Total Persons Highly Annoyed

Comparison of Population & Noise Impact of BSR vs. SERFR vs. DAVYJ

Abstract

During recent deliberations of the Select Committee for South Bay Arrivals, members of the committee have expressed a desire to have a metric, TPA (Total Persons Aggravated), to evaluate the impact of proposed airplane routes on underlying communities.

Referencing the FAA's publication of DNL noise modeling of the BSR, SERFR, and proposed DAVYJ routes, previously published federal government-sponsored research on the relationship between DNL noise exposure and high-levels of community annoyance, and available Census Block-level population information, we construct a similar metric, known as TPHA (Total Persons Highly Annoyed), to compare the impacts of these three routes on affected communities.

The calculated TPHA results for the three routes (BSR, SERFR, DAVYJ) reveal that there would be a greater number of people "highly annoyed" by DAVYJ (avg. 1,016) than SERFR (avg. 821) and BSR (avg. 674), and confirm that DAVYJ and BSR are not equivalent in their impact.

In addition, the FAA's DAVYJ noise modeling predicts **a significantly increased impact in the >45 dBA DNL noise contour: 24,892 people across the cities of East Palo Alto, Menlo Park, and Palo Alto** would live within this (loudest) noise contour, whereas the the FAA's >45 dBA DNL noise contours for the current SERFR and pre-NextGen BSR routes are unpopulated.

Methodology

Using the FAA's published DNL noise contours for BSR (circa 2014), SERFR, and DAVYJ arrivals, we generated georeferenced polygons outlining each of the primary DNL noise contours (35-40 dBA, 40-45 dBA, and >45 dBA) in the immediate vicinity of each of the flight paths. While this approach ignores the extent of the noise impact due to delay vectoring, the FAA's data does not provide reliable guidance as to the noise impact away from the flight path due to limitations in their noise simulation.

In addition, note that the FAA's noise modeling only takes into account the noise generated by flights on these specific routes; many of the affected regions are also affected by other airplane traffic (e.g. BDEGA and Oceanic arrivals into SFO, SFO southbound departures, SJC traffic,

etc), and so this analysis will likely understate the true impact of all airplane noise in our region. Finally, be aware that the impact of low-frequency noise is not adequately reflected in A-weighted decibel units, and DNL itself does not account for the increased impact of repetitive aircraft noise. That said, A-weighted dB and DNL measures are widely used in impact analysis and policy-making, and the availability and support for such metrics cannot be ignored.

Using commercial Geographic Information System (GIS) software[1], we were able to calculate the intersection between noise contour polygons and underlying Census Block[2]-level population data to count the number of affected people living in each of the noise contours.

To estimate the impact of noise on the affected populations, we refer to the so-called "FICON Curve" (also known as the "Updated Schultz Curve"). For decades, environmental planners have relied heavily on this curve for predicting the community annoyance[3] produced by noise from transportation noise sources. While we believe DNL and the "FICON Curve" significantly underestimate the true levels of annoyance or aggravation due to airplane noise, using these measures has the benefit of decades of acceptance and support by the federal government.

% Highly Annoyed

In 1978, T.J. Schultz reviewed data from social surveys concerning the noise of aircraft, street and expressway traffic, and railroads. According to Schultz "...the basic rule adopted was to count as 'highly annoyed' the people who responded on the upper 27% to 29% of the annoyance scale..." (Schultz 1978).

The U.S. Federal Interagency Committee on Noise (FICON) updated the so-called "Schultz Curve" in 1992 for use by federal agencies in aircraft noise-related environmental impact analyses (Federal Interagency Committee on Noise 1992). FICON declared that annoyance was its preferred ''summary measure of the general adverse reaction of people to noise,'' and that ''the percentage of the area population characterized as 'highly annoyed' by long-term exposure to noise'' was its preferred measure of annoyance.

While FICON recommended further research, they found that the updated Schultz Curve remains the best available source to predict community response to transportation

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[1] Geographical Information Systems simplify the process of visualizing, analyzing, and interpreting geographical data by providing built-in support for common operations and techniques.

[2] A Census Block is the smallest geographic unit used by the United States Census Bureau. Census blocks are generally small in area. In a city, a census block looks like a city block bounded on all sides by streets. Census blocks in suburban and rural areas may be large, irregular, and bounded by a variety of features, such as roads, streams, and transmission lines. Each of the routes studied involved an analysis of thousands of Census Blocks.

[3] Community annoyance can take many forms, from complaints to the airport, to forming groups that attend public meetings or protest changes at an airport, to filing lawsuits in response to anticipated or implemented changes in aircraft operations or noise.

noise. This is still the position of the Department of Defense and the other Federal agencies that comprise the Federal Interagency Committee on Aircraft Noise (FICAN).

