



**Federal Aviation
Administration**

Draft Environmental Assessment for Issuing an Experimental Permit to SpaceX for Operation of the DragonFly Vehicle at the McGregor Test Site, McGregor, Texas

May 2014

AOC-AST-14-01

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Draft Environmental Assessment for Issuing an Experimental Permit to SpaceX for Operation of the DragonFly Vehicle at the McGregor Test Site, McGregor, Texas

AGENCY: Federal Aviation Administration (FAA)

ABSTRACT: This Draft Environmental Assessment (EA) addresses the potential environmental impacts of FAA's Proposed Action of issuing an experimental permit to Space Exploration Technologies Corp. (SpaceX) for operation of the DragonFly reusable launch vehicle (RLV) at the McGregor test site, in McGregor, Texas. This Draft EA evaluates the potential impacts of the operation of the DragonFly RLV as well as construction of a launch pad. Potential environmental impacts of the Proposed Action and the No Action Alternative analyzed in detail in this Draft EA include impacts to air quality; noise and compatible land use; Department of Transportation Act: Section 4(f); historical, architectural, archaeological, and cultural resources; fish, wildlife, and plants; water quality (surface waters, groundwater, wetlands, and floodplains); natural resources and energy supply; hazardous materials, pollution prevention, and solid waste; light emissions and visual impacts; and socioeconomics, environmental justice, and children's environmental health risks and safety risks. Potential cumulative impacts of the Proposed Action and the No Action Alternative are also addressed in this Draft EA.

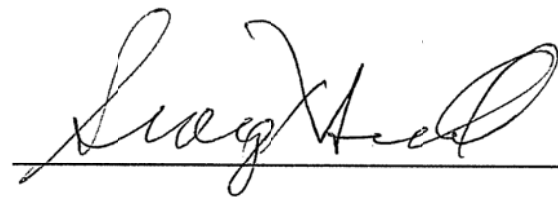
PUBLIC REVIEW PROCESS: In accordance with the National Environmental Policy Act of 1969, as amended (NEPA; 42 United States Code 4321, et seq.), Council on Environmental Quality NEPA implementing regulations (40 Code of Federal Regulations Parts 1500 to 1508), and FAA Order 1050.1E, *Environmental Impacts: Policies and Procedures, Change 1*, the FAA has initiated a public review and comment period for this Draft EA. Interested parties are invited to submit comments on the Draft EA, preferably in writing, on or before June 16, 2014, or 30 days from the date of publication of the Notice of Availability in the *Federal Register*, whichever is later. An electronic version of the Draft EA is available on the FAA website:

http://www.faa.gov/about/office_org/headquarters_offices/ast/environmental/review/permits

CONTACT INFORMATION: To request copies of the Draft EA, please contact Daniel Czelusniak, Office of Commercial Space Transportation, Federal Aviation Administration, 800 Independence Ave., SW, Suite 325, Washington, DC 20591; or by e-mail at Daniel.Czelusniak@faa.gov.

This Draft EA becomes a Federal document when evaluated, signed, and dated by the Responsible FAA Official.

Issued in Washington, DC on: 5/13/2014



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Commercial Space Transportation

