

Summary

S.1 Introduction

The Federal Aviation Administration (FAA) is evaluating Space Exploration Technologies Corporation's (SpaceX) Starship/Super Heavy program, in particular a proposal to operate the Starship/Super Heavy launch vehicle at its existing Boca Chica Launch Site in Cameron County, Texas (Figure S-1) and conduct launches originating from this site. SpaceX must obtain an experimental permit and/or a vehicle operator license from the FAA to operate the Starship/Super Heavy launch vehicle. Issuing an experimental permit or a vehicle operator license is considered a major federal action under the National Environmental Policy Act (NEPA) of 1969, as amended (42 United States Code 4321, et seq.), and the Council on Environmental Quality NEPA-implementing regulations (40 Code of Federal Regulations [CFR] Parts 1500–1508 [2020]) and requires an environmental review. The FAA is the lead federal agency for this environmental review.

SpaceX plans to execute its Starship/Super Heavy program over the next several years and may require a number of new or modified experimental permits or vehicle operator licenses issued from the FAA in order to execute the program. Thus, the FAA has drafted a Programmatic Environmental Assessment (PEA), which evaluates the potential environmental impacts of the activities associated with SpaceX's Starship/Super Heavy program. The FAA is not licensing the entire Starship/Super Heavy program because SpaceX does not have the full details of all its planned operations at this time. The applicant, however, has provided the FAA with an initial mission profile that has been analyzed in this PEA.

A programmatic document is a type of general, broad NEPA review from which subsequent NEPA documents can be tiered, focusing on the issues specific to the subsequent actions. The use of a programmatic environmental impact statement (EIS) or EA, and subsequent preparation of a project specific EIS or EA, is referred to as "tiering" the environmental review. The FAA has recognized that a programmatic review and tiering may be appropriate "to sequence environmental documents from the early stage of a proposed action to a subsequent stage to help focus on issues that are ripe for decision and exclude from consideration issues not yet ripe or already decided."¹

The completion of the environmental review process does not guarantee that the FAA will issue an experimental permit or vehicle operator license to SpaceX for Starship/Super Heavy launches at the launch site. SpaceX's license application must also meet FAA safety, risk, and financial responsibility requirements per 14 CFR Chapter III.

S.2 Purpose and Need

The purpose of SpaceX's proposal is to provide greater mission capability to the National Aeronautics and Space Administration, Department of Defense, and commercial customers. SpaceX's activities would continue to fulfill U.S. expectation that space transportation costs are reduced to make continued exploration, development, and use of space more affordable. The Space Transportation section of the

¹ See Paragraph 3-2, FAA Order 1050.1F, Environmental Impacts: Policies and Procedures. See also 40 CFR 1501.11 (2020).

National Space Transportation Policy of 1994 addressed the commercial launch sector, stating that “assuring reliable and affordable access to space through U.S. space transportation capabilities is fundamental to achieving National Space Policy goals.”

SpaceX’s proposal is needed to increase operational capabilities and cost effectiveness of space flight programs. Satisfaction of these needs benefits government and public interests to continue resource protection and reduce operation costs. Demand for launch services has continued to increase over the past 20 years beyond that originally proposed, and the space industry growth projections indicate this will continue into the foreseeable future.

SpaceX is now developing a multi-mission, fully reusable, super heavy-lift launch vehicle (Starship/Super Heavy). Starship/Super Heavy would reduce the cost of access to space, exceeding the capabilities of the Falcon 9 and Falcon Heavy launch vehicles, enabling cost-effective delivery of cargo and people to the Moon and Mars. SpaceX’s proposal would satisfy requirements for more efficient and effective space transportation methods and continue the U.S. goal of encouraging activities by the private sector to strengthen and expand U.S. space transportation infrastructure.

Figure S-1. Launch Site Location



S.3 Public Involvement

The FAA is using multiple methods of stakeholder engagement and public outreach to solicit comments and feedback regarding the proposal. The FAA conducted a public scoping process and is publishing this draft PEA for public review and comment.

The FAA sent an email on November 23, 2020, to interested parties notifying them that the FAA was in the beginning stages of conducting an environmental review for SpaceX's Starship/Super Heavy proposal. The FAA also sent an email December 22, 2020, stating that the agency was holding a public scoping period to determine the scope of issues for analysis in the draft PEA. The email provided an overview of the proposed project and the indication that the FAA would be considering the preparation of a programmatic EA as well as an overview of the FAA's overall environmental review process. The scoping comment period was open through January 22, 2021.

A total of 321 comments were received between December 22, 2020, and January 26, 2021. Concerns raised by commenters about the project included the following:

- Potential impacts on protected species and habitat
- Potential cumulative effects of the proposed project and other development projects in the Rio Grande Valley
- Closure of public areas such as local roads and Boca Chica Beach
- Level of environmental review (i.e., the appropriateness of an EA versus an environmental impact statement [EIS])
- Potential impacts on airspace
- Potential impacts on minority and low-income residents
- Potential impacts on land of cultural importance
- Safety of launch operations given the proximity to nearby liquefied natural gas facilities
- Degradation of the environment due to test and launch operations

Positive impacts raised by commenters included the following:

- Economic benefits to the regional economy
- Continued innovation and progress in commercial space transportation
- Benefits of reusable launch vehicles
- Job creation
- Ideal southerly location

All comments received during the scoping period were given equal consideration in the preparation of the draft PEA.

In accordance with CEQ's NEPA-implementing regulations and FAA Order 1050.1F, the FAA released this draft PEA for a 30-day public review. The FAA provided public notice of the availability of the draft PEA for public review and comment in the Federal Register and on its project website.

Following the close of the public comment period, the FAA will revise the draft PEA, as appropriate, in response to comments received, and a final EA will be prepared. The final PEA will reflect the FAA's consideration of comments and will provide responses to substantive comments. Following review of the final PEA, the FAA will either issue a Finding of No Significant Impact (FONSI), Mitigated FONSI, or issue a Notice of Intent to prepare an EIS.

The FAA developed a project website² and email listserv (which can be joined through the project website) to inform the public of the project. The FAA will update the website and provide email updates as the PEA and FAA licensing process progresses.

S.4 Proposed Action and Alternatives

The draft PEA for the Starship/Super Heavy Program was prepared by SpaceX under the supervision of the FAA. The FAA has an obligation, consistent with 40 CFR 1506.5(a) and 14 CFR 450.47, to independently evaluate and to take responsibility for the contents of the PEA. Subsequent to that independent evaluation, the PEA becomes a Federal document supporting the Federal actions described in the analyses. In the PEA, SpaceX has evaluated the environmental effects of certain launch-related infrastructure and pre-launch testing; however, the FAA's Federal action is limited to the licensing of launches and only certain pre-launch activity. By evaluating the Program, rather than only the Proposed Federal Action, the PEA represents a broad disclosure of environmental effects because it examines impacts of activities that are not part of the Federal action subject to NEPA review or special purpose law compliance.

