APPENDIX B
NOISE ANALYSIS

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NOISE ANALYSIS

In Support of Environmental Assessment for the Transition from C-2A to Navy V-22 Aircraft at Fleet Logistics Centers

- Naval Air Station North Island
  Halsey Field, San Diego, California

Final Report

Prepared for:

Naval Facilities Engineering Command – Atlantic
6506 Hampton Boulevard
Norfolk, VA 23508-1278

June 2017

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Noise Analysis in Support of Environmental Assessment for the Transition from C-2A to Navy V-22 Aircraft at Fleet Logistics Centers

Naval Air Station North Island, California

Final

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Prepared for:

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LIST OF ACRONYMS AND ABBREVIATIONS

°F	degrees Fahrenheit
AAD	Annual Average Daily
ANSI	American National Standards Institute
CPLO	Community Plans and Liaison Officer
dB	Decibel
DLG	Digital Line Graph
DNL	Day-Night Average Sound Level
DOD	Department of Defense
ft	feet
FRS	Fleet Replacement Squadron
GCA	Ground Controlled Approach
ID	Identification
IFR	Instrument Flight Rules
IGE	In Ground Effect
inHg	inches mercury
kPa-s/m^2	kilopascal-seconds per square meter
L_{max}	Maximum Sound Level
m	meter
NA90	Number of Events Above 90 dB SEL
NAS	Naval Air Station
NED	National Elevation Dataset
NMAP	NoiseMap software
NOLFIB	Naval Outlying Landing Field Imperial Beach
POI	Point of Interest
RNM	Rotorcraft Noise Model
SEL	Sound Exposure Level
U.S.	United States
USGS	United States Geological Survey
VFR	Visual Flight Rules
VRC	Fleet Logistics Squadron

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1.0 INTRODUCTION

The United States (U.S.) Department of the Navy (Navy) proposes to replace the C-2A Greyhound with the new CMV-22B Osprey at existing West and East Coast logistics support centers Naval Air Station (NAS) North Island, California and Naval Station Norfolk, Virginia. Under this Proposed Action, the Navy plans to:

- Replace 27 legacy C-2A aircraft with 38 CMV-22B aircraft operated by existing U.S. Fleet Forces Command logistics support squadrons (VRC);
- Establish a CMV-22B Fleet Replacement Squadron (FRS) for pilots and Naval aircrewmen;
- Establish a Maintenance School for maintenance personnel;
- Construct and renovate facilities to accommodate CMV-22B squadron aircraft and personnel; and
- Make adjustments to personnel levels (increases or decreases) associated with the aircraft transition.

This noise study is in support of the C-2A Greyhound to CMV-22B Osprey transition at NAS North Island, and considers four scenarios: Baseline, No Action, and Proposed Action Alternatives 1 and 2. For this analysis, the Baseline scenario reflects the current or recent NAS North Island operations data taken from the last six full years (2010-2015)[1]. The No Action Alternative includes completion of the in-progress increase of the number of H-60 rotary wing aircraft at NAS North Island. Proposed Action Alternative 1 would include the retirement the C-2A and replacement with CMV-22B in the operational squadron VRC-30, and would also include an FRS of five (5) CMV-22B aircraft located at NAS North Island. Proposed Action Alternative 2 would be the same as Alternative 1 (retirement of the C-2A and adding a full squadron of CMV-22B), but without the FRS located at NAS North Island.

Section 2 describes the methodology of this study. Section 3 includes the modeling data used and the noise exposure for the Baseline condition. Section 4 includes the modeling data used and the noise exposure for the No Action scenario. Section 5 includes the modeling data used and the noise exposure for the Proposed Action Alternative 1 scenario. Section 6 includes the modeling data used and the noise exposure for the Proposed Action Alternative 2 scenario. Section 7 summarizes the supplemental noise metrics calculated for this study.

2.0 METHODOLOGY

Table 2-1 summarizes the noise model parameters used in this analysis. This analysis utilizes the Department of Defense (DOD) NOISEMAP suite of computer programs (Wyle 1998; Wasmer Consulting 2006) containing the core computational programs called "NMAP", version 7.0 and 7.3, and Rotorcraft Noise Model (RNM) version 7.2.2. Note that NMAP version 7.3 was released on 28 March, 2017. Most of the work for this study was already accomplished with the previous version, but the new version was used for validation of calculations of maximum sound level (L_{max}), which is one of the features of the new software version.

[1] When this study began in 2016, the 2015 year represented the last full year for establishing baseline flight operations. Although not included in the baseline, the operations for 2016 were very similar, and would not have affected the baseline significantly.

Table 2-1. Noise Modeling Parameters		
Software	**Analysis**	**Version**
NMAP	Fixed wing aircraft	7.0
		7.3
RNM	Rotorcraft	7.2.2
Parameter	**Description**	
Receiver Grid Spacing	500 ft in x and y	
Metric	CNEL	
Basis	AAD Operations	
Topography		
Elevation Data Source	USGS 30m NED	
Elevation Grid Spacing	500 ft in x and y	
Impedance Data Source	USGS Hydrography DLG	
Impedance Grid spacing	500 ft in x and y	
Flow Resistivity of Ground (soft/hard)	225 kPa-s/m^2 / 100,000 kPa-s/m^2	
Modeled Weather (Monthly Averages 2009-2015; November selected)		
Temperature	62 °F	
Relative Humidity	73.5 %	
Barometric Pressure	30.02 in Hg	

Source: Cardno 2017.
Notes: ft = feet; CNEL = Community Noise Equivalent Level; AAD = Annual Average Daily; USGS = U.S. Geological Survey; m = meters; NED = National Elevation Dataset; DLG = Digital Line Graph; kPa-s/m^2 = kilopascal-seconds per square meter; ºF = degrees Fahrenheit; in Hg = inches Mercury.

2.1 Primary Noise Metric and Modeling

Community Noise Equivalent Level (CNEL) is the relevant metric for this study and is based on annual average daily aircraft operations. CNEL is similar to the Day-Night Average Sound Level (DNL), but is divided into three distinct time bands; day (7:00 a.m. to 7:00 p.m.), evening (7:00 p.m. to 10:00 p.m.), and night (10:00 p.m. to 7:00 a.m.). CNEL is the DOD standard for the State of California. The CNEL metric weighs operations that occur outside of daytime hours by adding 5 dB to operations occurring during the evening hours, and by adding 10 dB to those operations occurring at night, giving noise events more weight at times when most human observers are likely to be more annoyed by them. Note that the time frames for day, evening, and night do not change, and are therefore irrespective of the seasonal fluctuation in daylight. Therefore, it is possible for some evening operations to occur prior to the actual sunset, depending on the season.

Modeling of noise, using the NOISEMAP software suite, is accomplished by determining and building each aircraft's flight tracks (paths over the ground) and profiles (which include data such as altitude, airspeed, power settings, and other flight conditions). This information is developed iteratively with a Navy team primarily made up with representatives from flying squadrons, air-traffic control, and the Navy V-22 Fleet Introduction Team. The data is compiled in a data validation package which is approved for use by that Navy team prior to modeling (Cardno 2016). This is combined with information about the numbers of each type of operation by aircraft/track/profile, local climate, ground surrounding the airfield, and similar data related to ground runup of aircraft engines to sum the total noise energy experienced annually at a grid of points on the ground. In this case, as indicated in Table 2-1, that grid spacing was 500 ft. Noise exposure is presented in terms of contours, i.e., lines of equal value, of CNEL. CNEL contours of 65 to 85 dB, presented in 5-dB increments, provide a graphical depiction of the aircraft noise environment. NOISEMAP's ability to account for the effects of sound propagation includes consideration of terrain elevation, taken from the USGS NED, and ground impedance conditions, taken from USGS Hydrography data. In this case, “soft ground” (e.g., grass-covered ground) is modeled with a flow resistivity of 225 kPa-s/m^2 and “hard ground” (in this case, water) is modeled with a flow resistivity of 100,000 kPa-s/m^2. The modeling does not include the effect of shielding of on-base buildings. For ambient temperature, humidity, and pressure, each month was assigned a temperature, relative humidity, and barometric pressure from data available for that month for the years 2009 through 2015 (last full year of data available at the time the study began). NOISEMAP then determined and used the month with the weather values that produced the median results in terms of noise propagation effect, which in this case was the month of November (with the values noted in Table 2-1). This modeling process, using the NOISEMAP software suite, is the DOD-accepted method for representing the overall community noise exposure over time. Noise exposure is also presented in terms of CNEL at representative Points of Interest (POI). Points of interest were provided by NAS North Island staff, to include areas of interest based on regular noise complaints and other factors. The numbering system was provided by NAS North Island to maintain consistency with other documents. The resulting 13 POIs are listed in Table 2-2 and shown in Figure 2-1.

Table 2-2. POIs for NAS North Island

ID	Description
SL-1	Centennial Park
SL-2	Point Loma
SL-4	Hotel Del Coronado
SL-6	Silver Strand South
SL-7	Ferry Landing City of Coronado
SL-8	NASNI Beach
SL-13	Kona Kai Resort and Spa
SL-14	Cabrillo Elementary School
SL-15	Pier 32 Marina
SL-16	Chula Vista Marina
SL-17	Coronado Cays
SL-18	Loews Resort
SL-19	Coronado Municipal Beach

Source: NAS North Island 2016.

Source: NAS North Island 2016.

Figure 2-1. POIs in the vicinity of NAS North Island

2.2 ADDITIONAL (SUPPLEMENTAL) NOISE METRICS

Additional metrics evaluated for this study include L_{max} and Sound Exposure Level (SEL).

The highest A-weighted sound level measured during a single event in which the sound changes with time is called the maximum A-weighted sound level or L_{max}. L_{max} is the maximum level that occurs over a fraction of a second. For aircraft noise, the "fraction of a second" is one-eighth of a second, denoted as "fast" response on a sound level measuring meter. L_{max} is important in judging if a noise event will interfere with conversation, TV or radio listening, or other common activities. Although it provides some measure of the event, it does not fully describe the noise, because it does not account for how long the sound is heard (Wyle 2014).

SEL combines both the intensity of a sound and its duration. For an aircraft flyover, SEL includes the maximum and all lower noise levels produced as part of the overflight, together with how long each part lasts. It represents the total sound energy in the event. Because aircraft noise events last more than a few seconds, the SEL value is larger than L_{max}. It does not directly represent the sound level heard at any given time, but rather the entire event. SEL provides a much better measure of aircraft flyover noise exposure than L_{max} alone (Wyle 2014).

For this study, each of the 13 POIs was evaluated for its loudest events as modeled, sorted by maximum SEL value modeled with NMAP or RNM (depending on aircraft type). In Section 7, the three loudest events are shown for each POI location, with their SEL and L_{max} values. The L_{max} values were calculated using the new software version NMAP 7.3. This was done for all four scenarios (Baseline, No Action, and Alternatives 1 and 2).

Each of the POI locations was evaluated for potential sleep disturbance using the metric probability of awakenings (PA), according to the guidance provided by the Defense Noise Working Group for application of the American National Standards Institute (ANSI) standard S12.9-2008. This was done for all four scenarios (Baseline, No Action, and Alternatives 1 and 2). (DNWG 2009).

3.0 BASELINE CONDITION

The following subsections detail the modeling data and the resultant noise exposure for the Baseline. The Baseline is derived from an average of the historical data in the six full years (2010-2015) of air activity reports at NAS North Island.

3.1 MODELING DATA

Table 3-1 details the modeled annual flight operations at NAS North Island. The Baseline scenario includes 75,544 flight operations per year, approximately 73% of which are rotary wing (predominately H-60) and approximately 27% fixed wing (predominately C-2A and C-40, with a number of transient types included). Fixed wing aircraft primarily use the runway 29 (about 55% of the time), followed by runways 18 (about 35%), 36 (about 11%), and 11 (about 2%). Based rotary-wing aircraft (H-60) primarily use helicopter pads for departure and arrival. The most common runway used by the H-60 is runway 29, for the actual and practice instrument approaches to 29.

Some aircraft (H-60 and CMV-22B) are modeled with the RNM software module, while the rest are modeled with NMAP (see Chapter 2 for details and versioning, etc.). The outputs of those software modules were then combined into one overall resulting grid to generate the noise contours and other analyses for the Baseline condition. For this effort, elevation and hydrography data were generated from USGS Digital Elevation Models.

Table 3-1. Baseline Scenario Annual Flight Operations at NAS North Island

AIRCRAFT	Notes	DEPARTURES Day	% Day Depts	Eve	% Eve Depts	Night	% Night Depts	Total	VFR ARRIVALS Day	% Day VFR Arr	Eve	% Eve VFR Arr	Night	% Night VFR Arr	Total	IFR ARRIVALS Day	% Day IFR Arr	Eve	% Eve IFR Arr	Night	% Night IFR Arr	Total
BASED AICRAFT																						
H-60		8,378	66%	3,852	30%	456	4%	12,686	8,378	66%	3,852	30%	456	4%	12,686	-	-	-	-	-	-	-
H-60 (INTERFACILITY)	1	7,423	72%	2,643	25%	314	3%	10,380	7,423	72%	2,643	25%	314	3%	10,380	-	-	-	-	-	-	-
C-40		1,177	94%	75	6%	-	0%	1,252	1,117	94%	71	6%	-	0%	1,188	60	94%	4	6%	-	0%	64
E-2C		57	91%	5	8%	1	1%	63	57	91%	5	8%	1	1%	63	-	-	-	-	-	-	-
C-2		706	93%	30	4%	22	3%	758	667	93%	28	4%	21	3%	717	38	93%	2	4%	1	3%	41
BASED TOTALS		17,740		6,605		793		25,139	17,642		6,600		792		25,034	98		5		1		105
TRANSIENT AIRCRAFT																						
HEAVY JET	2	472	59%	79	10%	245	31%	796	460	59%	79	10%	245	31%	784	10	83%	-	-	2	-	12
LIGHT JET/FIGHTER	3	3,201	95%	115	3%	37	1%	3,353	3,200	96%	112	3%	30	1%	3,342	7	64%	3	27%	1	9%	11
TURBOPROP	4	871	68%	241	19%	167	13%	1,279	831	67%	236	19%	166	13%	1,233	40	87%	5	11%	1	2%	46
HELICOPTER	5	387	53%	243	33%	97	13%	727	387	53%	243	33%	97	13%	727	-	-	-	-	-	-	-
TRANSIENT TOTALS		4,931		678		546		6,155	4,878		670		538		6,086	57		8		4		69
TOTALS		***22,671***	**72%**	***7,283***	**23%**	***1,339***	**4%**	***31,294***	***22,520***	**72%**	***7,270***	**23%**	***1,330***	**4%**	***31,120***	***155***	**89%**	***13***	**8%**	***5***	**3%**	***174***

AIRCRAFT	Notes	VISUAL CLOSED PATTERNS (TOUCH AND GO) Day	% Day Vis Clsd	Eve	% Eve Vis Clsd	Night	% Night Vis Clsd	Total	INSTRUMENT PATTERNS (GCA) Day	% Day Gbox	Eve	% Eve Gbox	Night	% Night Gbox	Total	TOTAL Day	% Day	Eve	% Eve	Night	% Night	*OPERATIONS TOTAL*
BASED AIRCRAFT																						
H-60		-	-	-	-	-	-	-	6,567	91%	601	8%	74	1%	7,242	23,323	72%	8,305	25%	986	3%	***32,614***
H-60 (INTERFACILITY)	1	-	-	-	-	-	-	-								14,845	72%	5,286	25%	628	3%	***20,760***
C-40		-	-	-	-	-	-	-	221	78%	35	12%	29	10%	285	2,575	92%	185	7%	29	1%	***2,789***
E-2C		-	-	-	-	-	-	-	22	100%	-	-	-	-	22	137	92%	10	7%	1	1%	***148***
C-2		2,382	92%	218	8%	-	-	2,600	317	96%	13	4%	-	0%	330	4,110	92%	291	7%	45	1%	***4,446***
BASED TOTALS		2,382		218		-		2,600	7,127		649		103		7,879	44,990	74%	14,078	23%	1,689	3%	***60,757***
TRANSIENT AIRCRAFT																						
HEAVY JET	2	-	-	-	-	-	-	-	50	89%	6	11%	-	-	56	992	60%	164	10%	492	30%	***1,648***
LIGHT JET/FIGHTER	3	587	100%	-	-	-	-	587	1,743	98%	22	1%	9	1%	1,774	8,738	96%	252	3%	77	1%	***9,067***
TURBOPROP	4	-	-	-	-	-	-	-	45	75%	15	25%	-	-	60	1,787	68%	497	19%	334	13%	***2,618***
HELICOPTER	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	774	53%	486	33%	194	13%	***1,454***
TRANSIENT TOTALS		587		-		-		587	1,838		43		9		1,890	12,291	83%	1,399	9%	1,097	7%	***14,787***
TOTALS		***2,969***	**93%**	***218***	**7%**	***-***	**0%**	***3,187***	***8,965***	**92%**	***692***	**7%**	***112***	**1%**	***9,769***	***57,281***	**76%**	***15,477***	**20%**	***2,786***	**4%**	***75,544***

Source: Cardno 2016.
Notes: 1. Departures and Arrivals for aircraft flying to/from Naval Outlying Landing Field Imperial Beach (NOLFIB).
2. Includes aircraft such as: P-8, C-17, and C-5.
3. Includes aircraft such as: F/A-18 series, F-35 series, Lear Jet, and Citation.
4. Includes aircraft such as: C-12, C-130, and Dash-8.
5. Includes aircraft such as: H-60 (transient), H-53, and AS-530.

Figure 3-1 shows all of the modeled static run-up profile locations. Consistent with the flight operations, maintenance run-up activity was modeled on an Annual Average Daily (AAD) basis. Table 3-2 summarizes the run-up operations profiles (each aircraft profile/location used for these static operations is individually represented in the noise model while the table shows only a summary by aircraft type). Note that in the table, a profile being "different" may mean that it is modeled at a different spot on the airfield, have a different heading, or be for a completely different purpose. A complete breakout of all the profiles is documented in the noise data validation package (Cardno 2016).

Table 3-2. Summary of Static Profiles

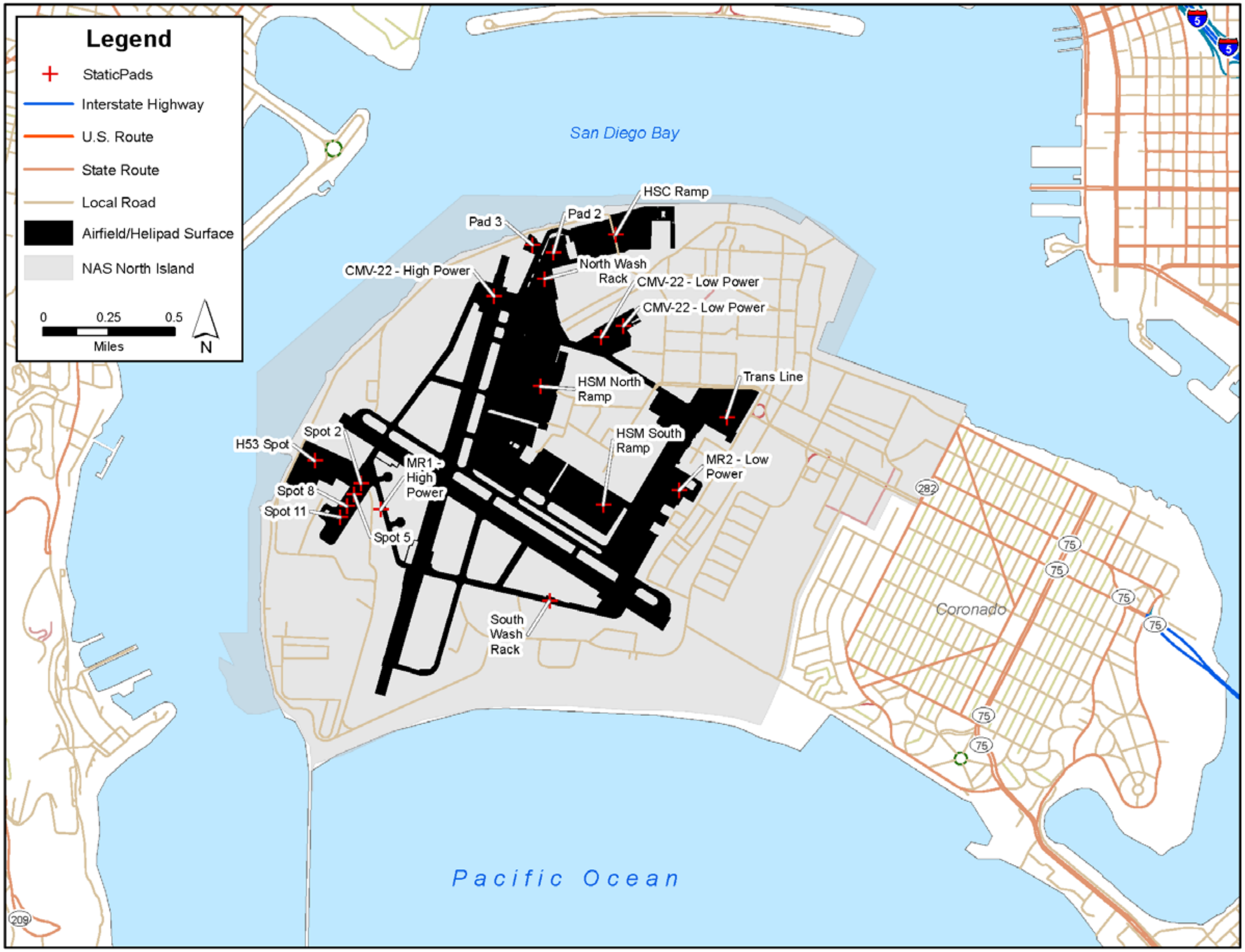
Aircraft Type	# Different Profiles Modeled	Total Annual Operations		
		Day	Evening	Nights
C-12	2	1058	10	0
C-21A	2	172	0	0
C-9A	2	150	0	0
CH-53	6	162	0	0
C-2	18	852	0	0
CMV-22	8	1762	0	0
F-18 A/C	44	1200	0	0
F-18 E/F	43	58	0	0
H-60	6	4765	1064	0

Source: Cardno 2016.
Notes: CMV-22 static operations are not part of the Baseline or No Action scenarios, only the Proposed Action Alternatives 1 and 2.

