noise	Community IEC 61672 Class 2 monitor	Calibrated single-event dBA, 2-s samples
Operations	BWI published annual operations	Daily flight counts for DNL

Table 1. Inputs, sources, and roles. Every row is public data or calibrated measurement; none is modeled from assumption.

Provenance note. One measurement dataset (14 Aug 2026) was recorded during a runway closure when Runway 33L handled both arrivals and departures; near-run-up-area contamination was removed by retaining only samples above 170 ft aircraft altitude, verified by the bearing sweep characteristic of a genuine overflight. This correction is documented because it materially changed an intermediate result and illustrates the provenance discipline the method requires.

3 Residential parcels

Residential parcels were selected from the county adopted-zoning layer by zoning class (RA, R1, R2, R5, R10, R15, R22, RLD). Parcel geometry was read at full resolution; the county-authoritative Acreage attribute was used rather than a computed area, and MultiPolygon parts and interior holes were handled explicitly. Near-zero-acre records (right-of-way and zoning-boundary slivers) were excluded as non-residential artifacts.

Corridor membership was defined not by a fixed lateral half-width but by the measured 62 dBA single-event departure footprint (Section 6), so that a parcel qualifies when it lies within the level of noise the method can defend, not within an arbitrary distance. An early draft used a parcel-centroid test within a 0.35-mile band; this was found to exclude entire subdivisions whose lot-polygon centroids fell just outside the band while their dwellings did not, and was replaced by the footprint-based, address-level approach below.

4 Addresses and geocoding

Zoning permits dwellings; it does not count them. To obtain actual residence counts, the county Structure Address Points layer was intersected with the corridor polygon by point-in-polygon test. This replaced a zoning-density estimate (~575 dwelling units across five parcels) with a measured count (9,240 residential address points across the full corridor), and corrected a specific error: a 64-acre parcel estimated at ~161 single-family homes proved to contain two addresses — undeveloped land, not a subdivision.

Address counts were validated against ACS housing-unit counts per block group: in nearly every block group the address-point count fell at or below the ACS housing-unit total, the signature of an essentially all-residential set with no material commercial contamination.

Each address was assigned to a 2020 Census block group using the U.S. Census Bureau Geocoder coordinate service [6]. Block groups are the finest geography at which ACS estimates are published [7].

5 Demographic attribution

For each block group containing corridor addresses, demographics were drawn from the American Community Survey 2019–2023 5-year estimates via the Census Data API [8]: median household income (table B19013), tenure (B25003), race (B02001), Hispanic origin (B03003), and population (B01003). Corridor-wide figures are home-weighted by the address count in each block group, so a block group contributes in proportion to the dwellings actually within the corridor.

Reported honestly, the corridor is predominantly middle-income (home-weighted median household income ≈ $118,000) and mostly owner-occupied (≈ 24% renters), not a low-income community. However, its lower-income block groups are markedly more diverse (minority share 81% below $60k versus 28% above $130k), so the burden's distribution carries a real equity dimension that a single median would conceal. Block-group estimates carry ACS sampling error and characterize the neighborhood a parcel sits in rather than its specific rooftops; both caveats are stated wherever the figures appear.

6 Flight-path reconstruction

Current departure and 33L arrival paths were reconstructed from recorded ADS-B track logs exported as KML, parsed to latitude, longitude, and pressure altitude. The current 15R departure corridor was characterized from measured live tracks; the proposed BRGHT path was constructed as a straight leg from the wheels-up rotation point to the published BRGHT waypoint, followed by a notional turn. A variant retaining the established WARYN waypoint (a 16° nudge rather than the current early turn) was modeled and found to produce a climb profile and noise footprint nearly identical to the direct BRGHT leg (7 ft lower at the waypoint; ~0.03 mi longer path).