The draft PEA evaluates two alternatives: the Proposed Action and the No Action Alternative.

S.4.1 Proposed Action (Preferred Alternative)

The FAA's Proposed Action, which is the preferred alternative, is to issue one or more experimental permits and/or a vehicle operator license(s) to SpaceX that would allow SpaceX to launch, which can include landing, Starship/Super Heavy. SpaceX's goal is to use Starship/Super Heavy for low Earth orbit, sun-synchronous orbit, geostationary transfer orbit, and interplanetary missions for cargo and humans.

The environmental analysis in the PEA focuses on the Boca Chica Launch Site, including potential additional development at the site. The FAA may conduct environmental reviews of additional proposed launch and reentry sites if SpaceX further develops proposals. Such reviews may be tiered off this PEA as appropriate.

SpaceX's proposed Starship/Super Heavy program consists of testing operations (suborbital launches) and orbital launches. If SpaceX becomes more successful with test flights, the Starship/Super Heavy launch vehicle program would increase orbital launches and perform fewer testing operations.

² See: https://www.faa.gov/space/stakeholder_engagement/spacex_starship/.

Annual proposed launch operations include suborbital launches and/or orbital launches. SpaceX’s proposal also includes launch-related activities at the Boca Chica Launch Site, such as tank tests, static fire engine tests, expansion of the vertical launch area (VLA) and solar farm, and construction of additional infrastructure. Finally, the proposal includes two potential landing sites for components of the Starship/Super Heavy—in the Gulf of Mexico and off the Hawaiian coast. All elements of the Proposed Action and SpaceX’s proposal are identified in Table S-1.

Table S-1. Elements of the Proposed Action

FAA Proposed Action	Elements of SpaceX’s Proposal	Brief Description
Issuance of an Experimental Permit or Vehicle Operator License	Test and Launch Operations	<ul style="list-style-type: none"> • Starship Static Fire Engine Tests • Super Heavy Static Fire Engine Tests • Starship Suborbital Launch • Super Heavy Launch • Starship Land Landing • Super Heavy Land Landing
	Tank Tests	<ul style="list-style-type: none"> • Test the structural capability of the launch vehicle stages
	Nominal Operational Closures	<ul style="list-style-type: none"> • SpaceX anticipates the proposed operations would require 500 hours of annual closure
	Anomaly Response Closures	<ul style="list-style-type: none"> • SpaceX anticipates debris cleanup would require up to 300 hours of annual closure to be used at the discretion of Cameron County, TPWD, TGLO, and USFWS
	Related Infrastructure Construction	<ul style="list-style-type: none"> • Redundant Launch Pad (Launch Pad B) and Commodities (11 tanks) • Redundant Landing Pad • Integration Towers • Tank Structural Test Stands • Desalination Plant • Support Buildings and Parking Lots • Power Plant • Trenching • Payload Processing Facility • Natural Gas Pretreatment System • Liquefier • Expanded Solar Farm • State Highway 4 Pull-offs

TPWD = Texas Parks and Wildlife Department; TGLO = Texas General Land Office; USFWS = U.S. Fish and Wildlife Service

S.4.2 Launch Vehicle

The fully integrated launch vehicle is comprised of two stages: Super Heavy is the first stage (or booster), and Starship is the second stage. The fully integrated Starship/Super Heavy launch vehicle is expected to be approximately 400 feet tall and 30 feet in diameter. As designed, both stages are reusable, with any potential refurbishment actions taking place at SpaceX facilities. Both stages are expected to have minimal post-flight refurbishment requirements; however, they might require periodic maintenance and upgrades. Unlike the SpaceX Falcon launch vehicle, Starship/Super Heavy would not have separable fairings or parachutes.

Super Heavy is expected to be equipped with up to 37 Raptor engines, and Starship will employ up to six Raptor engines. The Raptor engine is powered by liquid oxygen (LOX) and liquid methane (LCH₄) in a 3.6:1 mass ratio, respectively. Super Heavy is expected to hold up to 3,700 metric tons (MT) of propellant and Starship will hold up to 1,500 MT of propellant. Super Heavy, with all 37 engines, will have a maximum lift-off thrust of 74 meganewtons (MN), allowing for a maximum lift-off mass of approximately 5,000 MT. Starship, with six engines, will have a maximum lift-off thrust of 12 MN, allowing for a maximum lift-off mass of approximately 1,000 MT. Launch propellant and commodities are currently stored at the VLA in aboveground tanks. Commodities include liquid nitrogen (LN₂), water, gaseous oxygen, gaseous methane, gaseous nitrogen, helium, hydraulic fluid, LOX, and LCH₄.

S.4.3 Operations

Operations include tank tests, pre-flight operations, suborbital launches, and orbital launches. SpaceX is still in the testing stages of the launch vehicle, including ongoing Starship prototype tests that have been approved under a separate license. SpaceX also will need to conduct similar tests of Super Heavy prototypes, which have not yet been approved under a separate license. In the early stages of the Starship/Super Heavy program, SpaceX would conduct more tests (tank tests, static fire engine tests, and suborbital launches) and fewer orbital launches annually. If SpaceX becomes more successful with tests, the program would shift to more orbital launches and fewer tests. While the number of each operation may vary each year through the proposed launch program, SpaceX would not exceed the number of annual operations described below per year at its Boca Chica Launch Site (Table S-2).

Table S-2. Proposed Annual Operations

Operation	Time ^a	Program Development Phase	Operational Phase
Starship Static Fire Engine Test	Day	150 seconds	150 seconds
Super Heavy Static Fire Engine Test	Day	135 seconds	135 seconds
Starship Suborbital Launch	Day or Night	20	5
Super Heavy Launch ^b	Day or Night	3	5
Starship Land Landing ^c	Day or Night	23	10
Super Heavy Land Landing ^d	Day or Night	0	5

Notes:

^a SpaceX is planning to conduct most launches (suborbital and orbital) between the hours of 7:00 a.m. and 7:00 p.m. However, there could be launch delays due to unforeseen issues with the launch vehicle, weather conditions, or certain missions that require launching at a specific time at night to achieve a particular orbital position. For conservative purposes, the environmental review is assuming 20 percent of annual operations involving engine ignition (i.e., static fire engine tests, suborbital launches, and orbital launches) would occur at night.

^b A Super Heavy launch could be orbital or suborbital and could occur by itself or with Starship attached as the second stage of the launch vehicle.

^c A Starship land landing means a landing at the VLA. Other landing options for Starship include landing on a floating platform in the Gulf of Mexico, Atlantic Ocean, or Pacific Ocean. Alternatively, SpaceX could expend Starship in the Gulf of Mexico, Atlantic Ocean, or Pacific Ocean. Further environmental review of landing at sites not described in this document may be necessary.