3.2 NOISE EXPOSURE

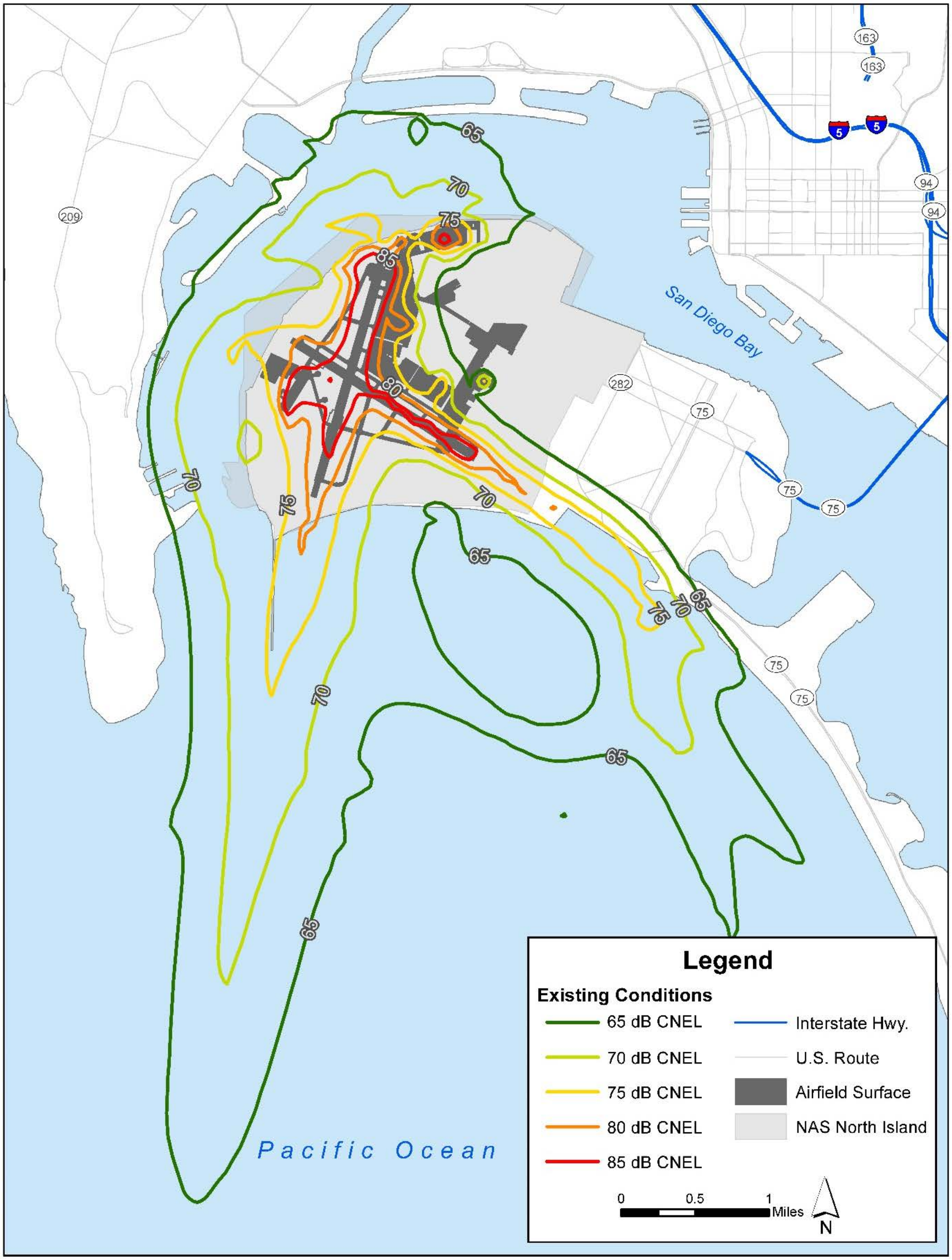
Figure 3-2 shows the resultant 65 dB to 85 dB CNEL contours in 5 dB increments for baseline daily aircraft events. The majority of the 65 dB CNEL baseline contour is located over water, generally to the south. However, the contour does extend down along the beach and shoreline of Coronado.

The computed CNEL for each of the 13 POIs are listed in Table 3-3, which shows that four locations are exposed to CNEL greater than or equal to 65 dB with one of them exposed to CNEL greater than 75 dB (point SL-19 – Coronado Municipal Beach). POIs SL-1, SL-4, and SL-8 (labeled 'Centennial Park', 'Hotel Del Coronado', and 'NASNI Beach', respectively) are located very near the arrival end of runway 29, and have baseline CNELs of 66, 67, and 66 dB, respectively. For Table 3-3, CNEL values are reported to the nearest tenth of a dB. Even under laboratory conditions, humans have a hard time detecting a difference of a whole dB, so results such as these are normally rounded off. In this case, to better compare the changes that will be illustrated in the following sections, we have not rounded off the values in the table.



Source: Cardno 2016

Figure 3-1. Static Run-up Locations Modeled



Source: Cardno 2017.

Figure 3-2. Baseline CNEL Contours for AAD Aircraft Operations at NAS North Island

Table 3-3. Baseline CNEL at POIs		
ID	**Description**	**CNEL (dB)**
SL-1	Centennial Park	65.8
SL-2	Point Loma	56.4
SL-4	Hotel Del Coronado	67.4
SL-6	Silver Strand South	58.1
SL-7	Ferry Landing City of Coronado	52.3
SL-8	NASNI Beach	65.6
SL-13	Kona Kai Resort and Spa	64.8
SL-14	Cabrillo Elementary School	55.6
SL-15	Pier 32 Marina	45.7
SL-16	Chula Vista Marina	56.9
SL-17	Coronado Cays	53.1
SL-18	Loews Resort	53.1
SL-19	Coronado Municipal Beach	76.7

Source: Cardno 2017.

4.0 NO ACTION SCENARIO

The following section details the modeling data and the resultant noise exposure for the No Action scenario, in which the H-60 operations increase by approximately 7.8% as part of an on-going increase in H-60 aircraft that would be complete by the time this action would be undertaken. C-2A aircraft would continue to operate at NAS North Island as they currently do. All other aircraft operations would be the same as the Baseline scenario.

4.1 MODELING DATA

Table 4-1 details the annual flight operations at NAS North Island under the No Action scenario. This scenario's annual flight operations are similar to those in the Baseline scenario (refer to Table 3-1), except it includes an additional 4,190 H-60 flight operations to account for H-60 increase at NAS North Island, making the No Action scenario total 79,734 operations. C-2A operations would remain unchanged. H-60 static runup operations change proportionally with the flight operations. All other flight and static operations remain unchanged from the Baseline.

Runway and track utilization for the remaining aircraft are identical to the Baseline scenario.

4.2 NOISE EXPOSURE

Figure 4-1 shows the resultant 65 dB to 85 dB CNEL contours in 5 dB increments for No Action daily flight events, compared to the Baseline. The noise exposure is almost identical to the Baseline scenario. Note that the dashed colored lines represent the noise contours for the No Action scenario, while the underlying grey lines represent the noise contours for the Baseline scenario. It is clear that the additional H-60 activities in the No Action do not contribute noticeably to the noise environment around NAS North Island.

Table 4-2 lists the computed CNEL for each of the 13 POIs under the No Action scenario, in addition to the change in CNEL at each of those points, as compared to the Baseline scenario. Changing from Baseline to No Action (4,190 additional H-60 operations) does not increase the CNEL at any of the POIs at a level detectable to the human ear. The normal convention is to report these values rounded to the nearest dB, but in this case, the first decimal is shown – not to indicate greater precision, but to avoid confusion from using rounded values where the delta seems like it may be a dB, and the actual difference is just a fraction of that. (E.g. CNEL value going from 60.4 to 60.5 dB has changed only 0.1 dB, but with rounded values would show 60 to 61 with a 1 dB change).

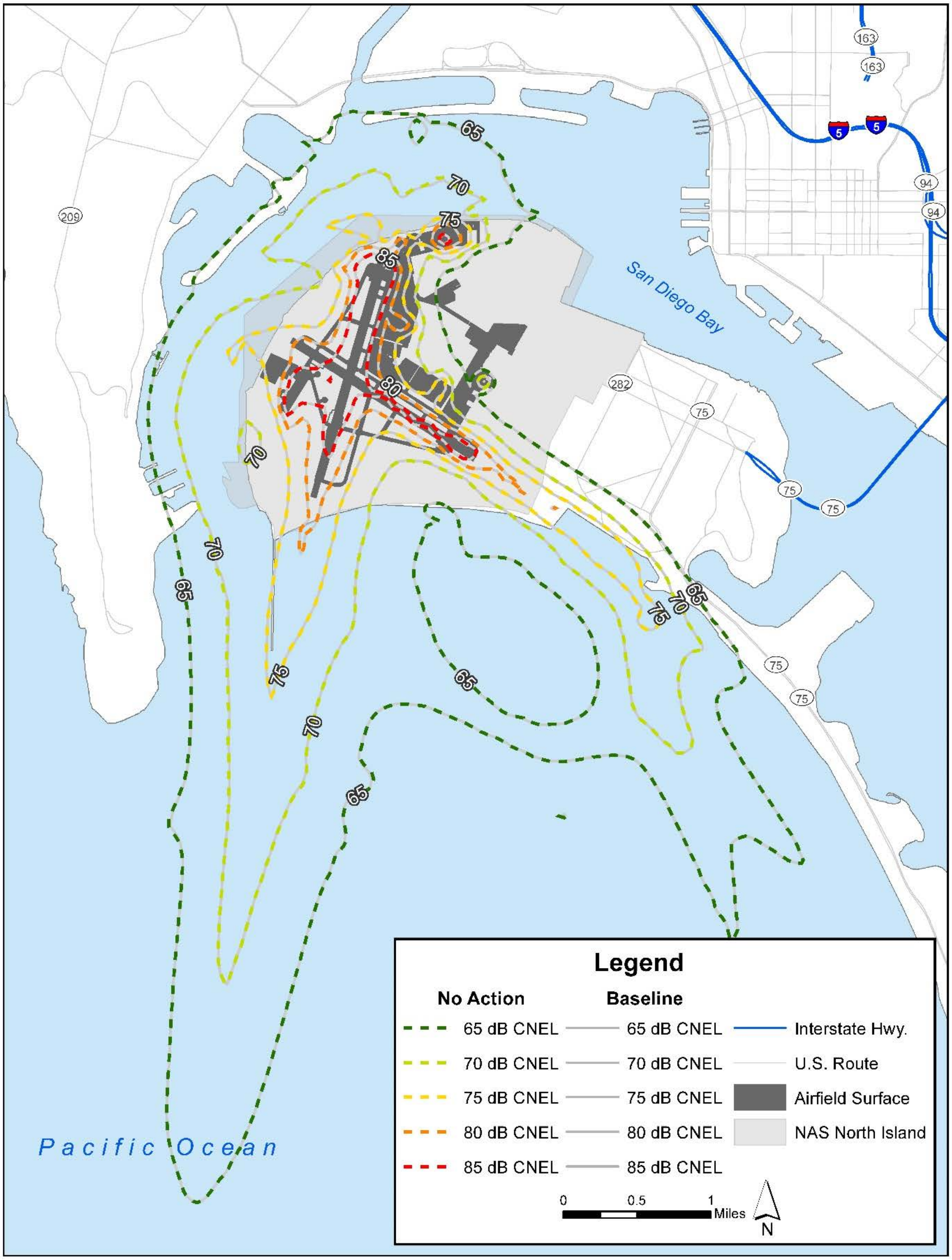
Table 4-1. No Action Scenario Annual Flight Operations at NAS North Island

AIRCRAFT	Notes	DEPARTURES							VFR ARRIVALS							IFR ARRIVALS						
		Day	% Day Depts	Eve	% Eve Depts	Night	% Night Depts	Total	Day	% Day Depts	Eve	% Eve Depts	Night	% Night Depts	Total	Day	% Day Depts	Eve	% Eve Depts	Night	% Night Depts	Total
BASED AICRAFT																						
H-60	1	9,036	*66%*	4,155	*30%*	492	*4%*	13,682	9,036	*66%*	4,155	*30%*	492	*4%*	13,682	-	-	-	-	-	-	-
H-60 (INTERFACILITY)	1,2	8,005	*72%*	2,851	*25%*	338	*3%*	11,195	8,005	*72%*	2,851	*25%*	338	*3%*	11,195	-	-	-		-	-	-
C-40		1,177	*94%*	75	*6%*	-	*0%*	1,252	1,117	*94%*	71	*6%*	-	*0%*	1,188	60	*94%*	4	*6%*	-	*0%*	64
E-2C		57	*91%*	5	*8%*	1	*1%*	63	57	*91%*	5	*8%*	1	*1%*	63	-	-	-	-	-	-	-
C-2		706	*93%*	30	*4%*	22	*3%*	758	667	*93%*	28	*4%*	21	*3%*	717	38	*93%*	2	*4%*	1	*3%*	41
BASED TOTALS		18,981		7,115		853		26,950	18,882		7,110		852		26,845	98		5		1		105
TRANSIENT AIRCRAFT																						
HEAVY JET	3	472	*59%*	79	*10%*	245	*31%*	796	460	*59%*	79	*10%*	245	*31%*	784	10	*83%*	-	*0%*	2	*17%*	12
LIGHT JET/FIGHTER	4	3,201	*95%*	115	*3%*	37	*1%*	3,353	3,200	*96%*	112	*3%*	30	*1%*	3,342	7	*64%*	3	*27%*	1	*9%*	11
TURBOPROP	5	871	*68%*	241	*19%*	167	*13%*	1,279	831	*67%*	236	*19%*	166	*13%*	1,233	40	*87%*	5	*11%*	1	*2%*	46
HELICOPTER	6	387	*53%*	243	*33%*	97	*13%*	727	387	*53%*	243	*33%*	97	*13%*	727	-	-	-	-	-	-	-
TRANSIENT TOTALS		4,931		678		546		6,155	4,878		670		538		6,086	57		8		4		69
TOTALS		***23,912***	***72%***	***7,793***	***24%***	***1,399***	***4%***	***33,104***	***23,760***	***72%***	***7,780***	***24%***	***1,390***	***4%***	***32,930***	***155***	***89%***	***13***	***8%***	***5***	***3%***	***174***

AIRCRAFT	Notes	VISUAL CLOSED PATTERNS (TOUCH AND GO)							INSTRUMENT PATTERNS (GCA)							TOTAL						*OPERATIONS TOTAL*
		Day	% Day Vis Clsd	Eve	% Eve Vis Clsd	Night	% Night Vis Clsd	Total	Day	% Day Gbox	Eve	% Eve Gbox	Night	% Night Gbox	Total	Day	% Day	Eve	% Eve	Night	% Night	
BASED AIRCRAFT																						
H-60		-	-	-	-	-	-	-	7,082	91%	648	8%	80	1%	7,810	25,153	72%	8,957	25%	1,063	3%	***35,174***
H-60 (INTERFACILITY)	1,2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16,010	72%	5,701	25%	677	3%	***22,390***
C-40		-	-	-	-	-	-	-	221	78%	35	12%	29	10%	285	2,575	92%	185	7%	29	1%	***2,789***
E-2C		-	-	-	-	-	-	-	22	100%	-	-	-	-	22	137	92%	10	7%	1	1%	***148***
C-2		2,382	92%	218	8%	-	-	2,600	317	96%	13	4%	-	0%	330	4,110	92%	291	7%	45	1%	***4,446***
BASED TOTALS		2,382		218		-		2,600	7,642		696		109		8,447	47,986	74%	15,145	23%	1,815	3%	***64,947***
TRANSIENT AIRCRAFT																						
HEAVY JET	3	-	-	-	-	-	-	-	50	89%	6	11%	-	0%	56	992	60%	164	10%	492	30%	***1,648***
LIGHT JET/FIGHTER	4	587	*100%*	-	-	-	-	587	1,743	98%	22	1%	9	1%	1,774	8,738	96%	252	3%	77	1%	***9,067***
TURBOPROP	5	-	-	-	-	-	-	-	45	75%	15	25%	-	0%	60	1,787	68%	497	19%	334	13%	***2,618***
HELICOPTER	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	774	53%	486	33%	194	13%	***1,454***
TRANSIENT TOTALS		587		-		-		587	1,838		43		9		1,890	12,291	83%	1,399	9%	1,097	7%	***14,787***
TOTALS		***2,969***	**93%**	***218***	**7%**	***-***	**0%**	***3,187***	***9,480***	**92%**	***739***	**7%**	***118***	**1%**	***10,337***	***60,277***	**76%**	***16,544***	**21%**	***2,912***	**4%**	***79,734***

Source: Cardno 2016.

Notes:
1. H-60 operations increase approximately 7.8% over Baseline to account for growth in H-60 fleet.
2. Departures and Arrivals for aircraft flying to/from NOLFIB.
3. Includes aircraft such as: P-8, C-17, and C-5.
4. Includes aircraft such as: F/A-18 series, F-35 series, Lear Jet, and Citation.
5. Includes aircraft such as: C-12, C-130, and Dash-8.
6. Includes aircraft such as: H-60 (transient), H-53, and AS-530.



Source: Cardno 2017.

Figure 4-1. No Action CNEL Contours for AAD Aircraft Operations at NAS North Island (compared to the Baseline)

Table 4-2. No Action CNEL at POIs

ID	Description	CNEL (dB)	Change in CNEL compared to Baseline (dB)
SL-1	Centennial Park	65.8	0.0
SL-2	Point Loma	56.5	0.1
SL-4	Hotel Del Coronado	67.4	0.0
SL-6	Silver Strand South	58.2	0.2
SL-7	Ferry Landing City of Coronado	52.5	0.3
SL-8	NASNI Beach	65.6	0.0
SL-13	Kona Kai Resort and Spa	64.9	0.0
SL-14	Cabrillo Elementary School	55.7	0.1
SL-15	Pier 32 Marina	46.0	0.3
SL-16	Chula Vista Marina	57.0	0.0
SL-17	Coronado Cays	53.2	0.2
SL-18	Loews Resort	53.1	0.1
SL-19	Coronado Municipal Beach	76.7	0.0

Source: Cardno 2017.

5.0 PROPOSED ACTION ALTERNATIVE 1 SCENARIO

The following section details the modeling data and the resultant noise exposure for the Proposed Action Alternative 1 scenario, in which the C-2A aircraft would be retired from NAS North Island, and would be replaced by CMV-22B aircraft. This accounts for the Fleet squadron (VRC-30) transition, as well as establishing an FRS containing 5 CMV-22B aircraft. All other aircraft operations are unchanged from those described in Section 4, No Action Alternative.

5.1 MODELING DATA

Table 5-1 details the annual flight operations at NAS North Island under the Proposed Action Alternative 1 scenario. The annual flight operations for Proposed Action Alternative 1 would increase compared to the No Action scenario (refer to Table 4-1). Under this scenario, the C-2A would be retired, removing 4,446 annual operations. The C-2A mission would be replaced with a CMV-22B Fleet squadron (totaling 10,278 annual operations). Additionally, an FRS for the CMV-22B would be located at NAS North Island adding an additional 5,686 annual CMV-22B operations. Under Proposed Action Alternative 1, these factors add up to a net increase of 11,518 operations compared to the No Action scenario, for a total of 91,251 annual operations. Also, the CMV-22B static run-up operations have been added to the scenario. All other flight and static operations remain unchanged from the No Action Alternative.

The CMV-22B will be replacing the mission of the C-2A. Due to the CMV-22B flight characteristics, it would operate slightly different than the C-2A that it is replacing. Figure 5-1 shows the modeled flight tracks for the Navy CMV-22B. Figure 5-2 shows, for comparison, the existing flight tracks for the C-2A that will no longer be used under either of the proposed action alternatives.

5.2 NOISE EXPOSURE

Figure 5-3 shows the resultant 65 dB to 85 dB CNEL contours in 5 dB increments for the Proposed Action Alternative 1 daily flight events. The noise exposure is almost identical to the No Action scenario. Note that the dashed colored lines represent the noise contours for the Proposed Action Alternative 1 scenario, while the underlying grey lines represent the noise contours for the No Action scenario. There is a very modest increase in the 65 CNEL contour, but most of the increases are seen over water, and not over populated areas. They result in the area where a closed pattern downwind and approach turn to runway 29 would occur (over water to the south of the base).

It is clear that replacement of the C-2A with the CMV-22B and the addition of a CMV-22B FRS would not noticeably alter the noise environment around NAS North Island.