The FAA recognizes that the data supporting this dose-response relationship are decades old, and that more recent noise annoyance surveys in other countries produce relationships that can differ significantly from the FICON Curve. Consequently, the FAA is developing and conducting a new, large-scale aircraft noise annoyance survey at about twenty U.S. airports that are served predominantly by jet aircraft. Until that study is completed, the FICON Curve remains the most reputable indicator of community response to high levels of airplane noise.

Our calculation of 'percentage highly annoyed' %HA uses the fitting function adopted by FICON (1992) as a dosage-effect relationship:

$$\%HA = \frac{100}{1+e^{11.13 - 1.141 * L_{dn}}}$$

Where:
***%HA** represents the percentage of affected people 'highly annoyed';*
***L_{dn}** represents the DNL value.*

Because the FAA-provided noise contours typically specify a range of DNL values, we calculate min and max TPHA values using the minimum and maximum DNL of a given range. Where only a minimum value is specified (>45 dBA DNL), we use 45 dBA for both the minimum and the maximum–without more detailed information from the FAA, we cannot know the true extent of the noise impact and annoyance in these regions.

Studied Noise Contours

In response to a request from the Select Committee on South Bay Arrivals, the FAA modeled the noise impact of the BSR, SERFR, and DAVYJ arrival routes on underlying communities. Consistent with FAA policy, the noise modeling was done based upon 60 randomly-chosen days in a 1 year period. For SERFR and BSR, actual flight tracks were used (for BSR, the 1 year period was calendar year 2014). For DAVYJ, the FAA modified SERFR flight tracks to reflect procedural changes anticipated for the notional route. These noise simulation results were presented by the FAA to the Select Committee at their Working Meetings on August 18, 2016 (SERFR, DAVYJ[4]) and September 1, 2016 (BSR).

[4] The FAA presented two noise simulation results for a notional DAVYJ route, one using lower altitudes (similar to the current SERFR route) and one using higher altitudes (similar to the historical BSR route). At this meeting, Steve May of the FAA indicated that he expected DAVYJ would use a descent profile similar to SERFR, and proceeded to compare the noise impacts of SERFR and DAVYJ using the lower altitude version of DAVYJ. As a result, we performed our analysis using the FAA-provided DAVYJ noise contours which reflect the lower (similar to SERFR) altitudes.

The FAA presented DNL noise contour maps for the three routes, as well as contours showing the change in DNL levels for DAVYJ vs. SERFR, and DAVYJ vs. BSR. The noise contour maps used ranges of values (e.g. 35-40 dBA DNL, 40-45 dBA DNL, etc.) and the size of these ranges was chosen by the FAA. Because the FAA's noise modeling could not adequately simulate the extent of delay vectoring from these routes, we limited our studied noise contours to just those portions in the immediate vicinity of the flight path. As a result, the TPHA figures calculate here will underestimate the true impact of these routes, particularly on neighboring communities heavily impacted by delay vectoring.

