APPLICATION FOR INCIDENTAL TAKE REGULATIONS AND LETTERS OF AUTHORIZATION; U.S. AIR FORCE LAUNCHES, AIRCRAFT AND HELICOPTER OPERATIONS AT VANDENBERG AIR FORCE BASE, CALIFORNIA

Submitted to:
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Executive Summary

Vandenberg Air Force Base (VAFB), located in Santa Barbara County, California, is submitting an application to renew an "Application for Incidental Take Regulations and Letters of Authorization; U.S. Air Force Launches, and Aircraft and Helicopter Operations at Vandenberg Air Force Base, California." "Take," as defined in the Marine Mammal Protection Act, may occur, but it is not expected to exceed Level B harassment.

This application shall replace an Incidental Harassment Authorization independently issued to and maintained by Space Exploration Technologies, Inc. (SpaceX) for certain operations at Space Launch Complex 4 (SLC-4), including "BoostBack" of first stage rocket components to SLC-4 West (refer to Appendix A).

There are 7 active missile launch facilities and 6 active space launch facilities on the 99,400 acre VAFB. One existing launch facility which has not been used in several years is being reactivated. Several new non-governmental space launch proponents have requested a very significant increase in launch frequency, however a large percentage of this increase will be comprised of new, smaller launch payloads and rockets then previously utilized at VAFB. These new launch proponents are not yet active, however we believe that they may be operational before the conclusion of this 5-year authorization. With these increases, the Air Force anticipates launch frequency will not exceed 15 missile and 100 rocket launches per year during the five-year period. A large majority of these rockets will be smaller than those previously launched at VAFB, but the largest new rockets will be slightly larger than those currently in use.

Piloted aircraft operations may result in very minimal levels of take, as VAFB no longer has aircraft stationed on site. However, security patrols and other routine aircraft operations do occasionally occur. Emergency aircraft operations (to include Search and Rescue, anti-Terrorism patrols and wildfire suppression are emergent in nature and thus not discussed further in this application.

The Air Force is also proposing to use Unmanned Aerial Systems (UAS or drones) for various purposes. Except for take-off and landing actions, a minimum altitude of 300 feet will be maintained for Class 0-2 UAS over all known marine mammal haul-outs when marine mammals are present. Class 3 will maintain a minimum altitude of 500 feet, except at take-off and landing. No Class 4 or 5 UAS will fly below 1000 feet over haul-outs.

Numerous monitoring and effects minimization measures are included within this application. A few notable updates to the previous application measures are requested. Following nearly twenty years of rocket launch monitoring on the Northern Channel Islands (NCI), the Air Force requests a reduction in monitoring requirements. Monitors have observed few effects beyond alert, startle or flush following sonic booms less than 5 pounds per square foot (psf). Therefore, we request that NMFS change the NCI monitoring requirements to:

- 1 March – 31 July, monitor pinnipeds when boom is modeled to exceed 2 psf.
- 1 August – 30 September, monitor pinnipeds when boom is modeled to exceed 3 psf.
- 1 October – 28 February, monitor pinnipeds when boom is modeled to exceed 4 psf.

Monitoring requirements for pinnipeds on VAFB:

- 1 January – 31 July, monitoring of all launches required, until sufficient monitoring data has been collected warranting further discussion and agreement between VAFB and NMFS.
- 1 January – 31 December (all year), Biological and acoustic monitoring of new rockets or rocket types that have not already been monitored is required, during at least the initial three launches of that rocket type.
- 1 January – 31 December (all year), Biological and acoustic monitoring of SpaceX or other boost-back and terrestrial landing actions required, when boom is modeled to exceed 1 psf.

All VAFB pinniped monitoring will be restricted to in-person, on-site monitoring up to three days before and two days after each launch; no personnel will be authorized to be present near the active haul-out areas at launch time due to safety requirements. VAFB agrees to conduct new and additional testing of remotely controlled video cameras, to potentially include night or low-light vision equipment. When and if these technologies test successfully, the Air Force will coordinate with the National Park Service to implement similar monitoring on the NCI.

The following species and number of individual marine mammals may be affected as a result of all VAFB activities, including government and tenant actions:

Pacific harbor seals (*Phoca vitulina richardsi)* – 103,000 animals at VAFB; 22,500 animals at NCI. A maximum 125,500 animals as a result of all activities described in this application.

California sea lions (*Zalophus californianus)* – 100,500 animals at VAFB; 675,500 at NCI. A maximum of 776,000 animals as a result of all activities described in this application.

Northern elephant seals (*Mirounga angustirostris*) – 50,000 at VAFB, 112,500 at NCI. A maximum of 162,500 animals as a result of all activities described in this application.

Steller sea lions (*Eumetopias jubatus*) – 2,500 at VAFB, 0 at NCI. A maximum of 2,500 animals as a result of all activities described in this application.

Northern fur seals (*Callorhinus ursinus*) – 0 on VAFB, 93,750 on NCI. A maximum of 93,750 from as a result of all activities described in this application.

Guadalupe fur seals (*Arctocephalus townsendi*) – 0 on VAFB, a maximum of 75 on NCI. A maximum of 75 animals affected as a result of all activities described in this application.

1. Operations with Potential to Result in Incidental Takes

Note: Each of the 14 items required by the National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS) for authorization requests is included as a bulleted topic at the beginning of each section. Some sections include more than one bulleted item. This was done in response to NOAA's request to reduce the size of submittal documents.

- Detailed description of specific activity or class of activities expected to result in incidental taking of marine mammals.

At Vandenberg Air Force Base (VAFB), the 30th Space Wing operates VAFB as well as its associated Western Range (Section 2; Figure 1). Manned and unmanned aircraft flying at low altitudes can disturb pinnipeds. Occasional helicopter and aircraft operations involve search-and-rescue, delivery of space vehicle components, launch mission support, security reconnaissance, and training flights. Use of Unmanned Aerial Systems (UAS or "drones") may also occur; Class 0-3 drones may operate at altitudes of 300 feet or more; Class 4 or 5 UAS will maintain a minimum altitude of 1000 feet.

VAFB supports launch activities for the U.S. Air Force, Department of Defense, National Aeronautics and Space Administration, and commercial entities. It is the primary west coast launch facility for placing commercial, government and military satellites into polar orbit on unmanned launch vehicles, and for the testing and evaluation of intercontinental ballistic missiles (ICBMs) and sub-orbital target and interceptor missiles. As described in the current SpaceX IHA, certain rocket components return to SLC-4 West for reuse; this action was formerly authorized under an independent IHA.

The following sections describe the launch vehicles and aircraft that have potential to incidentally take marine mammals. Launch vehicles may disturb pinnipeds with launch noises, sonic booms, and at close range, the sight of vehicles being launched. . Such impacts have been measured and monitored many times at VAFB over the past 25 years, resulting in some 100 reports by numerous qualified, independent researchers. These reports, covering from 1991 through 2011, were reviewed and summarized in two documents prior to the issuance of VAFBs prior 5-year Authorization and LOA in 2014 (MMCG and SAIC 2012a); these and more recent documents are available to NMFS upon request. Quarterly reports have been submitted to NMFS summarizing launch activity since 2014.

1.1 Space Vehicle Launches

There are currently six active facilities at VAFB used to launch satellites into polar orbit (Table 1). One existing launch facility (TP-01), on north VAFB, has not been used in several years but is being reactivated. These facilities support launch programs for the Atlas V, Delta II, Delta IV, Falcon 9 and Minotaur. The final launch of the Delta II rocket occurred in September 2018, however a new corporate entity has proposed to reutilize SLC-2W. Various booster and fuel packages can be configured to accommodate payloads of different sizes and weights.

Sonic booms on the Northern Channel Islands (NCI) resulting from VAFB launches (for SpaceX Boostback, refer to section 1.1.1) are dependent upon the trajectory of the launch in addition to the size of the rocket; for example "small" rockets, generally those less than 100 feet tall, are much less likely to result in a boom. We estimate that fewer than 10% of small rockets, 25% of medium rockets and 33% of large rockets will "boom" the NCI. Though exact numbers are uncertain, the Air Force believes that launches will result in NCI sonic booms not to exceed 5 times in 2019, 11 times in 2019 and 19 times in 2023. Additionally, sonic booms most frequently impact San Miguel and occasionally Santa Rosa Islands; Santa Cruz and Anacapa Islands are not expected to be impacted by sonic booms in excess of 1 pound per square

foot (psf). Pinnipeds hauled out on most if not all sites on Santa Cruz and Anacapa Islands will not be exposed to significant sonic booms.

The location of the launch sites in relation to specific pinniped haul-out and rookery areas at VAFB is shown in Figures 2 and 3. On Figure 2, launch complexes 3 and 4-E are both about 5.5 kilometers north of SLC-6 (additional figure available upon request).

The primary rocket launch programs and types are described above, but others may be implemented before this permit expires. Table 2 presents estimated launch numbers from calendar year 2019 to 2024, inclusive. The Air Force would notify NMFS of any new programs that would be implemented at VAFB. New rockets that are larger or louder than those that have been launched from VAFB previously would be monitored acoustically and biologically during their first launch, using the NOAA-approved launch monitoring protocols for VAFB. This would include new launch proponents using previously used facilities. Results of that monitoring would be shared promptly for further discussion.

Following nearly twenty years of rocket launch monitoring on the NCI, the Air Force requests a reduction in monitoring requirements. Monitors have observed few effects beyond alert, startle or flush following sonic booms less than of 5 psf. Only once in more than 20 years of launch monitoring has a response been categorized as a "stampede," after a boom measuring 8.92 psf resulted from a Titan IV launch (this boom level is much higher than any expected in the next 5 years). Refer to Table 8 and Section 7.1 for a detailed discussion of past results of sonic booms. Therefore, we request that NMFS change the NCI monitoring requirements to:

- 1 March – 31 July, monitor pinnipeds when boom is modeled to exceed 2 psf.
- 1 August – 31 December, monitor pinnipeds when boom is modeled to exceed 3 psf.
- 1 October – 28 February, monitor pinnipeds when boom is modeled to exceed 4 psf.

Table 1. Space Launch Vehicles (Rockets) and Nearest Haul-out Sites

Rocket	Rocket diameter	Rocket height	Launch facility	Nearest pinniped haul-out	Distance to haul-out
Current launch programs					
Atlas V	12.5 feet	191 feet	SLC-3E	North Rocky Point	9.9 km
Delta II	8 feet	128 feet	SLC-2W	Purisima Point	2.3 km
Delta IV	16 feet	236 feet	SLC-6	North Rocky Point	2.3 km
Falcon 9	12 feet	230 feet	SLC-4E	North Rocky Point	8.2 km
Minotaur	8 feet	81 feet	SLC-8	North Rocky Point	1.6 km
Minotaur/ Taurus	8 feet	91 feet	LF-576E	North Spur Road	0.8 km
Future launch programs[1]					
Vector	4 feet	64 feet	SLC-8	North Rocky Point	1.6 km
Firefly	6 feet	95 feet	SLC-2	Purisima Point	2.3 km
New Glenn	23 feet	200 feet	TBD	TBD	TBD
Vulcan	17.7 feet	>220 feet	SLC-3E	North Rocky Point	9.9 km
TBD	TBD	"small"	TP-01	Purisima Point	7.6 km

Abbreviations:
SLC = Space Launch Complex; LF = Launch Facility; E = East; W = West; TBD: To be determined
Notes: 1 – All future launch program specifications should be considered notional and subject to change

Figure 1. VAFB and the Western Range.

1.1.1 SpaceX Boost Back and Landing

Described in much greater detail in Appendix A, the boost-back and landing of the first stage of the SpaceX Falcon 9 rockets is to be covered in this document. The landing can occur either on pad LZ-4 within Space Launch Complex 4 or, for various reasons, on an autonomous "drone ship" no less than 50 kilometers offshore. It is important to note, however, that because the landing will always occur less than ten minutes after launch, it should be considered the same "harassment." If animals flush, they will often not have returned to the haul-out before the landing. Therefore, the Air Force does not anticipate than any new individuals will respond to boostback to a level that rises to take that were not already alerted or disturbed by the launch.

Table 2: Anticipated Number of Launches, by Year

Year	Small	Medium	Large
2019	5	10	5
2020	10	15	5
2021	25	20	10
2022	40	20	15
2023	50	30	20
2024	60	30	20

1.2 ICBM and MDA Launches

A variety of small missiles are launched from various facilities on north VAFB, including Minuteman III, an Intercontinental Ballistic Missile (ICBM) which is launched from underground silos. In addition, several types of interceptor and target vehicles are launched for the Missile Defense Agency (MDA). The MDA develops various systems and elements, including the Ballistic Missile Defense System (BMDS).

The BMDS test plans, including those involving tests from VAFB, are subject to constant change as the BMDS is being developed. Thus, it is difficult for the MDA to predict its launch schedule or number of launches over the next five years. However, due to test resource limitations, MDA does not envision conducting more than three missile tests per quarter (on average) over the next five years from VAFB, and none of the missiles would be larger than the Minuteman III. This limitation (three missiles per quarter and none being larger than the Minuteman III) can be used to establish the extent of potential impacts from MDA testing at VAFB over the next five years.

The primary missile programs and types are described above, but others may be implemented before this permit expires. The Air Force would notify NMFS of any new missile programs that would be implemented at VAFB. Completely new types of missiles would be monitored acoustically and biologically during their first launch, using the NOAA-approved launch monitoring protocols for VAFB. However, there is no requirement for monitoring of existing missile launches, following discussions with NMFS in 2016-2017.

LF-09 is the closest active missile launch facility to a haul-out area, located about 0.5 km from Little Sal (Figure 3). LF-10 is the most remote facility from any haul-out area, located about 2.7 km from Lion's Head. The trajectories of all missile launches are nearly due westward; thus, they do not cause sonic boom impacts on the northern Channel Islands (NCI). For these reasons, the Air Force does not anticipate or request take of marine mammals on the NCI due to missile launch operations. Additionally, following years of biological monitoring, NMFS and USAF agreed that nominal missile launches do not result in take of pinnipeds on VAFB.

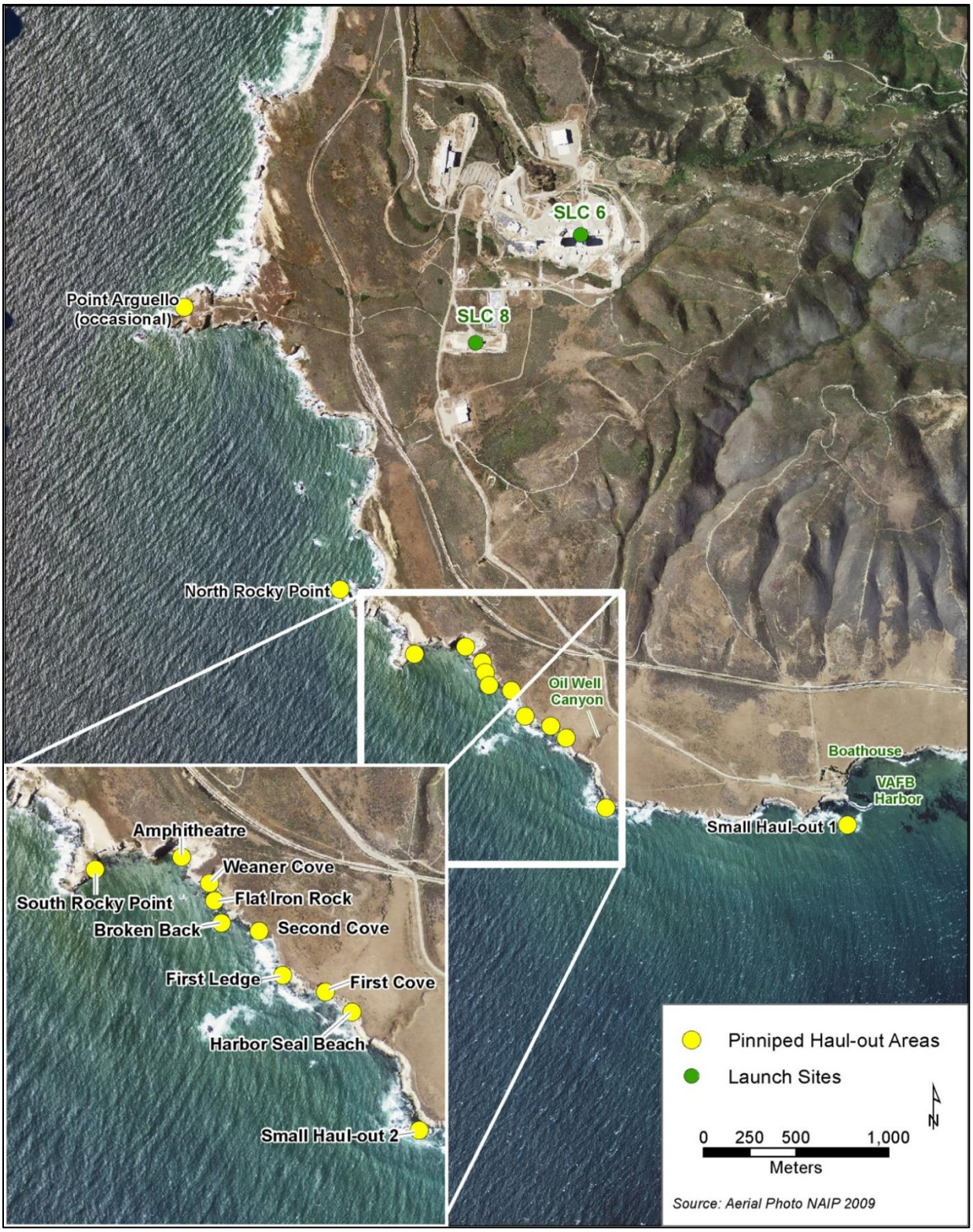

Figure 2. Launch Sites and Pinniped Haul-out Areas on South VAFB

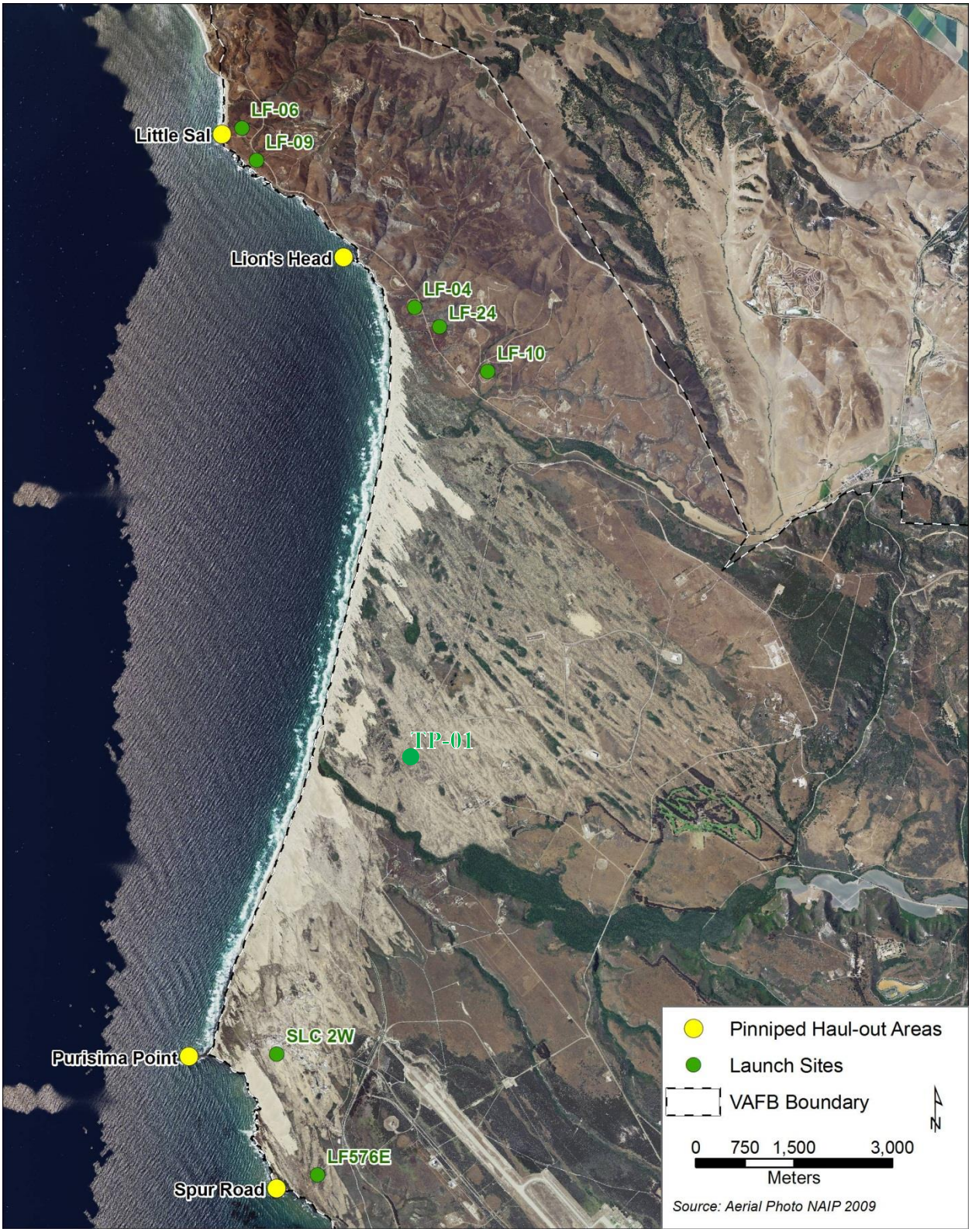

Figure 3. Launch Sites and Pinniped Haul-out Areas on North VAFB

1.3 Aircraft Operations

The VAFB airfield, located on north VAFB, supports various aircraft operations further described below. Aircraft operations include tower operations, such as take-offs and landings (training operations), and range operations such as overflights and flight tests. Over the past five years, an average of slightly more than 600 flights has occurred each year. There is low potential for take as aircraft operations may increase over the next 5 years, therefore we are requesting a small amount of take.