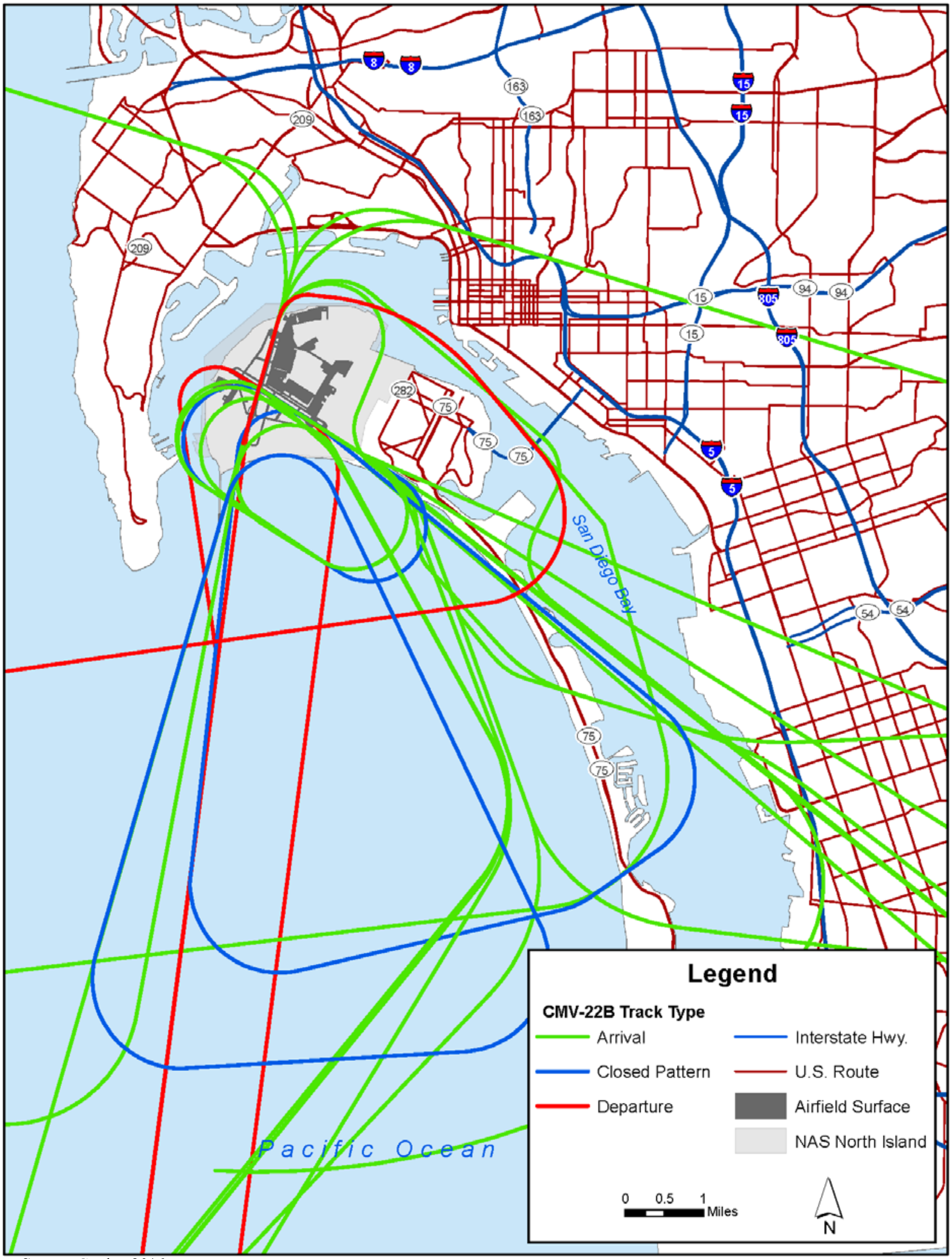
Table 5-1. Proposed Action Alternative 1 Annual Flight Operations for NAS North Island

AIRCRAFT	Notes	DEPARTURES							VFR ARRIVALS							IFR ARRIVALS						
		Day	% Day Depts	Eve	% Eve Depts	Night	% Night Depts	Total	Day	% Day VFR Arr	Eve	% Eve VFR Arr	Night	% Night VFR Arr	Total	Day	% Day IFR Arr	Eve	% Eve IFR Arr	Night	% Night IFR Arr	Total
BASED AIRCRAFT																						
H-60 NA	1	9,036	66%	4,155	30%	492	4%	13,682	9,036	66%	4,155	30%	492	4%	13,682	-	-	-	-	-	-	-
H-60 (INTERFACILITY) NA	1,2	8,005	72%	2,851	25%	338	3%	11,195	8,005	72%	2,851	25%	338	3%	11,195	-	-	-	-	-	-	-
C-40	1	1,177	94%	75	6%	-	0%	1,252	1,117	94%	71	6%	-	0%	1,188	60	94%	4	6%	-	0%	64
E-2C	1	57	91%	5	8%	1	1%	63	57	91%	5	8%	1	1%	63	-	-	-	-	-	-	-
V-22 (FRS)	3	621	79%	164	21%	-	0%	785	476	76%	133	21%	15	2%	624	153	95%	8	5%	-	0%	161
V-22 (FLEET)	4	1,310	75%	349	20%	87	5%	1,746	1,239	75%	330	20%	83	5%	1,652	71	75%	19	20%	5	5%	94
BASED TOTALS		20,206		7,598		918		28,723	19,930		7,544		929		28,404	284		31		5		319
TRANSIENT AIRCRAFT																						
HEAVY JET	5	472	59%	79	10%	245	31%	796	460	59%	79	10%	245	31%	784	10	83%	-	0%	2	17%	12
LIGHT JET/FIGHTER	6	3,201	95%	115	3%	37	1%	3,353	3,200	96%	112	3%	30	1%	3,342	7	64%	3	27%	1	9%	11
TURBOPROP	7	871	68%	241	19%	167	13%	1,279	831	67%	236	19%	166	13%	1,233	40	87%	5	11%	1	2%	46
HELICOPTER	8	387	53%	243	33%	97	13%	727	387	53%	243	33%	97	13%	727	-	-	-	-	-	-	-
TRANSIENT TOTALS		4,931		678		546		6,155	4,878		670		538		6,086	57		8		4		69
TOTALS		*25,137*	*72%*	*8,276*	*24%*	*1,464*	*4%*	*34,877*	*24,808*	*72%*	*8,214*	*24%*	*1,467*	*4%*	*34,489*	*341*	*88%*	*39*	*10%*	*9*	*2%*	*389*

AIRCRAFT	Notes	VISUAL CLOSED PATTERNS (TOUCH AND GO)							INSTRUMENT PATTERNS (GCA)							TOTAL						*OPERATIONS TOTAL*
		Day	% Day Vis Clsd	Eve	% Eve Vis Clsd	Night	% Night Vis Clsd	Total	Day	% Day Gbox	Eve	% Eve Gbox	Night	% Night Gbox	Total	Day	% Day	Eve	% Eve	Night	% Night	
BASED AIRCRAFT																						
H-60 NA	1	-	-	-	-	-	-	-	7,082	91%	648	8%	80	1%	7,810	25,153	72%	8,957	25%	1,063	3%	**35,174**
H-60 (INTERFACILITY) NA	1,2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16,010	72%	5,701	25%	677	3%	**22,390**
C-40	1	-	-	-	-	-	-	-	221	78%	35	12%	29	10%	285	2,575	92%	185	7%	29	1%	**2,789**
E-2C	1	-	-	-	-	-	-	-	22	100%	-		-		22	137	92%	10	7%	1	1%	**148**
V-22 (FRS)	3	2,982	78%	862	22%	-	-	3,844	272	100%	-		-		272	4,504	79%	1,167	21%	15	0%	**5,686**
V-22 (FLEET)	4	4,619	75%	1,540	25%	-	-	6,159	596	95%	31	5%	-	0%	627	7,835	76%	2,269	22%	175	2%	**10,278**
BASED TOTALS		7,601		2,402		-		10,003	8,193		714		109		9,016	56,214	74%	18,289	24%	1,961	3%	**76,464**
TRANSIENT AIRCRAFT																						
HEAVY JET	5	-	-	-	-	-	-	-	50	89%	6	11%	-	0%	56	992	60%	164	10%	492	30%	**1,648**
LIGHT JET/FIGHTER	6	587	100%	-	-	-	-	587	1,743	98%	22	1%	9	1%	1,774	8,738	96%	252	3%	77	1%	**9,067**
TURBOPROP	7	-	-	-	-	-	-	-	45	75%	15	25%	-	0%	60	1,787	68%	497	19%	334	13%	**2,618**
HELICOPTER	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	774	53%	486	33%	194	13%	**1,454**
TRANSIENT TOTALS		587		-		-		587	1,838		43		9		1,890	12,291	83%	1,399	9%	1,097	7%	**14,787**
TOTALS		*8,188*	*77%*	*2,402*	*23%*	*-*	*0%*	*10,590*	*10,031*	*92%*	*757*	*7%*	*118*	*1%*	*10,906*	*68,505*	*75%*	*19,688*	*22%*	*3,058*	*3%*	***91,251***

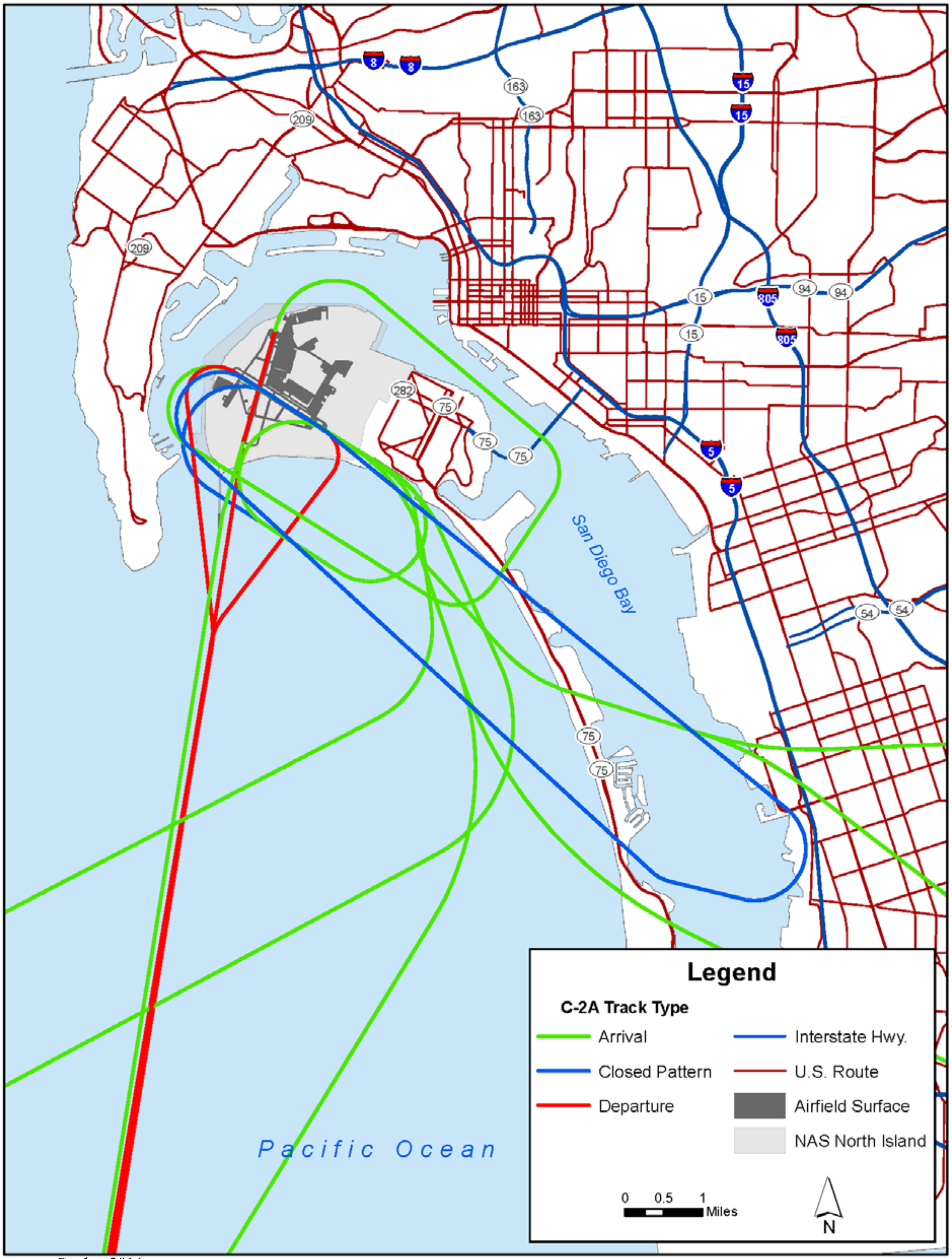
Source: Cardno 2016.

Notes:
1. H-60 operations increase approximately 7.8% over Baseline to account for growth in H-60 fleet.
2. Departures and Arrivals for aircraft flying to/from NOLFIB.
3. Data from "CMV-22 Flight Operations Calculator_7 Jun v3.xlsx" (Robusto).
4. Data source same as Note 3, but with adjusted percentages per CDR Cramer (75/20/5 for arr/dep).
5. Includes aircraft such as: P-8, C-17, and C-5.
6. Includes aircraft such as: F/A-18 series, F-35 series, Lear Jet, and Citation.
7. Includes aircraft such as: C-12, C-130, and Dash-8.
8. Includes aircraft such as: H-60 (transient), H-53, and AS-530.



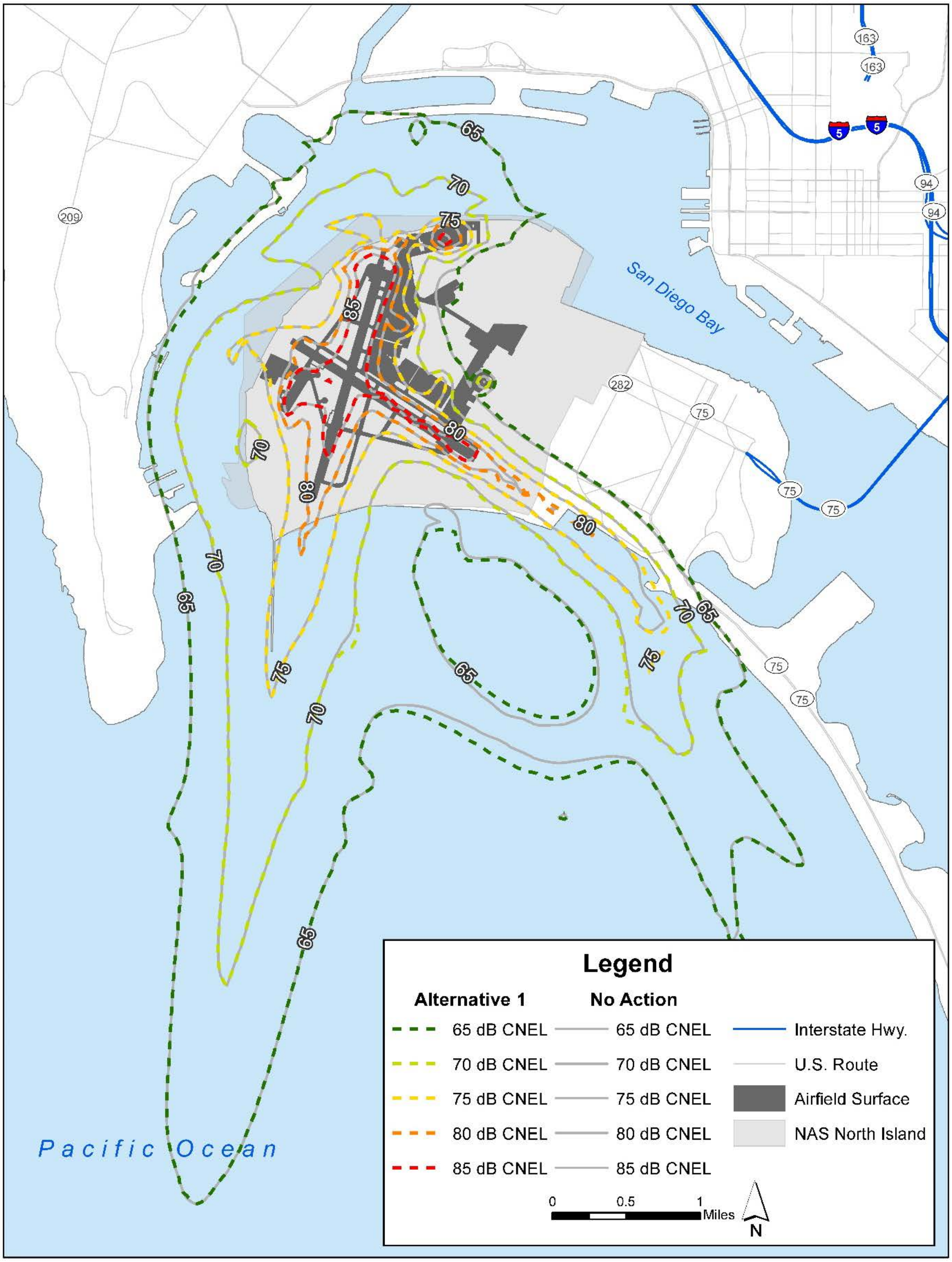
Source: Cardno 2016.

Figure 5-1. Flight Tracks Modeled for CMV-22B Operations at NAS North Island



Source: Cardno 2016.

Figure 5-2. Flight Tracks Modeled for C-2A Operations at NAS North Island



Source: Cardno 2017.

Figure 5-3. Proposed Action Alternative 1 CNEL Contours for NAS North Island (compared to the No Action)

Table 5-2 lists the computed CNEL for each of the 13 POIs under Alternative 1. Table 5-2 also shows the difference in computed CNEL between the No Action Alternative and Alternative 1. Changing from No Action to Proposed Action (by removing C-2A operations and replacing them with CMV-22B) does not change the CNEL at any of the POIs to a level detectable to the human ear. The normal convention is to report these values rounded to the nearest dB, but in this case, the first decimal is shown – not to indicate greater precision, but to avoid confusion from using rounded values where the delta seems like it may be 1 dB, and the actual difference is much smaller (e.g. CNEL value going from 60.4 to 60.5 dB has changed only 0.1 dB, but with rounded values would show 60 to 61 with a 1 dB change).

Table 5-2. Proposed Action Alternative 1 CNEL at POIs

ID	Description	CNEL (dB)	Change in DNL compared to No Action (dB)
SL-1	Centennial Park	66.1	0.3
SL-2	Point Loma	56.6	0.1
SL-4	Hotel Del Coronado	67.6	0.2
SL-6	Silver Strand South	58.2	0.0
SL-7	City of Coronado	52.8	0.3
SL-8	NASNI Beach	65.9	0.3
SL-13	Kona Kai Resort and Spa	64.4	-0.4
SL-14	Cabrillo Elementary School	55.4	-0.3
SL-15	Pier 32 Marina	46.2	0.2
SL-16	Chula Vista Marina	56.9	-0.1
SL-17	Coronado Cays	53.2	0.0
SL-18	Loews Resort	53.2	0.1
SL-19	Coronado Municipal Beach	77.4	0.7

Source: Cardno 2017.

6.0 PROPOSED ACTION ALTERNATIVE 2 SCENARIO

The following section details the modeling data and the resultant noise exposure for the Proposed Action Alternative 2 scenario, in which the C-2A aircraft would be retired from NAS North Island, with VRC-30 transitioning to the CMV-22B. Under this scenario, the FRS would not be located at NAS North Island. All other aircraft operations are unchanged from those described in Section 4, No Action Alternative.

6.1 MODELING DATA

Table 6-1 details the annual flight operations at NAS North Island under the Proposed Action Alternative 2 scenario. The annual flight operations for Alternative 2 would be similar to the No Action Alternative (refer to Table 4-1), except it replaces the 4,446 C-2A flight operations with 10,278 CMV-22B flight operations for the VRC-30 (Fleet), annually. Under this scenario the FRS would be located at Naval Station Norfolk. Therefore, there would be a total of 85,566 annual operations. CMV-22B run up operations were also modeled in this scenario, proportional to the number of flight operations. All other flight and static operations remain unchanged from the No Action Alternative.

The tracks and profiles modeled for CMV-22B are identical to those described in Section 5 pertaining to Alternative 1 noise exposure

6.2 NOISE EXPOSURE

Figure 6-1 shows the resultant 65 dB to 85 dB CNEL contours in 5 dB increments for the Proposed Action Alternative 2 daily flight events. The noise exposure is almost identical to the No Action scenario, with some minor deviations that occur mostly over water. Note that the dashed colored lines represent the noise contours for the Proposed Action Alternative 2 scenario, while the underlying grey lines represent the noise contours for the No Action scenario. It is clear that removal of the C-2A and the replacement with the CMV-22B would not noticeably alter the noise environment around NAS North Island.

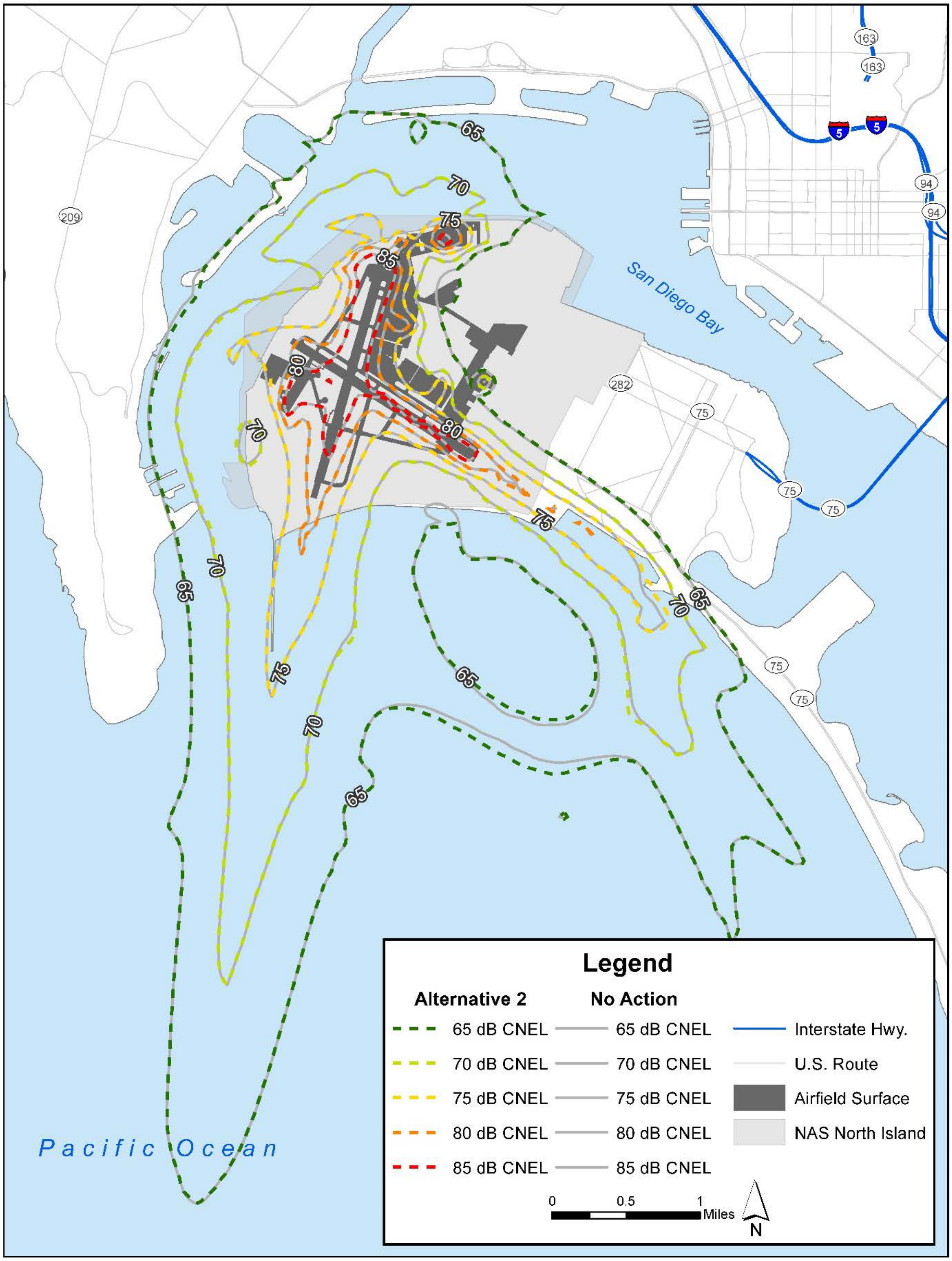
Table 6-1. Proposed Action Alternative 2 Annual Flight Operations for NAS North Island