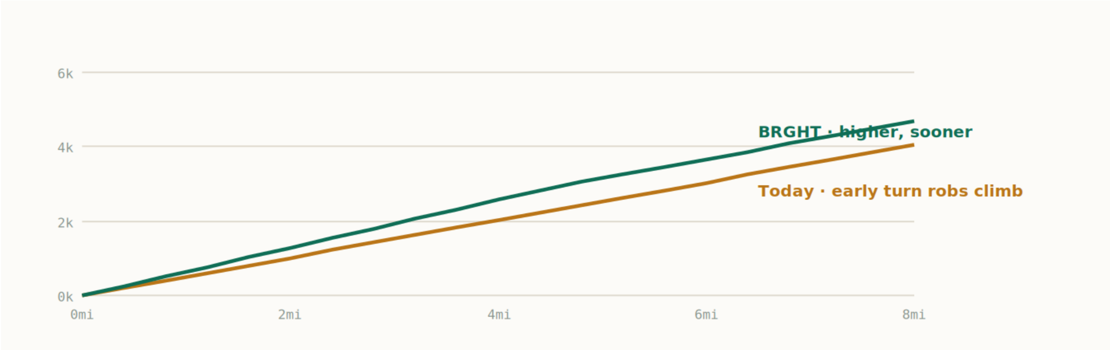

Figure 5. *Climb profile of the proposed straight-leg departure versus the current early-turning procedure. Deferring the turn permits a cleaner climb (644 vs 507 ft/mi), placing aircraft higher — and thus quieter — over communities beyond the turn.*

Arrival-corridor stability was checked across seven independent 33L approaches spanning one day: lateral spread was 0.19–0.38 mi at all distances, and same-day tracks overlaid to within ~283 ft at 3 mi — the tight concentration characteristic of performance-based navigation. The post-turn BRGHT segment is treated as notional throughout because no flown BRGHT tracks exist.

7 Empirical noise measurement and propagation

7.1 Instrument and single-event capture

Noise was measured with a community-operated sound-level meter meeting IEC 61672-1 Class 2 [4], logging A-weighted levels at 2-second intervals with per-overflight association to ADS-B identity, altitude, and slant range. Each overflight yields a time series of samples rather than a single reading, permitting integration to Sound Exposure Level.

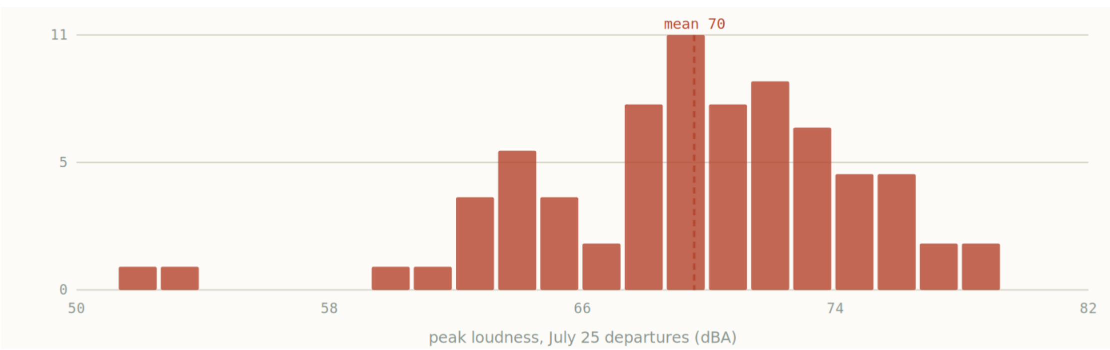

Figure 1. *Peak single-event loudness of individual departures over the receptor (representative single day, n=77). Most overflights peak in the upper 60s to upper 70s dBA and recur throughout the day.*

7.2 From level to SEL to DNL

For each overflight, SEL was computed by energy integration of the 2-second samples, $SEL = 10 \cdot \log_{10}(\Sigma\ 10^{(L_i/10)} \cdot \Delta t)$ with $\Delta t = 2$ s. DNL was then formed as $DNL = \overline{SEL} + 10 \cdot \log_{10}(N\_day + 10 \cdot N\_night) - 10 \cdot \log_{10}(86{,}400)$, applying the standard 10 dB nighttime (22:00–07:00) penalty. This is the definitional cumulative-exposure construction underlying the FAA metric [9]. The measured SEL-minus-L_max offset was +6.7 dB for departures and +8.4 dB for arrivals — replacing a +12 dB literature assumption used in an earlier draft that had overstated exposure by roughly 5 dB in DNL terms.

7.3 Distance attenuation (the power-law coefficient)

Propagation was represented by a power-law form, level = REF − K·20·$\log_{10}$(slant/slant_{ref}), where K = 1 is the free-field inverse-square (geometric-spreading) case and K > 1 captures the additional atmospheric and ground attenuation described by the standard outdoor-propagation and atmospheric-absorption references [10] [11] [12]. The coefficient K was not assumed but fit to the measured data.