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ACRONYMS AND ABBREVIATIONS

AGL	above ground level	MMH	monomethylhydrazine
APE	Area of Potential Effects	MSATs	Mobile Source Air Toxics
AST	Office of Commercial Space Transportation	NAAQS	National Ambient Air Quality Standards
BMPs	Best Management Practices	NAVFAC	Naval Facilities Engineering Command
CAA	Clean Air Act	NEPA	National Environmental Policy Act
CEQ	Council on Environmental Quality	NESHAP	National Emission Standards for Hazardous Air Pollutants
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act	NHPA	National Historic Preservation Act
CFR	Code of Federal Regulations	NRHP	National Register of Historic Places
CO	carbon monoxide	NSR	New Source Review
CTYRA	Central Texas Youth Rodeo Association	NTO	nitrogen tetroxide
CWA	Clean Water Act	NWI	National Wetlands Inventory
dB	decibel	NWIRP	Naval Weapons Industrial Reserve Plant
dBA	A-weighted decibels	O ₃	ozone
DNL	day-night average noise level	ppb	parts per billion
DOT	Department of Transportation	ppm	parts per million
EA	Environmental Assessment	PSD	Prevention of Significant Deterioration
EO	Executive Order	RCRA	Resource Conservation and Recovery Act
EPA	U.S. Environmental Protection Agency	RLV	Reusable Launch Vehicle
ESA	Endangered Species Act	ROI	Region of Influence
F9R	Falcon 9R	RP-1	refined petroleum
FAA	Federal Aviation Administration	SARA	Superfund Amendments and Reauthorization Act
FEMA	Federal Emergency Management Agency	SEL	Sound Exposure Level
ft	feet	SHPO	State Historic Preservation Officer
ft ²	square feet	TAC	Texas Administrative Code
HAPs	Hazardous Air Pollutants	TCEQ	Texas Commission on Environmental Quality
ISD	Independent School District	THC	Texas Historical Commission
GAO	Government Accountability Office	TPDES	Texas Pollutant Discharge Elimination System
GCD	Groundwater Conservation Districts	TPWD	Texas Parks and Wildlife Department
GHG	greenhouse gases	TSD	treatment, storage and disposal
kW-hr	kilowatt-hour	U.S.	United States
lb	pound	U.S.C.	United States Code
lbf	pounds force	USCB	United States Census Bureau
L _{max}	maximum sound level	USFWS	U.S. Fish and Wildlife Service
LOX	liquid oxygen	VOCs	Volatile Organic Compounds
MEDC	McGregor Economic Development Corporation		
mg/m ³	milligrams per cubic meter		
µg/m ³	micrograms per cubic meter		

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1.0 INTRODUCTION

Space Exploration Technologies Corp. (SpaceX) proposes to conduct suborbital launches and landings of the DragonFly reusable launch vehicle (RLV) at the McGregor, Texas test site located in McLennan and Coryell Counties (Exhibits 1-1 and 1-2). To conduct this experimental testing, SpaceX must obtain an experimental permit from the Federal Aviation Administration (FAA) Office of Commercial Space Transportation as described in 51 United States Code (U.S.C.) Subtitle V, ch. 509, § 50906 of the Commercial Space Launch Act of 2011.

Issuing an experimental permit is considered a major Federal action subject to environmental review under the National Environmental Policy Act of 1969, as amended (NEPA; 42 U.S.C. 4321, et seq.). The FAA has prepared this Draft Environmental Assessment (EA) in accordance with NEPA, Council on Environmental Quality (CEQ) NEPA implementing regulations (40 Code of Federal Regulations [CFR] Parts 1500 to 1508), and FAA Order 1050.1E, *Environmental Impacts: Policies and Procedures, Change 1* to evaluate the potential environmental impacts of activities associated with FAA's Proposed Action (see Section 2.1). The successful completion of the environmental review process does not guarantee that the FAA would issue an experimental permit to SpaceX. The Proposed Action also must meet all FAA safety, risk, and financial responsibility requirements per 14 CFR Part 400. Additional environmental analyses would be required for future SpaceX-proposed activities not addressed in this EA or in previous environmental documentation.

1.1 Background

Since 2003, SpaceX has leased an engine test site in McGregor, Texas from the City of McGregor. The leased area has grown from approximately 250 acres in 2003 to approximately 1,000 acres in 2013. As depicted in Exhibit 1-2, SpaceX leases Areas L and M, which includes administrative, storage, and support buildings, as well as stands to conduct engine testing. The test site is a portion of a larger area of property (approximately 9,700 acres) that was previously owned by the United States (U.S.) Navy and was the site of a Naval Weapons Industrial Reserve Plant (NWIRP) from 1966 to 1995. The test site is surrounded by agricultural land (Ag 1, Ag 2, and Ag 3) as depicted in Exhibit 1-2. Currently, SpaceX uses Areas L and M to test engines that are used in SpaceX launch vehicles (see Section 2.2 for additional information on SpaceX's existing activities at the McGregor test site). In October 2012, the FAA issued an experimental permit to SpaceX to conduct suborbital launches and landings of the Grasshopper RLV at the McGregor test site. To support Grasshopper operations, SpaceX constructed a concrete launch pad and additional support infrastructure. The action of issuing an experimental permit to SpaceX for Grasshopper operations was analyzed in the *Final Environmental Assessment for Issuing an Experimental Permit to SpaceX for Operation of the Grasshopper Vehicle at the McGregor Test Site, Texas* (FAA 2011). Since obtaining the experimental permit from the FAA, SpaceX has conducted nine successful suborbital launches and landings of the Grasshopper RLV at the McGregor test site. The experimental permit for the Grasshopper RLV test program was renewed by the FAA in September 2013.