1.3.1 Fixed-wing Aircraft Operations

Fixed-wing aircraft use VAFB for various purposes, including delivering rocket or missile components, high-altitude launches of space vehicles (e.g., Pegasus) and emergency landings. VAFB is also used for flight testing, evaluation of fixed-wing aircraft and training exercises, including touch and goes. Three approved routes are used that avoid established pinniped haul-out sites. Aircraft flown through VAFB airspace and supported by 30th Space Wing include, but are not limited to: B-1 and B-2 bombers, F-15, F-16 and F-22 fighters, V/X-22s, and KC-135 tankers. A small number of takes could occur from this action.

1.3.2 Helicopter Operations

The number of helicopter operations at VAFB has decreased considerably since 2008 with the deactivation of the VAFB helicopter squadron. Other squadrons and units sometimes use VAFB for such purposes as transiting through the area, exercises and launch mission support. A small number of takes could occur from this action. Emergency helicopter operations, including but not limited to search-and-rescue and wildfire containment actions are somewhat common, but due to the emergency nature of such actions, they are not predictable, thus we do not anticipate take from emergency actions.

1.3.3 Unmanned Aerial Systems Operations

Unmanned Aerial Systems ("drones") operations may include either rotary or fixed wing aircraft. These are typically divided into as many as six classes, numbered 0-5 (Table 3). Classes graduate in size from "nano" or class 0, which are often smaller than 5x5 inches and always weigh less than one pound, to Class 5, which can be as large as a small piloted aircraft. Classes 0-3 can be used in almost any location, Classes 4 and 5 typically require an actual runway and for that reason will only be operated from the VAFB airfield. A small number of takes could occur from this action.

Table 3: UAS Classes

UAS GROUP/ CLASS	Weight (pounds)	Operational Altitude (feet above ground level)	Speed (knots)
0	<1	<500	Low
1	1-20	<1,200	<100
2	21-55	<3,500	<250
3	<1,320	<18,000	<250
4	>1,320	<18,000	Any
5	>1,320	>18,000	Any

2 Dates, Durations and Region of Operations

- Dates, Frequency and Duration of activities and specific geographical region where they will occur.

2.1 Dates, Frequency and Durations of Operations

Launch and aircraft operations could occur at any time of the day or night during the period to be covered under this permit (27 March 2019 through 26 March 2024). The Air Force anticipates that no more than 15 missile and 100 rocket launches (many of these would be quite small) would occur in any year. This number is far higher than launch activity in previous years, but new commercial launch proponents advocate a very aggressive expansion of launches reaching polar orbits in the near future. 5 year launch activity shall not exceed 75 missile and 390 rocket launches without additional coordination with NMFS.

All launch operations would occur at VAFB, potentially resulting in launch noise and visual impacts there. Current launch actions at VAFB do not result in sonic booms impacting the mainland (SpaceX landings may "boom" the mainland, but this activity is, covered under a separate IHA), Potential sonic boom impacts from space launch vehicles could occur over the NCI. Missiles are launched in a westerly trajectory and will not impact the NCI.

2.2 Area of Operations

VAFB is composed of approximately 99,100 acres of land and approximately 42 miles of coastline, all within Santa Barbara County on the southern central coast of California. From here, space vehicles are launched into polar orbits on azimuths from 147 to 201 degrees, with sub-orbital flights to 281 degrees. Missile launches are directed west toward Kwajalein Atoll in the Pacific. This over-water sector, from 147 to 281 degrees, comprises the Western Range. Part of the Western Range encompasses the NCI (Figure 1).

The NCI include San Miguel, Santa Rosa, Santa Cruz and Anacapa islands, and all are part of Channel Islands National Park. The waters out to six nautical miles offshore from the islands comprise Channel Islands National Marine Sanctuary. The closest part of the NCI (Harris Point, San Miguel Island) is located more than 30 nautical miles south-southeast of the nearest launch facility. Potential impacts of sonic booms from space launch vehicles launched from VAFB are a matter of concern to the National Park Service as well as the U.S. Fish and Wildlife Service (USFWS) and NMFS, particularly at San Miguel Island. Sonic booms can result in an alert or other response from pinnipeds and other special status species. Sonic booms could also impact the other three NCI, although the booms are generally less intense farther east along the chain of islands.

3 Marine Mammals in Operations Area

- Species and numbers of marine mammals likely to be found within the activity area.

3.1 VAFB

Of the six species of pinnipeds known to occur in this region, four species of pinnipeds regularly haul out at VAFB. The remaining two species – both fur seals – are known along this part of the mainland coast

only from strandings (MMCG and SAIC 2011a and b; 2012a and c). All six species are discussed in this section.

3.1.1 Pacific Harbor Seals

Pacific harbor seals (*Phoca vitulina richardsi*[1]) are the most common marine mammals at VAFB. Harbor seals generally remain within 20 or 30 nautical miles from their haul-out sites, which consist of offshore rocks or reefs, and sandy or cobblestone coves. Occasional journeys of some 300 nautical miles have been recorded in some parts of California (Carretta *et al.* 2011).

There are 11 harbor seal haul-out sites on south VAFB. Since the Air Force's 2013 application was submitted, approximately 5 haul-outs have been largely abandoned due to sand deposition following natural cliff erosion (which allows increased beach access by terrestrial mesocarnivores). There are four harbor seal haul-out sites on north VAFB. The position of haul-outs in relation to the Space Launch Complexes (SLCs) and Launch Facilities (LFs) is shown in Figure 3. With the exception of Amphitheatre (harbor seal rookery) and South Rocky Point, nearly all of the haul-out sites are used during low tides and are wave-washed or submerged during high tides.

Harbor seal numbers have been estimated by various means over the years. Table 4 compares older estimates with current estimates. The older estimates are shown as they were presented, then as revised in accordance with correction factor currently used by NMFS for assessing populations (Harvey and Goley, 2011).

Table 4. VAFB Harbor Seal Population Estimates

Year	Month	Maximum Number of Animals Hauled Out	1.3X Correction Factor (1996-2008)	1.54X Correction Factor (2009-2012)[3]
1993[1]	June	300	390	462
1999[1]	June	400	520	616
2001[1]	June	500-515	650-670	770-793
2009[2]	June	304	395	468
2010[2]	June	249	324	383
2011[2]	June	259	337	399
2012[2,a]	January	179	231	274
2013[b]	November	185	241	285
2014[c]	October	216	281	333
2015	October	533	693	821
2016[d]	May	310	403	477
2017[e]	January	125	163	193

Sources:
1. Hanan and Beeson 1993, cited in Thorson and Francine 1997; Thorson *et al.* 2000; Berg *et al.* 2002; MSRS 2011a and b
2. MMCG and SAIC 2011a and b; 2012a and c
3. Harvey, J.T. and D. Goley. 2011.

Notes:
a. In 2012, January, October, and December all had totals over 150
b. In 2013, January, February, April, August, September, October, and November all had totals over 200
c. In 2014, May, September, October, November, and December all had totals over 150
d. In 2016, April, May, and October all had totals over 300
e. In 2017, January, February, September, and December all had totals over 100

Harbor seal population estimates are usually made during the summer molting season, when the greatest numbers of animals are hauled out. Surveys during 2011 and earlier follow this trend, though more recent

[1] The subspecies *richardsi* is sometimes spelled *richardii*. We use the most common spelling.

surveys (2012-2017) indicate that peak numbers are now seen in the fall and winter months at VAFB, generally October or January. Notes are included in Table 3 to indicate what months other high numbers were seen each year which are generally fall/winter months.

The harbor seal population at VAFB appears to fluctuate, potentially due to natural processes affecting the overall population. Some declines in use of VAFB for hauling out is likely related to a series of natural landslides at south VAFB, resulting in the abandonment of many haul-out sites. These slides have also resulted in extensive downcurrent sediment deposition, making these sites accessible to coyotes, which are now occasionally seen there. The displaced seals have likely shifted use to other haul-outs in the vicinity or have moved to Point Conception, about six miles south of the southern boundary of VAFB. High numbers of harbor seals have been reported at Point Conception and in the kelp beds from south VAFB to east of Point Conception (Laroche 2012). A new haul-out site on south VAFB was discovered at Point Arguello (Figure 2). This consists of a ledge in a deep, protected crack on the north side of the point. Though not a large area, it offers a suitable haul-out for both California and Steller sea lions and is used occasionally (refer to following sections).

On north VAFB, coyotes have been observed regularly at Spur Road and Purisima Point haul-out sites. Only rocky outcrops located just off shore and exposed during the lowest tides are utilized by harbor seals. Before the coyotes arrived, much more of the intertidal area was used. In 2012, a new haul-out site, informally dubbed Little Sal, was discovered on north VAFB near LF-06 (Figure 3).

3.1.2 California Sea Lions

Individual California sea lions (*Zalophus californianus*) have been noted hauled out at various locations along the VAFB coast; usually considered to be transient or stranded specimens. Larger numbers of California sea lions occasionally haul out on Point Conception, located south of VAFB. On VAFB, California sea lions are only regularly hauled out on North Rocky Point (Figure 2), occasionally on South Rocky Point and Amphitheatre Cove, with numbers often peaking in spring. North Rocky Point can be observed from the western extent of South Rocky Point utilizing a spotting scope, though some areas are not visible. Previous counts are underestimates, since biologists only started using the vantage point from South Rocky Point in mid-2016. About 150 animals is the highest figure surveyed prior to 2018.

Successful pupping has not been observed. During the 2003 pupping season, five pups were born at north Rocky Point but were abandoned shortly after birth (MMCG and SAIC 2012a). This general observation was repeated in 2012 and 2014-15. One possible hypothesis is that only California sea lions affected by domoic acid toxicity give birth at VAFB. These pups are either stillborn or very likely do not survive long.

In May through July of 2018, previously unprecedented numbers of California sea lions (500-900) were observed at South Rocky Point. Some sea lions were also seen at Amphitheater, a haul-out usually dominated by harbor and elephant seals. The gender and age-class distribution at Amphitheater is believed to be primarily Sub-adult (both sexes) and adult female California sea lions with no more than 5 mature males present at any one observation (again, no pupping was observed). At South Rocky Point, our initial thoughts were that these individuals were predominantly transiting sea lions, including juveniles, adult females and a small number of adult males. Simply said, it is too early for VAFB to hypothesize why California sea lion numbers on South base have more than quadrupled in recent months, and we look forward to closely monitoring future numbers and discussing additional monitoring and management of this species with NMFS.

3.1.3 Northern Elephant Seals

Northern elephant seals (*Mirounga angustirostris*) historically hauled out at VAFB only rarely, mostly subadult males. In 2004, a record count of 188 animals was made, mostly newly weaned seals (MMCG

and SAIC 2012a). In November 2016, mature adults were observed in Amphitheatre Cove, and pupping was first documented in January 2017 with 18 pups born and weaned. In January 2018, a total of 25 pups were observed born and weaned. We assume that this site will also be used for pupping in future years.

3.1.4 Steller Sea Lions

In April and May of 2012, Steller sea lions (*Eumetopias jubatus*) were observed for the first time at VAFB. Since that initial sighting, they have frequently been observed, however only at one location. A maximum of 16 adults have been documented in one month at the same locations that California sea lions haul out at North Rocky Point. Some individuals with distinctive scars were observed on several occasions over a several-week period, indicating that this site was being used over time rather than as a brief rest stop (MMCG and SAIC 2012a and c).

3.1.5 Fur Seals

Two species of furs seals exist in the region: the northern fur seal (*Callorhinus ursinus*) and the Guadalupe fur seal (*Arctocephalus townsendi*). No haul-out or rookery sites exist for fur seals on the mainland VAFB coast. The only specimens that do appear on mainland beaches are stranded animals, with only one fur seal stranding reported at VAFB. This involved a northern fur seal that came ashore at Surf Beach. (This beach is on VAFB property but has public access). This seal, a nine-month old male, was rescued by the Santa Barbara Marine Mammal Center (SBMMC) on 11 March 2012 (SBMMC 2012).

3.2 Northern Channel Islands

Several species of pinnipeds inhabit the NCI and are discussed island-by-island detailed in Table 5.

Table 5. NCI Pinniped Population Estimates

Species	San Miguel Island	Santa Rosa Island	Santa Cruz Island	Anacapa Island
Pacific harbor seal	900	1,000	1,000	100
California sea lion	32,000 pups born in 2012[1]	500[2]	1,200[2]	1,000[2]
Northern elephant seal	±10,000 pups yearly	±2,000 pups yearly	Occasional transient	Rare transient
Steller sea lion	Rare transient	None	None	None
Northern fur seal	9,968	None	None	None
Guadalupe fur seal	Rare transient	None	None	None

Sources: Carretta *et al.* 2011 and 2012; Allen and Angliss 2011 and 2012

1. No estimate is available for the total sea lion population on each main rookery island. Instead, pup counts are made at various breeding areas, and from this count, as estimate is made of the stock size, which includes pups, subadults and adults.
2. Regular surveys are not conducted of these islands, and pupping is very sporadic and minimal there. These are estimates of the total number of sea lions at these islands.

3.2.1 San Miguel Island

San Miguel Island is the largest and most diverse pinniped rookery on the west coast. Four species of pinnipeds regularly breed there, including California sea lions, northern elephant seals, northern fur seals, and Pacific harbor seals. Steller sea lions bred in the past on San Miguel Island (Allen and Angliss 2011 and 2012). They disappeared from San Miguel Island after the 1982-1983 El Niño and have been sighted only occasionally since then, thus far as individual animals. Guadalupe fur seals are reported occasionally at San Miguel Island, and in 1998, a pup was successfully weaned there (Melin and DeLong 1999).

Pinnipeds are found throughout the San Miguel Island coastline. The main rookeries for California sea lions and northern elephant seals are on Point Bennett. California sea lions also breed on Castle Rock, and are sometimes seen at Richardson Rock. Northern fur seals have small rookeries at Point Bennett and on Castle Rock. Pacific harbor seals occur along the north coast, at Tyler Bight and from Crook Point to Cardwell Point.

3.2.2 Santa Rosa Island

Three species of pinnipeds frequent Santa Rosa Island: Pacific harbor seals, California sea lions and northern elephant seals. Harbor seals are scattered throughout the island. Sea lions haul out at the west end, at Ford Point and at Carrington Point. A few California sea lions have been born on Santa Rosa, but no rookery has been established. Northern elephant seals mostly stay near the west end of the island, where they pup and breed.

3.2.3 Santa Cruz Island

Pacific harbor seals inhabit small coves and rocky ledges along much of the coast of Santa Cruz. California sea lions haul out from Painted Cave almost to Fraser Point, on the west end. Fair numbers haul out at Gull Island, off the south shore near Punta Arena. Pupping appears to be increasing there. Sea lions also haul out near Potato Harbor, on the northeast end of the island.

3.2.4 Anacapa Island

Pacific harbor seals haul out on rocky ledges, caves and cobble beaches in small numbers at Anacapa Island. California sea lions haul out by the hundreds on the south side of East Anacapa.

4 Marine Mammal Status and Distribution in Area

- Description of the status, distribution, and seasonal distribution of affected species or stocks of marine mammals likely to be affected by such activities.

The status and population of each stock is provided in the table below.

Table 6. Pinniped Stock Status

Species	Protected Status	Stock	Stock Size and Status
Pacific harbor seal	MMPA	California	30,968; slowly increasing
California sea lion	MMPA	U.S. Stock	296,750; increasing, with occasional declines
Northern elephant seal	MMPA	California breeding stock	179,000; increasing
Steller sea lion	MMPA; ESA delisted-2013	Eastern U.S.	41,638; slowly increasing
Northern fur seal	MMPA	San Miguel Island	14,050; increasing
Guadalupe fur seal	MMPA depleted & strategic; ESA threatened; CA Dept. Fish & Wildlife fully protected	Guadalupe Island Stock (no U.S. stock)	20,000; increasing

Sources: Carretta *et al.* 2011 and 2012.; Allen and Angliss 2011 and 2012, Howorth 2017 Pers Comm
Abbreviations:
MMPA = Marine Mammal Protection Act of 1972 and its amendments; ESA = Endangered Species Act of 1973 and its amendments.

4.1 Pacific Harbor Seal (California Stock)

4.1.1 Distribution

Harbor seals haul out on intertidal sandbars, rocky shores and beaches along the California coast and islands. From 400 to 600 haul-out sites exist (Carretta *et al.* 2011 and 2012). From a few animals to several hundred occupy each of these sites. Harbor seals generally haul out in greatest numbers during the afternoon, when it is usually warmest. Considerable beach area is often available irrespective of tides on some of the Channel Islands, especially at San Miguel and San Nicolas. On the mainland, however, harbor seals usually haul out during low tides in areas closest to the water because of threats from land. In some populated areas, they have switched to a nighttime haul-out pattern to avoid being disturbed (Howorth 1995).

4.1.2 Seasonal Distribution

Harbor seals generally forage locally but may travel up to 300 nautical miles on occasion, either to find food or suitable breeding areas. The greatest numbers haul out during the molting season, from May into August throughout the state (Carretta *et al.* 2011 and 2012). In general, both molting and pupping seasons occur earlier in Southern California and later farther north. In Southern California, the pupping season peaks from mid-February through April; at VAFB, it extends from March through June. Molting season follows, sometimes overlapping the pupping season. At VAFB, the greatest numbers of harbor seals historically hauled out in June, but in recent years the highest numbers have been in the fall and winter.

4.2 California Sea Lion (U.S. Stock)

4.2.1 Distribution

In the U.S., the breeding range of the California sea lion extends from the Channel Islands as far north as Año Nuevo Island in central California (Carretta *et al.* 2011 and 2012). San Miguel and San Nicolas islands are the main breeding areas for the California sea lion.

4.2.2 Seasonal Distribution

The pupping season begins in late May, reaching the peak about the third week of June. By July, most pups have been born. Females stay with the pups for the first few days, then begin going to sea for progressively longer foraging trips, returning periodically to nurse their pups. Mating takes place as the females come and go. The pups begin to catch their first fish at about three months of age, but will nurse as long as the mother allows it and provided they are not separated. This continues for about 8 to 12 months, usually no later than just before the next pup is born (Carretta *et al.* 2011 and 2012).

Females usually range from the Mexican border to as far north as San Francisco. If prey is scarce, particularly during El Niños, they have been known to extend their range into Oregon. Adult males claim their breeding territories in late May, usually leaving by August, with most animals moving north. Adult males may venture as far north as British Columbia or southeast Alaska.

4.3 Northern Elephant Seal (California Breeding Stock)

4.3.1 Distribution

The California breeding stock of the northern elephant seal extends from the Channel Islands to the southeast Farallon Islands (Carretta *et al.* 2011 and 2012). Pupping at VAFB was first documented in

January 2017. Pupping occurs from December through March, with peak breeding in mid-February. Pups are weaned at three to four weeks of age, then abandoned. The weaners then undergo their first molt, which can take several weeks. Afterwards, they venture seaward. Both pups and weaners can be washed out from rookery beaches and may end up almost anywhere along the California coast, usually from February through April.