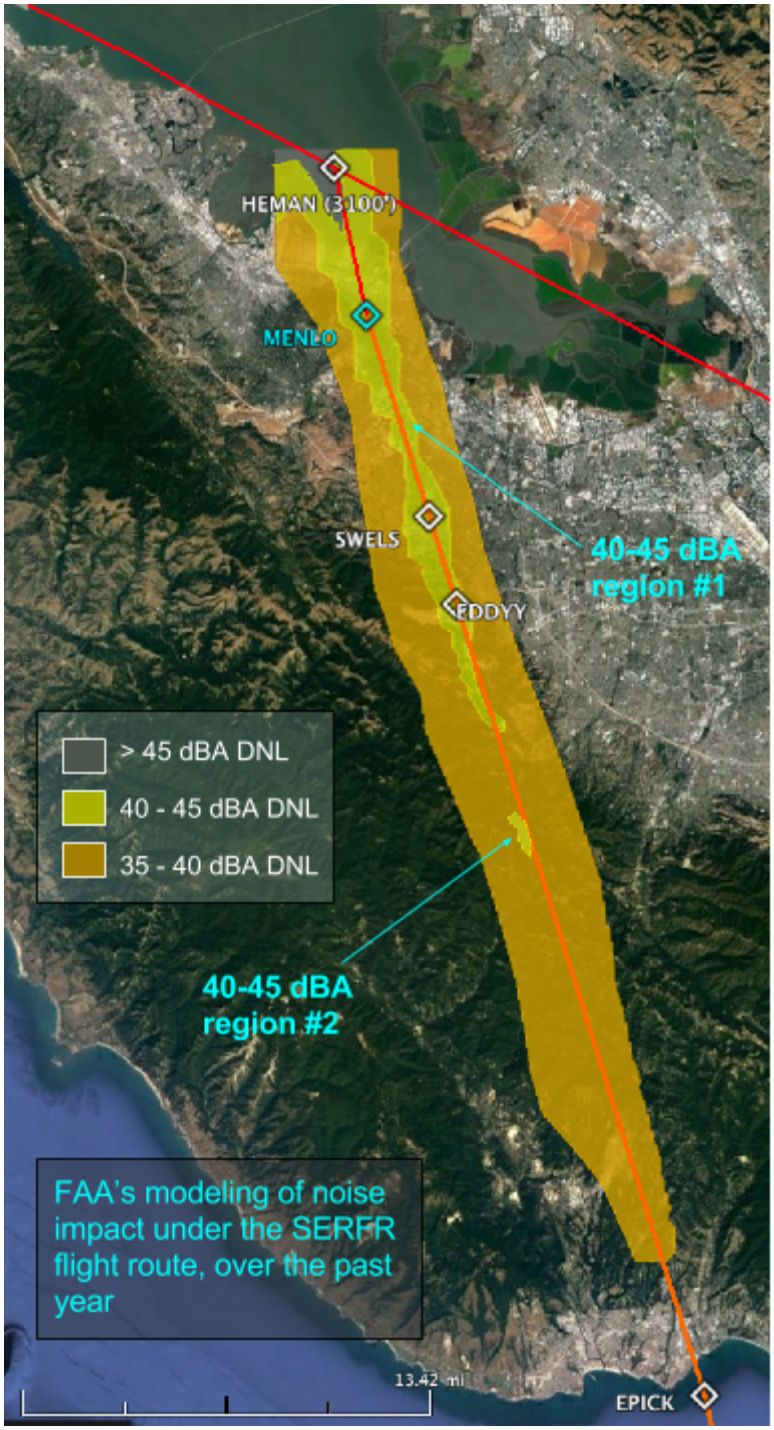
To generate our population impacts, it was necessary to create georeferenced versions of the FAA noise maps to accurately capture the outlines of the relevant noise contours[5], and to determine their precise location. Fortunately, the FAA noise contour maps include the location of several waypoints, whose locations are precisely defined using GPS coordinates, which made georeferencing straightforward. Once polygons outlining each of the noise contours were generated, our GIS software calculated the area of intersection between these noise contours and underlying Census Block Groups[6]. The population count for each area of intersections was generated by the GIS system's Weighted Block Centroid apportionment method which, though computationally expensive, uses underlying Census Block data to more accurately estimate population data in smaller geographic areas.

[5] We limited our analysis to three DNL ranges, 35-40, 40-45, and >45 dBA, both because these represent the areas of highest impact, and because the FAA's forced modeling of delay vectoring using 4 discrete routes makes it impossible to accurately separate the noise contours < 35 dBA caused by the main flight path vs. those of the vectored routes.