AIRCRAFT	Notes	DEPARTURES Day	% Day Depts	Eve	% Eve Depts	Night	% Night Depts	Total	VFR ARRIVALS Day	% Day VFR Arr	Eve	% Eve VFR Arr	Night	% Night VFR Arr	Total	IFR ARRIVALS Day	% Day IFR Arr	Eve	% Eve IFR Arr	Night	% Night IFR Arr	Total
BASED AICRAFT																						
H-60 NA	1	9,036	66%	4,155	30%	492	4%	13,682	9,036	66%	4,155	30%	492	4%	13,682	-	-	-	-	-	-	-
H-60 (INTERFACILITY) NA	1,2	8,005	72%	2,851	25%	338	3%	11,195	8,005	72%	2,851	25%	338	3%	11,195	-	-	-	-	-	-	-
C-40	1	1,177	94%	75	6%	-	0%	1,252	1,117	94%	71	6%	-	0%	1,188	60	94%	4	6%	-	-	64
E-2C	1	57	91%	5	8%	1	1%	63	57	91%	5	8%	1	1%	63	-	-	-	-	-	-	-
V-22 (FLEET)	3	1,310	75%	349	20%	87	5%	1,746	1,239	75%	330	20%	83	5%	1,652	71	75%	19	20%	5	5%	94
BASED TOTALS		19,585		7,434		918		27,938	19,454		7,411		914		27,780	131		23		5		158
TRANSIENT AIRCRAFT																						
HEAVY JET	4	472	*59%*	79	*10%*	245	*31%*	796	460	*59%*	79	*10%*	245	*31%*	784	10	*83%*	-	*0%*	2	*17%*	12
LIGHT JET/FIGHTER	5	3,201	*95%*	115	*3%*	37	*1%*	3,353	3,200	*96%*	112	*3%*	30	*1%*	3,342	7	*64%*	3	*27%*	1	*9%*	11
TURBOPROP	6	871	*68%*	241	*19%*	167	*13%*	1,279	831	*67%*	236	*19%*	166	*13%*	1,233	40	*87%*	5	*11%*	1	*2%*	46
HELICOPTER	7	387	*53%*	243	*33%*	97	*13%*	727	387	*53%*	243	*33%*	97	*13%*	727	-	-	-	-	-	-	-
TRANSIENT TOTALS		4,931		678		546		6,155	4,878		670		538		6,086	57		8		4		69
TOTALS		***24,516***	***72%***	***8,112***	***24%***	***1,464***	***4%***	***34,092***	***24,332***	***72%***	***8,081***	***24%***	***1,452***	***4%***	***33,865***	***188***	***83%***	***31***	***14%***	***9***	***4%***	***228***

AIRCRAFT	Notes	VISUAL CLOSED PATTERNS (TOUCH AND GO) Day	% Day Vis Clsd	Eve	% Eve Vis Clsd	Night	% Night Vis Clsd	Total	INSTRUMENT PATTERNS (GCA) Day	% Day Gbox	Eve	% Eve Gbox	Night	% Night Gbox	Total	TOTAL Day	% Day	Eve	% Eve	Night	% Night	*OPERATIONS TOTAL*
BASED AICRAFT																						
H-60 NA	1	-	-	-	-	-	-	-	7,082	91%	648	8%	80	1%	7,810	25,153	72%	8,957	25%	1,063	3%	***35,174***
H-60 (INTERFACILITY) NA	1,2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16,010	72%	5,701	25%	677	3%	***22,390***
C-40	1	-	-	-	-	-	-	-	221	78%	35	12%	29	10%	285	2,575	92%	185	7%	29	1%	***2,789***
E-2C	1	-	-	-	-	-	-	-	22	100%	-	-	-	-	22	137	92%	10	7%	1	1%	***148***
V-22 (FLEET)	3	4,619	75%	1,540	25%	-	-	6,159	596	95%	31	5%	-		627	7,835	76%	2,269	22%	175	2%	***10,278***
BASED TOTALS		4,619		1,540		-		6,159	7,921		714		109		8,744	51,710	73%	17,122	24%	1,946	3%	***70,779***
TRANSIENT AIRCRAFT																						
HEAVY JET	4	-	-	-	-	-	-	-	50	*89%*	6	*11%*	-	*0%*	56	992	*60%*	164	*10%*	492	*30%*	***1,648***
LIGHT JET/FIGHTER	5	587	*100%*	-	-	-	-	587	1,743	*98%*	22	*1%*	9	*1%*	1,774	8,738	*96%*	252	*3%*	77	*1%*	***9,067***
TURBOPROP	6	-	-	-	-	-	-	-	45	*75%*	15	*25%*	-	*0%*	60	1,787	*68%*	497	*19%*	334	*13%*	***2,618***
HELICOPTER	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	774	*53%*	486	*33%*	194	*13%*	***1,454***
TRANSIENT TOTALS		587		-		-		587	1,838		43		9		1,890	12,291	*83%*	1,399	*9%*	1,097	*7%*	***14,787***
TOTALS		***5,206***	***77%***	***1,540***	***23%***	***-***	***0%***	***6,746***	***9,759***	***92%***	***757***	***7%***	***118***	***1%***	***10,634***	***64,001***	***75%***	***18,521***	***22%***	***3,043***	***4%***	***85,566***

Source: Cardno 2016.

Notes:
1. H-60 operations increase approximately 7.8% over Baseline to account for growth in H-60 fleet.
2. Departures and Arrivals for aircraft flying to/from NOLFIB.
3. Data from "CMV-22 Flight Operations Calculator_7 Jun v3.xlsx" (Robusto)
4. Includes aircraft such as: P-8, C-17, and C-5.
5. Includes aircraft such as: F/A-18 series, F-35 series, Lear Jet, and Citation.
6. Includes aircraft such as: C-12, C-130, and Dash-8.
7. Includes aircraft such as: H-60 (transient), H-53, and AS-530.



Source: Cardno 2017.

Figure 6-1. Proposed Action Alternative 2 CNEL Contours at NAS North Island (compared to the No Action)

Table 6-2 lists the computed CNEL for each of the 18 POIs under Proposed Action Alternative 2. Table 6-2 also shows the difference in computed CNEL between the No Action Alternative and Alternative 2. Changing from No Action to Proposed Action Alternative 2 (by removing C-2A operations and replacing them with CMV-22B) does not change the CNEL at any of the POIs to a level detectable to the human ear. The normal convention is to report these values rounded to the nearest dB, but in this case, the first decimal is shown – not to indicate greater precision, but to avoid confusion from using rounded values where the delta seems like it may be 1 dB, and the actual difference is much smaller (e.g. CNEL value going from 60.4 to 60.5 dB has changed only 0.1 dB, but with rounded values would show 60 to 61 with a 1 dB change).

Table 6-2. Proposed Action Alternative 2 CNEL at POIs

ID	Description	CNEL (dB)	Change in CNEL compared to No Action (dB)
SL-1	Centennial Park	66.0	0.2
SL-2	Point Loma	56.5	0.0
SL-3	Hotel Del Coronado	67.5	0.2
SL-4	Silver Strand South	58.2	0.0
SL-7	City of Coronado	52.7	0.2
SL-8	NASNI Beach	65.8	0.2
SL-13	Kona Kai Resort and Spa	64.4	-0.4
SL-14	Cabrillo Elementary School	55.4	-0.3
SL-15	Pier 32 Marina	46.1	0.1
SL-16	Chula Vista Marina	56.9	-0.1
Sl-17	Coronado Cays	53.2	0.0
SL-18	Loews Resort	53.2	0.0
SL-19	Coronado Municipal Beach	77.1	0.5

Source: Cardno 2017.

7.0 SUPPLEMENTAL METRICS

7.1 MAXIMUM SOUND LEVEL AND SOUND EXPOSURE LEVEL

While a cumulative metric such as CNEL (highlighted in Sections 3 through 6 in this report) is excellent for showing the overall noise environment, it can also be of interest to know how loud the loudest events are at a particular location. To help answer these questions about the loudest events, calculations were made for each of the POIs (initially listed in Table 2-2) to find the loudest events at each of them, for each of the modeled scenarios (Baseline, No Action, and Proposed Action Alternatives 1 and 2). These POIs are modeled as individual points, and are a good representation of the areas immediately around them shown in Figure 2-1. Table 7-1 shows, for each POI, the aircraft and profile for the three events producing the highest SEL, and lists the SEL and the L_{max} for each. It also lists the number of daytime and nighttime events per day for each, and the total events per week. It allows for a demonstration that some "loud" events may occur in an area of a lower CNEL. For instance, at SL-4 (Hotel Del Coronado), the point has a CNEL value of 67 decibels, and has about 5 weekly events of F-18 flight operations which have an L_{max} of 108 dB. This shows that even while the overall noise (represented by CNEL) is considered lower, there are some events which would be more noticeable.

Comparison of Table 7-1 with the map in Figure 2-1, which shows the locations of the POIs, the loudest events tend to occur closest to the airfield and nearest the flight tracks that align with the runways at NAS North Island.

Note that there is only one table in this section, vice one for each scenario (Baseline, No Action, and Proposed Action Alternatives 1 and 2). Each of the scenarios was calculated separately, and the result was that they were all the same. The aircraft models contributing the loudest events were not those that are changing with the scenarios involved in this proposal (CMV-22B, and C-2A), so there are no differences. Table 7-1 as presented shows values that are constant across all of the scenarios. There are no changes in the loudest events at each of the POIs as we move from Baseline to No Action to Alternative 1 to Alternative 2.

Table 7-1. Loudest Events at Each POI

POI #	POI Name	Baseline CNEL (dBA)	Aircraft	Profile ID	Daily Events			TOTAL per week	SEL (dBA)	L_{max} (dBA)
					Day	Evening	Night			
SL-1	Centennial Park	65.8	F-18E/F	F18E-5	0.615	0.005	0.003	4.4	110.6	104.5
			F-18E/F	EA18G-5	0.047	0.025	0	0.5	110.6	104.5
			F-18E/F	F18E-8	0.04	0	0	0.3	110.6	104.7
SL-2	Point Loma	56.4	F-18E/F	F18E-2	0.029	0.002	0	0.2	103.3	93.8
			F-18E/F	EA18G-2	0.027	0.001	0	0.2	103.3	93.8
			F-18A/C	F18C-2	0.005	0	0	0.0	103.2	92.6
SL-4	Hotel Del Coronado	67.4	F-18E/F	F18E-8	0.04	0	0	0.3	113.2	108.6
			F-18E/F	F18E-5	0.615	0.005	0.003	4.4	112.9	108.2
			F-18E/F	EA18G-5	0.047	0.025	0	0.5	112.9	108.2
SL-6	Silver Strand South	58.1	C-5A	C5A-8	0.033	0.004	0	0.3	109.7	100.0
			LEARJET-25	LJ25-8	0.387	0	0	2.7	104.4	96.2
			F-18E/F	F18E-9	0.085	0.022	0.01	0.8	104.0	95.1
SL-7	City of Coronado	52.3	F-18E/F	F18E-4	0.013	0	0	0.1	110.9	104.3
			F-18A/C	F18C-4	0.002	0	0	0.0	104.3	98.0
			F-35A	F35C-4	0.002	0	0	0.0	104.2	73.4
SL-8	NASNI Beach	65.6	F-18E/F	F18E-2	0.029	0.002	0	0.2	115.6	110.1
			F-18E/F	EA18G-2	0.027	0.001	0	0.2	115.6	110.1
			F-18A/C	F18C-2	0.005	0	0	0.0	115.2	108.5
SL-13	Kona Kai Resort and Spa	64.8	F-35A	F35C-2	0.005	0	0	0.0	113.5	103.4
			F-18E/F	F18E-2	0.029	0.002	0	0.2	109.1	102.8
			F-18E/F	EA18G-2	0.027	0.001	0	0.2	109.1	102.8
SL-14	Cabrillo Elementary School	55.6	F-18E/F	F18E-2	0.029	0.002	0	0.2	100.2	91.1
			F-18E/F	EA18G-2	0.027	0.001	0	0.2	100.2	91.1
			F-18A/C	F18C-2	0.005	0	0	0.0	99.7	89.8
SL-15	Pier 32 Marina	45.7	C-5A	C5A-8	0.033	0.004	0	0.3	94.3	80.7
			F-35A	F35C-9	0.014	0.004	0.001	0.1	89.1	79.7
			F-18E/F	F18E-9	0.085	0.022	0.01	0.8	88.1	75.1
SL-16	Chula Vista Marina	56.9	C-5A	C5A-8	0.033	0.004	0	0.3	111.5	102.2
			LEARJET-25	LJ25-8	0.387	0	0	2.7	105.9	98.1
			F-18E/F	F18E-9	0.085	0.022	0.01	0.8	105.7	97.1
SL-17	Coronado Cays	53.1	C-5A	C5A-8	0.033	0.004	0	0.3	105.0	93.4
			LEARJET-25	LJ25-8	0.387	0	0	2.7	100.3	90.2
			F-18E/F	F18E-9	0.085	0.022	0.01	0.8	99.9	88.9
SL-18	Loews Resort	53.1	C-5A	C5A-8	0.033	0.004	0	0.3	101.7	85.5
			F-18E/F	F18E-6C	0.145	0.01	0.002	1.1	100.5	94.9
			F-18E/F	EA18G-6C	0.223	0.004	0	1.6	100.5	94.9
			F-18E/F	F18E-6D	0.145	0.01	0.002	1.1	100.5	94.9
			F-18E/F	EA18G-6D	0.223	0.004	0	1.6	100.5	94.9
SL-19	Coronado Muncipal Beach	76.7	F-18E/F	F18E-6C	0.145	0.01	0.002	1.1	121.2	117.5
			F-18E/F	EA18G-6C	0.223	0.004	0	1.6	121.2	117.5
			F-18E/F	F18E-6D	0.145	0.01	0.002	1.1	121.2	117.5
			F-18E/F	EA18G-6D	0.223	0.004	0	1.6	121.2	117.5
			F-18E/F	F18E-6A	0.145	0.01	0.002	1.1	121.2	117.5
			F-18E/F	EA18G-6A	0.223	0.004	0	1.6	121.2	117.5
			F-18E/F	F18E-6B	0.145	0.01	0.002	1.1	121.2	117.5
			F-18E/F	EA18G-6B	0.223	0.004	0	1.6	121.2	117.5

Source: Cardno 2017
Note: These L_{max} and SEL values apply to all four scenarios: Baseline, No Action, and Alternatives 1 and 2.

7.2 Sleep Disturbance

For residential areas, a typical concern is the possibility of disturbing sleep. The DOD guidance from the Defense Noise Working Group guides use of the ANSI standard S12.9 for this analysis, as explained in Section 2 of this document.

Table 7-2 shows the calculations for each POI. It lists the average number of events that result in an SEL above 90 dB per 9-hour night (i.e., this analysis used all 9 of the hours between 10:00 p.m. and 7:00 a.m. local time), also known as "NA90", and the cumulative probability of awakening at least once during that period for both a "windows closed" and "windows open" condition. This is represented for all four scenarios (Baseline, No Action, and Alternatives 1 and 2). There are not necessarily residences specifically at each of these points, but the points are good representations of the immediate surrounding areas where similar results could be expected.

Predictably, the areas closer to the runways have the highest probabilities of awakening.

The various scenarios show a small difference for POI SL-19, Coronado Municipal Beach, which is near the runway and under arrival tracks to runway 29. For most of the POIs, there is no difference noted. For SL-19 the shift from No Action to Alternative 1 (the option with the highest level of operations) shows at most a 1% increased probability of awakening on a given night. This methodology's results are for the entire year. The loudest events (as shown in Section 7.1) are loud enough to cause awakenings in some locations, but they occur in very low numbers at night. Therefore, the probabilities resulting from the calculations are low.

Table 7-2. Probability of Awakening at POIs by Scenario												
Location	Probability of Awakening at Least Once											
	Baseline			No Action			Alternative 1			Atlernative 2		
	NA90 [1]	Windows Closed [2]	Windows Open [3]	NA90 [1]	Windows Closed [2]	Windows Open [3]	NA90 [1]	Windows Closed [2]	Windows Open [3]	NA90 [1]	Windows Closed [2]	Windows Open [3]
SL-1 - Centennial Park	0.08	<1%	<1%	0.08	<1%	<1%	0.08	<1%	<1%	0.08	<1%	<1%
SL-2 - Point Loma	0.05	<1%	<1%	0.05	<1%	<1%	0.05	<1%	<1%	0.05	<1%	<1%
SL-4 - Hotel Del Coronado	0.08	<1%	<1%	0.08	<1%	<1%	0.09	<1%	<1%	0.09	<1%	<1%
SL-6 - Silver Strand South	0.15	<1%	<1%	0.16	<1%	<1%	0.16	<1%	<1%	0.16	<1%	<1%
SL-7 - City of Coronado	0.02	<1%	<1%	0.02	<1%	<1%	0.02	<1%	<1%	0.02	<1%	<1%
SL-8 - NASNI Beach	0.25	<1%	1-2%	0.25	<1%	1-2%	0.25	<1%	1-2%	0.25	<1%	1-2%
SL-13 - Kona Kai Resort and Spa	0.16	<1%	<1%	0.16	<1%	<1%	0.16	<1%	<1%	0.16	<1%	<1%
SL-14 - Cabrillo Elementary School	0.05	<1%	<1%	0.05	<1%	<1%	0.05	<1%	<1%	0.05	<1%	<1%
SL-15 - Pier 32 Marina	0.00	<1%	<1%	0.00	<1%	<1%	0.00	<1%	<1%	0.00	<1%	<1%
SL-16 - Chula Vista Marina	0.08	<1%	<1%	0.08	<1%	<1%	0.08	<1%	<1%	0.08	<1%	<1%
SL-17 - Coronado Cays	0.02	<1%	<1%	0.02	<1%	<1%	0.02	<1%	<1%	0.02	<1%	<1%
SL-18 - Loews Resort	0.04	<1%	<1%	0.04	<1%	<1%	0.04	<1%	<1%	0.04	<1%	<1%
SL-19 - Coronado Municipal Beach	0.89	2-3%	3-4%	0.89	2-3%	3-4%	1.10	2-3%	4-5%	1.07	2-3%	3-4%

Notes: [1.] Number of aircraft events at 90 dB SEL for Average 9-Hour Night.
[2.] 'Windows Closed' assumes a 25dB noise level reduction between the outdoors and the indoors, e.g., 90 dB SEL outdoors is 65 dB SEL indoors.
[3.] 'Windows Open' assumes a 15dB noise level reduction between the outdoors and the indoors, e.g., 90 dB SEL outdoors is 75 dB SEL indoors.

8.0 CONCLUSION

The Navy's proposal to replace the C-2A Greyhound with the new CMV-22B Osprey at NAS North Island, California was analyzed for effects on the noise environment in the surrounding community.

Neither of the alternatives results in a noticeable change in the DOD's primary noise metric, CNEL. In fact, the results are nearly indistinguishable from either the Baseline or the No Action scenario. This indicates that the aircraft and types of events that cause the primary contribution to the CNEL are not affected by this proposed change at NAS North Island.

At a variety of POIs in the community, the loudest expected regular events were also analyzed. The results of calculating the single event metrics L_{max} and SEL for the loudest events showed no difference between the either of the Proposed Action Alternatives and the No Action. This indicates that for the representative sampling of the surrounding area, the events that the public would experience as the loudest regular events will not change under the Proposed Action because they are not caused by either the aircraft being replaced (C-2A) or the new aircraft (CMV-22B).

Those same POIs were examined for changes to the probability of awakening, a measurement of the loudness and frequency of occurrence of loud events during the nighttime. These results show that for 12 of the 13 points, there is less than a 1% change in the probability of awakening during any given night. At POI 19, near the approach end of runway 29, there was a 1% increase in the probability of awakening under the assumption that the hypothetical person in question was trying to sleep with the windows open during night flying activity at NAS North Island.

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26 June 2017

MEMORANDUM

Subj: ADDITIONAL NOISE ANALYSIS OF LEAST TERN NESTING SITE AT NAVAL AIR STATION NORTH ISLAND, CALIFORNIA

Ref: (1) Noise Analysis in Support of Environmental Assessment for the Transition from C-2A to Navy V-22 Aircraft at Fleet Logistics Centers Naval Air Station North Island, California (June 2017)

1. The noise analysis completed for the proposed aircraft replacement at Naval Air Station (NAS) North Island focused on the effects on the population off-base. An additional question was asked about the effects of aircraft noise on the NAS North Island Least Tern Management Area (also known as the MAT Site), which is located on base. This memo addresses that question.

2. The MAT Site is located almost due south of the project site, on the south side of the adjacent "L" taxiway (Figure 1). The MAT Site is outlined in green, and the project site is outlined in red. The project site is an outline of the general area where a new hangar would be constructed, and where the parking area for the new aircraft would be located.

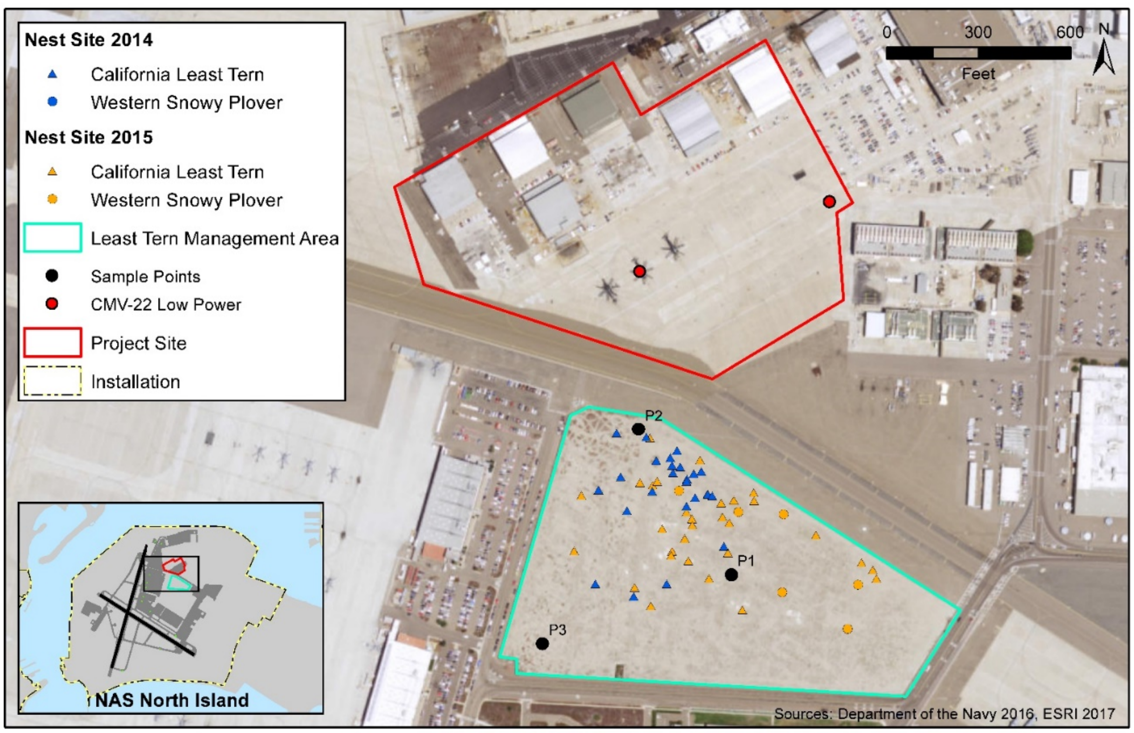

Figure 1

3. Noise modeling included both flight operations and ground operations that occur in the flight line and other places on the airfield. The numbers and types of flight and ground operations activities are as presented in the reference. The analysis in this memo is not due to any changes in those activities, but just the closer look at their effects in this area of the base.