^d A Super Heavy landing is part of a launch, as it would occur shortly after takeoff. A land landing means a landing at the VLA. Other landing options for Super Heavy include landing on a floating platform in the Gulf of Mexico or expending the booster in the Gulf of Mexico. Further environmental review of landing at sites not described in this document may be necessary.

S.4.4 Tank Tests

Prior to conducting a static fire engine test or launch of a Super Heavy or Starship prototype, SpaceX must conduct tank tests to ensure the tank's reliability. This involves performing proof pressure tests to confirm the structural integrity of the launch vehicle. Proof pressure tests are broken into two main categories: pneumatic and cryogenic. Pneumatic proof pressure testing consists of pressurizing the launch vehicle's tank with gaseous media (either helium, nitrogen, oxygen, or methane) and holding pressure for an extended duration. Cryogenic proof pressure tests consist of loading the tank with a single propellant (typically LN₂, LOX, or LCH₄). The tanks are then pressurized past their rated limit to confirm their structural capability with appropriate factors of safety. These proof pressure tests are designed to not release any propellant to the environment. All propellant is recycled back into the ground system tanks after the test is completed.

In addition to the proof pressure tests, SpaceX may perform development tests on test tank articles to validate design improvements or characterize vehicle behavior. These development tests include hydrostatic and cryogenic burst tests, in which the tanks are filled with water, LN₂, or LOX, and pressurized to a specific limit or to deliberate failure in order to characterize the structural capability of the production vehicles. Burst testing includes the deliberate release of the test media (water, LN₂, or LOX) to the environment upon failure of the primary structure.

S.4.5 Pre-flight Operations

Pre-flight operations include mission rehearsals and static fire engine tests. After final systems checkout, SpaceX would conduct a mission rehearsal without propellants on the launch vehicle (referred to as a *dry dress rehearsal*), followed by a mission rehearsal with propellants on the launch vehicle (referred to as a *wet dress rehearsal*) to verify full launch readiness.

After completing rehearsals, SpaceX would conduct static fire engine tests. The goal of a static fire engine test is to verify engine control and performance. A static fire engine test is identical to a wet dress rehearsal, except engine ignition occurs. During a static fire engine test, the launch vehicle engines are ignited for approximately 5-15 seconds and then shut down.

S.4.6 Suborbital Launches

SpaceX is proposing to conduct Starship suborbital launches. During a suborbital launch, Starship would launch from the VLA and ascend to high altitudes and then throttle down or shut off engines to descend, landing back at the VLA or downrange either directly in the Gulf of Mexico or on a floating platform in the Gulf of Mexico.

During the program's development, SpaceX is proposing to conduct up to 20 Starship suborbital launches annually. As the program progresses, SpaceX is proposing to conduct up to five Starship suborbital launches annually. Each launch would include a landing (Table S-2).

S.4.7 Orbital Launches

SpaceX is proposing to conduct up to five Starship/Super Heavy orbital launches annually. There could be multiple launches in close succession required to support a single mission (e.g., Lunar resupply missions). SpaceX's launch manifest (i.e., scheduled launches) is still being developed at this time and would evolve as the Starship/Super Heavy program develops. Each Starship/Super Heavy orbital launch would include an immediate boost-back and landing of Super Heavy. Landing could occur at the VLA or downrange in the Gulf of Mexico (either on a floating platform or expended in the Gulf of Mexico), no closer than approximately 19 miles off the coast. During flight, Super Heavy's engines would cut off at an altitude of approximately 40 miles and the booster would separate from Starship. Shortly thereafter, Starship's engines would start and burn to the desired orbit location. After separation, Super Heavy would rotate and ignite to conduct the retrograde burn, which would place it in the correct angle to perform a controlled landing. Super Heavy would land vertically and go into an automated safing sequence (i.e., put the vehicle in a safe state).

Similarly, each Starship/Super Heavy orbital mission would include a Starship landing after Starship completes its orbital mission. Starship landing could occur at the VLA or downrange in the Gulf of Mexico, Atlantic Ocean, or Pacific Ocean on a floating platform. Starship would land vertically on the pad or on a floating platform and go into an automated safing sequence.

During early unmanned orbital launches, SpaceX may require expending Super Heavy or Starship downrange in the Pacific Ocean, Atlantic Ocean, or Gulf of Mexico no closer than 19 miles offshore. If this occurs, SpaceX would not recover Super Heavy or Starship. SpaceX expects each stage would break up upon impact with the water's surface. SpaceX expects most of the launch vehicle would sink because it is made of steel. Lighter items may float but are expected to eventually become waterlogged and sink. If there are reports of large debris, SpaceX would coordinate with a party specialized in marine debris to survey the situation and sink or recover as necessary any large floating debris.

As the Starship/Super Heavy program is still in the early development phases, SpaceX has not identified all potential options for landing sites at this time. This PEA evaluates SpaceX's preliminary Starship landing site off the coast of Hawaii as part of SpaceX's first orbital launch. This location is located approximately 62 nautical miles north of Kauai, Hawaiian Islands. As SpaceX develops its landing capabilities downrange, SpaceX may plan to land the Starship on islands in the Pacific Ocean. If plans develop, landing activities on islands would be analyzed in a separate NEPA document, which could include an EA that tiers from this PEA.