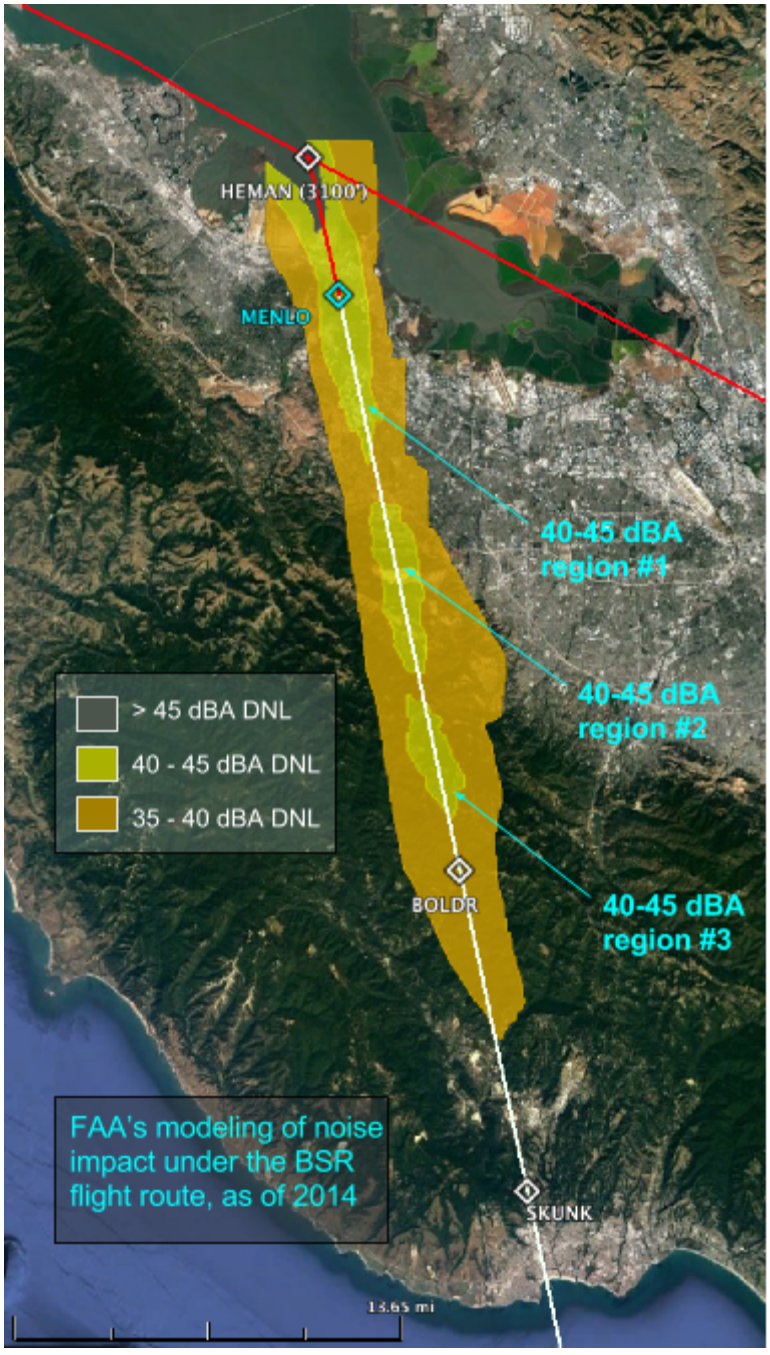
[6] A Census Block Group is a geographical unit used by the United States Census Bureau which is a collection of Census Blocks. It is the lowest level at which the Census Bureau publishes population estimates in-between decennial counts.

DAVYJ (Proposed) Noise Contours

SERFR (Current) Noise Contours



BSR (2014) Noise Contours



Population

The U.S. Census Bureau conducts its count every 10 years. In intervening years, the Census Bureau publishes estimates of population growth at the Census Block Group level. Our GIS provider, ESRI[7], provides an automated system for estimating population of within smaller, user-defined geographic areas, computed using Centroid Block Weighting of Block-level Census data. The ESRI 2016 estimate used in calculating TPHA is estimated population for July 1, 2016, and uses Census data supplemented by additional data from Experian, United States Postal Service, Internal Revenue Service, building permits and housing starts, and other data sources. We have also included ESRI's population counts within the specified noise contours using Census data from 2000 and 2010, along with ESRI's 2021 population estimate. The relative impact of the three routes as shown by this analysis is unaffected by choice of population dataset.

Results

The following table summarizes the population counts for each of the noise contours considered, for each of the three routes. Noise contour descriptions, such as "40-45 region #1", correspond to the labels on the noise maps from the preceding section. The population figures shown use 2000 and 2010 Census data, and ESRI's 2016 and 2021 population estimates. Because the FAA's noise contours specify a range of DNL values, we show min and max TPHA values using the minimum and maximum DNL for a given range. Where only a minimum value is specified (>45 dBA DNL), we use 45 dBA for both the minimum and the maximum.

Noise Exposure Region			Population				Annoyance Metrics			
Route	DNL Noise Contour (dBA)	Area (mi^2)	2000	2010	2016 (est)	2021 (est)	%HA (min)	%HA (max)	2016 TPHA (min)	2016 TPHA (max)
DAVYJ	>45	9.56	24,725	23,970	24,892	26,018	0.83%	0.83%	206	206
DAVYJ	40-45	38.5	62,609	68,000	71,451	75,248	0.41%	0.83%	294	592
DAVYJ	35-40	92	105,092	110,884	119,467	127,562	0.20%	0.41%	243	491
SERFR	>45	2.44	0	0	0	0	0.83%	0.83%	0	0
SERFR	40-45 region #1	23.9	61,132	62,099	65,335	68,843	0.41%	0.83%	269	541
SERFR	40-45 region #2	0.46	19	16	16	16	0.41%	0.83%	0	0
SERFR	35-40	101	119,857	127,024	135,352	143,938	0.20%	0.41%	276	556

[7] ESRI is an international supplier of geographic information system (GIS) software and applications. In 2014, Esri had a 43% share of the GIS software market worldwide, more than any other vendor.