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4. The noise modeling for the four scenarios (Baseline, No Action, Alternative 1 and Alternative 2) remains the same as depicted in the reference, which was focused on the off-base effects. What follows is an analysis of what that modeling shows for the MAT Site. Three points were identified for analysis on the MAT Site. They are labeled in Figure 1 as "P1", "P2", and "P3". P1 is a point roughly in the center of the polygon that is the MAT Site. P2 is the point in the MAT Site located closest to the proposed Navy V-22 flightline – expected to be the most affected by additional noise sources in the project site. P3 is the point in the MAT Site that had the highest Baseline Community Noise Equivalent Level (CNEL).

4. Table 1 shows the CNEL values for the three points in the MAT Site under each of the scenarios, along with the change from the No Action for each of the action alternatives.

Table 1: MAT Site Noise Analysis

	Point P1		Point P2		Point P3	
	CNEL (dB)	Change (dB)	CNEL (dB)	Change (dB)	CNEL (dB)	Change (dB)
Baseline	65	n/a	65	n/a	69	n/a
No Action	65	n/a	65	n/a	69	n/a
Alternative 1	65	<1	66	1	69	<1
Alternative 2	65	<1	66	<1	69	<1

Note that these are decibels CNEL. The CNEL metric was used for the reference, since the focus was on human impact, and the CNEL weighs time of day to accommodate regular human sleep patterns. Here, it may be more appropriate to use LEQ, which does not weigh by time of day, but without the weighting, the numbers would only get smaller, and since they are negligible changes already, it is sufficient to use the CNEL to show the relative lack of impact.

5. These values are shown in whole numbers to accurately represent the precision involved. Calculated values that would round to one are shown as such. Those that would round to zero are shown as "less than one" or "<1".

6. There is no standard for determining significance of changes in cumulative noise effects on Least Terns, but it is reasonable to conclude that a worst case rise of one decibel CNEL (and a smaller value for LEQ) is not significant.

7. Regarding the need for analysis of single event noise effects, which is a supplemental metric often used for points of interest, the modeling results from the referenced noise study show that the noisiest events at the MAT Site area are all produced by aircraft that will not change due to the proposed action. In other words, the noisiest events will not change because they are not caused by either the C-2A or the Navy V-22. Therefore, the fact that the Least Terns have established this nesting area under the existing noise environment indicates they are not significantly disturbed by the existing loud events.

G. Olander
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NOISE ANALYSIS

In Support of Environmental Assessment for the Transition from C-2A to Navy V-22 Aircraft at Fleet Logistics Centers

- Naval Station Norfolk Chambers Field, Norfolk, Virginia

Final

Prepared for:

Naval Facilities Engineering Command – Atlantic
6506 Hampton Boulevard
Norfolk, VA 23508-1278

May 2017

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Noise Analysis in Support of Environmental Assessment for the Transition from C-2A to Navy V-22 Aircraft at Fleet Logistics Centers

Naval Station Norfolk Chambers Field, Norfolk, Virginia

Final

Contract N62470-14-D-9003, Delivery Order 0007

May 2017

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LIST OF ACRONYMS AND ABBREVIATIONS

°F	degrees Fahrenheit
%QQBPA	Percent Torque
AAD	Annual Average Daily
CPLO	Community Plans and Liaison Officer
dB	Decibel
dBA	A-weighted decibels
DLG	Digital Line Graph
DNL	Day-Night Average Sound Level
DOD	Department of Defense
ft	feet
GCA	Ground Controlled Approach
ID	Identification
IGE	In Ground Effect
inHg	inches mercury
ISHP	Indicated Shaft Horsepower
kPa-s/m^2	kilopascal-seconds per square meter
L_{max}	Maximum Sound Level
m	meter
MARFORRES	Marine Forces Reserve
NA90	Number of Events Above 90 dB SEL
NED	National Elevation Dataset
NLR	Noise Level Reduction
NMAP	NoiseMap software
NS	Naval Station
OGE	Out of Ground Effect
POI	Point of Interest
RNM	Rotorcraft Noise Model
SEL	Sound Exposure Level
T&G	Touch-and-Go
U.S.	United States
USGS	United States Geological Survey
USMCR	United States Marine Corps Reserve
VA	Virginia
VMM	Marine Medium Tiltrotor Squadron
VRC	Fleet Logistics Squadron

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1.0 INTRODUCTION

The United States (U.S.) Department of the Navy (Navy) proposes to replace the C-2A Greyhound with the new CMV-22B Osprey at existing West and East Coast logistics support centers Naval Air Station (NAS) North Island, California and Naval Station (NS) Norfolk, Virginia. Under this Proposed Action, the Navy plans to:

- Replace 27 legacy C-2A aircraft with 38 CMV-22B aircraft operated by existing U.S. Fleet Forces Command logistics support squadrons (VRC);
- Establish a CMV-22B Fleet Replacement Squadron (FRS) for pilots and Naval aircrewmen;
- Establish a Maintenance School for maintenance personnel;
- Construct and renovate facilities to accommodate CMV-22B squadron aircraft and personnel; and
- Make adjustments to personnel levels (increases or decreases) associated with the aircraft transition.

This noise study is in support of the C-2A Greyhound to CMV-22B Osprey transition at NS Norfolk, and considers four scenarios: Baseline, No Action, and Proposed Action Alternatives 1 and 2. For this analysis, the Baseline scenario reflects NS Norfolk operations data taken from NS Norfolk air traffic activity reports from for the last five whole years (2011-2015)[1]. The No Action Alternative includes completion of the Marine Medium Lift Squadron (VMM-774) transition from CH-46E to MV-22B. This action is already underway and will be completed regardless of the decision made by the Navy for this current proposal. The No Action scenario represents the completed build-out of VMM-774 to 12 MV-22B aircraft. Proposed Action Alternative 1 would include replacement of Fleet C-2A aircraft with CMV-22B aircraft in VRC-40, stationed at NS Norfolk. Proposed Action Alternative 2 would include the VRC-40 transition to CMV-22B and the additional establishment of an FRS of five (5) CMV-22B at NS Norfolk.

Section 2 describes the methodology of this study. Section 3 includes the modeling data used and the noise exposure for the Baseline condition. Section 4 includes the modeling data used and the noise exposure for the No Action scenario. Section 5 includes the modeling data used and the noise exposure for the Proposed Action Alternative 1 scenario. Section 6 includes the modeling data used and the noise exposure for the Proposed Action Alternative 2 scenario. Section 7 summarizes the supplemental noise metrics calculated for this study.

2.0 METHODOLOGY

Table 2-1 summarizes the noise model parameters used in this analysis. This analysis utilizes the Department of Defense (DOD) NOISEMAP suite of computer programs (Wyle 1998; Wasmer Consulting 2006) containing the core computational programs called "NMAP", version 7.0 and 7.3, and Rotorcraft Noise Model (RNM) version 7.2.2. Note that NMAP version 7.3 was released on 28 March, 2017. Most of the work for this study was already accomplished with the previous version, but the new version was used

[1] When this study began in 2016, the 2015 year represented the last full year for establishing baseline flight operations. Although not included in the baseline, the operations for 2016 were very similar, and would not have affected the baseline significantly.

for validation of calculations of maximum sound level (L_{max}), which is one of the features of the new software version.

Table 2-1. Noise Modeling Parameters		
Software	**Analysis**	**Version**
NMAP	Fixed wing aircraft	7.0
		7.3
RNM	Rotorcraft	7.2.2
Parameter	**Description**	
Receiver Grid Spacing	500 ft in x and y	
Metric	DNL	
Basis	AAD Operations	
Topography		
Elevation Data Source	USGS 30m NED	
Elevation Grid Spacing	500 ft in x and y	
Impedance Data Source	USGS Hydrography DLG	
Impedance Grid spacing	500 ft in x and y	
Flow Resistivity of Ground (soft/hard)	225 kPa-s/m^2 / 100,000 kPa-s/m^2	
Modeled Weather (Monthly Averages 2009-2015; April selected)		
Temperature	63 °F	
Relative Humidity	63 %	
Barometric Pressure	30.03 in Hg	

Source: Cardno 2017.
Notes: ft = feet; DNL = Day-Night Average Sound Level; AAD = Annual Average Daily; USGS = U.S. Geological Survey; m = meters; NED = National Elevation Dataset; DLG = Digital Line Graph; kPa-s/m^2 = kilopascal-seconds per square meter; ºF = degrees Fahrenheit; in Hg = inches Mercury.

2.1 PRIMARY NOISE METRIC AND MODELING

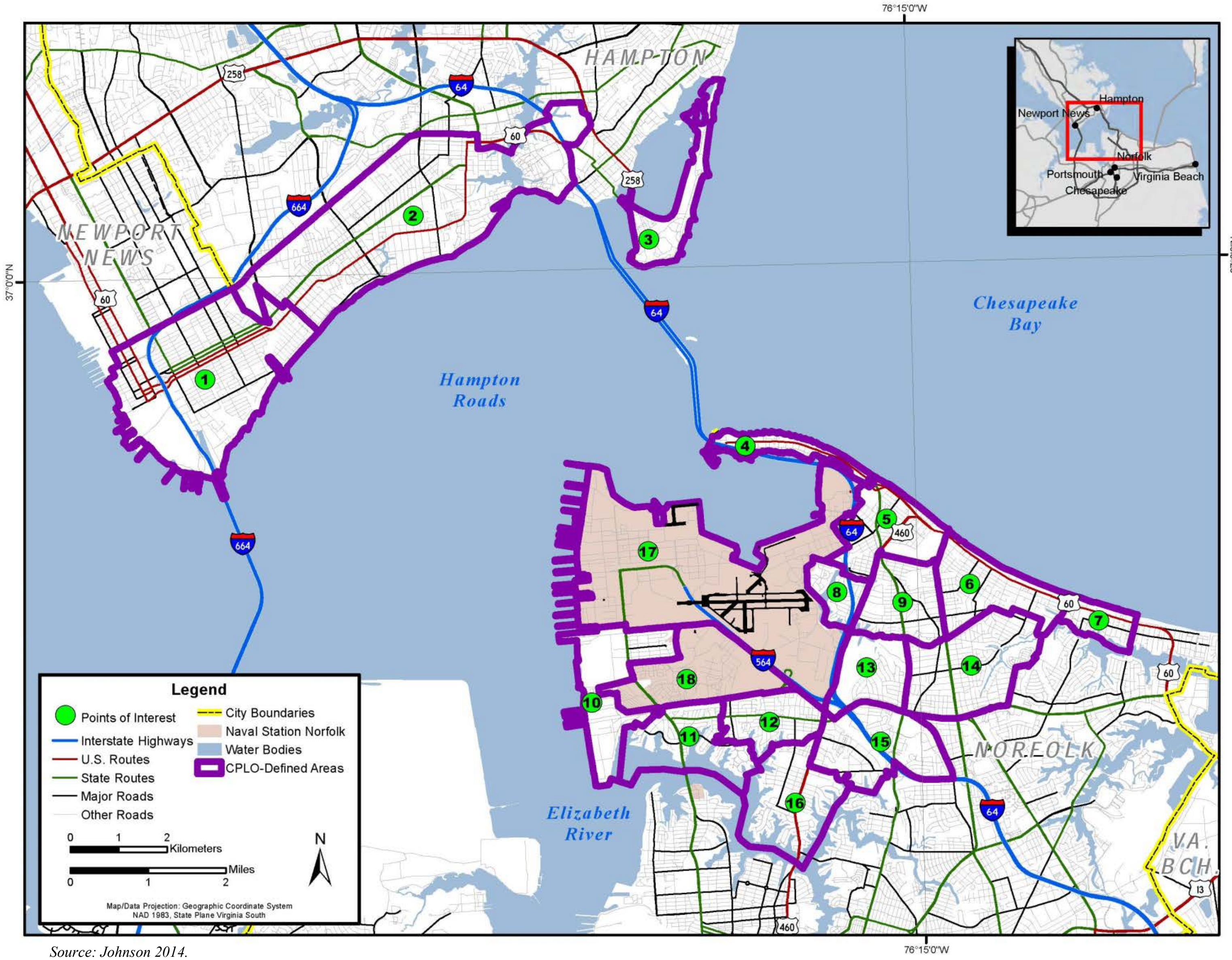
Day-Night Average Sound Level (DNL) is the relevant noise metric for this study and is based on annual average daily aircraft operations. DNL is the U.S. Government standard for modeling the cumulative noise exposure and assessing community noise impacts. DNL has two time periods of interest: daytime and nighttime. Daytime hours are from 7:00 a.m. to 10:00 p.m. local time. Nighttime hours are from 10:00 p.m. to 7:00 a.m. local time. DNL weighs operations occurring during its nighttime period by adding 10 decibels (dB) to their single-event sound level. Note that “daytime” and “nighttime” in calculation of DNL are sometimes referred to as “acoustic day” and “acoustic night” and always correspond to the times given above. This is often different than the “day” and “night” used commonly in military aviation, which are directly related to the times of sunrise and sunset, and vary throughout the year with the seasonal changes.

Modeling of noise, using the NOISEMAP software suite, is accomplished by determining and building each aircraft’s flight tracks (paths over the ground) and profiles (which include data such as altitude, airspeed, power settings, and other flight conditions). This information is developed iteratively with a Navy team primarily made up with representatives from flying squadrons, air-traffic control, and the Navy V-22 Fleet Introduction Team. The data is compiled in a data validation package which is approved for use by that Navy team prior to modeling (Cardno 2016). This is combined with information about the numbers of each type of operation by aircraft/track/profile, local climate, ground surrounding the airfield, and similar data related to ground runup of aircraft engines to sum the total noise energy experienced annually at a grid of points on the ground. In this case, as indicated in Table 2-1, that grid spacing was 500 ft. Noise exposure is presented in terms of contours, i.e., lines of equal value, of DNL. DNL contours of 65 to 85 dB, presented in 5-dB increments, provide a graphical depiction of the aircraft noise environment. NOISEMAP’s ability to account for the effects of sound propagation includes consideration of terrain elevation, taken from the USGS NED, and ground impedance conditions, taken from USGS Hydrography data. In this case, "soft ground" (e.g., grass-covered ground) is modeled with a flow resistivity of 225 kPa-s/m^2 and "hard ground" (in this case, water) is modeled with a flow resistivity of 100,000 kPa-s/m^2. The modeling does not include the effect of shielding of on-base buildings. For ambient temperature, humidity, and pressure, each month was assigned a temperature, relative humidity, and barometric pressure from data available for that month for the years 2009 through 2015 (last full year of data available). NOISEMAP then determined and used the month with the weather values that produced the median results in terms of noise propagation effect, which in this case was the month of April (with the values noted in Table 2-1). This modeling process, using the NOISEMAP software suite, is the DOD-accepted method for representing the overall community noise exposure over time. Noise exposure is also presented in terms of DNL at representative Points of Interest (POI). Because of the large number of possible POIs that might include individual schools, hospitals, churches, etc., the surrounding area was broken into U.S. Census tracts, and smaller tracts combined into representative geographic areas. This allows for a diverse sample of points which are spread out relatively evenly by population, such that they are a good surrogate for having hundreds of closely-spaced points representing individual churches, hospitals, schools, and neighborhoods. This process was coordinated with the NS Norfolk staff, particularly the Community Plans and Liaison Officer (CPLO) and is consistent with past noise studies at NS Norfolk. The resulting 18 POIs are listed in Table 2-2 and shown in Figure 2-1.

Table 2-2. POIs for NS Norfolk

ID	Description
1	Newport News
2	Hampton
3	Fort Monroe
4	Willoughby
5	West Ocean View
6	East Ocean View
7	Little Creek
8	North Granby
9	Northside
10	Terminal
11	Meadowbrook
12	Wards Corner
13	Central Granby
14	Brentwood
15	Suburban Park
16	South Granby
17	Naval Station
18	Camp Allen

Source: Johnson 2014.



Source: Johnson 2014.

Figure 2-1. POIs in the vicinity of NS Norfolk

2.2 ADDITIONAL (SUPPLEMENTAL) NOISE METRICS

Additional metrics evaluated for this study include Maximum Sound Level (L_{max}) and Sound Exposure Level (SEL).

The highest A-weighted sound level measured during a single event in which the sound changes with time is called the maximum A-weighted sound level or L_{max}. L_{max} is the maximum level that occurs over a fraction of a second. For aircraft noise, the "fraction of a second" is one-eighth of a second, denoted as "fast" response on a sound level measuring meter (ANSI 1988). L_{max} is important in judging if a noise event will interfere with conversation, TV or radio listening, or other common activities. Although it provides some measure of the event, it does not fully describe the noise, because it does not account for how long the sound is heard (Wyle 2014).

SEL combines both the intensity of a sound and its duration. For an aircraft flyover, SEL includes the maximum and all lower noise levels produced as part of the overflight, together with how long each part lasts. It represents the total sound energy in the event. Because aircraft noise events last more than a few seconds, the SEL value is larger than L_{max}. It does not directly represent the sound level heard at any given time, but rather the entire event. SEL provides a much better measure of aircraft flyover noise exposure than L_{max} alone (Wyle 2014).

For this study, each of the 18 POIs was evaluated for its loudest events as modeled, sorted by maximum SEL value modeled with NMAP or RNM (depending on aircraft type). In Section 7, the three loudest events are shown for each POI location, with their SEL and L_{max} values. The L_{max} values were calculated using the new software version NMAP 7.3. This was done for all four scenarios (Baseline, No Action, and Alternatives 1 and 2).

Each of the POI locations was evaluated for potential sleep disturbance using the metric probability of awakenings (PA), according to the guidance provided by the Defense Noise Working Group (DNWG) for application of the American National Standards Institute / Acoustical Society of America (ANSI/ASA) standard S12.9-2008.. This was done for all four scenarios (Baseline, No Action, and Alternatives 1 and 2). (DNWG 2009).

3.0 BASELINE CONDITION

The following subsections detail the modeling data and the resultant noise exposure for the Baseline. The Baseline is derived from an average of the historical data in the five full years (2011-2015) of air activity reports at NS Norfolk Chambers Field.

3.1 MODELING DATA

Table 3-1 details the modeled annual flight operations at NS Norfolk. The Baseline scenario includes 63,758 flight operations per year, approximately 43% of which are fixed wing (predominately E-2 and C-2) and approximately 55% rotary wing (predominately H-60). Less than 3% are tiltrotor aircraft (based MV-22B). Fixed wing aircraft (and some of the rotary wing aircraft) use the main runway 10/28, with about 49% in the 28 direction, and 51% in the 10 direction. Additionally, rotary wing aircraft use runway 09/27 and a series of pads on the northern edge of the airfield. The frequency of use for each of the pads and the approach and departure tracks leading to/from each is derived from historical data over the same period (2011-2015) and interviews with NS Norfolk staff.

Some aircraft (H-53, H-60, and MV-22B) are modeled with the RNM software module, while the rest are modeled with NMAP (see Chapter 2 for details and versioning, etc.). The outputs of those software modules were then combined into one overall resulting grid to generate the noise contours and other analyses for the Baseline condition. For this effort, elevation and hydrography data were used from the most recently generated noise modeling effort for NS Norfolk (2015). Additionally, the newest aircraft noise data for CH-53E (surrogate for the MH-53E), SH-60B (surrogate for the MH-60S and HH-60H), and MV-22B were used.

Table 3-1. Baseline Scenario Annual Flight Operations at NS Norfolk

Aircraft	Note	ARRIVALS																								
		Overhead					Straight-In					Main Field Pads					Heliport Pads					Heliport Runway				
		Day	% Day OVHD	Night	% Night OVHD	TOTAL	Day	% Day SI	Night	% Night SI	TOTAL	Day	% Day	Night	% Night	TOTAL	Day	% Day	Night	% Night	TOTAL	Day	% Day	Night	% Night	TOTAL
BASED AIRCRAFT																										
E-2		1,331	83%	282	18%	1,613	524	91%	52	9%	576	-		-		-	-		-		-	-		-		-
C-2		717	83%	152	18%	869	282	91%	28	9%	310	-		-		-	-		-		-	-		-		-
H-60		-		-		-	1,319	65%	710	35%	2,030	223	65%	120	35%	343	1,952	65%	1,051	35%	3,004	953	65%	513	35%	1,466
H-53		-		-		-	294	65%	158	35%	452	49	65%	27	35%	76	1,594	65%	858	35%	2,452	-		-		-
MV-22B (USMC)	1	133	92%	11	8%	144	81	92%	7	8%	88	-	0%	-	0%	-	-	0%	-	0%	-	-	0%	-	0%	-
BASED TOTALS		***2,181***		***445***		***2,626***	***2,500***		***955***		***3,455***	***272***		***147***		***419***	***3,546***		***1,909***		***5,456***	***953***		***513***		***1,466***
TRANSIENT AIRCRAFT																										
C-40	2	-		-		-	1,982	87%	304	13%	2,286	-		-		-	-		-		-	-		-		-
C-5	3	-		-		-	170	87%	26	13%	196	-		-		-	-		-		-	-		-		-
C-130	4	-		-		-	627	87%	96	13%	723	-		-		-	-		-		-	-		-		-
FA-18	5	238	87%	37	13%	275	238	87%	37	13%	275	-		-		-	-		-		-	-		-		-
TRANSIENT TOTALS		***238***		***37***		***275***	***3,017***		***463***		***3,480***	-		-		-	-		-		-	-		-		-
TOTAL Operations		**2,419**		**482**		**2,901**	**5,517**		**1,418**		**6,935**	**272**		**147**		**419**	**3,546**		**1,909**		**5,456**	**953**		**513**		**1,466**

Aircraft	Note	DEPARTURES										CLOSED PATTERNS										TOTAL OPERATIONS		
		Main Field					Heliport					Visual (T&G)					GCA Box							
		Day	% Day Dept	Night	% Night Dept	TOTAL	Day	% Day Dept	Night	% Night Dept	TOTAL	Day	% Day Vis Clsd	Night	% Night Vis Clsd	TOTAL	Day	% Day Gbox	Night	% Night Gbox	TOTAL	Day	Night	TOTAL
BASED AIRCRAFT																								
E-2		1,860	85%	328	15%	2,189	-		-		-	6,340	83%	1,306	17%	7,646	845	91%	80	9%	924	10,900	2,048	12,948
C-2		1,002	85%	177	15%	1,179	-		-		-	3,416	83%	703	17%	4,119	455	91%	43	9%	498	5,872	1,103	6,975
H-60		1,542	65%	830	35%	2,373	2,905	65%	1,564	35%	4,470	8,510	65%	4,582	35%	13,092	1,020	65%	549	35%	1,569	18,425	9,921	28,346
H-53		343	65%	185	35%	528	1,594	65%	858	35%	2,452	-		-		-	227	65%	122	35%	350	4,101	2,208	6,309
MV-22B (USMC)	1	214	92%	18	8%	232	-	-	-	-	-	902	92%	74	8%	976	133	92%	11	8%	144	1,463	121	1,584
BASED TOTALS		***4,962***		***1,538***		***6,500***	***4,499***		***2,423***		***6,922***	***19,167***		***6,665***		***25,833***	***2,680***		***805***		***3,485***	***40,761***	***15,401***	***56,162***
TRANSIENT AIRCRAFT																								
C-40	2	1,982	87%	304	13%	2,286	-		-		-	-		-		-	-		-		-	3,964	608	4,572
C-5	3	170	87%	26	13%	196	-		-		-	-		-		-	-		-		-	340	52	392
C-130	4	627	87%	96	13%	723	-		-		-	-		-		-	-		-		-	1,254	192	1,446
FA-18	5	477	87%	73	13%	550	-		-		-	-		-		-	74	87%	12	13%	86	1,027	159	1,186
TRANSIENT TOTALS		***3,256***		***499***		***3,755***	-		-		-	-		-		-	***74***		***12***		***86***	***6,585***	***1,011***	***7,596***
TOTAL Operations		**8,218**		**2,037**		**10,255**	**4,499**		**2,423**		**6,922**	**19,167**		**6,665**		**25,833**	**2,754**		**817**		**3,571**	**47,346**	**16,412**	**63,758**

Source: Cardno 2016.
Notes: 1. Baseline assumes VMM-774 operated only 4 aircraft
2. This included other medium sized jet aircraft.
3. This includes other large-sized jet aircraft.
4. This includes other turboprop aircraft.
5. This includes other fighter and/or trainer aircraft.