S.4.8 Operational Closures

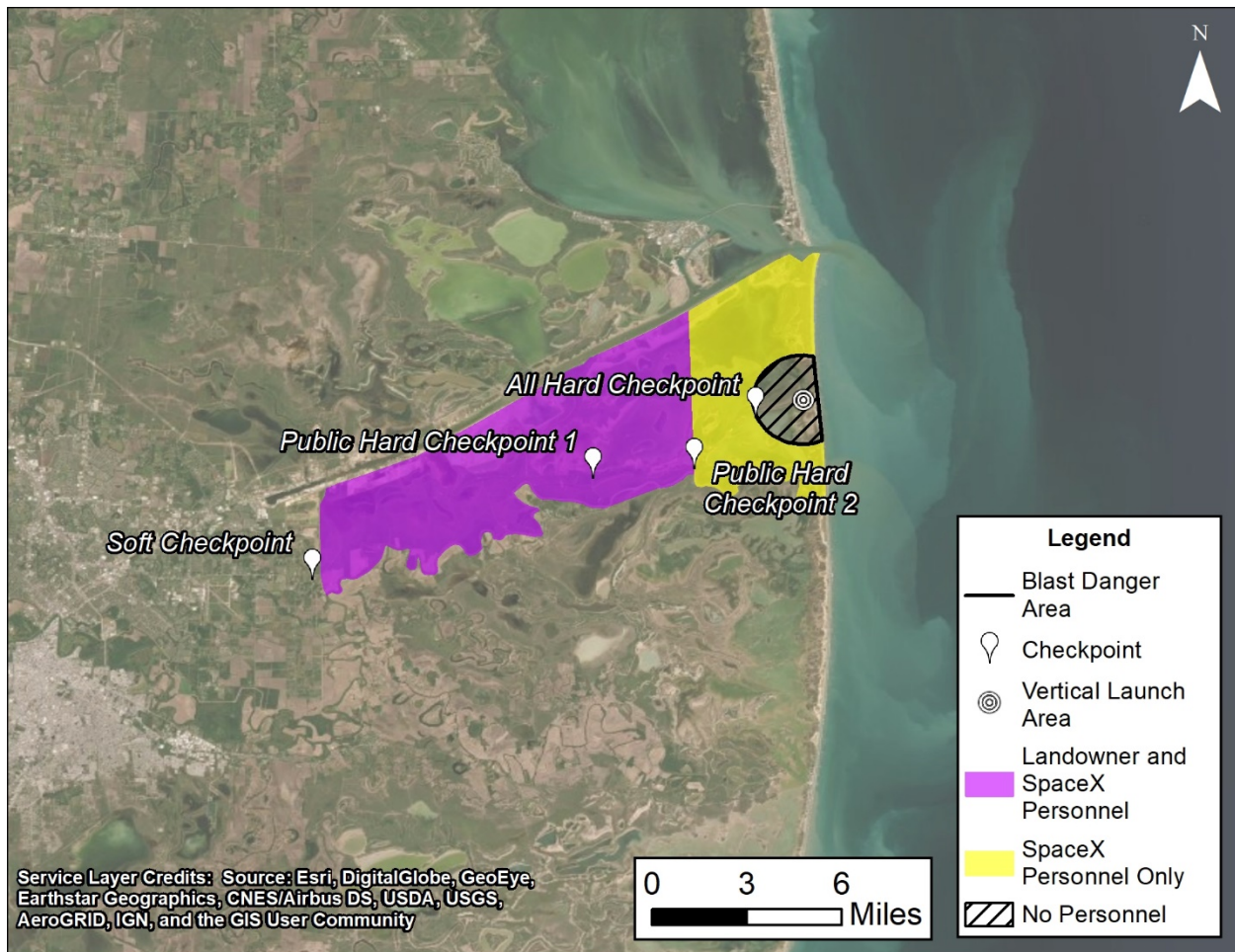
For purposes of the PEA, the FAA defines an operational closure as follows:

A closure begins when local law enforcement, under the direction of an order from the Cameron County Commissioners Court, shuts down State Highway 4 (SH 4) and Boca Chica Beach for a tank test, wet dress rehearsal, static fire engine test, or launch. A

closure ends when the operation is completed and local law enforcement opens SH 4 and Boca Chica Beach.

Tanks tests, wet dress rehearsals, static fire engine tests, and launches (suborbital and orbital) would require restricting public access in the vicinity of the VLA and securing land and water areas as part of public safety requirements. The areas on land that would be closed to public access is referred to as the *closure area* (Figure S-2). The closure area includes an area of Boca Chica Beach, ranging from the Brownsville Shipping Channel south to the U.S./Mexico border. The Brownsville Shipping Channel would be temporarily restricted during orbital launches and some suborbital launches, but not restricted during tank tests, wet dress rehearsals, or static fire engine tests.

Figure S-2. Closure Area



S.4.9 Construction

SpaceX is proposing additional launch-related construction, including expanding the solar farm near the launch and landing control center, adding infrastructure and facilities at the VLA, parking lots, a liquid natural gas pretreatment system, a liquefier, a payload processing facility, and trenching and pull-offs along State Highway 4. At the VLA, SpaceX is proposing to construct a redundant launch pad and

commodities, a redundant landing pad, two integration towers, tank structural test stands, a desalination plant, additional support buildings, and a power plant.

S.4.10 No Action Alternative

Under the No Action Alternative, the FAA would not issue new experimental permits or licenses to SpaceX for any test or launch operations at the Boca Chica Launch Site. SpaceX could conduct missions of the Starship prototype launch vehicle as authorized by the current license (LRLO 20-119). The license expires on May 27, 2022. This alternative provides the basis for comparing the environmental consequences of the Proposed Action.

S.5 Summary of Environmental Consequences

The following environmental impact categories were considered to provide context for understanding and assessing the potential environmental effects of the Proposed Action: air quality; climate; noise and noise-compatible land use; visual effects; cultural resources; Department of Transportation Act Section 4(f); water resources; biological resources; coastal resources; land use; hazardous materials, solid waste, and pollution prevention; natural resources and energy supply; and socioeconomics, environmental justice, and children’s environmental health and safety risks. Table S-3 provides a summary of potential environmental impacts from the Proposed Action. Table S-4 provides the mitigation measures that the FAA would ensure SpaceX implements to minimize environmental consequences.

Under the No Action Alternative, impacts to the human environment from Starship prototype suborbital launches would be similar to the types of launch-related impacts discussed in the FAA’s 2014 EIS. However, in general, the intensity of the impacts would be less than the impacts discussed in the 2014 EIS because the Starship prototype is a smaller launch vehicle and uses fewer engines (i.e., less thrust) than the Falcon Heavy. Also, the Starship prototype uses methane for fuel compared to Falcon Heavy’s use of kerosene.

Table S-3. Summary of Environmental Consequences

Environmental Impact Category	Proposed Action
Air Quality	Air emissions would result from the proposed construction activities, pre-launch and launch operations, power plant operations, natural gas pretreatment and gas liquefaction, and operation of employee and contractor vehicles. None of the emissions are expected to result in an exceedance of the National Ambient Air Quality Standards, as established by the U.S. Environmental Protection Agency under the Clean Air Act. Therefore, the Proposed Action is not expected to result in significant air quality impacts.
Climate	Proposed construction and operations would involve mobile source fuel combustion that would generate greenhouse gas (GHG) emissions from associated launch, landing, and test operations. Launch-related and power plant operations are estimated to emit 47,522 metric tons of carbon dioxide equivalent per year. This estimation is substantially less than the total GHG emissions generated by the United States in 2018. The Proposed Action is not expected to result in significant climate-related impacts.