BSR	>45	3.58	0	0	0	0	0.83%	0.83%	0	0
BSR	40-45 region #1	14.8	60,625	60,106	62,758	65,901	0.41%	0.83%	258	520
BSR	40-45 region #2	7.12	1,369	1,442	1,519	1,604	0.41%	0.83%	6	13
BSR	40-45 region #3	4.43	9	7	7	7	0.41%	0.83%	0	0
BSR	35-40	75.35	75,482	83,351	89,526	95,581	0.20%	0.41%	182	368

See Appendix for more detailed population breakdowns for each of these routes and noise contours.

Note that the >45 dBA DNL region for SERFR and BSR are over unpopulated areas in and along the San Francisco Bay, whereas **the >45 dBA DNL noise contour for the proposed DAVYJ route would overlie a populated area within the city limits of East Palo Alto, Menlo Park, and Palo Alto, and would impact an estimated 24,892 people**[8]. In addition, **the populations within the 40-45 dBA DNL noise contours are larger for DAVYJ than SERFR**, and both are larger than for BSR.

To provide an overall view of the total TPHA for each of the routes, we have aggregated the min and max TPHA values across all studied noise contours, and computed their average. **The expected number of Total Persons Highly Annoyed for the proposed DAVYJ route is 24% greater than the current SERFR route, and 51% greater than BSR circa 2014.**

Route	Overall TPHA (min)	Overall TPHA (max)	Overall TPHA (avg)
DAVYJ	743	1,289	1,016
SERFR	544	1,098	821
BSR	446	901	674

Conclusion

While the increased use and reduced cost of airplane travel delivers many societal benefits, it is clear from noise complaint volumes that many communities are being negatively impacted by recent changes to airplane routing, concentration, altitude, and procedure changes. The use of

[8] The population impact of the >45 dBA DNL noise contour may not be apparent looking at the FAA's published noise simulation slides comparing DAVYJ to SERFR, because the region is split between areas of "+2-4 dBA DNL" and "+/- 1 dBA DNL". That is, a portion of the area projected to exceed 45 dBA DNL if DAVYJ is implemented falls within the FAA's "-1 to +1 dBA DNL" change region and sits on the outer periphery of the FAA's current SERFR 40-45 dBA DNL noise contour. The crude granularity of the FAA's published data obscures this impact. A more detailed assessment of the impact within the "+/- 1 dBA DNL" noise contour would be possible if the FAA chooses to release more detailed noise estimates.

objective metrics such as TPHA can provide useful input to community advocates and policymakers at all levels of government as they attempt to understand and compare the impact of proposed changes on underlying populations.

In the studied comparison of populations affected by BSR, SERFR, and DAVYJ, it is clear that DAVYJ would impact a greater number of people, to a greater extent, than either the current SERFR or its predecessor BSR. While such a conclusion may have been apparent to some looking at the FAA's noise simulation results, the inclusion of the population impacted within each noise contour and the estimation of the population which is likely to be "highly annoyed" makes the impact of each potential route apparent to all and easy to compare.

Measures such as TPHA rely on data provided by, or authorized for use by, the FAA (noise simulation results, "Updated Schultz Curve" as published by FICON) or other data made available by the federal government (population data provided by the United States Census Bureau). In the future, we suggest that the FAA adopt this or a similar measure to make clear the expected impact to populations living underneath or affected by proposed changes.

References

1. FAA Presentation to Select Committee, Aug 18 Working Meeting, Slide 7
2. FAA Presentation to Select Committee, Aug 18 Working Meeting, Slide 9
3. FAA Presentation to Select Committee, Sep 1 Working Meeting, Slide 4
4. The Schultz curve 25 years later: A research perspective, Sanford Fidell, Acoustical Society of America, 2003
5. "New Research on Community Reaction to Aircraft Noise in the United States", N. Miller, N. Sizov, S. Lohr, D. Cantor; 11th International Congress on Noise as a Public Health Problem (ICBEN) 2014, Nara, JAPAN
6. ACRP Synthesis 9: Effects of Aircraft Noise: Research Update on Select Topics, Vincent Mestre; Transportation Research Board, 2008
7. Methodology Statement: 2016/2021 Esri US Demographic Updates, ESRI White Paper, June 2016

Appendix

Breakdown of Population and TPHA by City / Census Designated Place (CDP)

A census-designated place (CDP) is a concentration of population defined by the United States Census Bureau. CDPs have been used in each decennial census since 1980 as the counterparts of incorporated places, for the purposes of gathering and correlating statistical data. While performing this analysis, we discovered there were some Census Block Groups within the studied noise contours which did not correspond to the boundaries of an established city or CDP. We aggregated those unaffiliated Block Groups by county for each noise contour, and listed them here as “Other”.