4.3.2 Seasonal Distribution

Females and juveniles feed from California into Washington, while males travel as far as Alaska and the Aleutians. Males and females return between March through August to molt.

4.4 Steller Sea Lion (Eastern U.S. Stock)

4.4.1 Distribution

The eastern U.S. stock of Steller sea lions ranges from Cape Suckling, Alaska, to California (Cape Suckling is almost at the northernmost part of the Gulf of Alaska, at 140° west longitude.) Año Nuevo Island, in central California, is now the southernmost known breeding colony for Steller sea lions (Carretta *et al.* 2011 and 2012), although they did breed at San Miguel Island up until the 1982-1983 El Niño. Sightings were rare after that. From 2010 to 2012, individual Steller sea lions have shown up along the mainland coast of the Southern California Bight, often hauled out on navigation buoys. At VAFB, Steller sea lions have been observed in generally low numbers since approximately 2012, but no breeding or pupping behavior has been documented.

4.4.2 Seasonal Distribution

At Año Nuevo Island, Steller sea lions bear their young from May through July. Females alternate between foraging at sea and nursing their pups. Females continue this pattern, with the pups accompanying them to sea as they get older. Small numbers of juveniles and sub-adult males may be present at the rookery throughout the year. Pups can nurse up to a year, with some individuals continuing to nurse until they are two or three years old. Adult males remain at the rookery throughout the breeding season, then leave by September, migrating north to forage.

4.5 Northern Fur Seal (San Miguel Island Stock)

4.5.1 Distribution

Northern fur seals range from southern California to the Bering Sea and west to the Okhotsk Sea and Japan. About 74 percent of the breeding population is found on the Pribilof Islands of the southern Bering Sea. The San Miguel Island stock, though separate, comprises less than one percent of the population. While at sea, northern fur seals range throughout the North Pacific (Carretta *et al.* 2011 and 2012).

4.5.2 Seasonal Distribution

Adult males stay on or near haul-outs from May through August, with some non-breeding specimens remaining until November. Adult females generally stay on or near haul-outs from June to as late as November. Peak pupping is in early July. The pups are weaned at three to four months. Some juveniles are present year-round, but most juveniles and adults head for the open ocean and a pelagic existence until the next year.

4.6 Guadalupe Fur Seal (Guadalupe Island Stock)

4.6.1 Distribution

Guadalupe fur seals pup and breed mostly on Isla Guadalupe. All other Guadalupe fur seals are considered descendants of one breeding colony on the island, so only a single stock is recognized. In 1997, a new colony was discovered on Isla Benito del Este, off the west coast of Baja California. Guadalupe fur seals also are occasionally seen on San Miguel and San Nicolas Islands, almost always as single individuals. Single adult males twice established territories on San Nicolas Island which lasted a few years each time, but no females arrived (Carretta *et al.* 2011 and 2012). Melin and DeLong (1999) reported that a pup was born and successfully weaned on San Miguel Island in 1998.

4.6.2 Seasonal Distribution

Males arrive at the rookeries in late May or early June and remain for one to four months. After breeding, they head out to sea. Females give birth in June and July, with most births in mid-June. Pups are nursed for five to six months, although the females can lactate up to eleven months. Little is known of their seasonal distribution at sea.

5 Request for Five-year Permit for Incidental Take

- Type of incidental taking authorization being requested and the method of incidental taking.

Vandenberg Air Force Base (VAFB), 30th Space Wing (30 SW) requests a five-year permit and LOA for the harassment by Level B take of small numbers of marine mammals incidental to space vehicle and missile launches and aircraft operations. Under the Marine Mammal Protection Act of 1972 (MMPA) and its amendments, Level B harassment is defined as having "…the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild."

Discussions between NMFS and the U.S. Navy have determined that multiple year LOAs are beneficial to both the Navy and NMFS; VAFB greatly appreciated the issuance of a multiple-year LOA starting in calendar year 2014. The applicant understands that annual reports will still be necessary.

The five-year period is consistent with new regulations which allow for longer periods of validity for such authorizations. A five-year programmatic permit and LOA is requested because no potential for serious injury or mortality exists, or such potential can be negated by mitigation requirements. VAFB has complied with yearly incidental harassment LOAs issued over the nearly 20 years, as well as with the current LOA (valid 1 January 2018 through 26 March 2019; NOAA, NMFS 2017). VAFB has also followed the conditions of the current five-year permit (NOAA, NMFS 2014), as well as with previous five-year permits issued over the past 20 years. No serious injuries or mortalities of marine mammals have ever been known to result from VAFB operations. VAFB will continue to submit annual reports on its mitigation efforts, including reports on its monthly marine mammal surveys. VAFB did not renew Scientific Research Permit (SRP) Number 14197 upon its expiration in 2014. In addition, VAFB will submit marine mammal monitoring reports following each rocket launch during which monitoring was required.

6 Potential Number and Causes of Takes from Operations

- Age, sex, and reproductive condition, number of marine mammals by species that may be taken by each type of taking, and number of times such takings by each type of taking are likely to occur.

On 24 February 2014, NOAA published its final rule concerning the incidental taking by Level B harassment of marine mammals at VAFB (Federal Register, Vol. 79, No. 36; NOAA, NMFS 2014). Prior to that date, a Final Rule of 2012 amended an earlier rule that went into effect on 6 February 2009, in which VAFB was allowed to take marine mammals for a period of five years, or up to 2014. The main purpose of the 2012 amendments was to allow greater flexibility in the types and numbers of missile and rocket launches at VAFB. The 2009 rule allowed for up to 20 missile and 30 rocket launches a year. This was amended to allow for 15 missile and 35 rocket launches a year. Under the Final Rule, VAFB was still required to apply for LOAs and to report on marine mammal monitoring activities to ensure compliance with regulations designed to protect marine mammals.

6.1 VAFB

Table 6 below lists the limits of incidental take by Level B harassment over the five-year period requested in this application. Please note that these numbers are likely overestimates. Take numbers have been developed by multiplying the average number of each species present over a year, multiplied by the total expected number of authorized space launches. Because launches from different SLCs impact different haul-outs, we again recognize that the total numbers listed are almost certainly overestimates. These Level B takes are from noise or visual disturbance only; no launch actions covered in this authorization are expected to produce a sonic boom over the mainland. No Level A takes are anticipated. Disturbances from individual launch events last no longer than one hour per event; therefore previous attempts to quantify harassment "animal days" is no longer considered by the Air Force to be a useful strategy.

Possible increases in pinniped stocks at VAFB over the next five years were allowed for in selecting the number of takes from launches that could possibly occur.

Aircraft are required to maintain a 1000-foot "bubble" around pinniped haul-out and rookery areas except in emergency circumstances, such as Search and Rescue. One specific site, called Small Haul-Out 1, allows for a 500-foot "bubble," as pinnipeds using this particular site are more accustomed to anthropogenic disturbances. A small number of Level B takes by UAS may occur at Small Haul-Out 1, only. Only Pacific harbor seals and occasionally California sea lions are known to use this haul-out.

Table 7. Allowable Incidental Level B Take of Pinnipeds at VAFB (5 years)

Species	Age groups	Reproductive condition	Takes from noise or visual disturbance	Takes from aircraft operations	Takes from UAS operations
Pacific harbor seal	All	Pupping and breeding March through June	100,000	None	3,000
California sea lion	All	Pupping and breeding June through July, but no pupping yet observed at VAFB	100,000	None	500
Northern elephant seal	All	Pupping and breeding January-March, also "weaners"	50,000	None	None
Steller sea lion	All	No known pupping or breeding at VAFB	2,500	None	None
Northern fur seal	Mostly juveniles	Only stranded animals	None	None	None
Guadalupe fur seal	Juveniles	Only stranded animals	None	None	None

6.1.1 Harbor Seals

Pacific harbor seals haul out regularly at more than ten sites on both north and south VAFB. They are the most widespread pinniped species on VAFB, and have been seen in all months, including decades of successful pupping. Many of their sites are deluged by tidal fluctuation. Rocket launches from sites closer to the haul-outs (SLC's 2, 6 and 8, and LF-576E) are more likely to cause disturbance, including noise and visual impacts. Level B take of up to 100,000 animals is requested specific to space launches (400 animals, 390 launches over a 5-year period); Level B take of up to 3,000 animals is requested specific to UAS operations (30 animals, 100 operations over a 5-year period).

6.1.2 California Sea Lions

California sea lions only haul out regularly at Rocky Point (north and south) and Amphitheatre Cove. Both juveniles and adults of both sexes have been observed. Historically, the greatest numbers (possibly up to 300) usually appeared in late spring and summer, although some are usually present year-round (MMCG and SAIC 2011a and b; 2012a and c). During very high tides and strong winds, when spray is heavy, the sea lions often leave this site or are unable to access it. In 2018, nearly 1,000 California sea lions were observed at South Rocky Point (this information, informally shared with NMFS, will be included in VAFBs 2018 annual LOA report); also refer to section 3.1.2. Launches from SLC-6 and SLC-8, which are closest to North Rocky Point, would be the most likely to result in launch noise and visual impacts. Launches from SLC-3E and SLC-4E, both farther inland and some four times the distance, are less likely to impact California sea lions at North Rocky Point. Launches from north VAFB are not likely to affect California sea lions. Level B take of up to 100,000 animals is requested (average 400 animals, 390 launches over a 5-year period); Level B take of up to 500 animals is requested specific to UAS operations (5 animals, 100 operations over a 5-year period).

6.1.3 Northern Elephant Seals

Elephant seal pupping was first observed at VAFB in January 2017, preceded by several weeks of adult presence. Currently, only Amphitheatre Cove (Figure 2) is used by elephant seals for breeding and pupping. All age classes and sexes haul out on VAFB, at different times of the year, to rest, undergo molting, and reproduce. Juveniles and adults of both sexes also haul out at VAFB to undergo their catastrophic molt or occasionally to rest at other times of year. Level B take of up to 50,000 animals is requested (average 200 animals, 390 launches over a 5-year period).

6.1.4 Steller Sea Lions

Steller sea lions have been observed at VAFB since April 2012 (MMCG and SAIC 2012c). They have been observed frequently, but sporadically since then, never exceeding 12 individuals in one survey (unpublished data). Total individuals documented are very small, up to 34 total present in one year, Level B take of up to 2,500 animals is requested (10 animals, 390 launches over a 5-year period).

6.1.5 Fur Seals

Only one northern live fur seal has been reported at VAFB over the past 25 years (SBMMC 2012); therefore it is extremely unlikely that any will be taken. At least two deceased fur seals have been found on VAFB. Guadalupe fur seals have yet to be reported at VAFB. Consequently we are not requesting take on VAFB for either species.

6.2 Northern Channel Islands

The number of pinnipeds taken will depend on the intensity, frequency range and duration of the sonic boom or booms received by the pinnipeds (Table 7). The number of pinnipeds present where the boom strikes is also a significant factor. For example, on one occasion pinnipeds on one side of San Miguel Island, reacted to a boom, while animals four miles away on the other side never heard it, nor was it detected there by acoustic instruments (MMCG and SAIC 2012a).

The take table below is based on more than 20 years of observations during launches and considers the number of pinnipeds of each species expected to be present and each species' observed sensitivity to sonic booms (MMCG and SAIC 2012a). Summarizing 20 years of sonic boom modeling, we anticipate that no more than 30% of space launches will produce a sonic boom greater than 2 psf over the NCI (estimated to be 150 launches over 5 years). Therefore, Table 8 shows lower numbers of takes than those to sound and visual disturbance on VAFB, shown in Table 7 (except for California sea lions). No Level A takes are anticipated.

Table 8. Allowable Incidental Level B Take of Pinnipeds at the NCI

Species	Age groups	Sex	Reproductive condition	Takes from sonic booms in excess of 2 psf over 5-year period
Pacific harbor seal	All	Both	Pupping and breeding March through June	22,500
California sea lion	All	Both	Pupping and breeding June through July	675,000
Northern elephant seal	All	Both	Pupping December through March	112,500
Steller sea lion	Adult	Both	No pupping or breeding at NCI	None; virtually no current presence on San Miguel
Northern fur seal	Mostly juveniles	Both	Pupping and breeding in June and July	93,750
Guadalupe fur seal	Juveniles	Both	Only one pup noted in more than a century (summer & fall 1998)	75
Take estimates based upon 100 rocket launches per year, but no more than 30% resulting in a sonic boom >2 psf (likely an overestimate); therefore, 150 launches over a five-year period, multiplied by expected average monthly number of animals present on NCI, specifically: Pacific harbor seal: 300; California sea lion: 750; Northern elephant seal: 1,500; Northern fur seal: 1,250 Guadalupe fur seal: 1				

7 Impacts on Marine Mammal Habitats and Stocks

Anticipated impact of the activity upon stock;

- Anticipated impact of activities upon the habitat of marine mammal populations, and likelihood of restoration of affected habitat and;
- Anticipated impact of loss or modification of the habitat on the marine mammal populations involved.

No adverse impacts are anticipated on marine mammal stocks or populations. No impacts, losses or modifications are anticipated on marine mammal habitats; therefore, no restoration of marine mammal habitats would be necessary.

- Anticipated impact of the activity upon species.

Pinnipeds will be taken only by incidental harassment from noise or visual disturbances from manned and unmanned aircraft, rocket and missile launches. Reactions of pinnipeds to launch noise and sonic booms

have ranged from no response to heads-up alerts, from startle responses to some movements on land, and finally from some movements into the water, and on only one occasion, to a stampede, especially involving California sea lions at the NCI. This was the result of a sonic boom much louder than any boom expected in the next five years. Therefore, we consider the likelihood of a stampede to be very low.

- Anticipated Impacts from Launch Noise

From more than two decades of pinniped monitoring by numerous qualified, independent researchers, we know that at VAFB harbor seals generally alert to nearby launch noises, with some or all of the animals going into the water. Usually within minutes to two hours or so of each launch as many or more animals haul out than are present during each launch. Exceptions to this occur during rising tides, breakers or other disturbances are involved. When launches occur during high tides at VAFB, impacts at most beaches / haul-outs are greatly decreased, because the haul-out sites are submerged (MMCG and SAIC 2012a). Amphitheater and South Rocky Point are not completely submerged at high tide. We anticipate that such patterns will continue.

In addition to monitoring pinniped haul-out sites before, during and after launches, researchers were previously required to capture harbor seals at VAFB and Point Conception to test their sensitivity to launch noises. The goal was to determine whether launch noise affects the hearing of pinnipeds (MMCG and SAIC 2012a). The low frequency sounds from launches can be intense, with the potential of causing a temporary [hearing] threshold shift (TTS), in which part or all of an animal's hearing range is temporarily diminished. This can last from minutes to days, but eventually hearing returns to normal. Meanwhile, TTS has the potential to compromise the survival of the animal. A permanent [hearing] threshold shift (PTS) could occur if the sound is sufficiently loud. PTS is considered Level A take under the MMPA and is not authorized under the Final Rule, IHA or LOA. Auditory Brainstem Response (ABR) tests were performed under five-year SRPs starting in 1997. None of the tested seals showed any signs of TTS or PTS. The researchers stated that the animals could have experienced TTS but recovered fully by the time they were retested (MMCG and SAIC 2012a). This research has concluded. Thus, after 15 years of ABR research, we anticipate no impacts from launch noises on harbor seal hearing.

7.1 Anticipated Impacts from Sonic Booms

At the Channel Islands, Harbor seals react more strongly to sonic booms than most other species. Pups sometimes react more than adults, either because they are more easily frightened or because their hearing is more acute. Harbor seals also appear to be more sensitive to sonic booms than most other pinnipeds, often startling and fleeing into the water. From prior monitoring, no more than 27% of California sea lions have ever responded to sonic booms at a level that would be considered "take." Northern fur seals generally show little or no reaction. Northern elephant seals generally exhibit no reaction at all, except perhaps a heads-up response or some stirring, especially if sea lions in the same area or mingled with the elephant seals react strongly to the boom. Post-launch monitoring generally reveals a return to normal patterns within minutes up to an hour or two of each launch, regardless of species.

Table 9 compares modeled and actual sonic boom results at San Miguel Island. Launch monitoring has shown that few animals from the four species reacted to overpressures below 2 pounds per square foot (psf). In general, elephant seals did not react unless other animals around them reacted strongly or if the sonic boom was extremely loud. Northern fur seals seemed to react similarly. From limited data about the reactions of harbor seals, it appears likely that they were quite sensitive to sonic booms (MMCG and SAIC 2012a and c). Their reactions to launch noise at VAFB seem to suggest a sensitivity to low frequency sounds as well.

In summary, impacts have been considered minimal and temporary by various researchers. No evidence has been presented of abnormal behavior as a result of the launches, nor were any injuries or mortalities attributed to any launches. No pups were abandoned as a result of sonic booms. These findings came as a

result of more than twenty-five years of research by numerous qualified, independent researchers, from March 1991 through present. We anticipate that such patterns will continue.

Table 9. Sonic Boom Modeling and Actual Recorded Levels

Launch Date	Mission	Vehicle	Launch Site	Modeled psf	Recorded psf
April 2006	Cloudsat	Delta II	SLC-2	2.0	0
March 2008	NROL 28	Atlas V	SLC-3	2.0	1.24
October 2011	NPOESS	Delta II	SLC-2	1.5	0.671
February 2013	LDCM	Atlas V	SLC-3	1.00	0
April 2014	DMSP-19	Atlas V	SLC-3	>3	0.74
December 2014	NROL 35	Atlas V	SLC-3	>3	1.175
October 2015	NROL 55	Atlas V	SLC-3	>2	1.956
March 2017	NROL 79	Atlas V	SLC-3	1.4	2.2*
May 2018	InSight	Atlas V	SLC-3	1.53	0.64

* March 2017 sonic boom was "infrasonic and extremely brief; it could not have been heard or detected by humans or animals."

7.2 Anticipated Impacts from Aircraft

Following the establishment of the 1000-foot "bubble" around pinniped haul-out and rookery sites at VAFB many years ago, no instances of pinnipeds reacting to aircraft have been reported there; thus, no impacts from aircraft are anticipated (MMCG and SAIC 2012a). A small number of takes at Small Haul-Out 1 resulting for UAS operations are requested (refer to Table 6). Following coordination with NMFS (Long Beach), the "bubble" around Small Haul-Out 1 was reduced to 500 feet. This area is frequently used by recreationists, and is occasionally used for military mission harbor operations; it appears that pinnipeds (usually only harbor seals) using this haul-out are much more accustomed to human presence than those at other locations (unpublished data; Evans, personal observation).

8 Minimizing Potential Impacts to Marine Mammals

- Suggested means of accomplishing necessary monitoring and reporting that will result in increased knowledge of species, decreased levels of taking or impacts on populations of marine mammals expected to be present during activities.

8.1 Air Force Operations

8.1.1 Launches

The myriad of operations and requirements associated with each rocket and missile launch preclude the ability to alter or modify launch schedules. Launch dates are often scheduled months or years in advance. As each date approaches, technical issues and concerns can create short-term alterations to the launch schedule or delay launches for longer periods. Thus, it is not practical to modify launch schedules. Proven procedures, monitoring and research efforts designed for marine mammal protection (described below), help minimize potential impacts to marine mammals at VAFB and the NCI.

8.1.2 Flight Operations

The use of approved aircraft routes for testing and evaluation, as well as a requirement to remain outside of a 1,000-foot bubble around pinniped rookeries or haul-out sites (except in emergencies, and with a reduced, 500-foot bubble at Small Haul-out 1), ensures minimal impacts from aircraft operations to marine mammals

and their habitats on VAFB. Unmanned aerial systems in classes 0-2 are allowed at overflight altitudes of 300 feet. Class 3 will maintain a minimum altitude of 500 feet, except at take-off and landing. UAS in classes 4 and 5 only operate from the VAFB airfield.

8.2 Marine Mammal Monitoring

Impacts to marine mammals at VAFB and the NCI are monitored in several ways described in detail below. Such monitoring ensures that any impacts from existing rocket launches are observed and documented as required. It also ensures that impacts from new rockets and missiles (if any) are assessed and monitored. Finally, when significant alterations are made to rockets or missiles that could change the potential for impacts, then the impacts from such vehicles are also assessed and monitored.