Figure 3-1 shows all of the modeled static run-up profile locations. Consistent with the flight operations, maintenance run-up activity was modeled on an AAD basis. Table 3-2 presents the representative run-up operations profiles (each aircraft profile/location used for these static operations is individually represented in the noise model while the table shows the representative power settings by aircraft type).

Table 3-2. Representative Static Profiles

Aircraft Type	Run-up Type	Run-up Profile		
		Power Condition	Power Setting	Power Units
E-2C or C-2A	Low Power	Variable	1500	ISHP
E-2C or C-2A	High Power	Variable	4600	ISHP
MH-53E	Hover Check	Fixed	IGE/OGE	%QQBPA
MH-53E	High Power & Maint Check	Fixed	Ground Max	%QQBPA
H-60	Hover Check	Fixed	IGE	Power
H-60	Maint Check	Fixed	Idle	Power
MV-22B	Hover Check	Fixed	IGE	%QQBPA
MV-22B	Low Power	Fixed	Ground Idle	%QQBPA

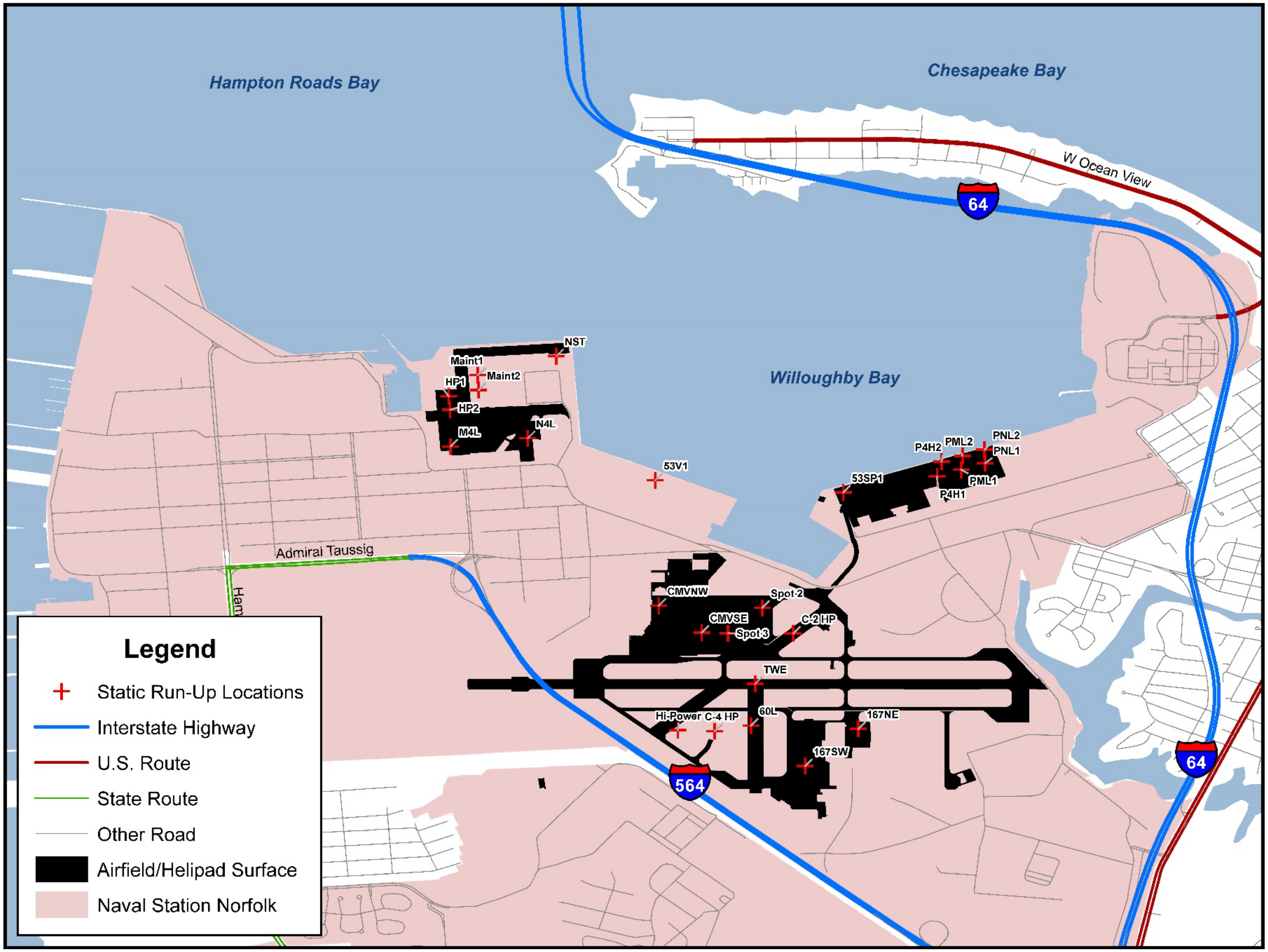
Source: Cardno 2016.
Notes: IGE = In Ground Effect; OGE = Out of Ground Effect; ISHP = Indicated Shaft Horsepower; % QQBPA = percent torque.

3.2 NOISE EXPOSURE

Figure 3-2 shows the resultant 65 dB to 85 dB DNL contours in 5 dB increments for baseline daily aircraft events. The 65 dB DNL baseline contour extends off base over land just slightly over the industrial area west-southwest of the base, not at all to the south, and up to 3 miles off base to the east. The rest of the area within the baseline 65 dB DNL contour is primarily over water.

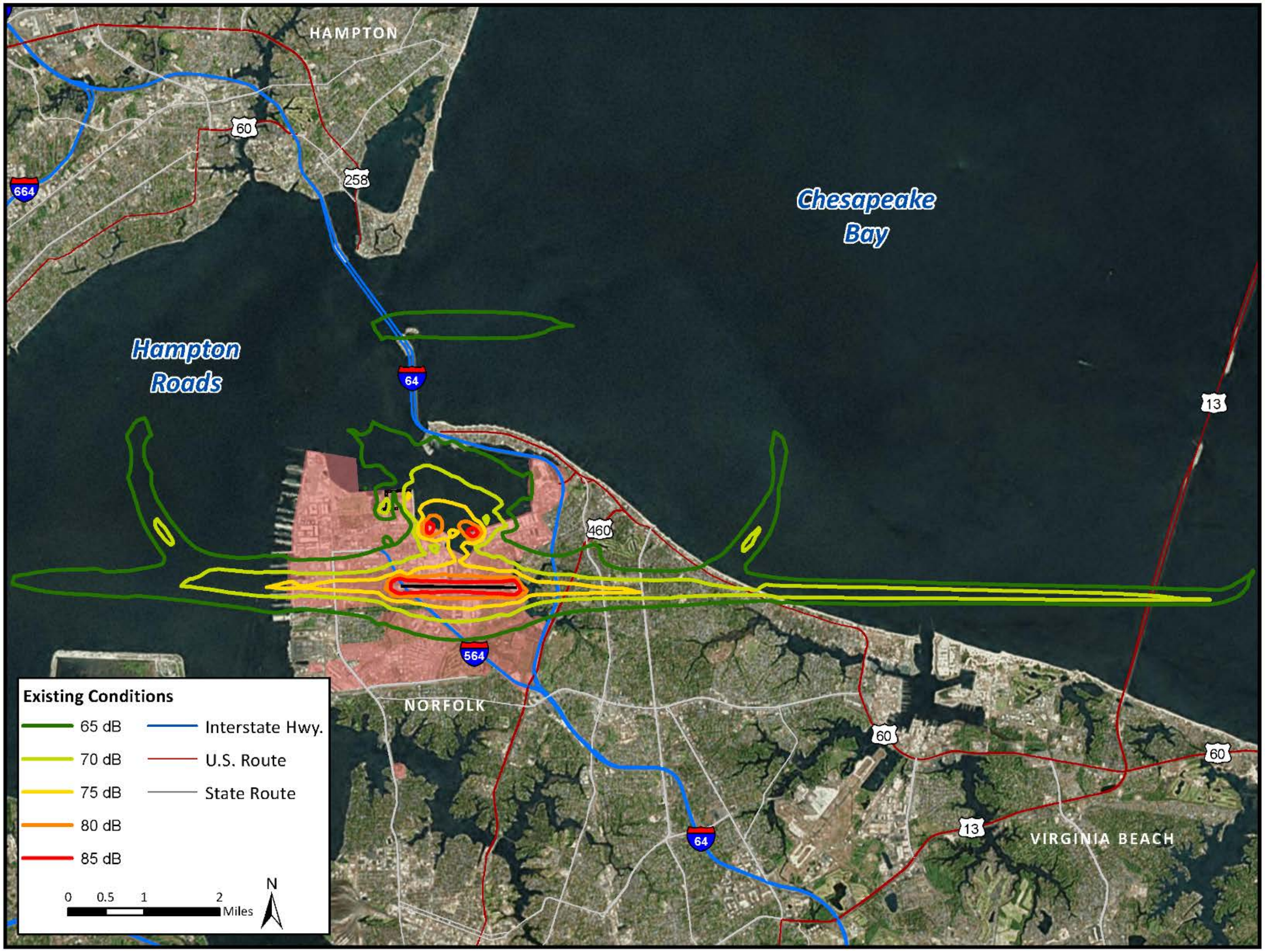
The various long, narrow segments observed in the baseline 65 dB DNL contour are due to closed GCA patterns and various arrival and departure routes to and from NS Norfolk.

The computed DNL for each of the 18 POIs are listed in Table 3-3, which shows that three locations are exposed to DNL greater than or equal to 65 dB with none of them exposed to DNL greater than 75 dB. POIs #8 and #9 (labeled ‘North Granby’ and ‘North End’, respectively) are located very near the departure end of runway 10, and have a baseline DNL of 74 and 75 dB, respectively. For Table 3-3, DNL values are reported to the nearest dB. Even under laboratory conditions, humans have a hard time detecting a difference of a whole dB, so results such as these are normally rounded off.



Source: Cardno 2017.

Figure 3-1. Static Run-up Locations Modeled



Source: Cardno 2017.

Figure 3-2. Baseline DNL Contours for AAD Aircraft Operations at NS Norfolk

Table 3-3. Baseline DNL at POIs

ID	Description	DNL (dB)
1	Newport News	50
2	Hampton	44
3	Fort Monroe	51
4	Willoughby	62
5	West Ocean View	61
6	East Ocean View	69
7	Little Creek	57
8	North Granby	74
9	Northside	75
10	Terminal	55
11	Meadowbrook	53
12	Wards Corner	55
13	Central Granby	57
14	Brentwood	52
15	Suburban Park	48
16	South Granby	46
17	Naval Station	62
18	Camp Allen	59

Source: Cardno 2017.

4.0 NO ACTION SCENARIO

The following section details the modeling data and the resultant noise exposure for the No Action scenario, in which the USMCR VMM-774, stationed at NS Norfolk, has their full complement of 12 MV-22B aircraft. C-2A aircraft would continue to operate at NS Norfolk as they currently do. All other aircraft operations would be the same as the Baseline scenario.

4.1 MODELING DATA

Table 4-1 details the annual flight operations at NS Norfolk under the No Action scenario. This scenario's annual flight operations are similar to those in the Baseline scenario (refer to Table 3-1), except it includes an additional 3,168 MV-22B flight operations to account for VMM-774 having a full squadron of aircraft, making the No Action scenario total 66,926 operations. US Marine Corps MV-22B static operations also increase proportionally. C-2A operations would remain unchanged. All other flight and static operations remain unchanged from the Baseline.

Runway and track utilization for the remaining aircraft are identical to the Baseline scenario.

4.2 NOISE EXPOSURE

Figure 4-1 shows the resultant 65 dB to 85 dB DNL contours in 5 dB increments for No Action daily flight events, compared to the Baseline. The noise exposure is almost identical to the Baseline scenario. Note that the dashed colored lines represent the noise contours for the No Action scenario, while the underlying grey lines represent the noise contours for the Baseline scenario. It is clear that the additional MV-22B activities in the No Action do not contribute noticeably to the noise environment around NS Norfolk.

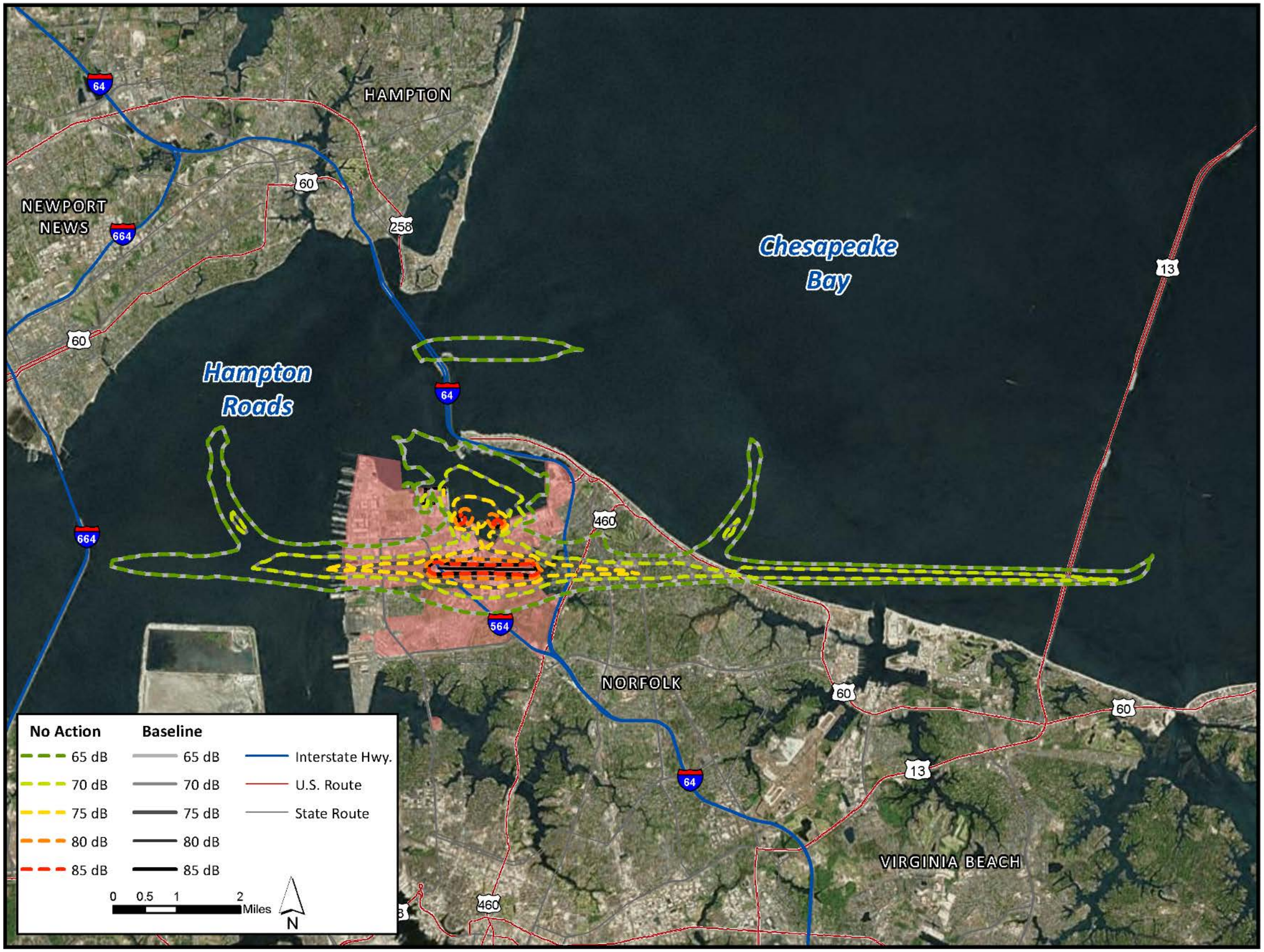
Table 4-2 lists the computed DNL for each of the 18 POIs under the No Action scenario, in addition to the change in DNL at each of those points, as compared to the Baseline scenario. Changing from Baseline to No Action (operations including a full 12 aircraft squadron for VMM-774) does not increase the DNL at any of the POIs at a level detectable to the human ear.

Table 4-1. No Action Scenario Annual Flight Operations at NS Norfolk

Aircraft	Note	ARRIVALS																								
		Overhead					Straight-In					Main Field Pads					Heliport Pads					Heliport Runway				
		Day	% Day OVHD	Night	% Night OVHD	TOTAL	Day	% Day SI	Night	% Night SI	TOTAL	Day	% Day	Night	% Night	TOTAL	Day	% Day	Night	% Night	TOTAL	Day	% Day	Night	% Night	TOTAL
BASED AIRCRAFT																										
E-2		1,331	83%	282	18%	1,613	524	91%	52	9%	576	-		-		-	-		-		-	-		-		-
C-2		717	83%	152	18%	869	282	91%	28	9%	310	-		-		-	-		-		-	-		-		-
H-60		-		-		-	1,319	65%	710	35%	2,030	223	65%	120	35%	343	1,952	65%	1,051	35%	3,004	953	65%	513	35%	1,466
H-53		-		-		-	294	65%	158	35%	452	49	65%	27	35%	76	1,594	65%	858	35%	2,452	-		-		-
MV-22B (USMC)	1	399	92%	33	8%	432	244	92%	20	8%	264	-	0%	-	0%	-	-	0%	-	0%	-	-	0%	-	0%	-
BASED TOTALS		***2,447***		***467***		***2,914***	***2,663***		***968***		***3,631***	***272***		***147***		***419***	***3,546***		***1,909***		***5,456***	***953***		***513***		***1,466***
TRANSIENT AIRCRAFT																										
C-40	2	-		-		-	1,982	87%	304	13%	2,286	-		-		-	-		-		-	-		-		-
C-5	3	-		-		-	170	87%	26	13%	196	-		-		-	-		-		-	-		-		-
C-130	4	-		-		-	627	87%	96	13%	723	-		-		-	-		-		-	-		-		-
FA-18	5	238	87%	37	13%	275	238	87%	37	13%	275	-		-		-	-		-		-	-		-		-
TRANSIENT TOTALS		***238***		***37***		***275***	***3,017***		***463***		***3,480***	-		-		-	-		-		-	-		-		-
TOTAL Operations		**2,685**		**504**		**3,189**	**5,680**		**1,431**		**7,111**	**272**		**147**		**419**	**3,546**		**1,909**		**5,456**	**953**		**513**		**1,466**

Aircraft	Note	DEPARTURES										CLOSED PATTERNS										TOTAL OPERATIONS		
		Main Field					Heliport					Visual (T&G)					GCA Box							
		Day	% Day Dept	Night	% Night Dept	TOTAL	Day	% Day Dept	Night	% Night Dept	TOTAL	Day	% Day Vis Clsd	Night	% Night Vis Clsd	TOTAL	Day	% Day Gbox	Night	% Night Gbox	TOTAL	Day	Night	TOTAL
BASED AIRCRAFT																								
E-2		1,860	85%	328	15%	2,189	-		-		-	6,340	83%	1,306	17%	7,646	845	91%	80	9%	924	10,900	2,048	12,948
C-2		1,002	85%	177	15%	1,179	-		-		-	3,416	83%	703	17%	4,119	455	91%	43	9%	498	5,872	1,103	6,975
H-60		1,542	65%	830	35%	2,373	2,905	65%	1,564	35%	4,470	8,510	65%	4,582	35%	13,092	1,020	65%	549	35%	1,569	18,425	9,921	28,346
H-53		343	65%	185	35%	528	1,594	65%	858	35%	2,452	-		-		-	227	65%	122	35%	350	4,101	2,208	6,309
MV-22B (USMC)	1	643	92%	53	8%	696	-	-	-	-	-	2,706	92%	222	8%	2,928	399	92%	33	8%	432	4,392	360	4,752
BASED TOTALS		***5,391***		***1,573***		***6,964***	***4,499***		***2,423***		***6,922***	***20,972***		***6,813***		***27,785***	***2,946***		***827***		***3,773***	***43,690***	***15,640***	***59,330***
TRANSIENT AIRCRAFT																								
C-40	2	1,982	87%	304	13%	2,286	-		-		-	-		-		-	-		-		-	3,964	608	4,572
C-5	3	170	87%	26	13%	196	-		-		-	-		-		-	-		-		-	340	52	392
C-130	4	627	87%	96	13%	723	-		-		-	-		-		-	-		-		-	1,254	192	1,446
FA-18	5	477	87%	73	13%	550	-		-		-	-		-		-	74	87%	12	13%	86	1,027	159	1,186
TRANSIENT TOTALS		***3,256***		***499***		***3,755***	-		-		-	-		-		-	***74***		***12***		***86***	***6,585***	***1,011***	***7,596***
TOTAL Operations		**8,647**		**2,072**		**10,719**	**4,499**		**2,423**		**6,922**	**20,972**		**6,813**		**27,785**	**3,020**		**839**		**3,859**	**50,275**	**16,651**	**66,926**

Source: Cardno 2016.
Notes: 1. For No Action, assumed that VMM-774 has full complement of 12 aircraft.
2. This includes other medium-sized jet aircraft.
3. This includes other large-sized jet aircraft.
4. This includes other turboprop aircraft.
5. This includes other fighter and/or trainer aircraft.