DAVYJ Breakdown

Noise Exposure Region		Location		Population				TPHA		
Route	DNL Noise Contour (dBA)	County	City / CDP	2000	2010	2016 (est)	2021 (est)	2016 (min)	2016 (max)	2016 (avg)
DAVYJ	>45	N/A	San Francisco Bay	0	0	0	0	0	0	0
DAVYJ	>45	San Mateo County	East Palo Alto	8,414	7,206	7,363	7,595	61	61	61
DAVYJ	>45	San Mateo County	Menlo Park	10,159	10,402	10,669	11,059	88	88	88
DAVYJ	>45	San Mateo County	Redwood City	0	0	0	0	0	0	0
DAVYJ	>45	Santa Clara County	Palo Alto	6,153	6,363	6,861	7,365	57	57	57
DAVYJ	40-45	N/A	San Francisco Bay	0	0	0	0	0	0	0

DAVYJ	40-45	San Mateo County	Atherton	548	552	582	617	2	5	4
DAVYJ	40-45	San Mateo County	East Palo Alto	8,720	7,993	7,949	8,136	33	66	49
DAVYJ	40-45	San Mateo County	Menlo Park	5,041	5,525	5,758	6,022	24	48	36
DAVYJ	40-45	San Mateo County	Redwood City	0	0	0	0	0	0	0
DAVYJ	40-45	San Mateo County	Other	716	814	822	835	3	7	5
DAVYJ	40-45	Santa Clara County	Los Altos	4,096	4,119	4,649	5,104	19	39	29
DAVYJ	40-45	Santa Clara County	Los Altos Hills	6,033	6,010	6,268	6,590	26	52	39
DAVYJ	40-45	Santa Clara County	Loyola CDP	213	255	265	278	1	2	2
DAVYJ	40-45	Santa Clara County	Palo Alto	30,545	32,313	34,027	35,918	140	282	211
DAVYJ	40-45	Santa Clara County	Stanford CDP	6,243	9,960	10,661	11,258	44	88	66
DAVYJ	40-45	Santa Clara County	Other	268	317	331	346	1	3	2
DAVYJ	40-45	Santa Cruz County	Other	186	142	138	139	1	1	1
DAVYJ	35-40	N/A	San Francisco Bay	0	0	0	0	0	0	0
DAVYJ	35-40	San Mateo County	Atherton	1,210	1,173	1,229	1,292	3	5	4

DAVYJ	35-40	San Mateo County	East Palo Alto	12,452	13,041	13,962	14,858	28	57	43
DAVYJ	35-40	San Mateo County	Menlo Park	3,443	3,445	3,552	3,698	7	15	11
DAVYJ	35-40	San Mateo County	North Fair Oaks CDP	1,252	1,231	1,290	1,356	3	5	4
DAVYJ	35-40	San Mateo County	Redwood City	6,701	6,678	7,134	7,602	15	29	22
DAVYJ	35-40	San Mateo County	Other	332	322	441	523	1	2	1
DAVYJ	35-40	Santa Clara County	Cupertino	1,789	2,075	2,280	2,473	5	9	7
DAVYJ	35-40	Santa Clara County	Los Altos	12,774	13,542	14,552	15,595	30	60	45
DAVYJ	35-40	Santa Clara County	Los Altos Hills	1,566	1,485	1,549	1,626	3	6	5
DAVYJ	35-40	Santa Clara County	Loyola CDP	2,572	2,639	2,873	3,116	6	12	9
DAVYJ	35-40	Santa Clara County	Mountain View	18,993	20,260	22,110	23,840	45	91	68
DAVYJ	35-40	Santa Clara County	Palo Alto	20,915	23,170	25,642	27,816	52	105	79
DAVYJ	35-40	Santa Clara County	Saratoga	5	5	5	6	0	0	0
DAVYJ	35-40	Santa Clara County	Stanford CDP	1,733	2,833	2,918	2,956	6	12	9
DAVYJ	35-40	Santa Clara County	Other	495	560	586	616	1	2	2