The monitoring and reporting protocols proposed in this application are similar to those used during the former five-year programmatic permit and meet all requirements of the current LOA. On both VAFB and NCI, monitors typically complete 4-6 observations of each significant haul-out area each day, over a period of 3-5 hours.

8.2.1 VAFB Launch Monitoring

Multiple years of monitoring has shown no take results from missile launches and therefore biological monitoring of missile launches is not proposed. The biological monitoring for new or reconfigured vehicles will follow the protocols discussed below. Rockets that have already been analyzed acoustically and monitored during the initial three launches are *not* monitored except during the elephant seal and harbor seal pupping season (1 January through 31 July), whereas all new vehicle launches will be monitored for the first three launches. If no unusual or different effects from existing vehicles is observed, then monitoring will be discontinued after discussions with NMFS. Also, if new vehicle launches are monitored outside of the harbor seal pupping season, then the two-week follow-up pup survey (described below) will not be required. VAFB agrees to conduct new and additional testing of remotely controlled video cameras, to potentially include night or low-light vision equipment. When and if these technologies test successfully, the Air Force will coordinate with the National Park Service to implement similar monitoring on the NCI.

For launches that occur during the elephant seal and/or harbor seal pupping season (1 January to 31 July), monitoring will be conducted by at least one NMFS-approved marine mammal observer trained in marine mammal science. Authorized marine mammal observers shall have demonstrated proficiency in the identification of all age and sex classes of both common and uncommon marine mammal species found at VAFB. They shall be knowledgeable of approved count methodology and have experience in observing pinniped behavior, especially that due to human disturbances. Monitoring at the haul-out site closest to the facility where the vehicle will be launched will begin at least 72 hours prior to the launch and continue until at least 48 hours after the launch. A follow-up survey will be made within two weeks of the launch to ensure that there were no adverse effects to pups. For launches that occur during daylight, time-lapse video recordings will be made of the reactions of the seals to each launch. This is necessary because access to observation points near launches is not allowed during the launches themselves due to personnel safety issues. As noted above, monitoring using remotely controlled cameras, will be considered and tested Monitors are not allowed to be present within the launch area or at the VAFB haul-outs at the time of launch for safety reasons.

Monitoring for each launch will include multiple surveys each day that record, when possible: species, number, general behavior, presence of pups, age class, gender, and reaction to launch noise, or to natural or other human-caused disturbances. Environmental conditions will also be recorded, including: visibility, air temperature, clouds, wind speed and direction, tides, and swell height and direction. A launch monitoring report containing all of the required information in an approved format will be submitted to

NMFS within its deadlines. An annual report describing all of the launches during each year will also be submitted to NMFS within its deadlines and in an approved format.

8.2.2 VAFB Monthly Monitoring

Marine mammal species of concern at VAFB listed in the past and current LOAs include Pacific harbor seals, California sea lions and northern elephant seals. The main focus is on elephant and harbor seals along the VAFB coastline, especially during pupping season. However, discoveries of unsuccessful California sea lion pupping on VAFB in 2003 (Section 3.1.2) and reports of substantial numbers of northern elephant seals hauling out on the VAFB coastline starting in 2004 (Section 3.1.3) indicated the need for continuing to collect baseline data on VAFB's pinniped population. The subsequent observation of Steller sea lions starting in 2012 (Section 3.1.4), the discovery of northern elephant seal pupping in 2017 (3.1.3) and a large increase in California sea lions noted in May-July 2018 (3.1.2; no pupping was observed) are also notable results of recurring monitoring. Should local populations continue to increase, the numbers and species of marine mammals included in the LOA may require adjustment to ensure that incidental take protections are adequate for MMPA compliance.

Another goal of the monthly surveys is to assess the relative abundance of pinnipeds at peak haul-out times, usually during the lowest afternoon tides. Launches are not scheduled around tides. If a launch occurs during a high tide, no animals are usually present because most haul-out areas are usually submerged, with the exceptions of North and South Rocky Point, and Amphitheatre Cove as previously mentioned. An erroneous assumption could be made that a launch affected haul-out patterns when in fact only a high tide affected them. The monthly surveys allow researchers to assess haul-out patterns and relative abundance over time, presenting a better picture of pinniped population trends at VAFB and whether Air Force operations are having cumulative impacts.

Monthly marine mammal surveys will be conducted to monitor the abundance, distribution and status of pinnipeds at VAFB. Whenever possible, these surveys will be timed to coincide with the lowest afternoon tides of each month, when the greatest numbers of animals will usually be hauled out. This timing is not always possible if the tides occur too close to sunrise or sunset, since south VAFB surveys start about two hours before the low tide and end two hours afterward. North VAFB surveys are either conducted by a separate surveyor on the same day as south VAFB, or on the day before/after south VAFB surveys. North VAFB surveys require approximately 90 minutes. Monitoring during nighttime low tides is not possible because of the dangerously unstable nature of the bluffs overlooking many of the observation points. Occasional VAFB or area closures also sometimes preclude monitoring on a given day, in which case the next best day will be selected.

During the monthly surveys, a NOAA-approved monitor, as required in the LOA, will visit each site. In addition, another person may accompany the monitor for safety reasons. Counts will be made and recorded at each site, then the monitor(s) will move to the next site.

Data gathered will include: species, number, general behavior, presence of pups, age class, gender, and any reactions to natural or human-caused disturbances. Environmental conditions will also be recorded, including: visibility, air temperature, clouds, wind speed and direction, tides, and swell height and direction. Monthly reports will be submitted to VAFB and an annual report, describing all of the monthly surveys each year, will also be submitted to NMFS within its deadlines and in an approved format.

8.2.3 NCI Sonic Boom Modeling

Sonic boom modeling will be performed prior to all rocket launches. PCBoom, a commercially available modeling program, or an acceptable substitute, will be used to model sonic booms from new vehicles.

Different versions of the PCBoom software provide different specificities of results; for example PCBoom 3 tends to provide results rounded to the nearest $1/10^{th}$ of one PSF, whereas PCBoom 4 produces predications to the $1/100^{th}$ of one PSF – however, as just models (or predictions), it seems that the more precise results of PCBoom 4 tend to be less accurate.

Launch parameters specific to each launch will be incorporated into each model, these include: launch direction and trajectory, rocket weight, length, engine thrust, engine plume drag, and launch profile (vehicle position versus time from launch to first-stage burnout), among other aspects. Various weather scenarios will be analyzed from NOAA weather records for the region, then run through the model. Among other factors, these will include the presence or absence of the jet stream, and if present, its direction, altitude and velocity. The type, altitude, and density of clouds will also be considered. From these data, the models will predict peak amplitudes and impact locations. Should a model indicate that a peak overpressure of 2 pound per square foot (psf) or greater could impact the NCI, then acoustic and biological monitoring, described in the next section, may be implemented.

Modeling will not be required for launches of currently deployed missiles because of their trajectories west of VAFB and north of SMI and the previously well-documented acoustic properties of the missiles. When missiles are launched in a generally western direction (they turn south several hundred miles from VAFB and at high altitude), there is no sonic boom impact on the SMI, thus there is no concern for pinnipeds from these launches.

8.2.4 NCI Launch Monitoring

Acoustic and biological monitoring will be conducted on the NCI if the sonic boom model indicates that pressures from a boom will reach or exceed the psf level detailed in Table 10. These dates have been determined appropriate to account for sensitive seasons, primarily pupping, for the various pinniped species. The monitoring site will be selected based upon the model results. Emphasis will be placed on selecting a location on one of the islands where the maximum sound pressures are reached and where suitable assemblages of pinnipeds are present.

Table 10. Proposed NCI Sonic Boom Level Requiring Monitoring, By Date

Sonic boom level	Dates
>2 psf	1 March – 31 July
>3 psf	1 August – 30 September
>4 psf	1 October – 28 February

Specialized acoustic instruments will be used to record sonic booms generated during launches from VAFB. The recordings will then be analyzed to determine the intensity, duration and frequency of sonic booms so this can be compared with levels considered potentially harmful to marine mammals. The analysis can also be used to validate the efficacy of the model.

Biological monitoring will be conducted at the closest significant haul-out site to the modeled sonic boom impact area. Emphasis will be placed upon selecting a site where pinnipeds are present that are most sensitive or least understood when it comes to reactions to sonic booms. At present, monitoring the reactions of northern fur seals and Pacific harbor seals to sonic booms is more important than monitoring those of California sea lions and northern elephant seals, which have already been monitored more often (Table 8). Monitoring the reactions of mother-pup pairs of any species is also important.

Considering the large numbers of pinnipeds found on some island beaches—sometimes thousands—smaller focal groups will be monitored instead. Estimates of the entire beach population will be made and

their reactions to the launch noise noted. Photos and/or video recordings can help with this task if feasible. This is not always practical when visibility is reduced, not all animals are in sight from one observation point, severe glare, and/or other factors.

Monitoring will be conducted by at least one NMFS-approved marine mammal observer, trained in marine mammal science. Another person will accompany the monitor for safety reasons. Monitoring will usually commence at least 72 hours prior to the launch, during the launch and at least 48 hours after the launch, unless no sonic boom is detected by the monitors and/or by the acoustic recording equipment, at which time monitoring would be stopped. If the launch occurs in darkness, night vision equipment will be used. Monitoring for each launch will include multiple surveys each day that record, when possible: species, number, general behavior, presence of pups, age class, gender, and reaction to sonic booms or natural or human-caused disturbances. Photos and/or video recordings will be taken when feasible.

Environmental conditions will also be recorded, including: visibility, air temperature, clouds, wind speed and direction, tides, and swell height and direction. A launch monitoring report containing all of the required information and in an approved format will be submitted to NMFS within its deadlines. An annual report describing all launch monitoring during each year will also be submitted to NMFS within its deadlines and in an approved format.

8.3 Scientific Research

VAFB did not renew the SRP that expired in 2014. No Air Force led research by VAFB is currently in progress or planned, however the Air Force has cooperated with permitted researchers from the University of California - Santa Cruz, California Polytechnic State University - San Luis Obispo and other universities.

Unexpected responses of pinnipeds to scientific research, beyond "alert" or "flush," will be promptly reported to NMFS and discussed in detail in VAFB's annual LOA report.

8.4 Coordination of Reporting Requirements

- Suggested means of minimizing burdens by coordinating such reporting requirements with other schemes already applicable to other persons conducting such activity.

Each monitoring task has its own reporting requirements. Monitoring tasks at VAFB are conducted by government employees or independent consulting firms selected by the Air Force, or in some cases, privately through the launch proponent (e.g., SpaceX). Task-specific reports, such as a monitoring reports for a specific launch or quarterly reports on monthly surveys, are submitted to natural resource managers in the 30th Civil Engineer Squadron, then to NMFS. At the end of each reporting period, annual reports are prepared by qualified personnel. Descriptions of various tasks in the annual reports are based on data from specific monitoring efforts over the year and often contain information about work conducted by other firms. This eliminates duplication of efforts and allows for a more objective approach in the annual reports.

8.5 Coordination of Research Activities

- Suggested means of learning of, encouraging and coordinating research opportunities, plans and activities related to reducing such incidental taking and evaluating its effects.

Monitoring tasks at VAFB are conducted by government employees and various qualified, independent consulting firms. New findings, such as the 2012 discovery of Steller sea lions at VAFB, or of northern elephant seal pupping in 2017 are promptly reported to NMFS.

A five-day launch monitoring effort may bracket a period of low tides needed for the monthly surveys. If two different firms have been selected for these separate tasks, such firms will coordinate with the natural resource managers in the 30th Civil Engineer Squadron. This means that one firm will share data needed by another firm so that a duplication of efforts does not occur. This reduces the potential for impacts from the research efforts by avoiding too many observers on the scene. As an example, a firm observing pinnipeds at Rocky Point to fulfill the five-day launch monitoring requirement will share its data with another firm conducting a monthly survey. The data applied to the monthly survey results will be obtained for the same survey day to ensure consistent data gathering. Since both firms will employ qualified biologists and utilize approved monitoring protocols, the LOA requirements can be satisfactorily met.

Ongoing research at VAFB on sea otters (*Enhydra lutris nereis*) is authorized by the USFWS. A variety of government agencies and universities participate in this research. Often such research takes biologists into areas not censused during launch monitoring efforts or monthly marine mammal surveys. Good communications between the researchers ensure that findings of interest to other researchers are shared. As one example, the presence of increased numbers of harbor seals at Point Conception and in nearby kelp beds (Laroche 2012) was of interest to researchers conducting monthly surveys at VAFB. In other cases, deceased sea otters that have washed ashore in areas monitored during launches or during monthly surveys are immediately brought to the attention of appropriate parties. When possible, researchers on the scene have collected the carcasses for pickup and detailed necropsies by authorized sea otter researchers. This has ensured that such carcasses are recovered before they begin to deteriorate, become washed away by a high tide, or scavenged by predators such as coyotes (*Canis latrans*) or turkey vultures (*Cathartes aura*). Each carcass is important, and fresh specimens are much more valuable because of what can be learned from them.

Research on western snowy plovers (*Charadrius nivosus*), federally listed as threatened, and California least terns (*Sternula antillarum browni*), federally listed as endangered, is carried out in season on various sandy beaches throughout VAFB. Purisima Point happens to host colonies of these listed birds as well as being a haul-out and rookery area for harbor seals. Marine mammal surveyors avoid conflicts by viewing harbor seals a safe distance from the birds with a spotting scope, or by providing monitors that also are qualified to work with both species of birds.

When launch monitoring is required at the NCI, notification is provided to Channel Islands National Park. In turn, checks are made to ensure that using a prospective launch monitoring site would not interfere with ongoing research on the island by others, especially NMFS researchers from the National Marine Mammal Laboratory in Seattle, who have a field station on San Miguel Island, and other researchers from NMFS Southwest Fisheries in La Jolla, CA. Launch monitors at San Miguel sometimes utilize the ranger station above Cuyler Harbor or the NMFS field station above Point Bennett as a base of operations. This is done on an as-available basis in a way that does not conflict with other island research activities. Launch monitors also coordinate travel to and from the NCI with the National Park Service and other researchers, for both personnel and supply transportation.

9 Potential Impact of Operations on Subsistence Uses

- Anticipated impact of activities on availability of species or stocks of marine mammals for subsistence uses;
- Availability and feasibility of equipment, methods, and manner of conducting activity or other means of effecting the least practicable adverse impact upon affected species or stocks, their habitat, availability for subsistence uses and;
- Plan of cooperation or information on measures taken to minimize adverse effects on availability of marine mammals for subsistence uses where proposed activity would take place in or near traditional arctic subsistence hunting area and/or affect the availability of species or stocks of marine mammals for arctic subsistence uses.

No subsistence use of marine mammals exists in or near this area of Air Force operations; thus, no impacts to such uses would occur.

10 Section 7 Consultations and Biological Opinions

Section 7 consultations for the federally listed threatened southern sea otter (*Enhydra lutris nereis*) were completed with the U.S. Fish and Wildlife Service. Two Biological Opinions are currently in effect for current launch programs on VAFB, authorizing potential effects to southern sea otters, including one Programmatic Biological Opinion issued to the Air Force (8-8-13-F-49R) and one issued to Space Exploration Technologies, Inc (SpaceX; Biological Opinion 2017-F-1480). In 2016, NMFS concurred with a finding that space launches were "may affect, but are not likely to adversely affect" the federally listed threatened Guadalupe fur seal on the NCI (NOAA-NMFS, 2016). We believe that the level of potential Level B take described in this application does not exceed the ESA "NLAA" determination described above.

The eastern U.S. stock of Steller sea lions was delisted on 4 November 2013 (NMFS 2013). Steller sea lions have been seen at VAFB in very small numbers (up to 16) starting in April 2012. The site at which the Steller sea lions were observed is included in monthly surveys.

11 Equipment, Methods and Activities to Minimize Adverse Impact upon Affected Species or Stocks and Their Habitat

The myriad of operations and requirements associated with each rocket and missile launch preclude the ability to easily alter or modify launch schedules. Launch dates are often scheduled months or years in advance. For example, avoiding launches "when possible" during pupping season has little realistic value.

As the launch date approaches, small technical issues and concerns frequently create short-term alterations to the launch schedule, or delay launches for longer periods. Therefore, it is not practicable to modify launch schedules. Required monitoring and procedures in place for marine mammal protection ensure the least practicable adverse impacts from launches to marine mammals and their habitats on VAFB and the NCI.

Unless constrained by human safety, national security, or launch trajectories, the Air Force shall ensure the least practicable adverse impacts on Pacific harbor seals, California sea lions, northern elephant seals, Steller sea lions and northern fur seals, by:

(A) Ensuring that all aircraft and helicopter flight paths maintain a minimum distance of 1,000 feet from recognized seal haul-outs and rookeries (e.g., Point Sal, Purisima Point, Rocky Point), except in emergency situations such as Law Enforcement response or Search and Rescue operations (Small Haul-Out 1 has a 500 foot avoidance distance);
(B) Unmanned aerial vehicles in classes 0-2 avoid pinnipeds by a minimum of 300 feet;
(C) Avoiding, whenever possible, launches that will produce a sonic boom over the Northern Channel Islands during the peak pinniped pupping season of March through June; and
(D) Reviewing the launch procedure and monitoring methods. In cooperation with NMFS, if any incidents of injury or mortality of a pinniped discovered during post-launch surveys or indications of affects to the distribution, size, or productivity of the affected pinniped populations as a result of the authorized activities are thought to have occurred. If necessary, appropriate changes must be made through modification to this Authorization prior to conducting the next launch of the same vehicle.

11.1 Summary of Monitoring Protocols for VAFB

For launches that occur during the elephant seal and/or harbor seal pupping season (1 January to 31 July),

(A) Monitoring will be conducted by at least one qualified marine mammal observer, trained in marine mammal science (refer to section 8.2.1), at each appropriate pinniped monitoring location, to record the effects of launches on pinniped populations.
(B) Monitoring at the haul-out site closest to the appropriate launch facility will commence at least 72 hours prior to the launch and continue until at least 48 hours after the launch.
(C) A follow-up survey will be made within two weeks of the launch to ensure that there were no adverse effects to marine mammals.
(D) For launches that occur during daylight, monitoring will be supplemented with video recording of mother-pup seal responses to the launch.
(E) Acoustic and biological monitoring will be conducted for new launch vehicles and other programs during at least the first launch, whether it occurs within the pupping season or not.
(F) Monitoring for each launch will include multiple surveys each day that record, when possible: species, number of animals, general behavior, presence of pups, age class, gender, and reaction to launch noise (only during the harbor seal and Northern elephant seal pupping seasons), sonic booms, or other natural or human-caused disturbances. Environmental conditions, including: tide, wind speed, air temperature, and swell will also be recorded.
(G) A report detailing the collected information will be submitted to the NOAA NMFS within 90 days of each monitored launch.

For launches that occur the remainder of the year (1 August to 31 December), no monitoring will be required (the current situation at VAFB).

11.2 Summary of Monitoring Protocols for the NCI

Using a sonic boom prediction model to determine the location of sonic booms in the vicinity of the NCI, biological and acoustic monitoring will be conducted on the NCI (San Miguel, Santa Cruz, and/or Santa Rosa Islands) whenever a sonic boom greater than 2.0 psf is predicted to impact one of the islands between 1 March and 31 July; greater than 4.0 psf between 1 July and 31 December; greater than 3.0 psf between 1 January and 28 February.

(A) Monitoring will be conducted at the closest significant haul-out site to the sonic boom impact area.
(B) Monitoring will be conducted by at least one qualified marine mammal observer, trained in marine mammal science.
(C) Monitoring will commence at least 72 hours prior to the launch and continue until at least 48 hours after the launch, unless no sonic boom is detected by the monitors and the acoustic recording equipment, at which time monitoring would be stopped.
(D) Monitoring for each launch will include multiple surveys each day that record, when possible: species, number of animals, general behavior, presence of pups, age class, gender, and reaction to launch noise, sonic booms or other natural or human-caused disturbances. Environmental conditions will also be recorded, including: tide, wind speed, air temperature, and swell. Due to the large numbers of pinnipeds found on some beaches of SMI, smaller focal groups should be monitored in detail rather than the entire beach population. A general estimate of the entire beach population should be made once a day and reaction to the launch noise noted.
(E) During the pupping season, and for launches that occur during daylight, monitoring will be supplemented with photography or video recording of mother-pup seal responses to the launch.
(F) During the pupping season of any species affected by a launch (Table 7), a follow-up survey will be made within two weeks of the launch to ensure that there were no adverse effects on any marine mammals.
(G) A report detailing the collected information will be submitted to the NOAA NMFS within 90 days of each monitored launch.