Fitting integrated SEL against slant range across 687 clean departure events spanning 0.4–2.9 mi gave SEL = 73.0 − 25.0·$\log_{10}$(slant), i.e. K ≈ 1.25 (R^2 = 0.57). Because the residual scatter reflects aircraft type, meteorology, and geometry, the coefficient is stated as K ≈ 1.2 rather than to false precision. An earlier value of K = 1.78 was derived from peak-level (L_max) recession tracking — a different physical quantity — and is not used for cumulative-exposure work; the energy-based K ≈ 1.2 is the appropriate coefficient for SEL and DNL. This reconciliation (peak-decay versus energy-attenuation) is retained in the record because it materially widens the affected area: a gentler attenuation means noise carries farther, increasing rather than decreasing the number of homes in the footprint.

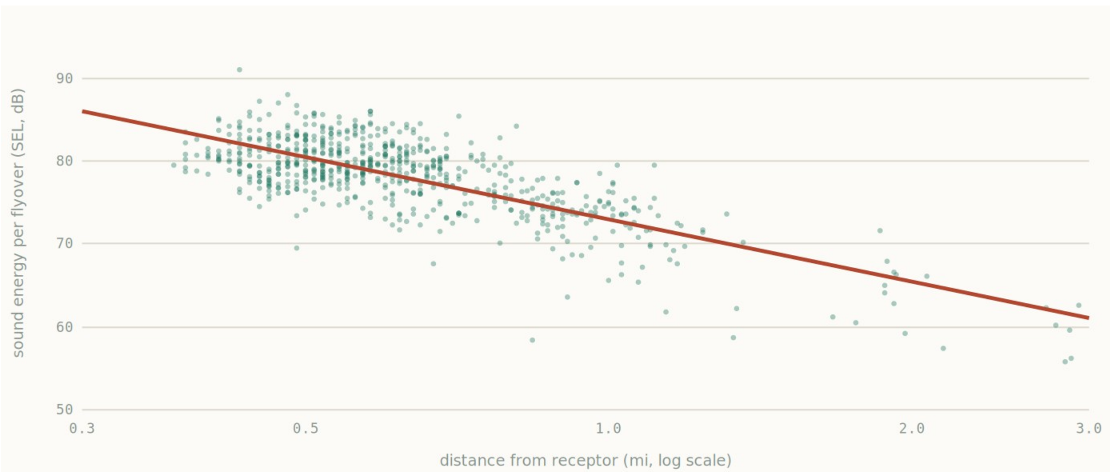

Figure 2. *Integrated Sound Exposure Level versus slant distance for 687 measured departures (0.4–2.9 mi). The fit gives SEL = 73.0 − 25.0·$\log_{10}$(slant), i.e. K ≈ 1.25 (R^2 = 0.57). Scatter reflects aircraft type, meteorology, and geometry; the coefficient is reported as K ≈ 1.2.*

8 Results

8.1 Cumulative exposure (DNL)

Measured receptor DNL, computed on the SEL basis above, is approximately 51 dB for 15R departures alone and approximately 57 dB for the loudest arrival geometry (aircraft nearly overhead at touchdown, peaks to 80 dBA); the combined departures-plus-arrivals figure is approximately 52 DNL. Even the loudest measured single-event geometry therefore falls roughly 8 dB below the 65 DNL significance threshold; reaching 65 would require on the order of seven times the current operation count. This is the central quantitative finding: the loudest, most frequent exposure the instrument records does not approach the level the governing metric treats as significant.