Environmental Impact Category	Proposed Action
<p>Noise and Noise-Compatible Land Use</p>	<p>The Proposed Action would result in short-term increases in sound levels from the use of heavy equipment during construction and modification of the launch site. Starship/Super Heavy launch operations would temporarily increase sound levels during static fire engine tests and launches, including landings. Starship/Super Heavy orbital launch (takeoff) events would be the loudest single events of all the proposed launch operations. Sound levels during landing would be less than sound levels during takeoff due to lower total engine thrust used for landing operations.</p> <p>Noise from individual launch (including landing) and static fire engine test events is expected to be heard by people in the surrounding communities, including Brownsville, Laguna Vista, Port Isabel, and South Padre Island. On behalf of SpaceX, KBR modeled estimated cumulative sound levels (day-night average sound levels [DNL]) for projected launch (including landing) and static fire engine test operations. Cumulative noise in the surrounding communities, whether from multiple events of a single operation type or from all the individual events combined, is estimated to be below levels associated with adverse noise exposure. The Proposed Action is not expected to increase noise by DNL 1.5 decibels (dB) or more for a noise sensitive area that is exposed to noise at or above the DNL 65 dB noise exposure level, or that will be exposed at or above the DNL 65 dB level due to a DNL 1.5 dB or greater increase, when compared to the no action alternative for the same timeframe. Therefore, the Proposed Action is not expected to result in significant noise impacts.</p> <p>SpaceX modeled single-event sonic boom levels during Starship and Super Heavy descent. Predicted overpressure levels for a Starship landing range from 1.2 to 2.2 pounds per square foot (psf). The 2.2 psf contour is estimated to be less than 1 nautical mile from land. Overpressures between 2.2 and 1 psf are predicted to impact areas of South Padre Island. Populated areas in Mexico are not predicted to be impacted by Starship sonic booms. Predicted overpressure levels for a Super Heavy landing range from 2.5 to 15 psf. Brazos Island State Park, Boca Chica Bay, Boca Chica State Park, portions of the Lower Rio Grande National Wildlife Refuge (NWR), Boca Chica Village, and Tamaulipas, Mexico would experience levels up to 15 psf. Cumulative sonic boom levels were converted to a C-weighted DNL (CDNL) to allow for comparison to FAA’s significance threshold in DNL. Populated areas would not be exposed to areas above 2.5 psf during Starship landings or 11 psf during Super Heavy landings. The cumulative 2.5 psf and 11 psf contour for sonic booms is approximately equivalent to CDNL 60, which is less than FAA’s significance threshold for noise. Therefore, the Proposed Action is not expected to result in significant noise impacts. Structural damage on South Padre Island from sonic booms generated during Super Heavy landings at the vertical launch area (VLA) is expected to be rare with only minor impacts, such as glass breakage, if it does occur.</p>
<p>Visual Effects</p>	<p>Potential visual impacts to the landscape include glare from the proposed infrastructure and Starship/Super Heavy launch vehicles at the launch site and light emissions during nighttime launch and testing operations. SpaceX would finalize and implement its Facility Design and Lighting Management Plan, which includes measures that are intended to minimize nighttime lighting impacts to the surrounding areas and mitigate sky glow.</p> <p>Given the location of the Boca Chica Launch Site adjacent to the NWR and state parks, most of the proposed infrastructure would be visible to visitors of these areas. Also, the taller infrastructure may be visible to visitors of the Palmito Ranch Battlefield National Historic Landmark (NHL) and South Padre Island. Two permanent integration towers, each 490 feet tall, and a 450-foot-tall crane would be present at the VLA; the crane would</p>

Environmental Impact Category	Proposed Action
	<p>remain at that height at most times. When on the launch pad, the integrated Starship/Super Heavy would be approximately 450 feet above ground level.</p> <p>The area in the vicinity of the Boca Chica Launch Site has been developed for SpaceX's private production and manufacturing activities, including the addition of numerous tall structures and facility lighting. It is anticipated that the addition of new tall infrastructure would look visually similar to the existing infrastructure, and would not contrast with the visual character of the study area. SpaceX would implement all measures identified in the Section 106 Memorandum of Agreement (MOA) for the current undertaking. Accordingly, the Proposed Action is not expected to result in significant visual effects.</p>
Cultural Resources	<p>The Proposed Action has the potential to affect a total of 18 historic properties. Potential effects could result from visual or auditory effects or from ground vibrations. Other potential effects consist of impacts resulting from the increased visitation and use of the area due to SpaceX's presence. The FAA has made a finding of <i>adverse effect</i> to 13 of the historic properties, because the effects could diminish the integrity of the properties, which is one of the criteria for listing on the National Register of Historic Places. The adversely affected properties include the Lama de los Ebanitos Cemetery, Palmito Ranch Battlefield NHL, Sheridan's Railroad Bridge, Palmetto Pilings Historical Marker, Queen Isabella Memorial Causeway, Long Island Swing Bridge, Queen Isabel Inn, Garcia Pasture historical marker, Alta Vista Apartments, Point Isabel Lighthouse, Charles Champion House, and Port Isabel Cemetery.</p> <p>The FAA is currently conducting NHPA Section 106 consultation with the State Historic Preservation Officer and other consulting parties. The final PEA will document the results of this consultation. As part of the consultation, the FAA is working with the signatories and invited signatories of the 2014 Section 106 Programmatic Agreement (PA) to amend the PA for the current undertaking. The consultation will also include resolving adverse effects. Accordingly, the Proposed Action is not expected to result in significant impacts to cultural resources.</p>
Department of Transportation Act, Section 4(f)	<p>The Proposed Action would not result in a permanent incorporation of any Section 4(f) property. The proposed launch activities would have temporary, intermittent impacts on the access and availability of Section 4(f) properties within the closure area. During launches, public access to Boca Chica State Park, Brazos Island State Park, the South Bay Coastal Preserve, and major portions of the NWR, including the NHL, would be closed for safety and security reasons and to alleviate concerns regarding the potential impacts to public lands from the viewing public. Closures would occur on an intermittent basis, up to 500 hours per year, and would be temporary. The proposed launches would produce short-term, high sound levels in nearby Section 4(f) properties, which would last a few minutes for each launch, including landing. A launch-related anomaly could result in an explosion on the launch pad, which could spread debris within adjacent Section 4(f) properties. An additional 300 hours of closure could be used exclusively to address anomalies, such as debris generated from an explosion or a fire on the launch pad. Based on the analysis in the draft PEA, the FAA has made the preliminary determination that the Proposed Action would not result in a <i>use</i> of any Section 4(f) property. The FAA is consulting with officials having jurisdiction over the 4(f) properties. The FAA is also seeking public input through the public comment period for the draft PEA. The Final PEA will document the FAA's final Section 4(f) determination.</p>
Water Resources	<p>Construction activities could affect surface waters through ground disturbance activities and use of construction equipment. Potential impacts to groundwater quality during construction include contamination from spills or leaks from construction vehicles and machinery. Surface water discharges from runoff during construction and operations</p>