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APPENDIX A

SpaceX Launch and Landing
Vandenberg Air Force Base

Prepared by:

ManTech SRS Technologies, Inc.

30 CES/CEIEA

17 December 2018

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ACRONYMS AND ABBREVIATIONS

˚C	degrees Celsius
˚F	degrees Fahrenheit
dB	decibel
dBA	A-weighted decibe
ESA	Endangered Species Act
ft.	foot or feet
FTS	Flight System Termination
km	kilometer
km^2	square kilometer(s)
lb.	pound(s)
LOA	Letter of Authorization
m	meter
MECO	Main Engine Cut Off
mi.	mile(s)
MMPA	Marine Mammal Protection Act
nm	nautical miles
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
psf	pounds per square foot
rms	root mean squared
SLC	Space Launch Complex
SLC-4W	Space Launch Complex 4 West
SLC-4E	Space Launch Complex 4 East
SpaceX	Space Exploration Technologies Corporation
U.S.	United States
U.S.C.	United States Code
USAF	United States Air Force
VAFB	Vandenberg Air Force Base

1 Description of Activity

1.1 Introduction

Vandenberg Air Force Base (VAFB) occupies approximately 99,100 acres (400 square kilometers [km^2]) of central Santa Barbara County, California, approximately halfway between San Diego and San Francisco (Figure 1-1). The Santa Ynez River and State Highway 246 divide VAFB into two distinct parts: North Base and South Base. Space Launch Complex (SLC) 4 West (SLC-4W), which is located on South Base, approximately 0.5 miles (mi.) (0.8 kilometer [km]) inland from the Pacific Ocean, is the primary landing facility for the Falcon 9 First Stage on VAFB (Figure 1-2). SLC-4 East (SLC-4E), which is located approximately 715 feet (ft.) (218 meters [m]) east of SLC-4W, is the launch facility for the Falcon 9 Program (Figure 1-2). Although SLC-4W is the preferred landing location for the Falcon 9 First Stage, SpaceX has identified two contingency landing locations in the Pacific Ocean that would be exercised if there were critical assets on south VAFB that would not permit an overflight of the First Stage or other reasons that would not permit landing at SLC-4W (e.g., heavy payload). These contingency landing locations are depicted in Figure 1-3 and are referred to as the Contingency Landing Location and Iridium Landing Area.

SpaceX is currently operating the Falcon 9 Launch Vehicle Program at SLC-4 on VAFB. National Oceanic and Atmospheric Administration (NOAA) Fisheries Office of Protected Resources previously issued regulations and Letters of Authorization (LOA) that authorize the take of marine mammals, by Level B harassment, incidental to launches of up to 50 rockets per year from VAFB (79 Federal Register 10016). This LOA is effective from March 2014 to March 2019 and includes Falcon 9 launches at VAFB.

SpaceX received an IHA from NOAA Fisheries, dated May 19, 2016, for Falcon 9 First Stage recovery activities. This IHA was valid from June 30, 2016, to June 29, 2017. On August 2, 2016, SpaceX notified NOAA Fisheries that it was proposing to perform barge landings southwest of San Nicolas Island ("Iridium Landing Area") because of mission restrictions. NOAA Fisheries concurred that a take of marine mammals would not likely occur from this change and a revision to the IHA was not warranted (Jordan Carduner, NOAA Fisheries, pers. comm. August 3, 2016). Only one landing occurred during the IHA period, which was in the Iridium Landing Area. Therefore, the Falcon 9 boost-back and landing did not result in any takes of marine mammals during this period.

SpaceX proposes to perform Falcon 9 First Stage boost-back and landings, up to 12 events per year, at either SLC-4W or the contingency landing locations, which is an increase from the prior year.

Regional Map of Santa Barbara and San Luis Obispo Counties

Location of the Proposed Action Area
(SLC-4 on Vandenberg Air Force Base)

0 6 12 18 24 Miles

Figure 1-1. Regional Location of VAFB

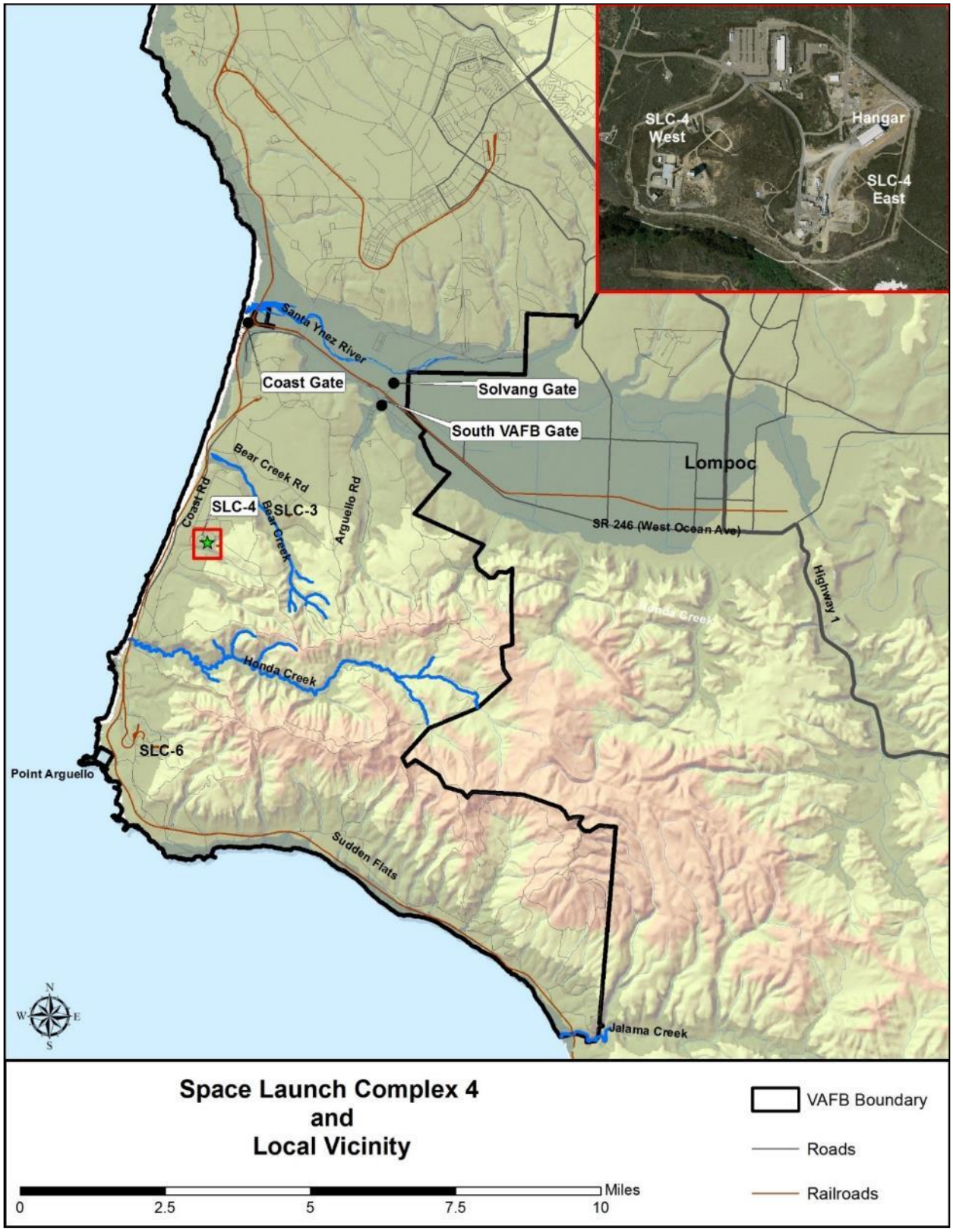

Figure 1-2. Location of SLC-4 and Vicinity

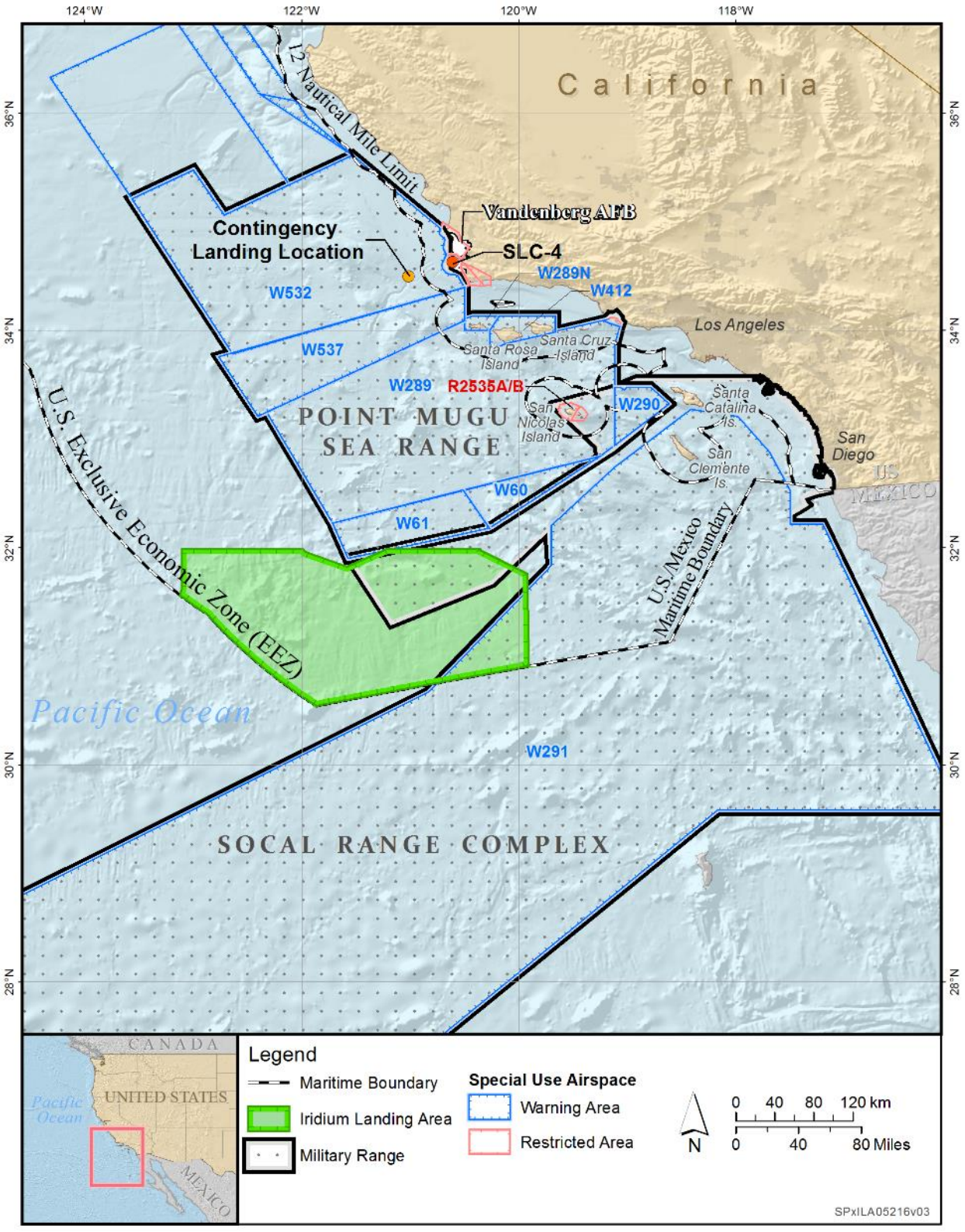

Figure 1-3. Proposed Contingency Landing Areas and Vicinity

1.2 Proposed Action

SpaceX proposes to return the Falcon 9 First Stage booster to SLC-4 for potential reuse up to 12 times per year. This includes performing boost-back maneuvers (in-air) and landings of the Falcon 9 First Stage on the pad at SLC-4W or at two contingency landing options should it not be feasible to land the First Stage at SLC-4W. The first contingency landing option is on a barge located at least 27 nautical miles (nm) (50 km) offshore of VAFB. The second contingency landing option is on a barge within the Iridium Landing Area. The Iridium Landing Area is an approximately 33,153 square kilometers (km^2) area that is located approximately 122 nm (225 km) southwest of San Nicolas Island's coastal waters and 133 nm (245 km) southwest of San Clemente Island's coastal waters. It extends as far north as 32nd parallel north (32°N), as far east as the Patton Escarpment, and as far south and west as the U.S. Pacific Coast Region Exclusive Economic Zone (Figure 1-3). Table 1 depicts the current SpaceX launch schedule from SLC-4 and the anticipated landing areas (Note that this schedule is subject to unanticipated changes).

Table 1. Notional Falcon 9 Launch Schedule from SLC-4

Date	Booster	Payload	Landing Location
Jan 7 2019	Falcon 9	Iridium 7	Droneship
Feb 1 2019	Falcon 9	RadarSat	SLC-4W
Sep 1, 2019	Falcon 9	Flight 53	SLC-4W
Oct 1, 2019	Falcon 9	SAOCOM	SLC-4W

1.2.1 Falcon 9 Boost-back and Landing at SLC-4W

SpaceX proposes to return the Falcon 9 First Stage booster to SLC-4W at VAFB for potential reuse up to 12 times per year. The Falcon 9 First Stage is 12 ft. in diameter and 160 ft. in height, including the interstage that would remain attached during landing.

Figure 1-4 provides a graphical depiction of the boost-back and landing sequence. Figure 1-5 shows an example of the boost-back trajectory of the First Stage (depicted by the green path) and the second stage trajectory (depicted by the yellow path). After the First Stage engine cutoff, concurrent to the second stage ignition and delivery of the payload to orbit, exoatmospheric cold gas thrusters would be initiated to flip the First Stage into position for a "retrograde burn." Three of the nine First Stage Merlin engines would be restarted to conduct the retrograde burn in order to reduce the velocity of the First Stage and to place the First Stage in the correct angle to land. Once the First Stage is in position and approaching its landing target, the three engines would cut off to end the boost-back burn. The First Stage would then perform a controlled descent using atmospheric resistance to slow the stage down and guide it to the landing pad target. The First Stage is outfitted with grid fins that allow cross range corrections as needed. The landing legs on the First Stage would then deploy in preparation for a final single engine burn that would slow the First Stage to a velocity of zero before landing on the landing pad at SLC-4W.

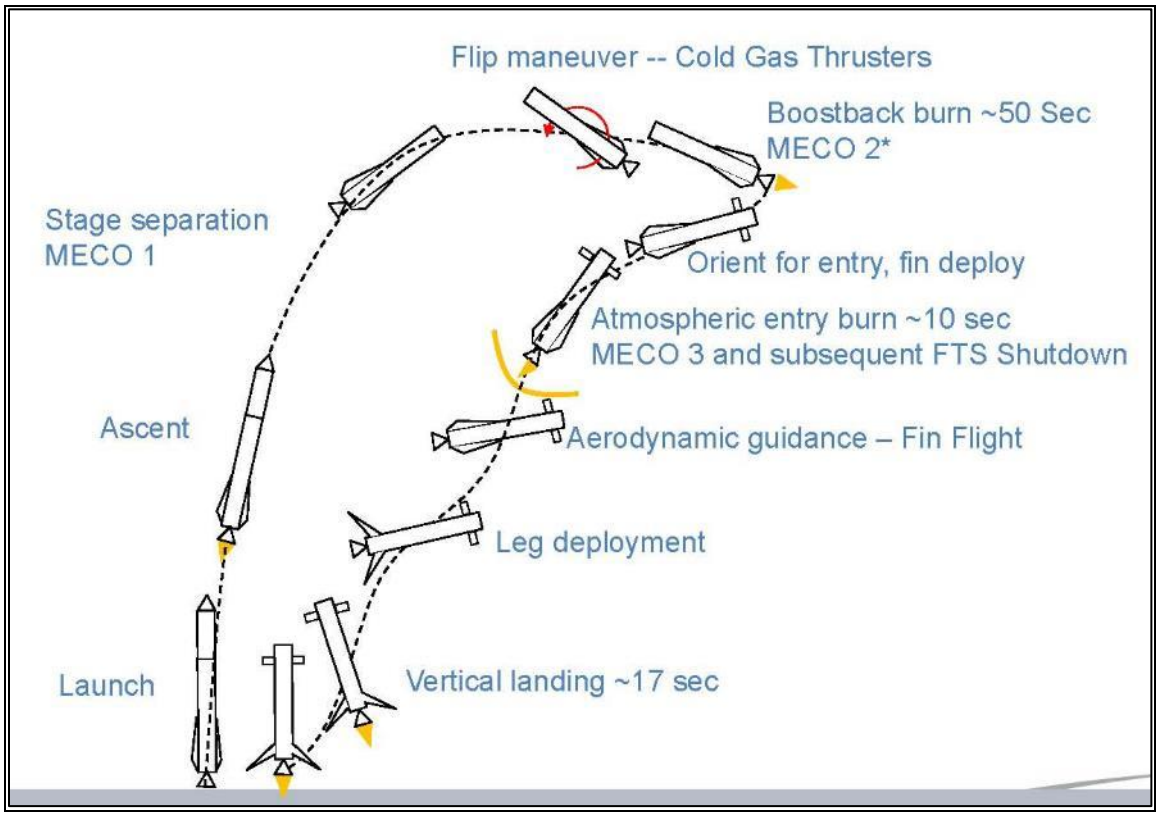

Figure 1-4. Stages of Boost-Back and Propulsive Landing
(Notes: MECO = Main Engine Cut Off; FTS = Flight Termination System)

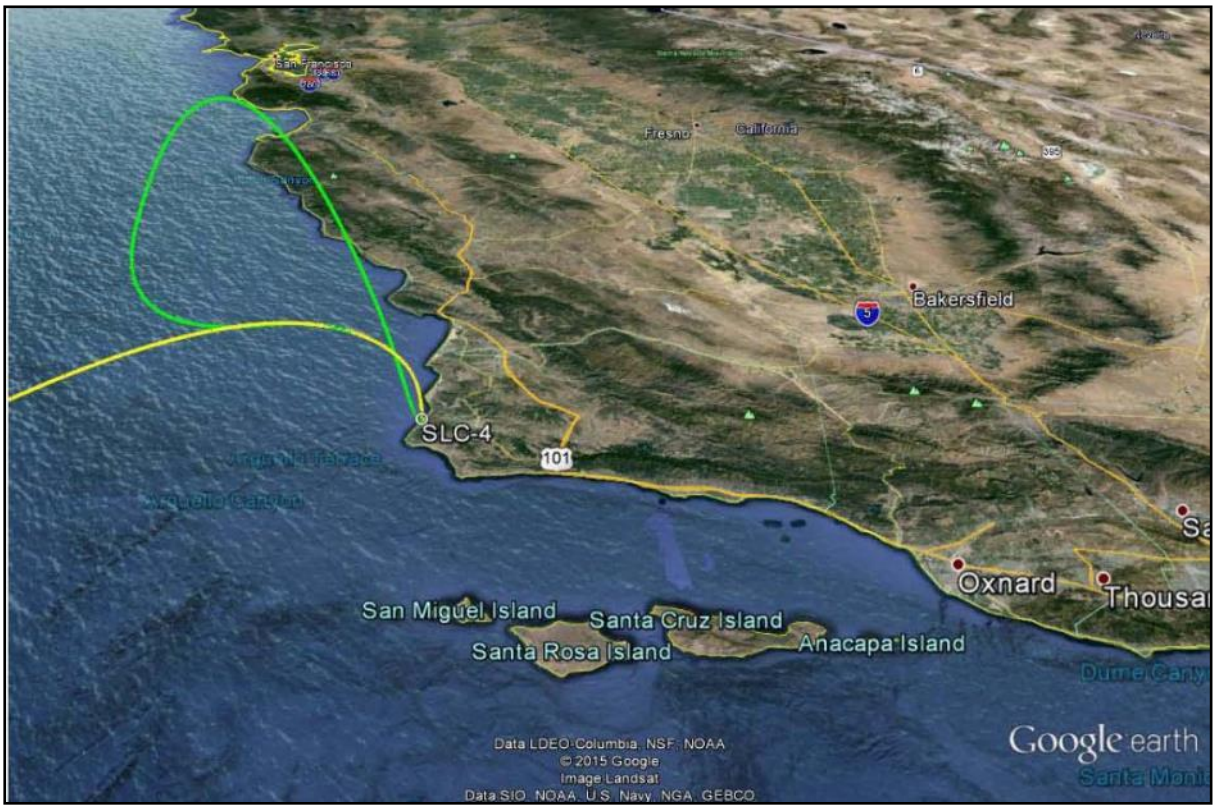

Figure 1-5. Example Trajectories for the Falcon 9's First Stage Return Path (green line) and Second Stage Path (yellow line) for a landing at SLC-4W on VAFB

1.2.2 Contingency Barge Landing

As a contingency action to landing the Falcon 9 First Stage on the SLC-4W pad at VAFB, SpaceX proposes to return the Falcon 9 First Stage booster to a barge in the Pacific Ocean (Figure 1-6). The barge is specifically designed to be used as a First Stage landing platform and would be located at least 27 nm (50 km) offshore of VAFB (Figure 1-7) or within the Iridium Landing Area (Figure 1-8). These contingency landing locations would be used when landing at SLC-4W would not be feasible. The maneuvering and landing process described above for a pad landing would be the same for a barge landing. Three vessels would be required for a barge landing:

1. Barge/Landing Platform – approximately 300 ft. long and 150 ft. wide;
2. Support Vessel – approximately 165 ft. long research vessel; and
3. Ocean Tug – 120 ft. long open water commercial tug.