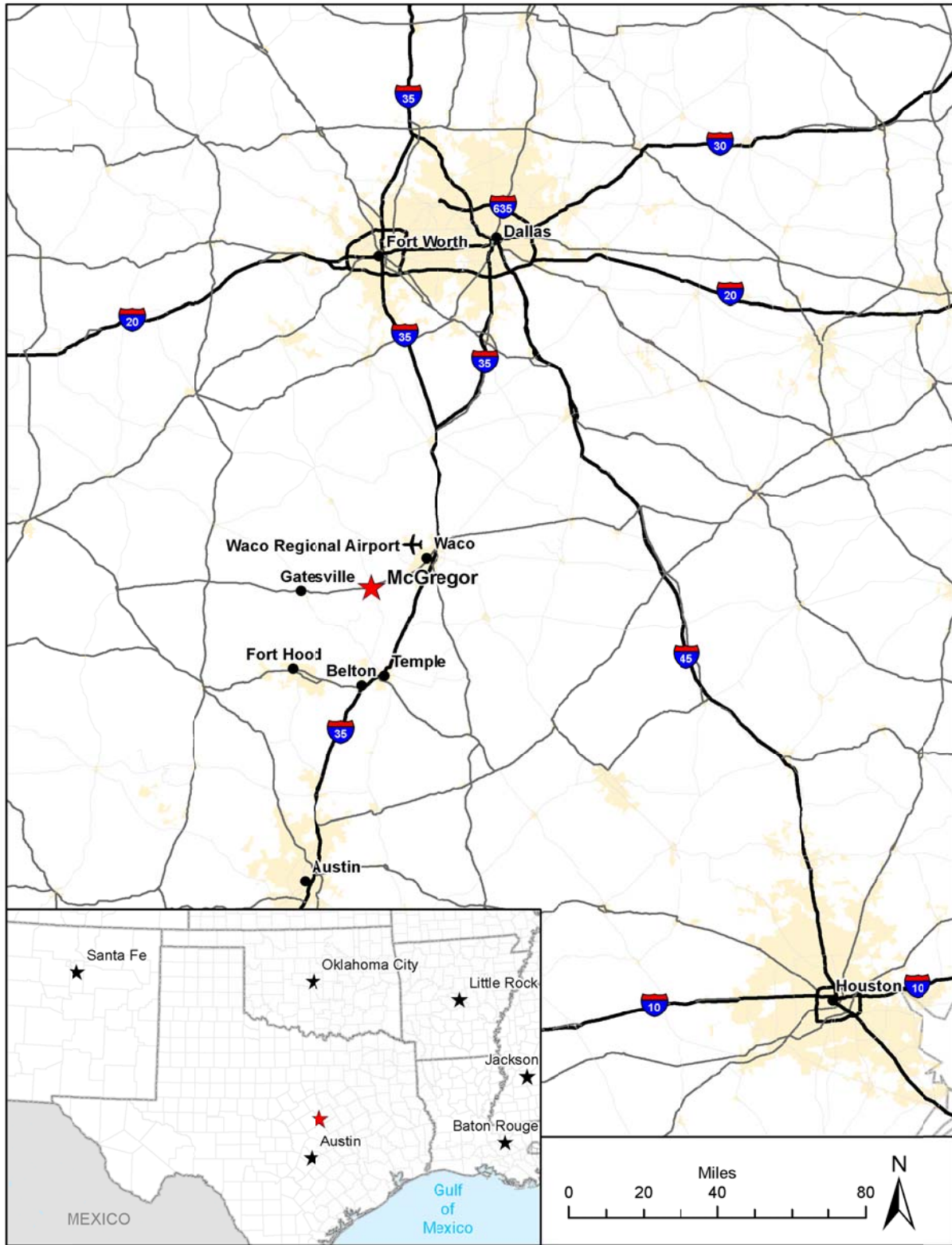


Exhibit 1-1. Regional Location of McGregor, Texas

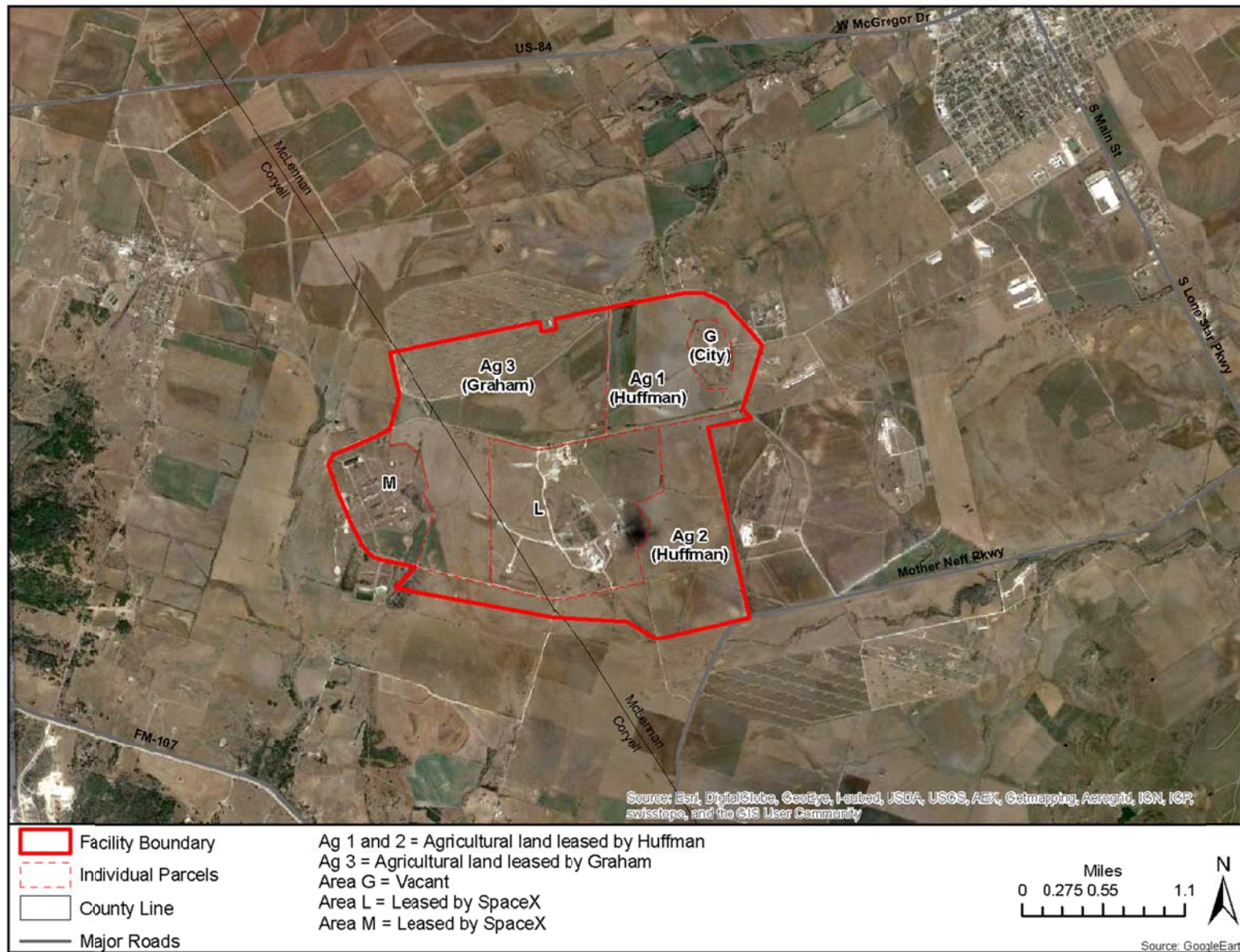


Exhibit 1-2. McGregor Test Site

In addition, SpaceX received an experimental permit for the Falcon 9R (F9R), which is similar to the Grasshopper vehicle. The F9R test program consists of 10 launches at McGregor. The Grasshopper RLV and the F9R test programs would be completed prior to the implementation of the Proposed Action. Therefore, the baseline conditions (refer to Section 2.2, *No Action Alternative*) for the analysis in this EA do not include the Grasshopper RLV and F9R test program operations.