Environmental Impact Category	Proposed Action
	<p>would be managed according to requirements of the Texas Pollutant Discharge Elimination System. The Proposed Action would have minimal impact to groundwater quality with stormwater treatment and industrial wastewater systems that are properly designed and operated in accordance with permit conditions. Construction is anticipated to permanently fill 17.16 acres of wetlands. Wetland impacts would be mitigated through the Clean Water Act Section 404 permitting process. Fill material would be required to elevate areas of proposed expansion out of the floodplain. The proposed expansions would result in the filling of 25.8 acres of floodplain. Filling this relatively small area (less than 1 percent of the contiguous area) would not result in new areas being subject to 100-year floods, nor would it result in existing areas subject to 100-year floods becoming more prone to floods. Accordingly, the Proposed Action is not expect to result in significant impacts on water resources.</p>
<p>Biological Resources</p>	<p>Construction activities would impact terrestrial habitats and wildlife. A loss of vegetation associated with land clearing activities would occur, but the affected area is negligible compared to the overall habitat available in the Lower Rio Grande Valley. Wildlife species could experience a noise-induced startle response from construction and operations. The Proposed Action is not expected to adversely affect essential fish habitat.</p> <p>The FAA has determined the Proposed Action would adversely affect species listed under and critical habitat designated under the federal Endangered Species Act (ESA). The FAA submitted a Biological Assessment to the U.S. Fish and Wildlife Service and requested to initiate formal consultation per ESA Section 7. Adverse effects to listed species and critical habitat will be minimized through the ESA consultation process. The FAA will not conclude its NEPA process until U.S. Fish and Wildlife Service issues a Biological Opinion and Incidental Take Statement.</p> <p>The FAA is also conducting ESA Section 7 consultation with the National Marine Fisheries Service (NMFS) but does not expect the Proposed Action would result in adverse effects to ESA-listed species and critical habitat under NMFS jurisdiction. The Final PEA will document the results of all interagency consultations. The Proposed Action is not expected to result in significant impacts on biological resources.</p>
<p>Coastal Resources</p>	<p>The Proposed Action at the SpaceX Boca Chica Launch Site would take place in the coastal zone. Landing and recovery operations would not take place in intertidal areas, salt marshes, estuaries, or coral reefs. The Proposed Action does not include any coastal construction or seafloor-disturbing activities and would be consistent with commonly occurring Gulf of Mexico maritime operations. The Proposed Action is not prohibited for development within the Coastal Barrier Resource System Unit, as the project is not federally funded. SpaceX is responsible for coordinating with the Texas General Land Office (TGLO) to ensure its activities are consistent with the Texas Coastal Management Program (TCMP). The FAA may not issue a permit or license to SpaceX unless SpaceX's proposed activities meet the consistency requirements of the TCMP. During preparation of the 2014 EIS, the TGLO did not raise any objections to SpaceX's Falcon proposal. Therefore, the Proposed Action is not expected to result in significant impacts to coastal resources.</p>
<p>Land Use</p>	<p>The Proposed Action is consistent with existing land uses at the Boca Chica Launch Site, and would not violate any local land use ordinances, plans, or zoning ordinances. Closure areas would be established prior to launch-related operations and publicized by Cameron County. Closures would be limited to up to 500 hours per year per the agreement between Cameron County and SpaceX for nominal operations and up to an additional 300 hours per year to address anomalies. Cameron County has established a hotline for road closure updates for the public (956-548-9541), and public notices will also be available on</p>

Environmental Impact Category	Proposed Action
	the Cameron County webpage. Additionally, the Texas Department of Transportation has authorized a SpaceX Roadway Closure Traffic Control Plan for use on State Highway 4. Accordingly, the Proposed Action is not anticipated to result in significant land use impacts.
Hazardous Materials, Solid Waste, and Pollution Prevention	SpaceX would use hazardous materials and generate hazardous and solid wastes during construction and operation. SpaceX would implement its Anomaly Response Plan and Spill Prevention, Control, and Countermeasure Plan in the event of an accidental release of hazardous materials. The Proposed Action would not generate solid waste that exceeds the capacity of the Seabreeze landfill currently used by SpaceX. SpaceX would comply with all applicable federal, state, and local rules and regulations pertaining to the proper storage, handling, and use of hazardous materials. Therefore, the Proposed Action is not expected to result in significant impacts related to hazardous materials, solid waste, and pollution prevention.
Natural Resources and Energy Supply	Construction and operation would require the use of natural and energy resources. Power generation and propellant development is part of the Proposed Action. As such, the Proposed Action would not have the potential to cause demand to exceed available or future supplies of applicable resources. Impacts on natural resources and energy supply are not anticipated to be significant.
Socioeconomics, Environmental Justice, and Children’s Environmental Health and Safety Risks	<p>The Proposed Action does not involve activities anticipated to adversely affect existing economic activity, income, employment, population, housing, sustenance, public services, and social conditions. Launch operations may result in moderate economic benefits, including increased demand in the workforce, higher revenues, and increased per capita income in the local area. While the population under the poverty threshold may not directly benefit through employment and income, it may indirectly benefit as regional economic health is improved through the proposed increase in employment for commercial space exploration activity.</p> <p>The counties within the study area, and the Census Block Group where the Boca Chica Launch Site is located, have substantially higher proportions of minority and low-income populations than Texas as a whole. While the Proposed Action would result in visual and noise impacts, those changes would not disproportionately impact minority and low-income populations.</p> <p>The Proposed Action is located in a sparsely populated area approximately 6 miles from the nearest public school. Boca Chica Village is the only residential area near the Proposed Action and has no children under the age of 18. The Proposed Action would not increase risks to children’s environmental health or safety.</p> <p>Impacts on socioeconomics, environmental justice, and children’s environmental health and safety risks are not anticipated to be significant.</p>

Table S-4. Mitigation Measures

Environmental Impact Category	Measure
Air Quality	<ul style="list-style-type: none"> • Periodic water spraying to control particulates and fugitive dust • Best Management Practices (BMPs) such as minimal idling of engines, watering of soils to be disturbed, and use of low volatility coatings.