The support vessels would originate from Long Beach Harbor and be positioned to support contingency landings. The tug and support vessel would be staged 5 to 7 mi. away from the landing location. The barge to be used as the landing platform was originally a McDonough Marine Deck Barge with dimensions of 300 ft. by 100 ft. The barge has an operational displacement of 24,000,000 pounds (lb.) and is classified as an American Bureau of Shipping Class-A1 Ocean barge. The Barge was modified to accommodate the First Stage landing by increasing its width to 150 ft. and installing a dynamic positioning system and a redundant communications and command and control system. The barge has been inspected by the U.S. Coast Guard, and SpaceX has obtained a Certificate of Inspection for its operation under the service of Research Vessel.

Figure 1-6. Barge Landing Platform

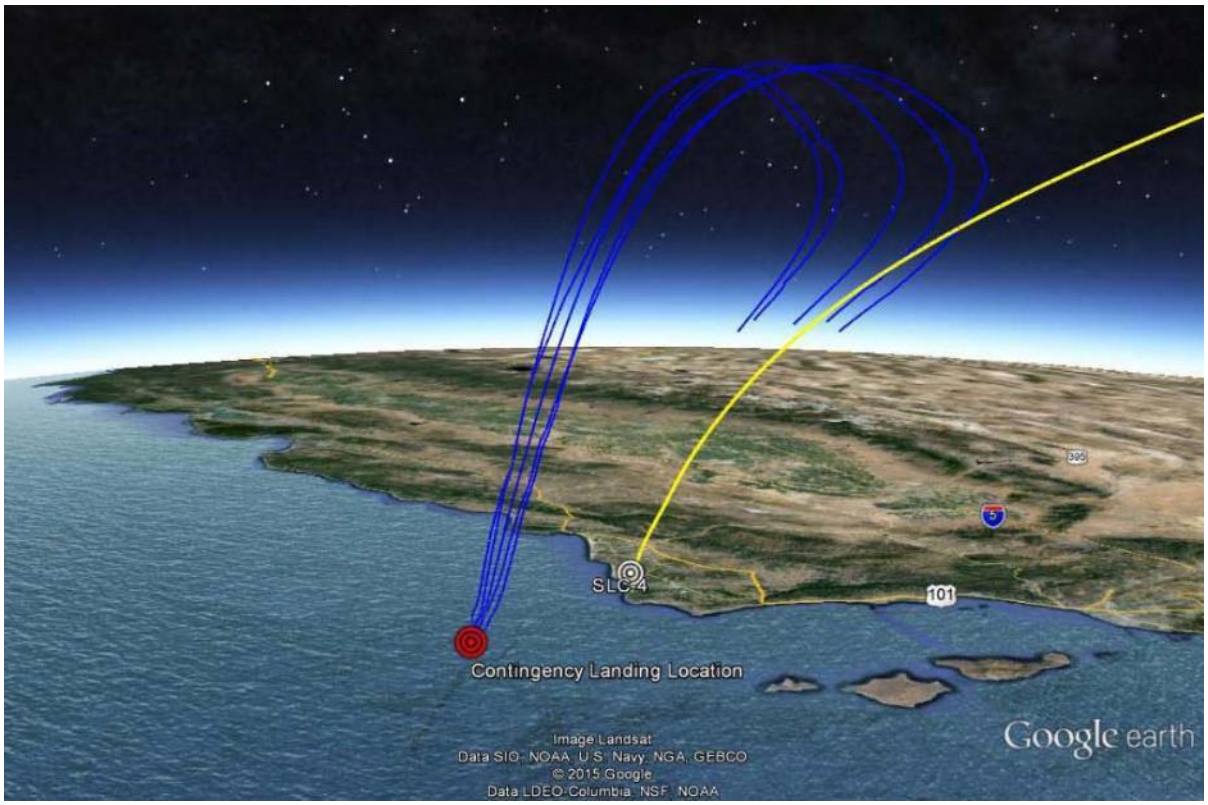

Figure 1-7. Trajectories for Variations of the Contingency First Stage Return Path to a Barge Landing at the Contingency Landing Location (blue lines) and Second Stage Path (yellow line)

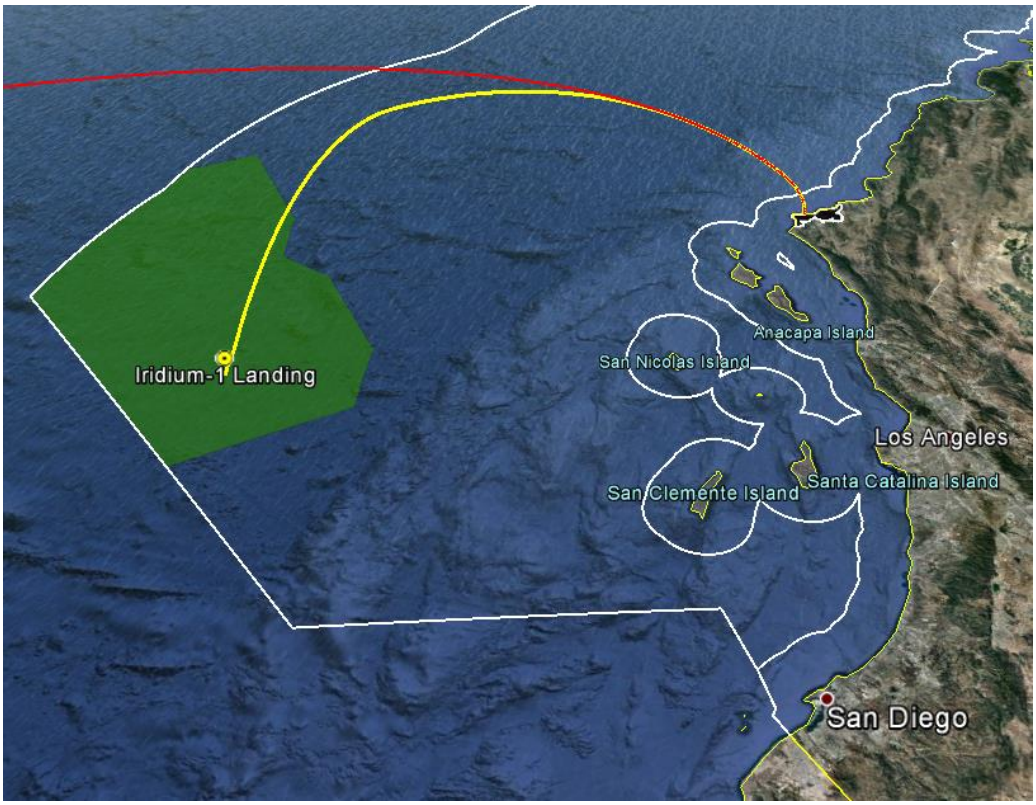

Figure 1-8. Trajectories for Variations of the Contingency First Stage Return Path to a Barge Landing within the Iridium Landing Area (yellow line)

The Support Vessel is a 165 ft. long research vessel that is capable of housing the crew, instrumentation and communication equipment, and supporting debris recovery efforts, if necessary. The U.S. Coast Guard would have the opportunity to have a representative on this vessel during the operation and a representative in the Launch and Landing Control on VAFB to coordinate required clearances and approve access back to the barge after the landing after the landing as they deem required.

The Tug is a 120 ft. open-water commercial ocean vessel. The primary operation of the tug is to tow the barge into position at the landing site and tow the barge and rocket back to Long Beach Harbor. After landing, the First Stage would be secured onto the barge and transported to the Long Beach Harbor for off-loading hazardous materials and transport to a SpaceX testing facility in McGregor, Texas, to complete acceptance testing again before re-flight. Once testing is completed, the First Stage would be transported back to the SLC-4W pad or another SpaceX launch facility for reuse.

1.2.2.1 Concept of Operation for Barge Landing

The following outlines the concept of operation for a barge landing. All times are correlated to a launch time of T-0:

T-12 Hours	Barge/landing platform on-station and crew begins system activations
T-6 Hours	Tow line is released and the barge is holding position via the dynamic positioning system
T-4 Hours	The crew transfers from the barge to the support vessel
T-2 Hours	The support vessel departs the area to a pre-determined staging area, and VAFB Range Safety is notified
T-1 Hour	The support vessel is at the staging area and Range Safety has been notified
T+8 minutes	Landing occurs
T+10 minutes	Range Safety confirms it is safe for the support vessel and tug to return to the landing site and conveys permission to reenter area
T+60 minutes	The support vessel and tug are back at the landing site
T+2 hours	The barge/landing platform is secured to the towline for towing to Long Beach Harbor.

T- = time to scheduled launch, T+ = time after launch

2 Duration and Location of Activities

SpaceX would perform up to twelve boost-back and landing events per year during all times of the year. A sonic boom (overpressure of high-energy impulsive sound) and landing noise would be generated during each boost-back event and are therefore expected parts of the Proposed Action that helps define the geographic area of impact. During an unsuccessful barge landing, the Falcon 9 First Stage would likely explode, creating an impulsive in-air noise. These acoustic stressors, as well as other potential stressors, would have different geographic regions of influence and are described below.

2.1 Launches

SpaceX launches the Falcon 9 at SLC-4E. During launch events, the Falcon 9 would emit a combustible light source (flame) as engines ignite. These light emissions would be more visible during nighttime operations. The launch noise is estimate to be up to approximately 110 A-weighted decibels (dBA) at the landing pad (Figure 2-1). This noise would attenuate below 70 dBA approximately 11 mi. from SLC-4E. From the launch pad, the trajectory of the Falcon 9 First Stage would be either westward or southward from SLC-4E depending on the payload's orbital mission.

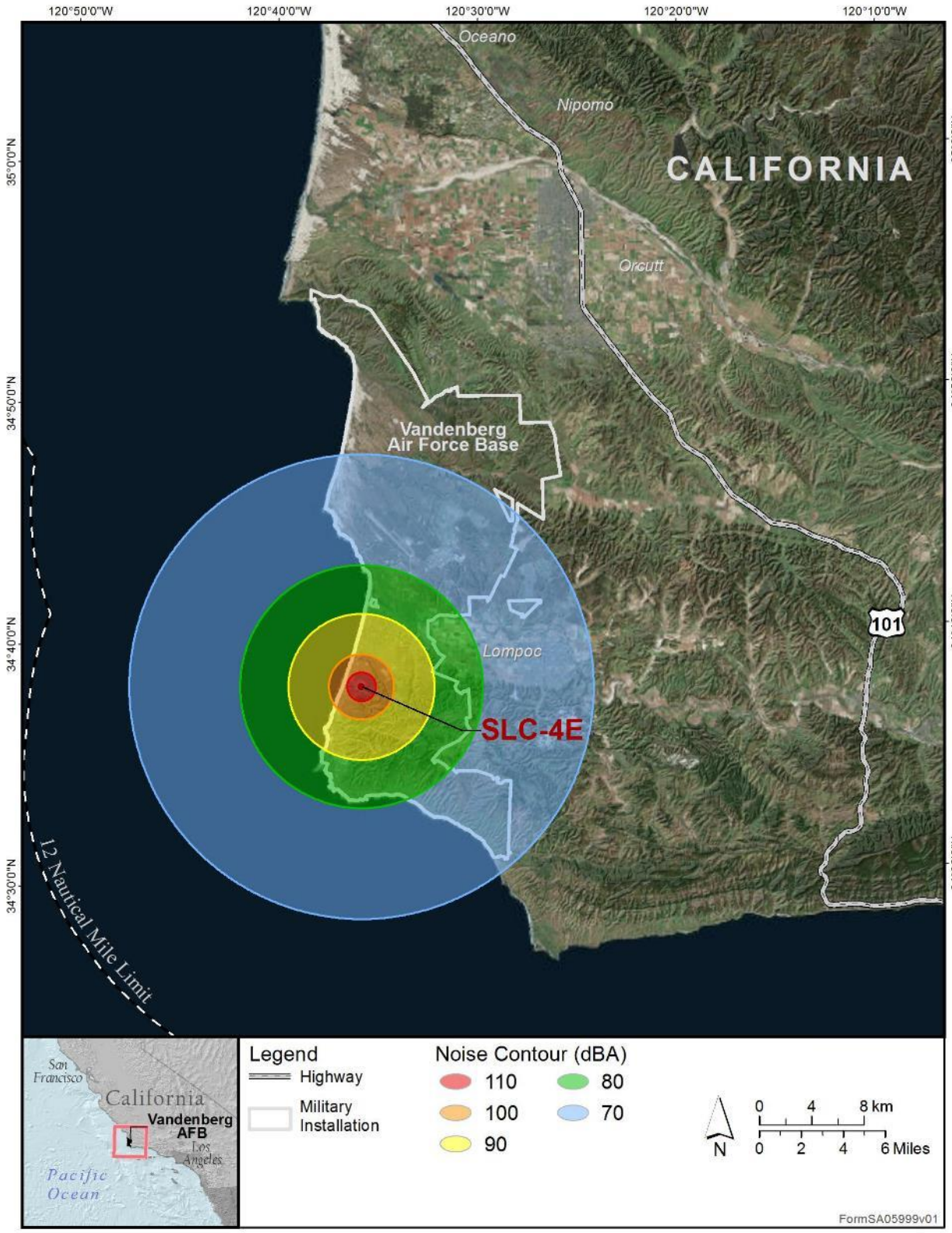

Figure 2-1. Estimated Launch Noise of Falcon 9 First Stage at SLC-4E

2.2 Sonic Boom

During descent, when the First Stage is supersonic, a sonic boom (overpressure of high-energy impulsive sound) would be generated. Sonic booms would occur in proximity to the landing areas and may be heard during or briefly after the boost-back and landing, depending on the location of the observer. Previous acoustic modeling determined these overpressures would reach as high as 2.0 pounds per square feet (psf) at the landing area and up to 3.1 psf south of the landing areas. Recent observations show that these early models underestimated the near-field overpressures. Therefore, SpaceX and the U.S. Air Force (USAF) have developed new estimates for near-field overpressures based on actual observations from past Falcon 9 First Stage boost-back and landing events.

The USAF predicts that a boost-back and landing of the Falcon 9 First Stage at SLC-4W would produce a sonic boom with overpressures as high as 8.5 psf at SLC-4W, which would attenuate to levels below 1.0 psf at approximately 15.90 mi. (25.59 km) from the landing area (Figure 2-2). This estimate is based, in part, on actual observations from Falcon 9 boost-backs and landings at Cape Canaveral. Wyle predicted that a boost-back and landing of the Falcon 9 First Stage at SLC-4W would produce a sonic boom with overpressures up to 3.1 psf in the North Channel Islands (San Miguel Island, Santa Rosa Island, and Santa Cruz Island) (Figure 2-5 and Figure 2-5). In addition, Blue Ridge Research Consultation predicts that a boost-back and landing of the Falcon 9 First Stage at SLC-4W would produce sonic boom with overpressures between 0.5 and 2 psf near the Northern Channel Islands (James, et al., 2017) (Figure 2-3). The Wyle and Blue Ridge Research Corporation models provide a more accurate representation of likely far-field effects from a sonic boom (i.e., overpressures at the North Channel Islands) than Figure 2-2.

During a contingency barge-landing event, sonic boom overpressure would be directed at the ocean surface while the first-stage booster is supersonic. The Wyle model is used to show potential far-field effects from First Stage landings offshore of VAFB or within the Iridium Landing Area. It is anticipated that the Northern Channel Islands would experience overpressures of less than 1 psf from a First Stage barge landing off the coast of VAFB (Figure 2-6 and Figure 2-7). First Stage boost-backs and landings within the Iridium Landing Area would not likely produce measurable overpressures at any land surface (Figure 2-8 and Figure 2-9).

2.3 Landing Noise

Previously, SpaceX proposed to use a single engine burn during landing. SpaceX now proposes to use a three-engine burn during landing. This engine burn, lasting approximately 17 seconds, would generate between 70 and 110 decibels (dB) of noise centered on SLC-4W, but affecting an area up to 15 nm (27.8 km) offshore of VAFB (Figure 2-10). Engine noise would also be produced during the barge landing of the Falcon 9 First Stage, which was estimated by extrapolating the landing noise profile from a SLC-4W landing. Engine noise during the barge landing is expected to be between 70 and 110 dB non-pulse, in-air noise affecting a radial area up to 15 nm (27.8 km) around

the contingency landing location (Figure 2-11) and the Iridium Landing Area (Error! Reference source not found.**).**

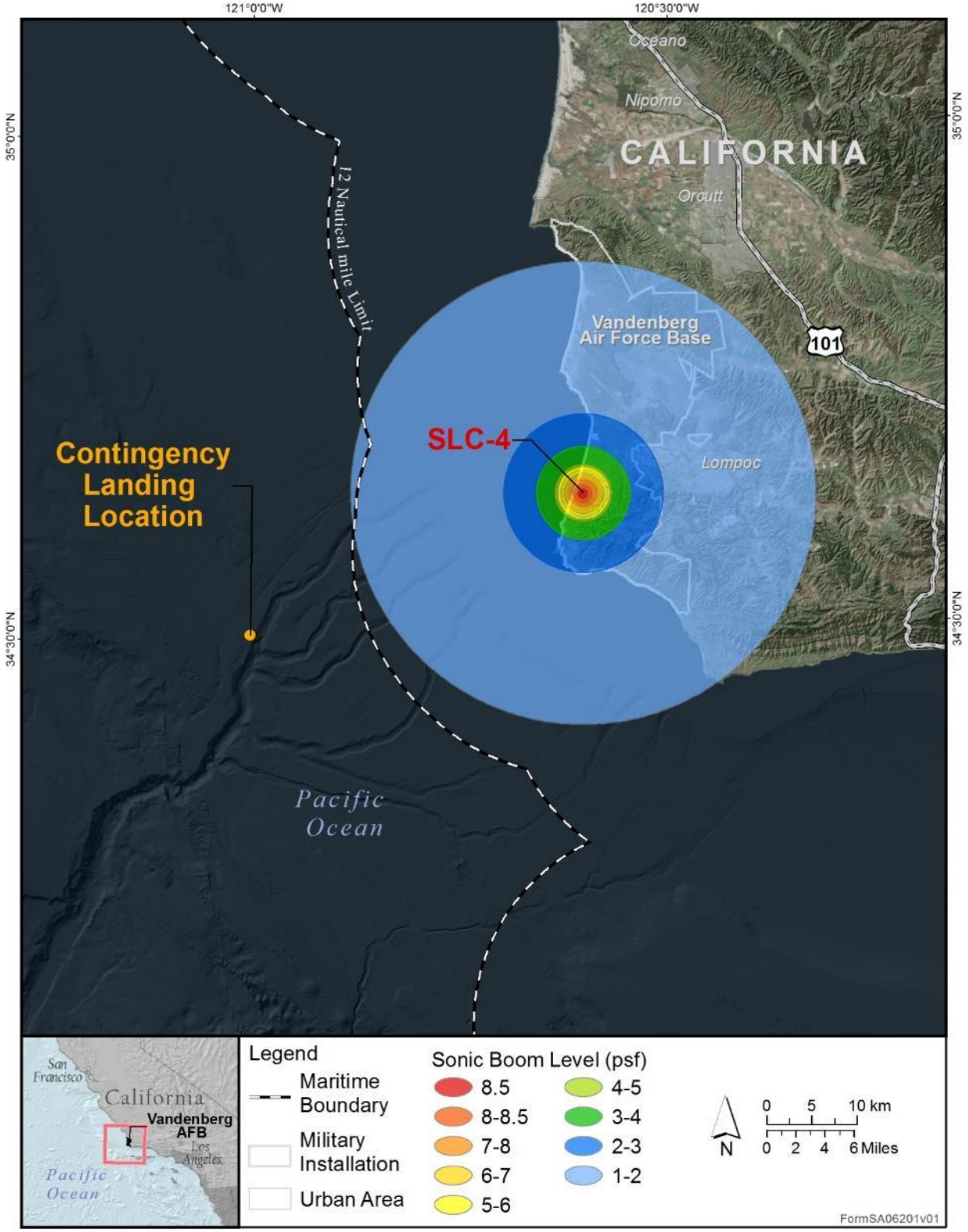

Figure 2-2. Estimated Near-Field Sonic Boom Contours for Falcon 9 First Stage Landing at SLC-4W (USAF Model)