1.2 Role of the FAA

The FAA licenses and regulates U.S. commercial space launch and reentry activity, as well as the operation of non-Federal launch and reentry sites, as authorized by Executive Order (EO) 12465, *Commercial Expendable Launch Vehicle Activities*, and the Commercial Space Launch Act of 2011 (51 U.S.C. Subtitle V, ch. 509, §§ 50901-50923). The FAA's mission is to ensure public health and safety and the safety of property while protecting the national security and foreign policy interests of the U.S. during commercial launch and reentry operations. In addition, the FAA is directed to encourage, facilitate, and promote commercial space launches and reentries.

The FAA has the responsibility, under the Commercial Space Launch Act, to do the following:

- Promote economic growth and entrepreneurial activity through use of the space environment for peaceful purposes
- Encourage the U.S. private sector to provide launch vehicles, reentry vehicles, and associated services by
 - simplifying and expediting the issuance and transfer of commercial licenses, and
 - facilitating and encouraging the use of government-developed space technology
- Ensure that the Secretary of Transportation provides oversight and coordinates the conduct of commercial launch and reentry operations, issue and transfer commercial licenses authorizing those operations, and protects the public health and safety, safety of property, and national security and foreign policy interests of the U.S.
- Facilitate the strengthening and expansion of the U.S. space transportation infrastructure, including the enhancement of U.S. launch sites and launch-site support facilities, and development of reentry sites, with Federal, State, and private sector involvement, to support the full range of U.S. space-related activities.

The decision for the FAA to issue an experimental permit to SpaceX is considered a major Federal action under NEPA. The FAA is responsible for analyzing the potential environmental impacts associated with permitting commercial launch vehicles.

1.3 Purpose and Need

SpaceX's purpose of requesting an experimental permit from the FAA is for SpaceX to test the capability of the DragonFly RLV to execute precision landings on land. SpaceX's need for the experimental permit is to conduct tests to further develop the capability for the Dragon capsule to land, so that it can be reused. One of SpaceX's goals is to reduce the cost of access to space. Being able to reuse the Dragon capsule would help meet this goal by eliminating the costs associated with building another capsule.

The **purpose** of the FAA's Proposed Action in connection with SpaceX's request for an experimental permit is to fulfill the FAA responsibilities under the Commercial Space Launch Act, 51 U.S.C. Subtitle V, Ch. 509, §§ 50901-50923, for oversight of experimental permit activities. The Proposed Action would be consistent with the objectives of the Commercial Space Launch Act.

The **need** for the FAA action of issuing an experimental permit results from the statutory direction from Congress under the Commercial Space Launch Act to protect the public health and safety, safety of property, and national security and foreign policy interest of the U.S. and to encourage, facilitate, and promote commercial space launch activities by the private sector in order to strengthen and expand U.S. space transportation infrastructure. The FAA expects to receive an application for an experimental permit from SpaceX to conduct launch operations of the DragonFly RLV at the McGregor test site. The FAA must review the application and determine whether to issue the experimental permit.

1.4 Public Involvement

In accordance with NEPA, CEQ NEPA implementing regulations (40 CFR Parts 1500 to 1508), and FAA Order 1050.1E, *Environmental Impacts: Policies and Procedures, Change 1*, the FAA has initiated a public review and comment period for this Draft EA. Interested parties are invited to submit comments on environmental issues and concerns, preferably in writing, on or before June 16, 2014, or 30 days from the date of publication of the Notice of Availability in the *Federal Register*, whichever is later. An electronic version of the Draft EA is available on the FAA website:

http://www.faa.gov/about/office_org/headquarters_offices/ast/environmental/review/permits

The FAA invites interested agencies, organizations, Native American tribes, and members of the public to submit comments on all aspects of this Draft EA. The FAA will consider all comments on this Draft EA in preparing a Final EA. To facilitate FAA consideration and response to comments, it is critical that comments be as specific as possible and clearly state concerns or recommendations related to the issues addressed in this Draft EA.