Environmental Impact Category	Measure
	<ul style="list-style-type: none"> Compliance with Texas Commission on Environmental Quality’s (TCEQ) authorization under the Oil and Gas Standard Permit, including adherence to any permit conditions.
Climate	None proposed.
Noise and Noise-Compatible Land Use	<p>The FAA would ensure that SpaceX utilizes its notification plan to educate the public and announce when a launch or landing event would occur. Announcements of upcoming Starship/Super Heavy launches and landings would serve to warn people about these noise events and would likely help reduce human adverse reactions to these noise events. The plan would involve issuing statements to news outlets and law enforcement so that when noise is heard, the public would understand what has occurred. This approach is consistent with the public notification efforts conducted by SpaceX at Cape Canaveral Space Force Station and Vandenberg Space Force Base. SpaceX would be responsible for resolving any structural damage caused by a sonic boom.</p>
Visual Effects	<ul style="list-style-type: none"> SpaceX would implement all avoidance and minimization measures identified in its Facility Design and Lighting Management Plan. Minimization measures include directing, shielding, or positioning lighting to avoid visibility from the beach, minimize lateral light spread, and decrease uplighting; turning off lights when not needed; using low-pressure sodium to the extent practicable; installing lighting with multiple levels of control (i.e., some, all, or none of the lights can be turned on); and installing lighting timers where appropriate. SpaceX would conduct lighting inspections to identify and eliminate any unnecessary lighting between March 15th and October 31st (sea turtle nesting season) and send results of the inspections to the FAA. When elimination of a light source is not a viable option, whether due to personnel safety needs or mission critical operations, SpaceX shall perform internal due diligence to reduce and eliminate lighting as a best practice within operational locations. SpaceX would implement all measures identified in the Section 106 MOA as part of Section 106 consultation for the current undertaking.
Cultural Resources	<ul style="list-style-type: none"> SpaceX would implement all measures identified in the Section 106 MOA as part of Section 106 consultation for the current undertaking.
Department of Transportation Act, Section 4(f)	<ul style="list-style-type: none"> SpaceX would restore the State Highway 4 (SH 4) right-of-way to pre-disturbance conditions after installation of utilities. In the event of an anomaly, SpaceX would notify Texas Parks and Wildlife Department (TPWD), Texas General Land Office (TGLO), and/or any other landowner per the procedure outlined in SpaceX’s Anomaly Response Plan. Following an anomaly, SpaceX would release the closure area west of the “All Hard Checkpoint” to allow visitors to continue to access the National Historic Landmark and National Wildlife Refuge (NWR) while anomaly-response actions are taken. SpaceX would keep the “All Hard Checkpoint” in place to protect public safety and implement the measures outlined in its Anomaly Response Plan. Debris removal would occur by a method as determined by TPWD and agreed to by SpaceX. Restoration measures regarding any adverse impacts to landforms include: monitoring disturbed areas for spread of non-native vegetation and removal upon discovery; spreading seeds found locally from preferred grass species, and regrading disturbed land to its pre-existing condition. Alternative restoration approaches may be considered as determined by TPWD and agreed to by SpaceX. Restoration areas with respect to algal flats include grooming of tracks with the use of hand tools and ambient soils to prevent further impacts, removing fill, establishing the proper slope within the tidal range, and inoculating the soils with a mixture of the

Environmental Impact Category	Measure
	<p>dominant algal species, or any other approach as determined by TPWD and agreed to by SpaceX.</p> <ul style="list-style-type: none"> • SpaceX would perform notifications prior to a planned closure and in accordance with its Closure Notification Plan, including: <ul style="list-style-type: none"> ○ Providing a forecast of planned closures one to two weeks in advance of the closure on the County’s website and/or send via email to the agency distribution list. Information about the proposed closure would be posted on Cameron County’s website. ○ Sending closure notifications to the regulatory and public land-managing agencies as plans finalize (typically 24–48 hours prior to the closure). The agencies would continue to receive updates immediately when the closures go into place and when the closures end, as well as cancellations of requested closures. SpaceX personnel at the launch and landing control center would send these notifications to ensure the most up-to-date information is distributed. ○ Sending real time status and updates on closures through a text message alert service. Subscribers can text “BEACH” TO 1-877-591-2152 to receive updates.
Water Resources	<ul style="list-style-type: none"> • SpaceX would implement its Spill Prevention, Control, and Countermeasures (SPCC) Plan to minimize the potential for accidental releases of polluting substances. • In conjunction with final design and Clean Water Act (CWA) permitting, SpaceX would submit a Notice of Intent to TCEQ for application of the general permit authorization for point source discharges of stormwater associated with industrial activity to surface water in the state. SpaceX would develop a Stormwater Pollution Prevent Plan (SWPPP) that would adhere to the permit effluent limitations and requirements applicable to the industrial activities. • If water treatment or retention is required, SpaceX would contain water in retention ponds. • SpaceX would develop appropriate sampling protocols and water quality criteria in coordination with the TCEQ in accordance with Texas Surface Water Quality. • SpaceX would manage any deluge water according to state and local water quality requirements (e.g., pretreatment permits, National Pollutant Discharge Elimination System [NPDES] permits, etc.). • SpaceX would adhere to proper marine vessel operating procedures and use of appropriate BMPs in the event of a recovery operation discharge or spill. • SpaceX would employ proper design redundancies of commodity storage facilities, containment around all hydraulic systems, safety measures in launch vehicle processes, and spill response and clean-up measures. • SpaceX would dispose of brine generated from the desalination plant through TCEQ-permitted sub-surface disposal injection wells in accordance with the Safe Drinking Water Act and TCEQ requirements, or containerization for off-site disposal. • Pursuant to CWA Section 404, SpaceX would coordinate with U.S. Army Corps of Engineers (USACE) to develop an appropriate compensatory mitigation plan for unavoidable impacts to wetlands. • SpaceX would coordinate with Cameron County floodplain administrators to obtain a development permit in accordance with the National Flood Insurance Program as well as county regulations.
Biological Resources	<p>The FAA would ensure that SpaceX implements the following measures to minimize impacts on biological resources.</p>

Environmental Impact Category	Measure
	<p>Construction Measures</p> <ul style="list-style-type: none"> • In conjunction with final design and CWA permitting, SpaceX will be updating its SWPPP. The SWPPP includes BMPs for erosion and sedimentation controls, including techniques to diffuse and slow the velocity of stormwater to reduce potential impacts (e.g., soil loss and sedimentation) to water quality during construction. All construction activities with the potential to impact water quality from potential runoff from the site would be conducted in accordance with the stormwater permit, including measures identified in the SWPPP. • Prior to entry and exit into unpaved areas of the vertical launch area (VLA), SpaceX would ensure heavy equipment traverses over a construction shaker or rumble plates or rock bed located at the VLA to remove any sediment and dirt for purposes of preventing the introduction and spread of non-native plant species. SpaceX would inspect the equipment to ensure that hydraulic fittings are tight, hydraulic hoses are in good condition (and replaced if damaged), and there are no petroleum leaks. • SpaceX would not place excavated or fill material in delineated CWA Section 404 waters of the United States except as authorized by a permit from the USACE. SpaceX would ensure that discharged water associated with concrete mixing and placement activities does not reach surrounding water bodies or pools unless specifically authorized in a Department of Army permit. • SpaceX would contract a qualified biologist to be present during the beginning of the construction period to provide all construction personnel with an environmental worker-education briefing that would include, but not be limited to, the following: <ul style="list-style-type: none"> ○ Wildfire prevention measures, including restricting smoking to areas clear of vegetation, ensuring no fires of any kind are ignited, and equipping vehicles with spark arrestors and fire extinguishers ○ Information regarding noxious/invasive weeds; the spread of noxious/invasive weeds would be limited by routine inspections of the area and removal of any such species ○ Requirements for safe handling and disposal of hazardous wastes ○ Proper disposal of all organic and inorganic litter and garbage (including cigarette butts). Such material would be disposed of in covered containers. The construction contractor would dispose all trash and debris off site daily. ○ Requirements for safe handling and disposal of hazardous wastes • If proposed construction activities occur during the avian breeding season (February 15 through August 31), SpaceX would ensure construction activities occur in accordance with the Migratory Bird Treaty Act to avoid impacts to nesting migratory birds within the project area. Specifically, a biologist would check the proposed areas of construction activities, including laydown areas, for nests (in shrubs and on the ground) once before the construction phase has begun. If the biologist finds an active nest, construction workers would not directly or indirectly disturb the nest or adjacent areas until the biologist determines the nest is no longer in use. • SpaceX would incorporate raptor protection measures into project design and any above-ground utility upgrades. For example, SpaceX would equip structures with devices to discourage nest building and perching (e.g., monopole technology and visual fright devices). • SpaceX would educate its personnel on the potential for vehicle collisions with ocelots and jaguarundis and encourage personnel to reduce speeds along SH 4. Any contractor or employee disobeying speed limits would be disciplined.