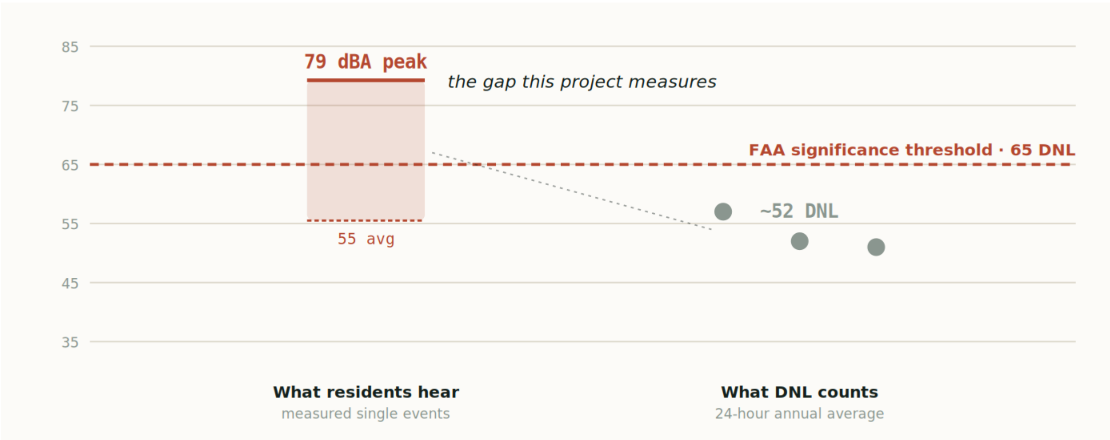

Figure 3. *Measured single-event peaks (left, what residents hear) against annual-average DNL (right, what the metric counts). Even the loudest arrivals reach only ~57 DNL; the combined figure is ~52 — roughly 13 dB below the 65 threshold.*

8.2 Distribution of change over baseline

Because FAA significance evaluates the increase over the no-action baseline, each of the 9,240 corridor homes was assigned the difference between its proposed-procedure and current-procedure departure exposure. The distribution (mean +1.2 dB, SD 4.3 dB) is reported in full rather than as a single value:

Change vs today	Homes	Share	Reading
≥ 1.5 dB quieter (relief)	2,641	29%	procedure moves noise away
within ±1.5 dB (no change)	2,115	23%	already overflown today
1.5–3 dB louder (modest)	1,465	16%	small increase
≥ 3 dB louder	3,019	33%	reportable-band increase

Table 2. Change in single-event departure exposure vs the current procedure, per residence (K ≈ 1.2). Relief and increase are reported at equal weight; the split near ±1.5 dB rests on a three-track current-departure model and is the softer edge of the estimate.

The procedure is thus not a clean benefit: roughly a quarter of homes gain relief, a further quarter change little (they are already overflown), and roughly half bear a measurable increase — a third of them at the ≥3 dB level that is reportable within the 60–65 DNL band. Deltas are relatively robust to the choice of K because the coefficient largely cancels in a difference.

9 Regulatory framework applied

Under FAA Order 1050.1 (Change 1050.1G, which superseded 1050.1F [13] [14]), a significant noise impact is a DNL 1.5 dB or greater increase for an area at or above DNL 65 dB (or brought to ≥65 by the action). Reportable increases are defined at 3 dB within the 60–65 DNL band and 5 dB within the 45–60 DNL band [15]. The compatibility threshold of DNL 65 dB derives from 14 CFR Part 150 [16].

Applied to the measured results, two facts hold simultaneously and without contradiction. First, the proposed procedure crosses no significance threshold anywhere, because no receptor reaches DNL 65; this makes the change administratively low-risk. Second, the same measurements demonstrate the metric's insensitivity to single-event disturbance: dozens of daily overflights peaking above 65 dBA at a receptor computing to ~52 DNL. These are presented as distinct arguments — permissibility under the current rule, and a measured critique of the rule — never conflated.

10 Limitations

- Arrival attenuation slope is borrowed from the departure fit; measured arrival events cluster near touchdown (0.1–0.35 mi) and cannot independently constrain the slope.
- The current-departure baseline rests on three measured tracks; the relief-versus-increase split near ±1.5 dB is correspondingly the softer part of the estimate.
- The post-turn BRGHT segment is notional; no flown BRGHT tracks exist.
- DNL depends on operation counts, day/night split, and the SEL construction; central estimates are reported and are sensitive to these by 1–2 dB.
- Demographics are block-group ACS estimates with sampling error, characterizing neighborhoods rather than specific rooftops.
- This is an independent measured screening, not an FAA AEDT model, and does not produce official noise contours.

11 Reproducibility

Every step above is reproducible from public data plus the measurement record: county zoning and address layers are open downloads; Census geography and ACS estimates are public APIs; flight tracks are recorded ADS-B; and the noise model is fully specified by its anchor (measured SEL) and coefficient (measured K). Intermediate artifacts — the corridor polygon, the per-home noise and demographic join, and the SEL/K fits — are archived on the project OSF repository. A reviewer beginning from the same public sources and the published measurement log will arrive at the same figures.