DAVYJ	35-40	Santa Cruz County	Ben Lomond CDP	5,709	5,192	5,309	5,490	11	22	16
DAVYJ	35-40	Santa Cruz County	Boulder Creek CDP	49	43	44	46	0	0	0
DAVYJ	35-40	Santa Cruz County	Brookdale CDP	324	320	335	352	1	1	1
DAVYJ	35-40	Santa Cruz County	Felton CDP	1,746	1,603	1,705	1,809	3	7	5
DAVYJ	35-40	Santa Cruz County	Lompico CDP	1,205	1,137	1,197	1,259	2	5	4
DAVYJ	35-40	Santa Cruz County	Mount Hermon CDP	1,037	1,023	1,063	1,109	2	4	3
DAVYJ	35-40	Santa Cruz County	Paradise Park CDP	271	311	339	365	1	1	1
DAVYJ	35-40	Santa Cruz County	Pasatiempo CDP	657	649	667	689	1	3	2
DAVYJ	35-40	Santa Cruz County	Santa Cruz	170	1,089	1,283	1,287	3	5	4
DAVYJ	35-40	Santa Cruz County	Scotts Valley	2,506	2,325	2,470	2,613	5	10	8
DAVYJ	35-40	Santa Cruz County	Zayante CDP	630	565	592	626	1	2	2
DAVYJ	35-40	Santa Cruz County	Other	4,561	4,168	4,341	4,547	9	18	13

SERFR Breakdown

Noise Exposure Region		Location		Population				TPHA		
Route	DNL Noise Contour (dBA)	County	City / CDP	2000	2010	2016 (est)	2021 (est)	2016 (min)	2016 (max)	2016 (avg)
SERFR	>45	N/A	San Francisco Bay	0	0	0	0	0	0	0
SERFR	>45	San Mateo County	Redwood City	0	0	0	0	0	0	0
SERFR	40-45 region #1	N/A	San Francisco Bay	0	0	0	0	0	0	0
SERFR	40-45 region #1	San Mateo County	Atherton	0	0	0	0	0	0	0
SERFR	40-45 region #1	San Mateo County	East Palo Alto	11,858	10,481	10,650	10,958	44	88	66
SERFR	40-45 region #1	San Mateo County	Menlo Park	12,557	12,952	13,328	13,836	55	110	83
SERFR	40-45 region #1	San Mateo County	Redwood City	0	0	0	0	0	0	0
SERFR	40-45 region #1	San Mateo County	Other	575	657	662	673	3	5	4
SERFR	40-45 region #1	Santa Clara County	Cupertino	0	0	0	0	0	0	0
SERFR	40-45 region #1	Santa Clara County	Los Altos	5,820	6,044	6,792	7,468	28	56	42
SERFR	40-45 region #1	Santa Clara County	Los Altos Hills	2,781	2,833	2,928	3,056	12	24	18

SERFR	40-45 region #1	Santa Clara County	Loyola CDP	563	610	655	705	3	5	4
SERFR	40-45 region #1	Santa Clara County	Palo Alto	26,917	28,448	30,161	31,974	124	250	187
SERFR	40-45 region #1	Santa Clara County	Stanford CDP	0	0	80	91	0	1	0
SERFR	40-45 region #1	Santa Clara County	Other	62	74	77	81	0	1	0
SERFR	40-45 region #2	Santa Clara County	Other	3	4	4	4	0	0	0
SERFR	40-45 region #2	Santa Cruz County	Other	16	12	12	12	0	0	0
SERFR	35-40	N/A	San Francisco Bay	0	0	0	0	0	0	0
SERFR	35-40	San Mateo County	Atherton	1,771	1,735	1,820	1,917	4	7	6
SERFR	35-40	San Mateo County	East Palo Alto	17,642	17,674	18,535	19,538	38	76	57
SERFR	35-40	San Mateo County	Menlo Park	4,281	4,649	4,841	5,070	10	20	15
SERFR	35-40	San Mateo County	North Fair Oaks CDP	3,430	3,364	3,539	3,739	7	15	11
SERFR	35-40	San Mateo County	Redwood City	7,121	7,038	7,491	7,972	15	31	23
SERFR	35-40	San Mateo County	Other	473	479	600	686	1	2	2
SERFR	35-40	Santa Clara County	Cupertino	3,805	4,258	4,601	4,941	9	19	14