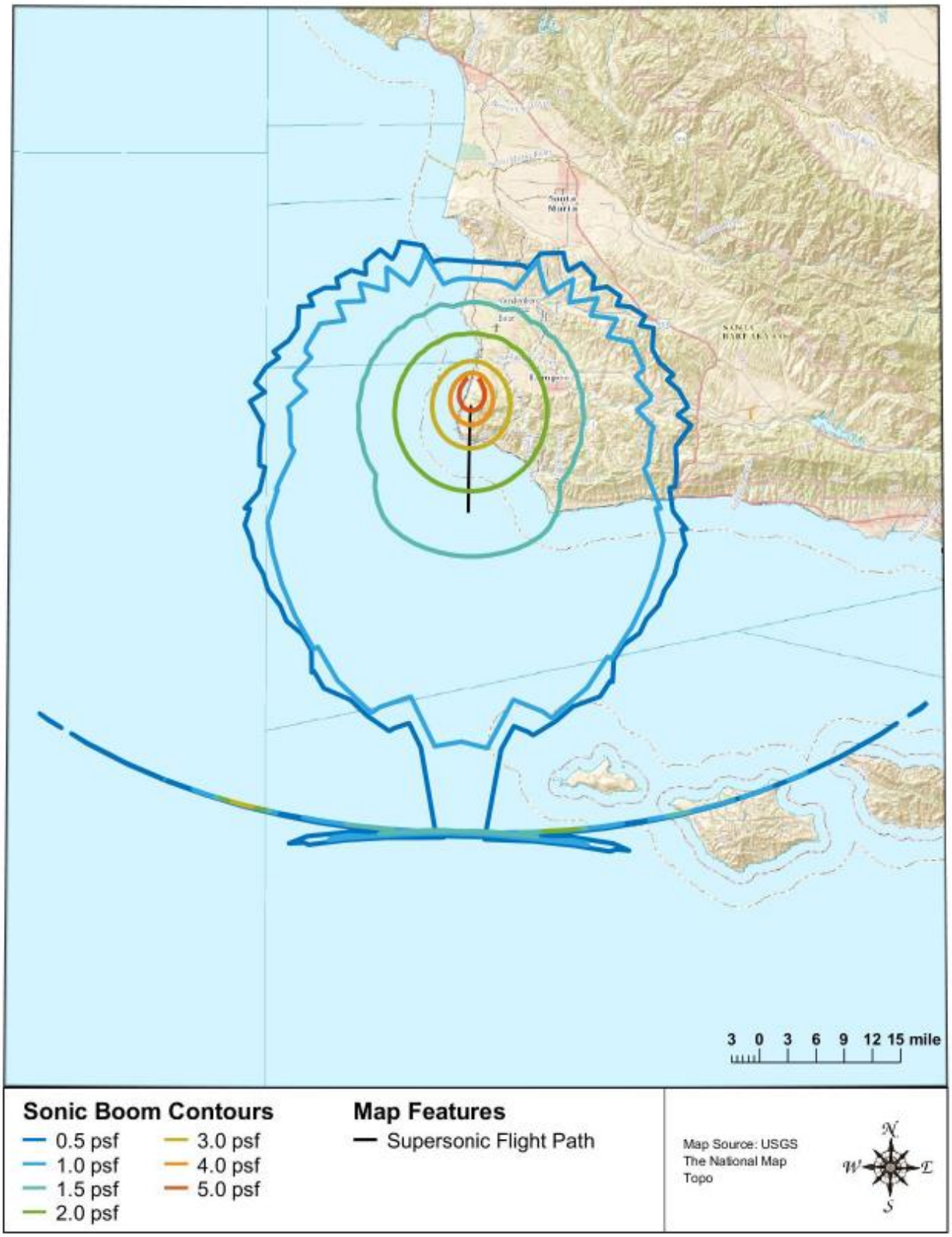

Figure 2-3. Estimated Far-Field Sonic Boom Contours for Falcon 9 First Stage Landing at SLC-4W (Blue Ridge Research Corporation Model)

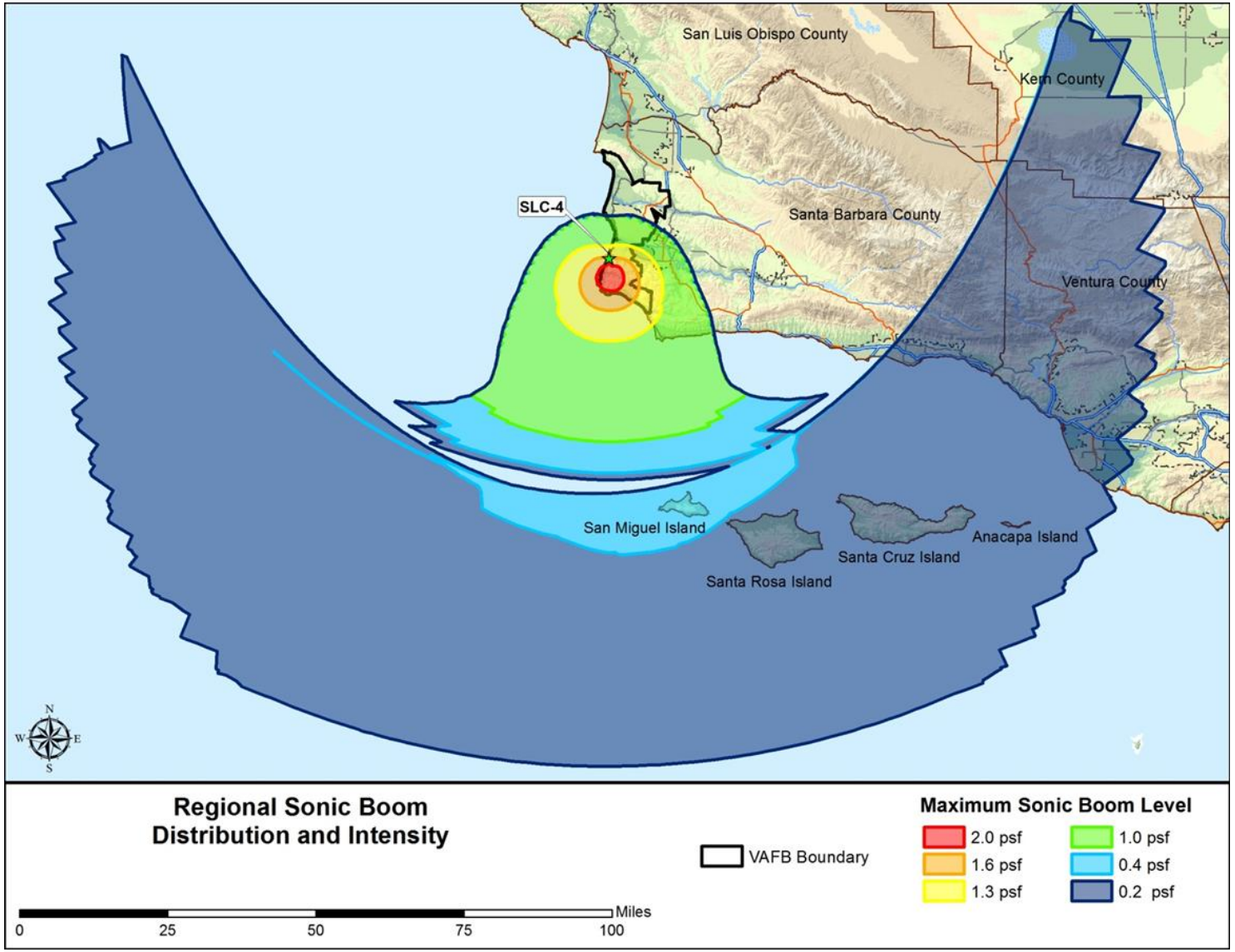

Figure 2-4. Estimated Far-Field Sonic Boom Contours for Falcon 9 First Stage Landing at SLC-4W with an Incoming Trajectory for a Light Payload (Wyle Model)

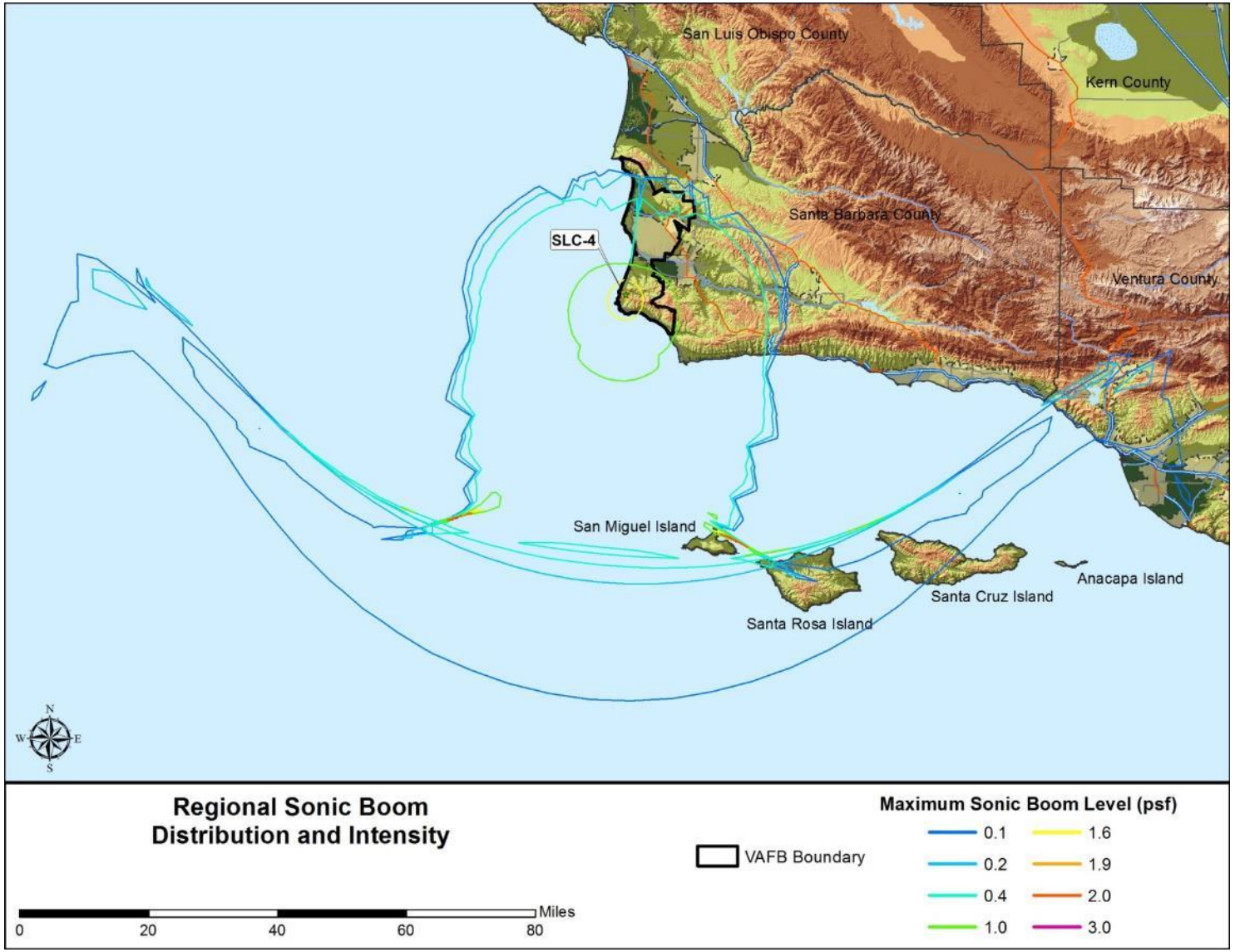

Figure 2-5. Estimated Far-Field Sonic Boom Contours for Falcon 9 First Stage Landing at SLC-4W with an Incoming Trajectory for a Heavy Payload (Wyle Model)

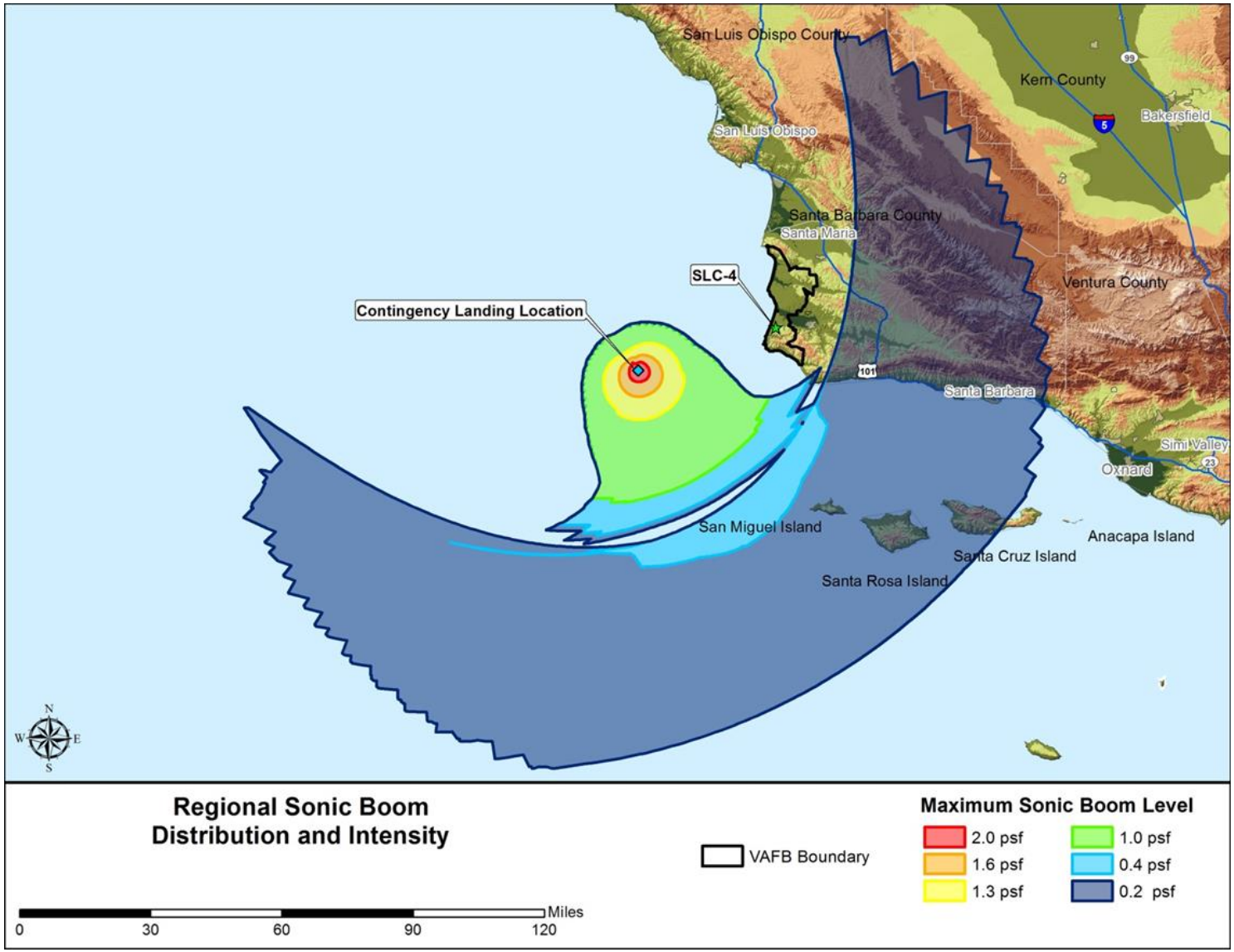

Figure 2-6. Hypothetical Far-field Sonic Boom Overpressure for Contingency Action of Drone Ship Landing Offshore of VAFB with an Incoming Trajectory for a Light Payload (Wyle Model)

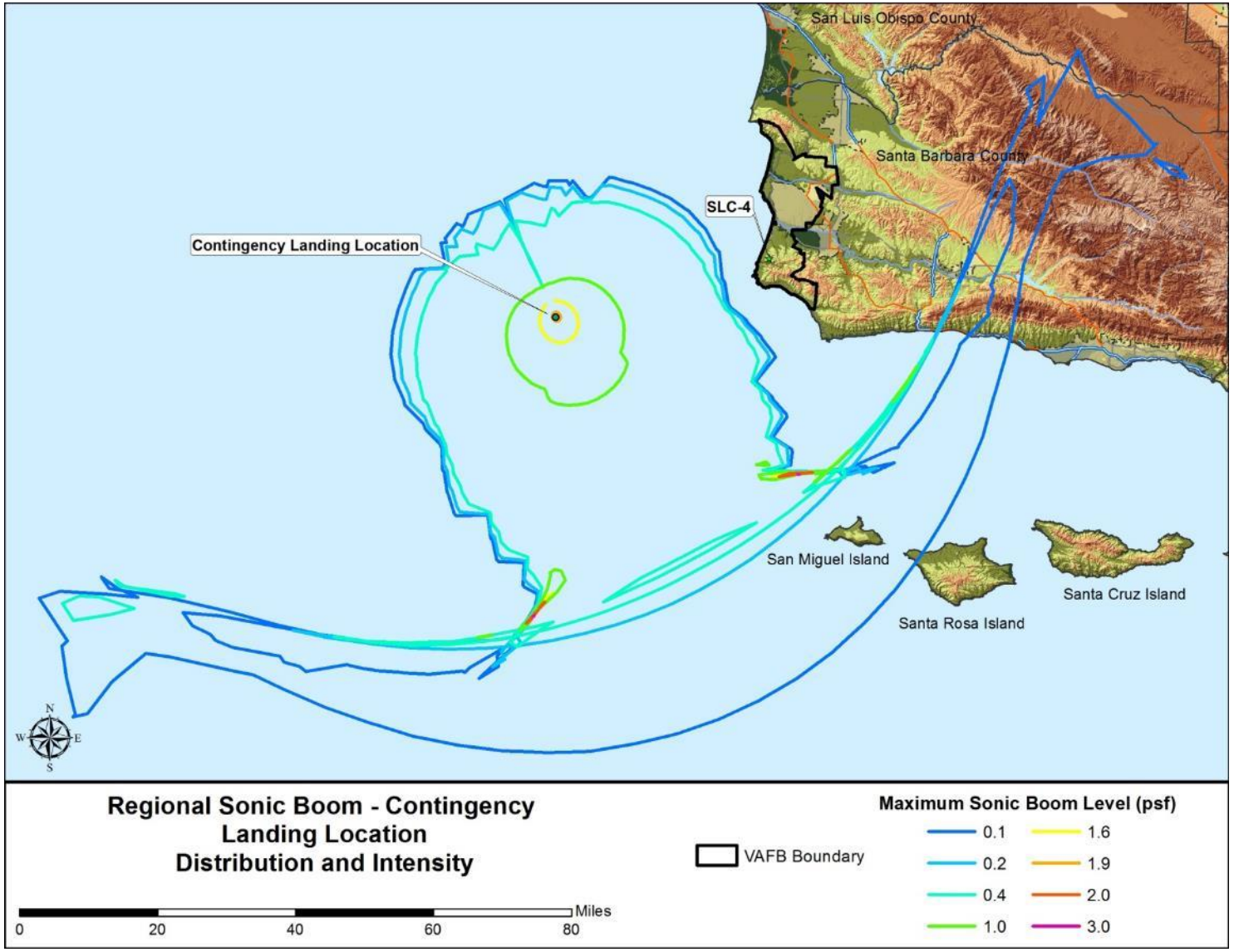

Figure 2-7. Hypothetical Far-field Sonic Boom Overpressure for Contingency Action of Drone Ship Landing Offshore of VAFB with an Incoming Trajectory for a Heavy Payload (Wyle Model)