Source: Cardno 2017.

Figure 4-1. No Action DNL Contours for AAD Aircraft Operations at NS Norfolk (compared to the Baseline)

Table 4-2. No Action DNL at POIs

ID	Description	DNL (dB)	Change in DNL compared Baseline (dB)
1	Newport News	50	-
2	Hampton	44	-
3	Fort Monroe	51	-
4	Willoughby	62	-
5	West Ocean View	61	-
6	East Ocean View	69	-
7	Little Creek	57	-
8	North Granby	74	-
9	Northside	75	-
10	Terminal	55	-
11	Meadowbrook	53	-
12	Wards Corner	55	-
13	Central Granby	57	-
14	Brentwood	52	-
15	Suburban Park	48	-
16	South Granby	46	-
17	Naval Station	62	-
18	Camp Allen	59	-

Source: Cardno 2017.

5.0 PROPOSED ACTION ALTERNATIVE 1 SCENARIO

The following section details the modeling data and the resultant noise exposure for the Proposed Action Alternative 1 scenario, in which the C-2A aircraft would be retired from NS Norfolk, and would be replaced by CMV-22B aircraft. This accounts for the Fleet squadron (VRC-40) transition, and NOT the FRS. All other aircraft operations are unchanged from those described in Section 4, No Action Alternative.

5.1 MODELING DATA

Table 5-1 details the annual flight operations at NS Norfolk under the Proposed Action Alternative 1 scenario. The annual flight operations for Proposed Action Alternative 1 would be similar to the No Action scenario (refer to Table 4-1), except it replaces the 6,975 C-2A flight operations with 6,944 CMV-22B flight operations. Additionally, the CMV-22B static run-up operations have been added to the scenario. All other flight and static operations remain unchanged from the No Action Alternative.

The CMV-22B will be replacing the mission of the C-2A, and will operate very similarly to the USMCR MV-22B aircraft already based at NS Norfolk. There are some subtle differences, based on the different Navy and Marine Corps missions, but those small differences are mostly in proportions of things that are done differently. Figure 5-1 shows the modeled flight tracks for both the Navy CMV-22B and the Marine Corps MV-22B, and the only track that is unique is the closed pattern to runway 09 that the Marines use and the Navy plans to not use. That training is still modeled for the Marines, and is not for the Navy. Otherwise, Navy CMV-22B profiles are all based on the Marine MV-22B profiles that are already being flown at NS Norfolk. Figure 5-2 shows, for comparison, the flight tracks for the C-2A that will no longer be used under either of the proposed action alternatives.

5.2 NOISE EXPOSURE

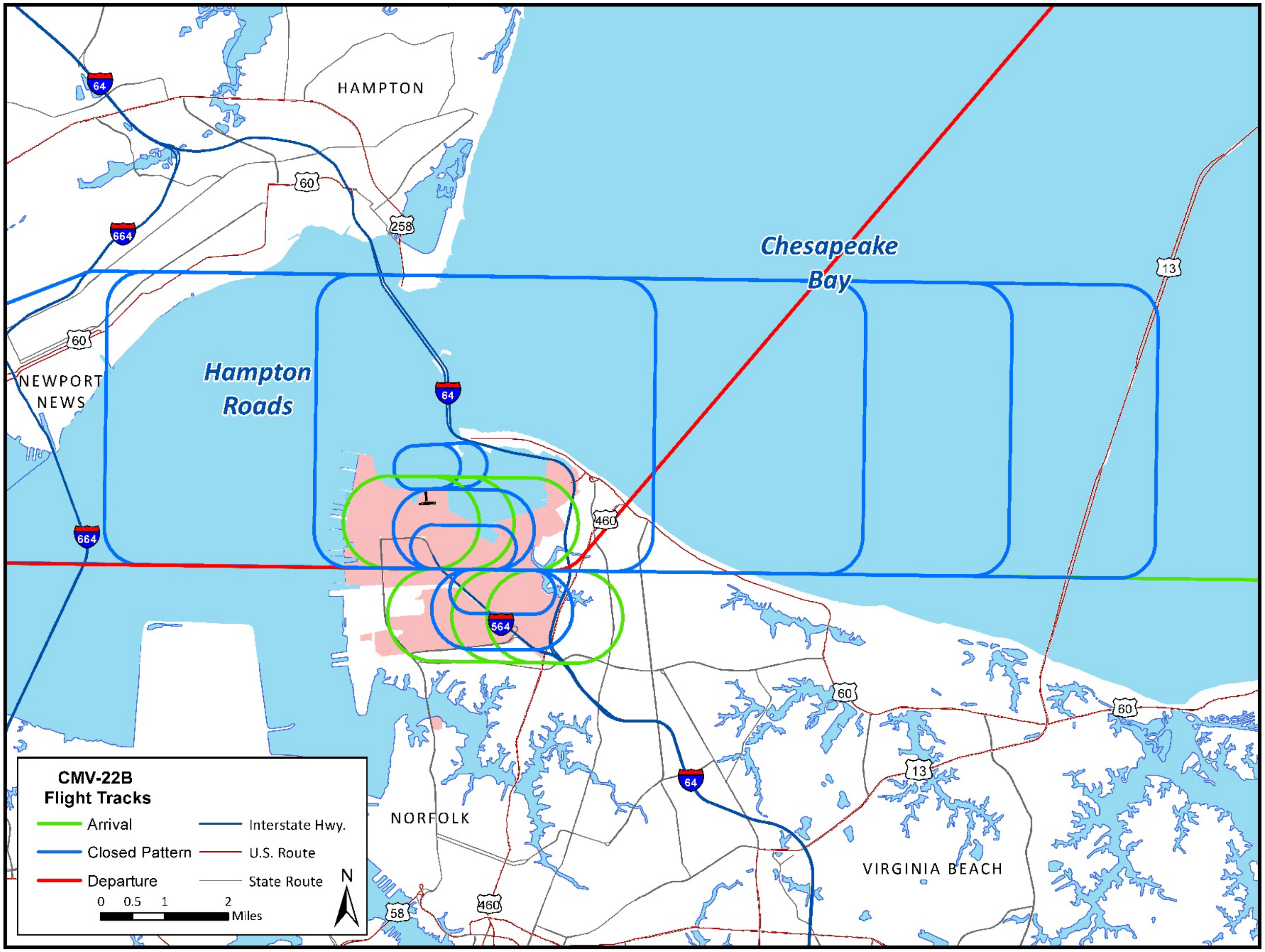
Figure 5-3 shows the resultant 65 dB to 85 dB DNL contours in 5 dB increments for the Proposed Action Alternative 1 daily flight events. The noise exposure is almost identical to the No Action scenario. Note that the dashed colored lines represent the noise contours for the Proposed Action Alternative 1 scenario, while the underlying grey lines represent the noise contours for the No Action scenario. It is clear that replacement of the C-2A with the CMV-22B would not noticeably alter the noise environment around NS Norfolk.

Table 5-1. Proposed Action Alternative 1 Annual Flight Operations for NS Norfolk

		ARRIVALS																								
		Overhead					Straight-In					Main Field Pads					Heliport Pads					Heliport Runway				
Aircraft	Note	Day	% Day OVHD	Night	% Night OVHD	TOTAL	Day	% Day SI	Night	% Night SI	TOTAL	Day	% Day	Night	% Night	TOTAL	Day	% Day	Night	% Night	TOTAL	Day	% Day	Night	% Night	TOTAL
BASED AIRCRAFT																										
E-2		1,331	83%	282	18%	1,613	524	91%	52	9%	576	-		-		-	-		-		-	-		-		-
H-60		-		-		-	1,319	65%	710	35%	2,030	223	65%	120	35%	343	1,952	65%	1,051	35%	3,004	953	65%	513	35%	1,466
H-53		-		-		-	294	65%	158	35%	452	49	65%	27	35%	76	1,594	65%	858	35%	2,452	-		-		-
MV-22B (USMC)		399	92%	33	8%	432	244	92%	20	8%	264	-	0%	-	0%	-	-	0%	-	0%	-	-	0%	-	0%	-
CMV-22 (Fleet)	1	570	95%	30	5%	600	396	95%	21	5%	417					-					-					-
BASED TOTALS		***2,300***		***345***		***2,645***	***2,777***		***961***		***3,738***	***272***		***147***		***419***	***3,546***		***1,909***		***5,456***	***953***		***513***		***1,466***
TRANSIENT AIRCRAFT																										
C-40	2	-		-		-	1,982	87%	304	13%	2,286	-		-		-	-		-		-	-		-		-
C-5	3	-		-		-	170	87%	26	13%	196	-		-		-	-		-		-	-		-		-
C-130	4	-		-		-	627	87%	96	13%	723	-		-		-	-		-		-	-		-		-
FA-18	5	238	87%	37	13%	275	238	87%	37	13%	275	-		-		-	-		-		-	-		-		-
TRANSIENT TOTALS		***238***		***37***		***275***	***3,017***		***463***		***3,480***	***-***		***-***		***-***	***-***		***-***		***-***	***-***		***-***		***-***
TOTAL Operations		**2,538**		**382**		**2,920**	**5,794**		**1,424**		**7,218**	**272**		**147**		**419**	**3,546**		**1,909**		**5,456**	**953**		**513**		**1,466**

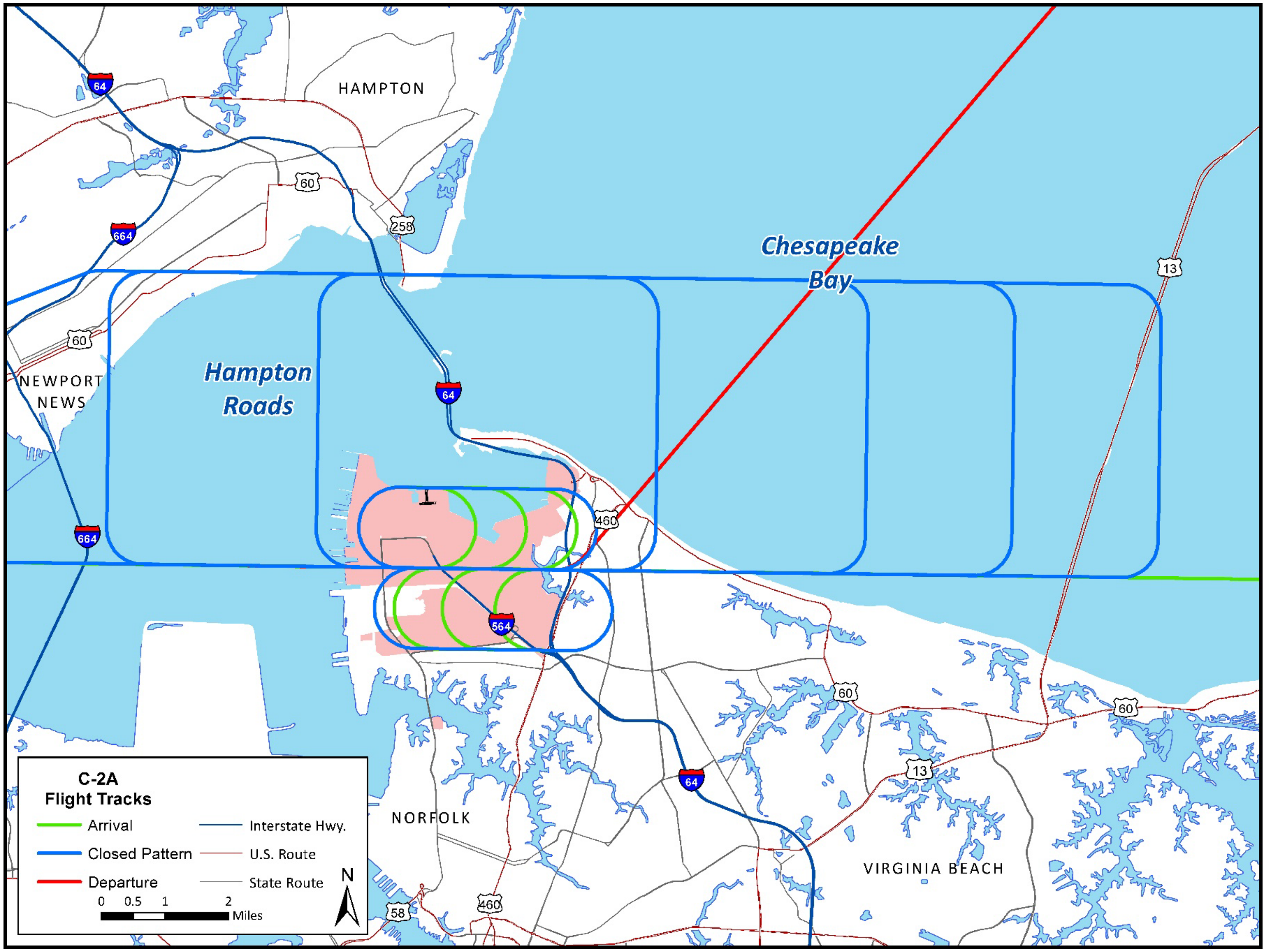
		DEPARTURES										CLOSED PATTERNS										TOTAL OPERATIONS		
		Main Field					Heliport					Visual (T&G)					GCA Box							
Aircraft	Note	Day	% Day Dept	Night	% Night Dept	TOTAL	Day	% Day Dept	Night	% Night Dept	TOTAL	Day	% Day Vis Clsd	Night	% Night Vis Clsd	TOTAL	Day	% Day Gbox	Night	% Night Gbox	TOTAL	Day	Night	TOTAL
BASED AIRCRAFT																								
E-2		1,860	85%	328	15%	2,189	-		-		-	6,340	83%	1,306	17%	7,646	845	91%	80	9%	924	10,900	2,048	12,948
H-60		1,542	65%	830	35%	2,373	2,905	65%	1,564	35%	4,470	8,510	65%	4,582	35%	13,092	1,020	65%	549	35%	1,569	18,425	9,921	28,346
H-53		343	65%	185	35%	528	1,594	65%	858	35%	2,452	-		-		-	227	65%	122	35%	350	4,101	2,208	6,309
MV-22B (USMC)		643	92%	53	8%	696	-	-	-	-	-	2,706	92%	222	8%	2,928	399	92%	33	8%	432	4,392	360	4,752
CMV-22 (Fleet)	1	966	95%	51	5%	1,017	-		-		-	3,547	95%	731	5%	4,278	575	95%	57	5%	632	6,054	890	6,944
BASED TOTALS		***5,355***		***1,447***		***6,802***	***4,499***		***2,423***		***6,922***	***21,103***		***6,841***		***27,944***	***3,066***		***841***		***3,907***	***43,872***	***15,427***	***59,299***
TRANSIENT AIRCRAFT																								
C-40	2	1,982	87%	304	13%	2,286	-		-		-	-		-		-	-		-		-	3,964	608	4,572
C-5	3	170	87%	26	13%	196	-		-		-	-		-		-	-		-		-	340	52	392
C-130	4	627	87%	96	13%	723	-		-		-	-		-		-	-		-		-	1,254	192	1,446
FA-18	5	477	87%	73	13%	550	-		-		-	-		-		-	74	87%	12	13%	86	1,027	159	1,186
TRANSIENT TOTALS		***3,256***		***499***		***3,755***	***-***		***-***		***-***	***-***		***-***		***-***	***74***		***12***		***86***	***6,585***	***1,011***	***7,596***
TOTAL Operations		**8,611**		**1,946**		**10,557**	**4,499**		**2,423**		**6,922**	**21,103**		**6,841**		**27,944**	**3,140**		**853**		**3,993**	**50,457**	**16,438**	**66,895**

Source: Cardno 2016.
Notes: 1. VRC-40 operating with 12 aircraft.
2. This includes other medium-sized jets.
3. This includes other large-sized jets.
4. This includes other turboprop aircraft.
5. This includes other fighter and/or trainer aircraft.



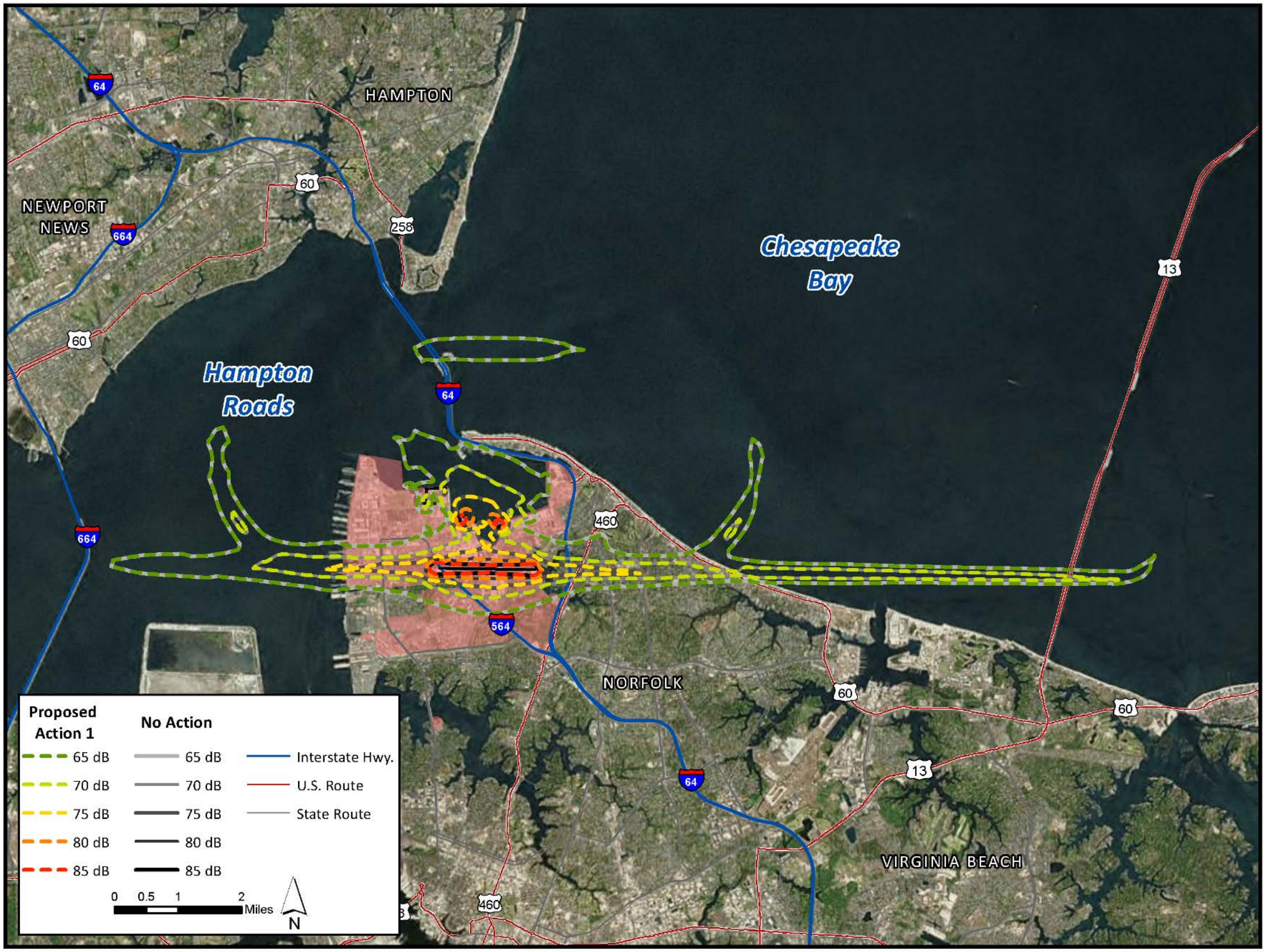
Source: Cardno 2016.

Figure 5-1. Flight Tracks Modeled for CMV-22 and MV-22 Operations at NS Norfolk Chambers Field



Source: Cardno 2016.

Figure 5-2. Flight Tracks Modeled for C-2A Operations at NS Norfolk Chambers Field



Source: Cardno 2017.

Figure 5-3. Proposed Action Alternative 1 DNL Contours for NS Norfolk (compared to the No Action)

Table 5-2 lists the computed DNL for each of the 18 POIs under the Action Alternative 1. Table 5-2 also shows the difference in computed DNL between the No Action and Action Alternative 1. Changing from No Action to Proposed Action (by removing C-2A operations and replacing them with CMV-22B) does not change the DNL at any of the POIs to a level detectable to the human ear.

Table 5-2. Proposed Action Alternative 1 DNL at POIs

ID	Description	DNL (dB)	Change in DNL compared to No Action (dB)
1	Newport News	50	-
2	Hampton	44	-
3	Fort Monroe	51	-
4	Willoughby	62	-
5	West Ocean View	61	-
6	East Ocean View	69	-
7	Little Creek	57	-
8	North Granby	74	-
9	Northside	75	-
10	Terminal	55	-
11	Meadowbrook	53	-
12	Wards Corner	55	-
13	Central Granby	57	-
14	Brentwood	52	-
15	Suburban Park	48	-
16	South Granby	46	-
17	Naval Station	62	-
18	Camp Allen	59	-

Source: Cardno 2017.

6.0 PROPOSED ACTION ALTERNATIVE 2 SCENARIO

The following section details the modeling data and the resultant noise exposure for the Proposed Action Alternative 2 scenario, in which the C-2A aircraft would be retired from NS Norfolk, with VRC-40 transitioning to the CMV-22B. Additionally, an FRS squadron of 5 CMV-22B aircraft would also be based at NS Norfolk. All other aircraft operations are unchanged from those described in Section 4, No Action Alternative.

6.1 MODELING DATA

Table 6-1 details the annual flight operations at NS Norfolk under the Proposed Action Alternative 2 scenario. The annual flight operations for Alternative 2 would be similar to the No Action (refer to Table 4-1), except it replaces the 6,975 C-2A flight operations with 6,944 CMV-22 flight operations for the VRC-40 (Fleet) squadron, and adds an additional 5,684 CMV-22 operations for the FRS, annually. Additionally, the FRS would add some additional CMV-22 static run-up operations to the scenario. All other flight and static operations remain unchanged from the No Action Alternative.

The tracks and profiles modeled for CMV-22B are identical to those described in Section 5 pertaining to Alternative 1 noise exposure

6.2 NOISE EXPOSURE

Figure 6-1 shows the resultant 65 dB to 85 dB DNL contours in 5 dB increments for the Proposed Action Alternative 2 daily flight events. The noise exposure is almost identical to the No Action scenario. Note that the dashed colored lines represent the noise contours for the Proposed Action Alternative 2 scenario, while the underlying grey lines represent the noise contours for the No Action scenario. It is clear that removal of the C-2A and the replacement with the CMV-22B and the addition of a CMV-22B FRS would not noticeably alter the noise environment around NS Norfolk.