The following agencies and federally-recognized Native American Tribes have been contacted regarding the preparation of this EA:

- The State Historic Preservation Officer (SHPO) - Texas Historical Commission (THC)
- The Texas Parks and Wildlife Department (TPWD)
- The Comanche Nation of Oklahoma
- The Tonkawa Tribe of Oklahoma

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2.0 PROPOSED ACTION AND ALTERNATIVES

2.1 Proposed Action

The Proposed Action (preferred alternative) is for the FAA to issue an experimental permit to SpaceX, which would authorize SpaceX to conduct suborbital launches and landings of the DragonFly RLV from the McGregor test site in McGregor, Texas. To support the DragonFly RLV activities under the experimental permit, SpaceX would construct a 40 foot (ft) by 40 ft launch pad. Therefore, the Proposed Action analyzed in this Draft EA includes the activities that would be authorized by the experimental permit (i.e., the operation of the launch vehicle) as well as the construction of the launch pad.

Under the FAA experimental permit program (implemented by 14 CFR Part 437), the FAA issues experimental permits to commercial launch operators for the operation of developmental reusable suborbital rockets on suborbital trajectories. Under the Proposed Action, the experimental permit would be valid for one year and would authorize an unlimited number of launches. The FAA could renew the experimental permit if requested, in writing, by SpaceX at least 60 days before the permit expires. SpaceX anticipates that the DragonFly RLV program would require up to 2 years to complete (2014 – 2015). Therefore, the Proposed Action considers one new permit and one potential permit renewal.

Although an experimental permit would authorize an unlimited number of launches, the FAA must estimate the number of launches in order to analyze potential environmental impacts. The FAA in coordination with SpaceX has assumed a certain number of annual launch operations that could be conducted under any one experimental permit for the DragonFly RLV at the McGregor test site. A maximum of 30 annual operations are proposed in each year of operation, distributed between the four operation types (see Table 2.1-1). This estimation is a maximum number and considers potential multiple launches per day and potential launch failures. All operations would occur between the hours of 7:00 a.m. and 10:00 p.m.

Table 2.1-1. Proposed Annual Operations of the DragonFly RLV

Operation Type	Description	Annual Operations
Propulsive Assist	Drop the RLV from a helicopter from up to 10,000 ft, deploy parachutes and land with SuperDraco engines; engines would fire for 5 seconds	2
Full Propulsive Landing	Drop the RLV from a helicopter from up to 10,000 ft and land only with SuperDraco engines (no parachute); engines would fire for 5 seconds	2
Propulsive Assist Hopping	RLV takes off from launch pad and lands with parachutes; engines would fire for 25 seconds	8
Full Propulsive Hopping	RLV takes off from launch pad, hovers, and lands propulsive (no parachute); engines would fire for 25 seconds	18
Total Operations		30

SpaceX is currently considering two locations for the DragonFly RLV launch operations within the McGregor test site: the existing Grasshopper launch pad and the DragonRider test area. If operations

would occur at the DragonRider test area, construction of a 40 ft by 40 ft launch pad would be necessary (see Exhibit 2-1). The proposed operating area would be considered the entire McGregor test site as depicted in Exhibit 1-2.

2.1.1 DragonFly RLV

The DragonFly RLV is the Dragon capsule with an integrated trunk (which may or may not be attached during a DragonFly operation) and up to four steel landing legs. The Dragon capsule primary structure consists of a welded aluminum pressure vessel, primary heat shield support structure, back shell thermal protection system support structure, and a nosecone. This structure supports secondary structures including eight SuperDraco engines (two in each of the four modules [quadrants]), propellant tanks, pressurant tanks, parachute system, and necessary avionics. The propulsion system includes four self-contained quadrants with independent sets of propellant tanks for system redundancy. The SuperDraco engine uses a fuel-centered injector to provide appropriate performance for the application. It is also designed to seal off both fuel and oxidizer from the combustion chamber, enabling operation with fast shut-off and limited propellant “dribble” volumes.