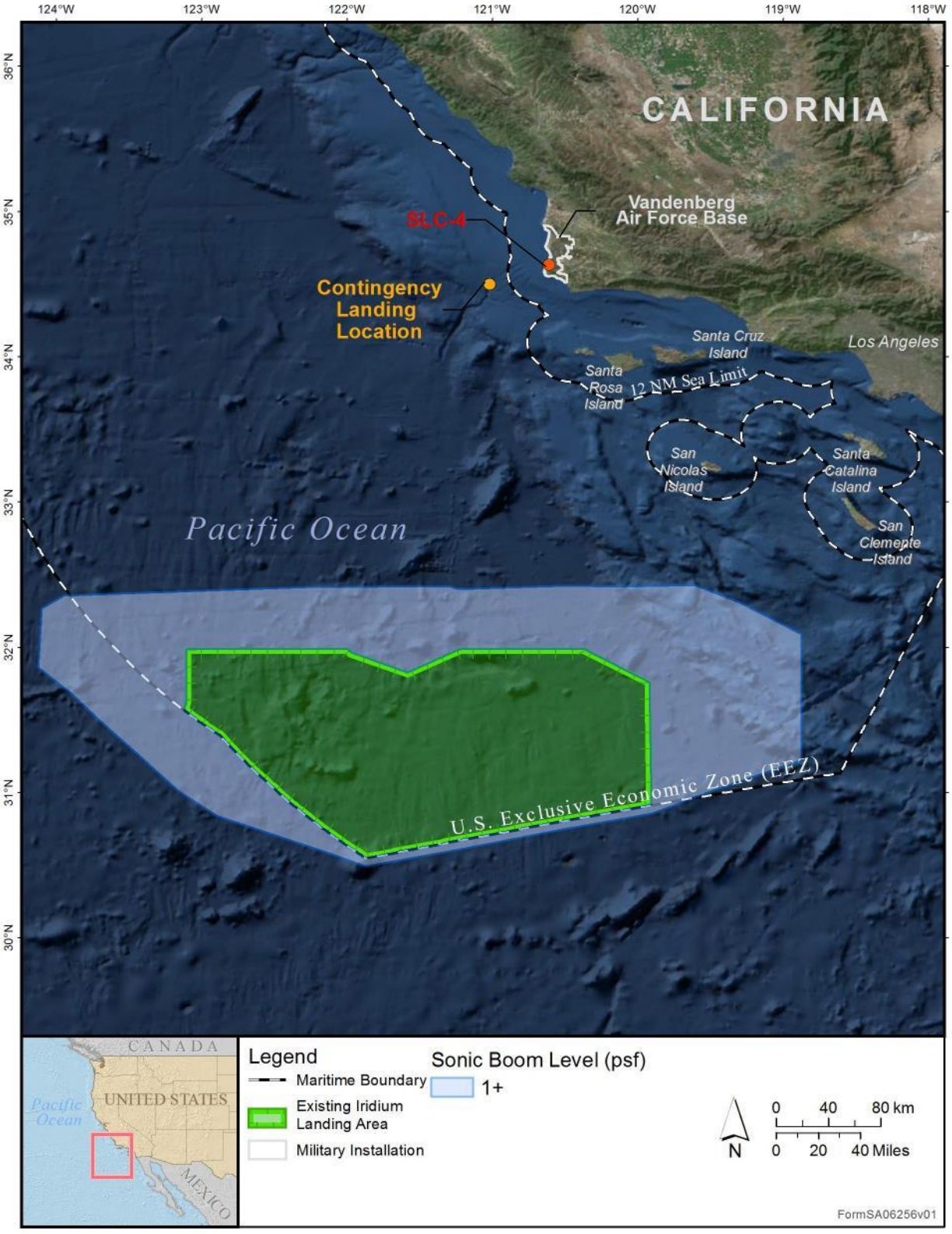
124°W
123°W
122°W
121°W
120°W
119°W
118°W
36°N
35°N
34°N
33°N
32°N
31°N
30°N
CALIFORNIA
Vandenberg Air Force Base
SLC-4
Contingency Landing Location
Santa Cruz Island
Los Angeles
Santa Rosa Island
12 NM Sea Limit
San Nicolas Island
Santa Catalina Island
San Clemente Island
Pacific Ocean
U.S. Exclusive Economic Zone (EEZ)
CANADA
UNITED STATES
Pacific Ocean
MEXICO
Legend
Maritime Boundary
Existing Iridium Landing Area
Military Installation
Sonic Boom Level (psf)
1+
N
0 40 80 km
0 20 40 Miles
FormSA06256v01

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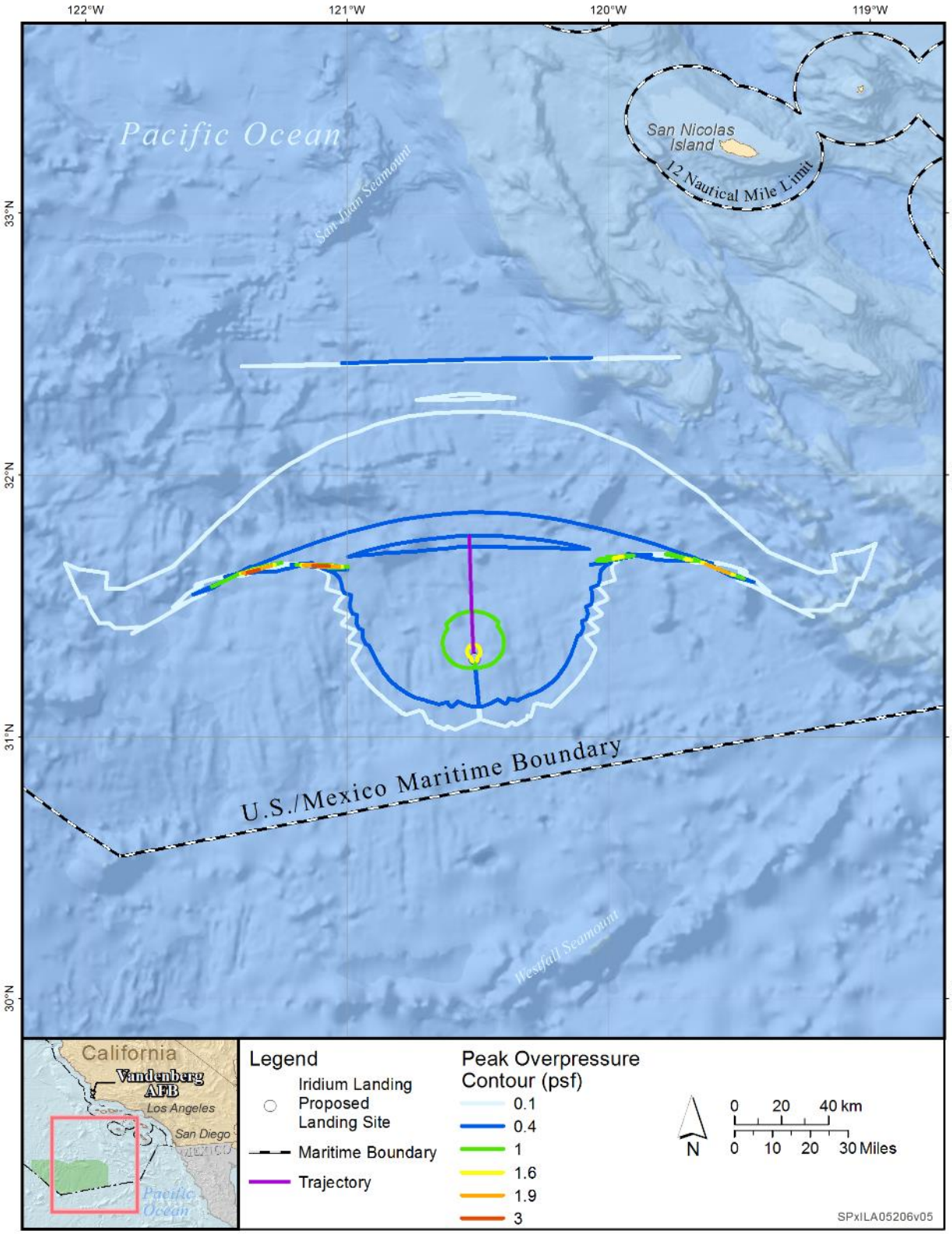
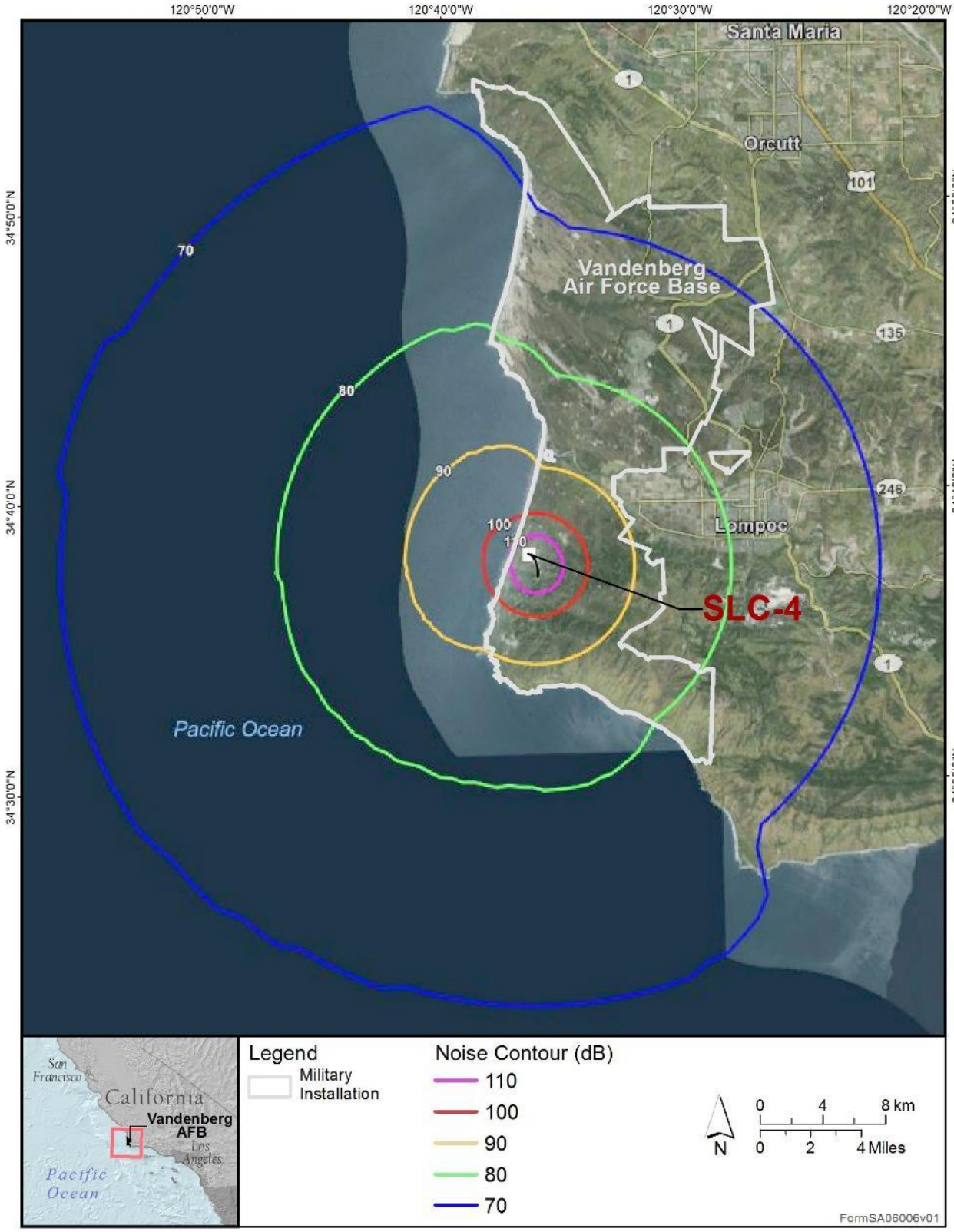
Figure 2-8. Estimated Far-Field Sonic Boom Contours for Falcon 9 First Stage Landing within the Iridium Landing Area



Source: (Bradley, 2016b)

Figure 2-9. Example Sonic Boom within the Iridium Landing Area (Wyle Model)



Source: (Bradley, 2016a)

Figure 2-10. Estimated Landing Noise of Falcon 9 First Stage at SLC-4

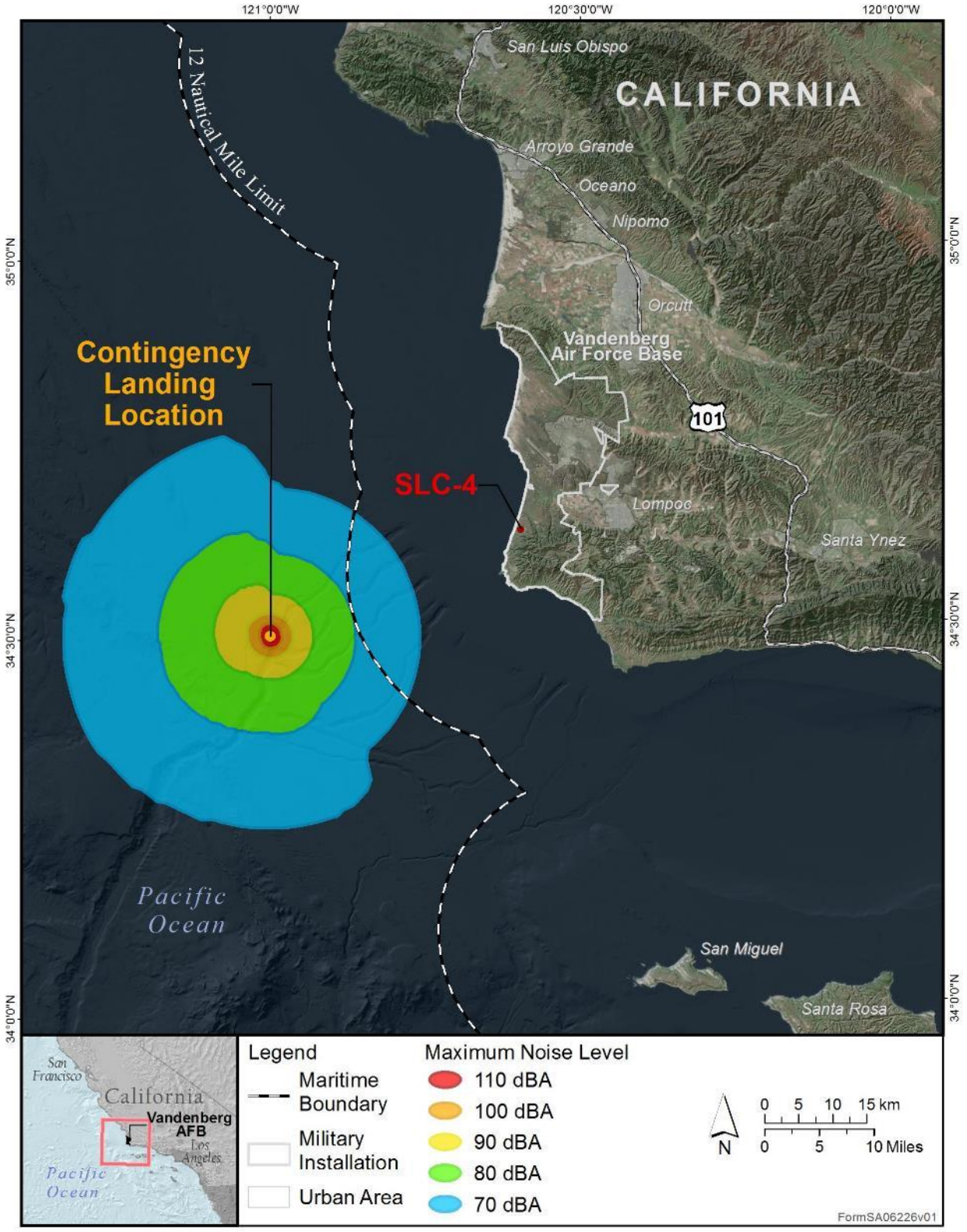
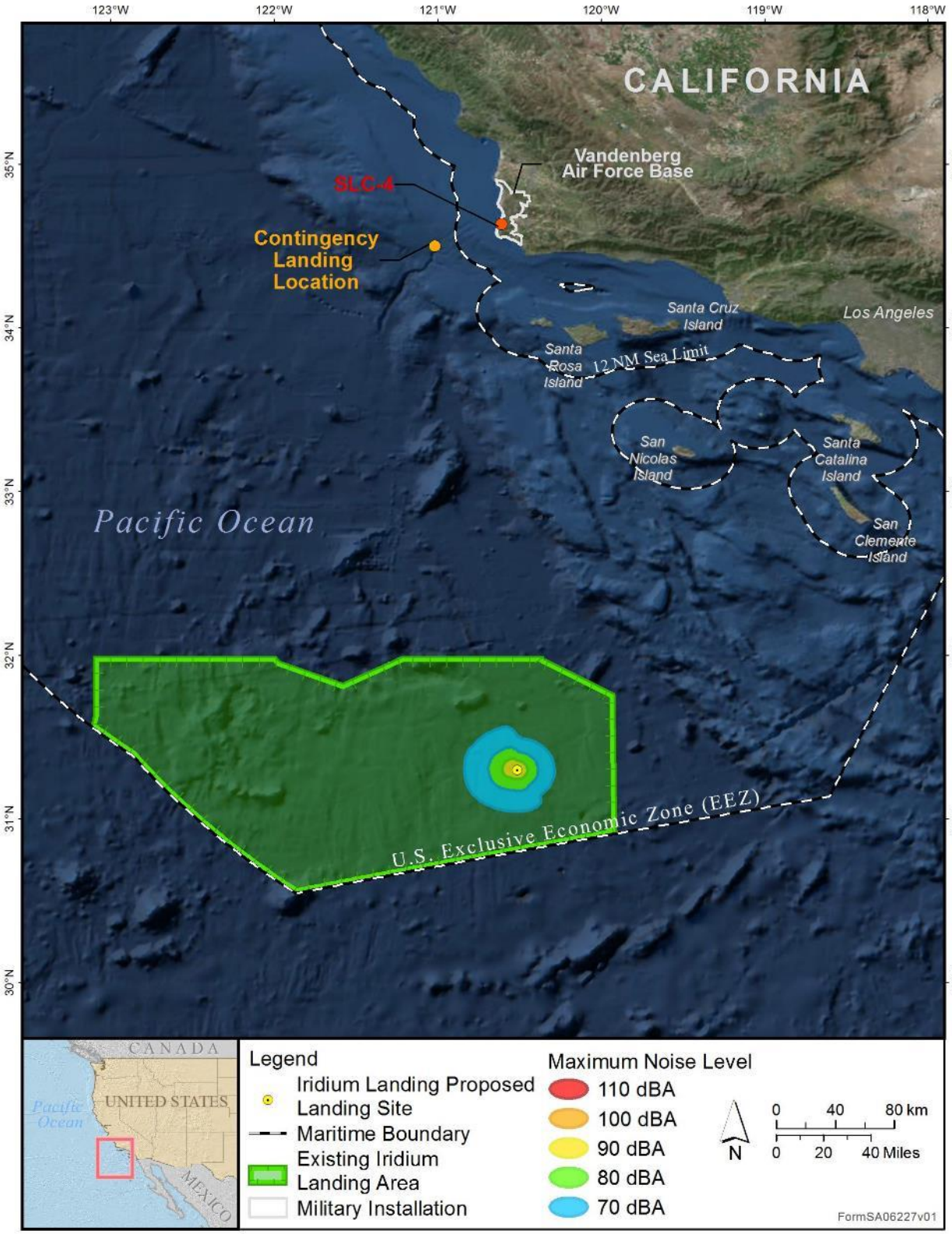


Figure 2-11. Estimated Landing Noise of Falcon 9 First Stage at the Contingency Landing Location



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