SERFR	35-40	Santa Clara County	Los Altos	13,821	14,435	15,347	16,325	31	63	47
SERFR	35-40	Santa Clara County	Los Altos Hills	4,202	4,080	4,282	4,521	9	18	13
SERFR	35-40	Santa Clara County	Loyola CDP	2,571	2,647	2,855	3,074	6	12	9
SERFR	35-40	Santa Clara County	Mountain View	12,437	13,092	14,356	15,508	29	59	44
SERFR	35-40	Santa Clara County	Palo Alto	28,698	30,417	32,763	35,107	67	135	101
SERFR	35-40	Santa Clara County	Saratoga	1,751	1,678	1,764	1,865	4	7	5
SERFR	35-40	Santa Clara County	Stanford CDP	6,243	9,960	10,581	11,167	22	43	33
SERFR	35-40	Santa Clara County	Other	1,194	1,319	1,360	1,417	3	6	4
SERFR	35-40	Santa Cruz County	Lompico CDP	926	873	911	955	2	4	3
SERFR	35-40	Santa Cruz County	Scotts Valley	4,859	5,021	5,256	5,493	11	22	16
SERFR	35-40	Santa Cruz County	Zayante CDP	437	392	411	434	1	2	1
SERFR	35-40	Santa Cruz County	Other	4,307	4,026	4,156	4,334	8	17	13

BSR Breakdown

Noise Exposure Region		Location		Population				TPHA		
Route	DNL Noise Contour (dBA)	County	City / CDP	2000	2010	2016 (est)	2021 (est)	2016 (min)	2016 (max)	2016 (avg)
BSR	>45	N/A	San Francisco Bay	0	0	0	0	0	0	0
BSR	>45	San Mateo County	Menlo Park	0	0	0	0	0	0	0
BSR	>45	San Mateo County	Redwood City	0	0	0	0	0	0	0
BSR	40-45 region #1	N/A	San Francisco Bay	0	0	0	0	0	0	0
BSR	40-45 region #1	San Mateo County	East Palo Alto	17,571	15,650	15,777	16,213	65	131	98
BSR	40-45 region #1	San Mateo County	Menlo Park	12,517	12,921	13,300	13,811	55	110	82
BSR	40-45 region #1	San Mateo County	Redwood City	0	0	0	0	0	0	0
BSR	40-45 region #1	San Mateo County	Other	247	285	286	289	1	2	2
BSR	40-45 region #1	Santa Clara County	Los Altos Hills	278	274	284	298	1	2	2
BSR	40-45 region #1	Santa Clara County	Palo Alto	26,007	27,476	29,155	30,942	120	242	181
BSR	40-45 region #1	Santa Clara County	Stanford CDP	4,007	3,500	3,954	4,349	16	33	25

BSR	40-45 region #2	Santa Clara County	Los Altos Hills	1,232	1,282	1,352	1,429	6	11	8
BSR	40-45 region #2	Santa Clara County	Other	137	160	167	175	1	1	1
BSR	40-45 region #3	Santa Clara County	Other	0	0	0	0	0	0	0
BSR	40-45 region #3	Santa Cruz County	Other	9	7	7	7	0	0	0
BSR	35-40	N/A	San Francisco Bay	0	0	0	0	0	0	0
BSR	35-40	San Mateo County	Atherton	1,387	1,355	1,424	1,502	3	6	4
BSR	35-40	San Mateo County	East Palo Alto	10,036	10,661	11,499	12,293	23	47	35
BSR	35-40	San Mateo County	Menlo Park	3,371	3,711	3,851	4,022	8	16	12
BSR	35-40	San Mateo County	North Fair Oaks CDP	842	831	861	897	2	4	3
BSR	35-40	San Mateo County	Redwood City	5,724	5,656	5,993	6,405	12	25	18
BSR	35-40	San Mateo County	Other	784	830	956	1,048	2	4	3
BSR	35-40	Santa Clara County	Cupertino	1,439	1,627	1,783	1,932	4	7	5
BSR	35-40	Santa Clara County	Los Altos	11,276	11,801	13,072	14,269	27	54	40
BSR	35-40	Santa Clara County	Los Altos Hills	5,495	5,382	5,600	5,880	11	23	17

BSR	35-40	Santa Clara County	Loyola CDP	1,820	1,910	2,078	2,252	4	9	6
BSR	35-40	Santa Clara County	Mountain View	2,610	2,754	3,414	3,880	7	14	10
BSR	35-40	Santa Clara County	Palo Alto	24,045	25,719	27,436	29,218	56	113	84
BSR	35-40	Santa Clara County	Saratoga	656	600	643	690	1	3	2
BSR	35-40	Santa Clara County	Stanford CDP	2,738	7,569	7,853	8,084	16	32	24
BSR	35-40	Santa Clara County	Other	579	663	693	729	1	3	2
BSR	35-40	Santa Cruz County	Ben Lomond CDP	0	0	0	0	0	0	0
BSR	35-40	Santa Cruz County	Lompico CDP	1,202	1,134	1,193	1,256	2	5	4
BSR	35-40	Santa Cruz County	Zayante CDP	0	0	0	0	0	0	0
BSR	35-40	Santa Cruz County	Other	1,484	1,154	1,183	1,232	2	5	4