Appendix Supplementary case figures

The following figures support the argument developed in the body but are secondary to the core method. They are collected here and referenced from the relevant sections.

A. Departure DNL by distance

Referenced from §8.1. Departure DNL falls off rapidly with distance and remains well below the 65 dB significance threshold at every realistic residential distance.

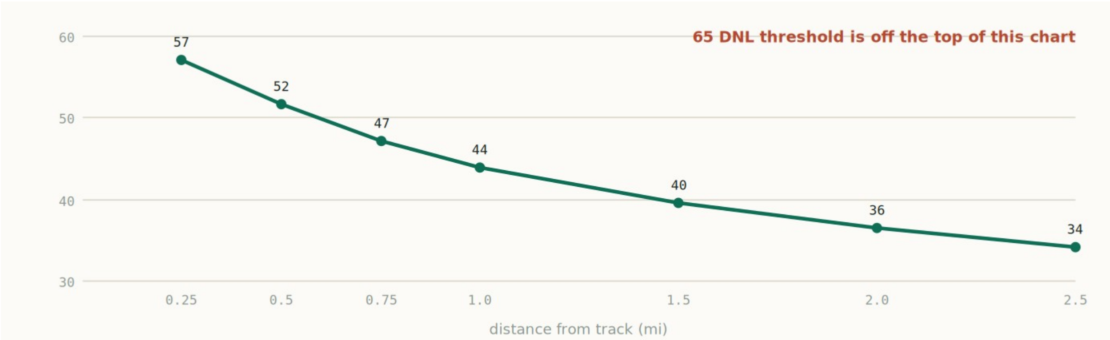

Figure A1. *Modeled departure DNL by distance from the track (measured energy attenuation, K ≈ 1.2). The 65 DNL threshold lies above the top of the chart at all distances shown.*

B. Corridor demographics

Referenced from §5. The corridor is predominantly middle-income, but diversity rises sharply as block-group income falls, locating the equity concern precisely.

Figure B1. *Residences by block-group median income, with minority share noted beneath each band. Diversity rises as income falls (81% minority below $60k versus 28% above $130k).*

C. Sound-energy distribution

Referenced from §7.2. The spread of integrated SEL across all measured departures — the raw material aggregated into DNL.

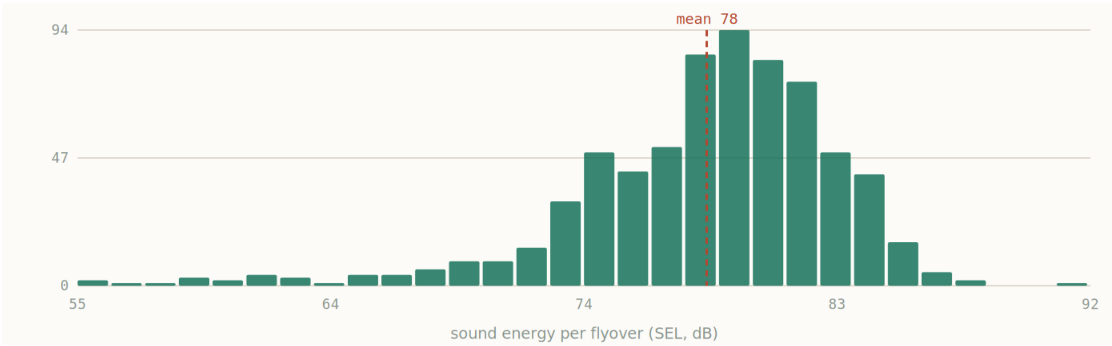

Figure C1. *Distribution of integrated Sound Exposure Level across 687 measured departures (mean 78.0 dB, SD 4.9). These loud, frequent events average across a mostly-quiet day to the sub-threshold DNL values reported in §8.*

References

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15. U.S. Department of Transportation, FAA. Air Traffic Noise Screening thresholds: DNL 1.5 dB at/above 65; 3 dB within 60–65; 5 dB within 45–60. Procedures for Handling Airspace Matters, Ch. 32.
16. Code of Federal Regulations. 14 CFR Part 150, Airport Noise Compatibility Planning, Appendix A, Table 1 (DNL 65 dB land-use compatibility).

All citations verified against primary sources, August 2026. Standards (IEC, ISO, SAE) are identified by designation and year; the reader should consult the current published edition. This report is independent community research and is not affiliated with or endorsed by the FAA.