Table 6-1. Proposed Action Annual Flight Operations for NS Norfolk

Aircraft	Note	ARRIVALS: Overhead Day	% Day OVHD	Night	% Night OVHD	TOTAL	Straight-In Day	% Day SI	Night	% Night SI	TOTAL	Main Field Pads Day	% Day	Night	% Night	TOTAL	Heliport Pads Day	% Day	Night	% Night	TOTAL	Heliport Runway Day	% Day	Night	% Night	TOTAL
BASED AIRCRAFT																										
E-2		1,331	83%	282	18%	1,613	524	91%	52	9%	576	-		-		-	-		-		-	-		-		-
H-60		-		-		-	1,319	65%	710	35%	2,030	223	65%	120	35%	343	1,952	65%	1,051	35%	3,004	953	65%	513	35%	1,466
H-53		-		-		-	294	65%	158	35%	452	49	65%	27	35%	76	1,594	65%	858	35%	2,452	-		-		-
MV-22B (USMC)		399	92%	33	8%	432	244	92%	20	8%	264	-	0%	-	0%	-	-	0%	-	0%	-	-	0%	-	0%	-
CMV-22 (FRS)	1	321	76%	102	24%	423	300	83%	62	17%	362					-					-					-
CMV-22 (Fleet)	2	570	95%	30	5%	600	396	95%	21	5%	417					-					-					-
BASED TOTALS		***2,622***		***447***		***3,068***	***3,077***		***1,023***		***4,100***	***272***		***147***		***419***	***3,546***		***1,909***		***5,456***	***953***		***513***		***1,466***
TRANSIENT AIRCRAFT																										
C-40	3	-		-		-	1,982	87%	304	13%	2,286	-		-		-	-		-		-	-		-		-
C-5	4	-		-		-	170	87%	26	13%	196	-		-		-	-		-		-	-		-		-
C-130	5	-		-		-	627	87%	96	13%	723	-		-		-	-		-		-	-		-		-
FA-18	6	238	87%	37	13%	275	238	87%	37	13%	275	-		-		-	-		-		-	-		-		-
TRANSIENT TOTALS		***238***		***37***		***275***	***3,017***		***463***		***3,480***	-		-		-	-		-		-	-		-		-
TOTAL Operations		**2,860**		**484**		**3,343**	**6,094**		**1,486**		**7,580**	**272**		**147**		**419**	**3,546**		**1,909**		**5,456**	**953**		**513**		**1,466**

Aircraft	Note	DEPARTURES: Main Field Day	% Day Dept	Night	% Night Dept	TOTAL	Heliport Day	% Day Dept	Night	% Night Dept	TOTAL	CLOSED PATTERNS: Visual (T&G) Day	% Day Vis Clsd	Night	% Night Vis Clsd	TOTAL	GCA Box Day	% Day Gbox	Night	% Night Gbox	TOTAL	TOTAL OPERATIONS Day	Night	TOTAL
BASED AIRCRAFT																								
E-2		1,860	85%	328	15%	2,189	-		-		-	6,340	83%	1,306	17%	7,646	845	91%	80	9%	924	10,900	2,048	12,948
H-60		1,542	65%	830	35%	2,373	2,905	65%	1,564	35%	4,470	8,510	65%	4,582	35%	13,092	1,020	65%	549	35%	1,569	18,425	9,921	28,346
H-53		343	65%	185	35%	528	1,594	65%	858	35%	2,452	-		-		-	227	65%	122	35%	350	4,101	2,208	6,309
MV-22B (USMC)		643	92%	53	8%	696	-	-	-	-	-	2,706	92%	222	8%	2,928	399	92%	33	8%	432	4,392	360	4,752
CMV-22 (FRS)	1	620	79%	165	21%	785	-		-		-	2,981	78%	862	22%	3,843	272	100%	-	0%	272	4,495	1,190	5,685
CMV-22 (Fleet)	2	966	95%	51	5%	1,017	-		-		-	3,547	95%	731	5%	4,278	575	95%	57	5%	632	6,054	890	6,944
BASED TOTALS		***5,975***		***1,612***		***7,587***	***4,499***		***2,423***		***6,922***	***24,084***		***7,703***		***31,787***	***3,338***		***841***		***4,179***	***48,367***	***16,617***	***64,984***
TRANSIENT AIRCRAFT																								
C-40	3	1,982	87%	304	13%	2,286	-		-		-	-		-		-	-		-		-	3,964	608	4,572
C-5	4	170	87%	26	13%	196	-		-		-	-		-		-	-		-		-	340	52	392
C-130	5	627	87%	96	13%	723	-		-		-	-		-		-	-		-		-	1,254	192	1,446
FA-18	6	477	87%	73	13%	550	-		-		-	-		-		-	74	87%	12	13%	86	1,027	159	1,186
TRANSIENT TOTALS		***3,256***		***499***		***3,755***	-		-		-	-		-		-	***74***		***12***		***86***	***6,585***	***1,011***	***7,596***
TOTAL Operations		**9,231**		**2,111**		**11,342**	**4,499**		**2,423**		**6,922**	**24,084**		**7,703**		**31,787**	**3,412**		**853**		**4,265**	**54,952**	**17,628**	**72,580**

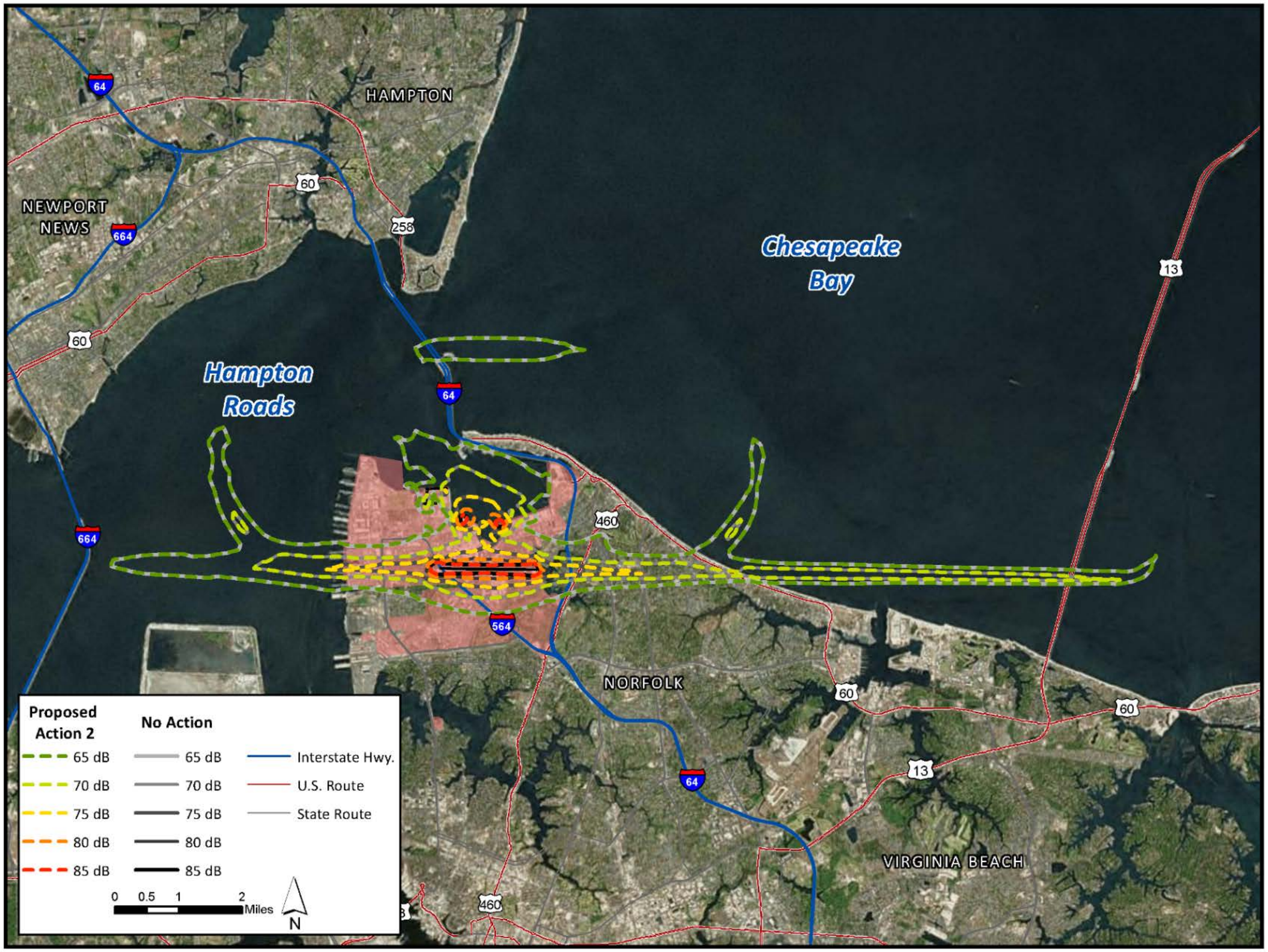
Source: Cardno 2016.
Notes: 1. Navy CMV-22B FRS operating with 5 aircraft.
2. VRC-40 operating with 12 aircraft.
3. This includes other medium-sized jet aircraft.
4. This includes other large-sized jet aircraft.
5. This includes other turboprop aircraft.
6. This includes other fighter and/or trainer aircraft.

Table 6-2 lists the computed DNL for each of the 18 POIs under the Action Alternative 2. Table 6-2 also shows the difference in computed DNL between the No Action and Action Alternative 2. Changing from No Action to Proposed Action Alternative 2 (by removing C-2A operations and replacing them with CMV-22B, and adding a 5 aircraft FRS) does not change the DNL at any of the POIs to a level detectable to the human ear.

Table 6-2. Proposed Action Alternative 2 DNL at POIs

ID	Description	DNL (dB)	Change in DNL compared to No Action (dB)
1	Newport News	50	-
2	Hampton	44	-
3	Fort Monroe	51	-
4	Willoughby	62	-
5	West Ocean View	61	-
6	East Ocean View	69	-
7	Little Creek	57	-
8	North Granby	74	-
9	Northside	75	-
10	Terminal	55	-
11	Meadowbrook	53	-
12	Wards Corner	55	-
13	Central Granby	57	-
14	Brentwood	52	-
15	Suburban Park	48	-
16	South Granby	46	-
17	Naval Station	62	-
18	Camp Allen	59	-

Source: Cardno 2017.



Source: Cardno 2017.

Figure 6-1. Proposed Action Alternative 2 DNL Contours at NS Norfolk (compared to the No Action)

7.0 SUPPLEMENTAL METRICS

7.1 MAXIMUM SOUND LEVEL AND SOUND EXPOSURE LEVEL

While a cumulative metric such as DNL (highlighted in Sections 3 through 6 in this report) is excellent for showing the overall noise environment, it can also be of interest to know how loud the loudest events are at a particular location. To help answer these questions about the loudest events, calculations were made for each of the POIs (initially listed in Table 2-2) to find the loudest events at each of them, for each of the modeled scenarios (Baseline, No Action, and Proposed Action Alternatives 1 and 2). These POIs are modeled as individual points, and are a good representation of the areas immediately around them shown in Figure 2-1. Table 7-1 shows, for each POI, the aircraft and profile for the three events producing the highest SEL, and lists the SEL and the L_{max} for each. It also lists the number of daytime and nighttime events per day for each, and the total events per week. It allows for a demonstration that some "loud" events may occur in an area of a lower DNL. For instance, at POI #1 (Newport News), the point has a DNL value of 50 decibels, and has about 2 weekly events of MH-53E flight operations which have an L_{max} of 82.6 dB. This shows that even while the overall noise (represented by DNL) is considered low, there are some events which would be more noticeable.

Comparison of Table 7-1 with the map in Figure 2-1, which shows the locations of the POIs, the loudest events tend to occur closest to the airfield and nearest the flight tracks that align with the runways at NS Norfolk.

Note that there is only one table in this section, vice one for each scenario (Baseline, No Action, and Proposed Action Alternatives 1 and 2). Each of the scenarios was calculated separately, and the result was that they were all the same. The aircraft models contributing the loudest events were not those that are changing with the scenarios involved in this proposal – (MV-22B, CMV-22B, and C-2A), so there are no differences. Table 7-1 as presented shows values that are constant across all of the scenarios. There are no changes in the loudest events at each of the POIs as we move from Baseline to No Action to Alternative 1 to Alternative 2.

Table 7-1. SEL and L_{max} for Loudest Single Events at each POI

POI #	POI Name	DNL (dBA)	Aircraft	Profile ID	Daily Events Day	Daily Events Night	TOTAL per week	SEL (dBA)	Lmax (dBA)
1	Newport News	50	MH-53E	717	0.16	0.09	1.8	93.1	82.6
			F-18E/F	609	0.052	0.008	0.4	85.8	72.9
			MH-53E	701_5	1.08	0.58	11.6	84.1	66.0
2	Hampton	44	F-18E/F	609	0.052	0.008	0.4	91.9	82.3
			MH-53E	717	0.16	0.09	1.8	84.9	70.2
			F-18E/F	605	0.333	0.051	2.7	83.3	71.7
3	Fort Monroe	51	F-18E/F	609	0.052	0.008	0.4	97.5	89.1
			F-18E/F	610	0.05	0.008	0.4	96.9	88.5
			F-18E/F	605	0.333	0.051	2.7	92.8	82.7
4	Willoughby	62	F-18E/F	601	0.666	0.102	5.4	94.1	87.0
			F-18E/F	602	0.64	0.098	5.2	94.0	87.0
			F-18E/F	609	0.052	0.008	0.4	92.3	82.1
5	West Ocean View	61	C-5A	201	0.237	0.036	1.9	105.4	95.3
			F-18E/F	601	0.666	0.102	5.4	102.7	95.1
			F-18E/F	609	0.052	0.008	0.4	98.4	90.9
6	East Ocean View	69	F-18E/F	606	0.32	0.049	2.6	115.9	111.0
			F-18E/F	604	0.32	0.049	2.6	113.2	107.3
			F-18E/F	610	0.05	0.008	0.4	109.3	104.8
7	Little Creek	57	F-18E/F	610	0.05	0.008	0.4	109.2	102.6
			F-18E/F	604	0.32	0.049	2.6	103.3	96.5
			C-5A	204	0.228	0.035	1.8	101.1	94.9
8	North Granby	74	F-18E/F	610	0.05	0.008	0.4	121.3	118.2
			F-18E/F	604	0.32	0.049	2.6	118.2	114.9
			F-18E/F	606	0.32	0.049	2.6	117.6	114.0
9	Northside	75	F-18E/F	610	0.05	0.008	0.4	124.5	122.6
			F-18E/F	606	0.32	0.049	2.6	120.1	116.7
			F-18E/F	604	0.32	0.049	2.6	118.9	115.1
10	Terminal	55	F-18E/F	609	0.052	0.008	0.4	97.9	87.9
			F-18E/F	602	0.64	0.098	5.2	96.1	87.1
			F-18E/F	610	0.05	0.008	0.4	94.5	87.8
11	Meadowbrook	53	F-18E/F	602	0.64	0.098	5.2	94.9	88.2
			F-18E/F	601	0.666	0.102	5.4	94.0	87.8
			F-18E/F	609	0.052	0.008	0.4	93.6	83.6
12	Wards Corner	55	F-18E/F	601	0.666	0.102	5.4	97.3	89.6
			F-18E/F	602	0.64	0.098	5.2	96.5	89.6
			F-18E/F	609	0.052	0.008	0.4	95.2	85.0
13	Central Granby	57	F-18E/F	609	0.052	0.008	0.4	100.7	92.7
			F-18E/F	601	0.666	0.102	5.4	100.2	93.6
			F-18E/F	602	0.64	0.098	5.2	97.2	91.5
14	Brentwood	52	F-18E/F	604	0.32	0.049	2.6	97.5	88.3
			F-18E/F	606	0.32	0.049	2.6	95.4	85.5
			F-18E/F	610	0.05	0.008	0.4	93.5	82.9
15	Suburban Park	48	F-18E/F	601	0.666	0.102	5.4	92.0	85.3
			F-18E/F	609	0.052	0.008	0.4	90.5	81.9
			F-18E/F	602	0.64	0.098	5.2	89.9	84.1
16	South Granby	46	F-18E/F	601	0.666	0.102	5.4	89.0	81.4
			F-18E/F	602	0.64	0.098	5.2	87.8	81.4
			F-18E/F	609	0.052	0.008	0.4	86.8	76.4
17	Naval Station	62	F-18E/F	609	0.052	0.008	0.4	104.8	96.1
			F-18E/F	610	0.05	0.008	0.4	104.4	96.4
			F-18E/F	602	0.64	0.098	5.2	104.2	97.8
18	Camp Allen	59	F-18E/F	602	0.64	0.098	5.2	102.5	96.1
			F-18E/F	609	0.052	0.008	0.4	100.9	92.1
			F-18E/F	610	0.05	0.008	0.4	100.9	91.9

Source: Cardno 2016
Note: These values apply to all four scenarios: Baseline, No Action, and Alternatives 1 and 2.

7.2 SLEEP DISTURBANCE

For residential areas, a typical concern is the possibility of disturbing sleep. The DOD guidance from the Defense Noise Working Group guides use of the American National Standards Institute (ANSI) standard S12.9 for this analysis, as explained in Section 2 of this document.

Table 7-2 shows the calculations for each POI. It lists the average number of events which result in an SEL above 90 dB per 9-hour night (this analysis used all 9 of the hours between 10:00 p.m. and 7:00 a.m. local time), also known as "NA90", and the cumulative probability of awakening at least once during that period for both a "windows closed" and "windows open" condition. This is represented for all four scenarios (Baseline, No Action, and Alternatives 1 and 2). There are not necessarily residences specifically at each of these points, but the points are good representations of the immediate surrounding areas where similar results could be expected.

Predictably, the areas closer to the runways have the highest probabilities of awakening.

The various scenarios show a small difference for POIs 8 and 9 (both very close to the runways). For most of the POIs, there is no difference noted. For the two points mentioned, the shift from No Action to Alternative 2 (largest option) shows at most a 3% increased probability of awakening on a given night.

Table 7-2. Sleep Disturbance for POIs by Scenario

Location	Probability of Awakening at Least Once											
	Baseline			No Action			Alternative 1			Atlernative 2		
	NA90 [1]	Windows Closed [2]	Windows Open [3]	NA90 [1]	Windows Closed [2]	Windows Open [3]	NA90 [1]	Windows Closed [2]	Windows Open [3]	NA90 [1]	Windows Closed [2]	Windows Open [3]
1 - Newport News	0.09	<1%	<1%	0.09	<1%	<1%	0.09	<1%	<1%	0.09	<1%	<1%
2 - Hampton	0.008	<1%	<1%	0.008	<1%	<1%	0.008	<1%	<1%	0.008	<1%	<1%
3 - Fort Monroe	0.237	<1%	<1%	0.237	<1%	<1%	0.237	<1%	<1%	0.237	<1%	<1%
4 - Willoughby	0.316	<1%	1-2%	0.316	<1%	1-2%	0.316	<1%	1-2%	0.316	<1%	1-2%
5 - West Ocean View	0.775	1-2%	2-3%	0.775	1-2%	2-3%	0.775	1-2%	2-3%	0.775	1-2%	2-3%
6 - East Ocean View	0.765	2-3%	3-4%	0.765	2-3%	3-4%	0.765	2-3%	3-4%	0.765	2-3%	3-4%
7 - Little Creek	0.431	<1%	1-2%	0.431	<1%	1-2%	0.431	<1%	1-2%	0.431	<1%	1-2%
8 - North Granby	2.454	7-8%	10-11%	2.62	7-8%	10-11%	3.764	9-10%	13-14%	3.894	9-10%	13-14%
9 - Northside	2.601	6-7%	9-10%	2.808	6-7%	9-10%	1.528	6-7%	9-10%	3.058	7-8%	10-11%
10 - Terminal	0.393	<1%	1-2%	0.393	<1%	1-2%	0.393	<1%	1-2%	0.393	<1%	1-2%
11 - Meadowbrook	0.216	<1%	<1%	0.216	<1%	<1%	0.216	<1%	<1%	0.216	<1%	<1%
12 - Wards Corner	0.216	<1%	<1%	0.216	<1%	<1%	0.216	<1%	<1%	0.216	<1%	<1%
13 - Central Granby	0.35	<1%	1-2%	0.35	<1%	1-2%	0.35	<1%	1-2%	0.35	<1%	1-2%
14 - Brentwood	0.216	<1%	<1%	0.216	<1%	<1%	0.216	<1%	<1%	0.216	<1%	<1%
15 - Suburban Park	0.11	<1%	<1%	0.11	<1%	<1%	0.11	<1%	<1%	0.11	<1%	<1%
16 - South Granby	0	NA	NA	0	NA	NA	0	NA	NA	0	NA	NA
17 - Naval Station	0.353	1-2%	1-2%	0.353	1-2%	1-2%	0.353	1-2%	1-2%	0.353	1-2%	1-2%
18 - Camp Allen	0.353	<1%	1-2%	0.353	<1%	1-2%	0.353	<1%	1-2%	0.353	<1%	1-2%

Notes: 1. Number of aircraft events at 90 dB SEL for Average 9-Hour Night.
2. 'Windows Closed' assumes a 25dB noise level reduction (NLR) between the outdoors and the indoors, e.g., 90 dB SEL outdoors is 65 dB SEL indoors.
3. 'Windows Open' assumes a 15dB noise level reduction (NLR) between the outdoors and the indoors, e.g., 90 dB SEL outdoors is 75 dB SEL indoors.

8.0 CONCLUSION

The Navy's proposal to replace the C-2A Greyhound with the new CMV-22B Osprey at NS Norfolk, Virginia was analyzed for effects on the noise environment in the Naval Station's surrounding community.

Neither of the alternatives results in a noticeable change in the DOD's primary noise metric, DNL. In fact, the results are nearly indistinguishable from either the Baseline or the No Action scenario. This indicates that the aircraft and types of events that cause the primary contribution to the DNL are not affected by this proposed change at NS Norfolk.

At a variety of POIs in the community, the loudest expected regular events were also analyzed. The results of calculating the single event metrics L_{max} and SEL for the loudest events showed no difference between the either of the Proposed Action Alternatives and the No Action. This indicates that for the representative sampling of the surrounding area, the events that the public would experience as the loudest regular events will not change under the proposed action. These events do not include any by the aircraft being replaced (C-2A) or the new aircraft (CMV-22B).

Those same POIs were examined for changes to the probability of awakening, a measurement of the loudness and frequency of occurrence of loud events during the nighttime. These results show that for 16 of the 18 points, there is less than a 1% change in the probability of awakening during any given night. At two points immediately adjacent to the east end of the main runway, there was a 1-3% increase in the probability of awakening, the 3% figure at the point closest to the runway under the assumption that the hypothetical person in question was trying to sleep with the windows open during night flying activity at the NS Norfolk.

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