Environmental Impact Category	Measure
	<ul style="list-style-type: none"> • SpaceX would limit vehicle operation to existing paved and unpaved roads, parking areas, and authorized construction sites. Vehicle operators within the VLA would not exceed 25 miles per hour. • SpaceX would continue contracting a qualified biologist to conduct pre-, during, and post-construction biological monitoring (vegetation and birds). This monitoring is ongoing and would continue to be conducted within 1 mile of construction areas. Monitoring reports would continue to be sent to the U.S. Fish and Wildlife Service (USFWS) annually. <p>Operational Measures</p> <ul style="list-style-type: none"> • SpaceX would update its Facility Design and Lighting Management Plan to account for Starship/Super Heavy launches and related infrastructure and request input from USFWS and TPWD. The intent of the plan is to minimize design and lighting effects on wildlife, including ESA-listed species. Examples of lighting requirements that would be incorporated into the plan include: <ul style="list-style-type: none"> ○ Directing, shielding, or positioning facility lighting to avoid visibility from the beach, minimize lateral light spread, and decrease uplighting (without compromising safety and security of personnel). ○ Turning off lights when not needed. ○ Using low pressure sodium, to the extent practicable, during sea turtle nesting season. Limitations to the use of low-pressure sodium include the use of white lighting required for protection and safety of SpaceX personnel for ground support operations performed 24/7 throughout the year and the use of bright spotlighting during nighttime launch activities. ○ Installing new lighting with multiple levels of control (i.e., some, all, or none of the lights can be turned on) so that lighting levels can be matched with specific activities. ○ Where lighting is not essential to safety or security of personnel, installing timers to switch lights off in the evening. Where applicable and not a threat to security, installing motion-detector switches. • SpaceX would educate its personnel on the potential for vehicle collisions with ocelots and jaguarundis and encourage personnel to reduce speeds along SH 4. Any contractor or employee disobeying speed limits would be disciplined. SpaceX-owned or -operated vehicles would be restricted to existing paved and dirt roads and parking areas. SpaceX vehicle operators would not exceed 25 miles per hour near the VLA. • SpaceX would continue contracting a qualified biologist to conduct pre- and post-launch biological surveys (vegetation and birds). Monitoring would be conducted within 1 mile of the VLA the day before a Starship or Super Heavy launch and the day after the launch. Monitoring reports would be sent to the USFWS following compilation and analysis of the data. • SpaceX would continue working with Sea Turtle Inc. to provide sea turtle survey data within the action area to the USFWS annually. • In coordination with NWR staff, SpaceX would develop a protocol (e.g., Closure Notification Plan) providing as much advance notice as practicable to minimize disruption to refuge and land management activities. • In coordination with NWR staff, SpaceX would identify further options that would assist in protecting refuge lands and species habitats from impacts that may occur from public intrusions prior to closures. For example, vehicle barriers, in the form of

Environmental Impact Category	Measure
	<p>short, spaced posts, sufficiently close together to prevent a truck or all-terrain vehicle from entering, but wide enough apart to allow for terrestrial animals to pass. This could be done alongside SH 4 or other identified roads where the footprint is already disturbed.</p> <ul style="list-style-type: none"> • SpaceX would coordinate with the USFWS to fund additional resources or projects to enforce the closures required for launch operations. • If an anomaly occurs, SpaceX would coordinate with TPWD and USFWS prior to retrieving or cleaning up launch vehicle components on sensitive habitat. SpaceX would work with TPWD and USFWS to evaluate any damage and determine appropriate mitigation. SpaceX would be responsible for the cost to mitigate any damages. SpaceX would comply with its applicable site plans, including its Anomaly Response Plan, Security Plan, and Fire Mitigation and Response Plan.
Coastal Resources	None proposed.
Land Use	<ul style="list-style-type: none"> • SpaceX would notify and coordinate with the oil and gas operators prior to any launch (including landing).
Hazardous Materials, Solid Waste, and Pollution Prevention	<p>SpaceX would implement the following measures to minimize impacts related to hazardous materials, solid waste, and pollution prevention:</p> <ul style="list-style-type: none"> • SpaceX would handle any release of a hazardous material according to the management procedures described in its Anomaly Response Plan. • SpaceX would comply with all applicable federal, state, and local rules and regulations pertaining to the proper storage, handling, and use of hazardous materials. • SpaceX would implement its SPCC Plan to prevent and address accidental spills or releases of hazardous materials. • SpaceX would report any release of a hazardous material in the Gulf of Mexico through the U.S. Coast Guard National Response Center. • SpaceX would comply with the International Convention for the Prevention of Pollution from Ships Annex IV and the CWA NPDES Program regarding vessel discharge of large commercial vessels for offshore landings on platforms. • SpaceX would implement the appropriate handling and management procedures for hazardous materials when venting residual LOX and LCH4. • Hazardous materials such as fuels, ordnance, chemicals, and payload components would be transported over public transportation routes to the appropriate facilities in accordance with DOT regulations. • SpaceX would treat or remove any soils adversely affected by spills in accordance with applicable federal and state regulations. • In the event of an anomaly, SpaceX would respond to all accidental releases of polluting substances quickly and implement appropriate clean-up measures in accordance with applicable laws to minimize impacts to the environment. • SpaceX would store solid wastes in covered receptacles until disposal to avoid offsite deposition, recycle solid wastes to the extent practicable, and dispose of the remaining solid waste in appropriately permitted landfills. • SpaceX would collect, store, and dispose of hazardous materials, substances, and wastes used and generated as part of recovery operations using practices that minimize the potential for accidental releases or contact with storm or marine water and in accordance with the Hazardous Materials and Emergency Response Plan, SWPPP, and SPCC Plan, as well as Resource Conservation and Recovery Act and Occupational Safety and Health Administration regulations.

Environmental Impact Category	Measure
	<ul style="list-style-type: none"> SpaceX would assemble an emergency response team that would be responsible for responding to hazards and spills for all Starship/Super Heavy propellants.
Natural Resources and Energy Supply	None proposed.
Socioeconomics, Environmental Justice, and Children's Environmental Health and Safety Risks	None proposed.