The DragonFly RLV weighs approximately 14,000 pounds (lbs) un-fueled, with a height of 17 ft and a base width of 13 ft. Each pair of SuperDraco engines (eight total engines) are mounted to a monolithic aluminum bracket. This bracket is connected to the pressure vessel with three mounts.

The propulsion system uses a nitrogen tetroxide (NTO) and monomethylhydrazine (MMH) propellant combination. The amount of propellant for each type of operation varies and is discussed further in Section 2.1.1.1, *Proposed Operations*. The DragonFly RLV has a maximum operational propellant load of approximately 400 gallons; however, the propellant loads would be different depending on the test type (see Section 2.1.1.1 for further discussion on propellant loads by test type).

The parachute system consists of two dual initiated drogue mortars. A drogue is a small parachute that deploys first in order to pull a larger parachute. The mortar is a low velocity explosive that is fired to release the drogue parachute. Each of the two drogue parachutes has an area of approximately 452 square feet (ft²). All components except the main parachutes are mounted on the outside of the forward bulkhead. The main parachutes fill the volume between two radial bulkheads below the side hatch. Each of the three main parachutes has an area of approximately 10,935 ft².



**Dragon Capsule with
Integrated Trunk**



Exhibit 2-1. Existing Grasshopper Launch Pad and DragonRider Test Area

Deployment of the parachutes system begins with both drogue mortars firing simultaneously through blowout panels (each panel weighs 8 lbs and is approximately 2 ft by 2ft). The panels would then fall to the ground within the proposed operating area.

Proposed Operations

As discussed above, the DragonFly RLV test program is expected to be conducted under an experimental permit and would consist of up to 30 annual operations, distributed between four types of operations (see Table 2.1-1). Multiple test operations could occur each day between the hours of 7:00 a.m. and 10:00 p.m., and would be consistent with SpaceX's lease with the City of McGregor. For example, the terms of the lease prohibit SpaceX from conducting engine tests between the hours of 12:00 a.m. and 7:00 a.m. The DragonFly RLV would be unmanned during all launch operations. However, 10 additional staff would be located at the McGregor test site to support DragonFly RLV operations.

Pre-flight and Post-flight Activities

Pre-flight and post-flight activities would be similar for each test type. Pre-flight activities include preparing the DragonFly RLV for launch and providing ground operations support for launch and landing. The DragonFly RLV would be transported by truck or tractor-trailer from its storage location at the McGregor test site to the launch pad. Similarly, trucks would be used to transport the propellants from the propellant storage area to the launch pad.

Standard safety precautions, such as clearing the area of unnecessary personnel and ignition (including spark) sources, would be implemented. The DragonFly RLV would be fueled with the appropriate amount of propellant for the proposed test type (see Section 2.1.1.2 – 2.1.1.5 below for a description of test types). In the event of a spill or release, propellant-loading operations would be halted. Any spills would be cleaned up according to the SpaceX's Spill Response Procedures for the McGregor test site. Following the propellant transfer, the propellant-loading equipment would be removed from the launch area.

During preparations for launch, the electrical and mechanical connections of the DragonFly RLV would be inspected, and flight control diagnostics and health checks would be completed to ensure proper operation of electrical systems and moving parts. The DragonFly RLV would initiate its formal launch sequence (i.e., ignition of its propulsion system) after all preparation and pre-flight operations were completed.

Post-flight activities include DragonFly RLV landing and safing¹. During a nominal launch, the vehicle would land either back on the launch pad or in a predetermined targeted site within the operating area in the vicinity of launch pad. Safing activities would begin upon completion of all launch and landing

¹ Safing refers to shutting down the launch vehicle and ensuring the vehicle is in a safe condition before transporting the vehicle to its storage facility.

activities and engine shutdown. The propellant lines would be drained into a suitable container. A ground crew would perform and supervise all pre-flight, flight, and landing operations and would be familiar with the operating protocol for the specific test type.

Flight Profile

Flight profile refers to the take-off (or drop), flight, and landing of the launch vehicle. The flight profile for each operation type is discussed below.

Propulsive Assist

For the propulsive assist test, a helicopter (an Erickson E-model or equivalent) would arrive at the McGregor test site from Waco Regional Airport. The DragonFly RLV would then be tethered to the helicopter using a cable. A maximum of 300 gallons of propellant would be loaded into the DragonFly RLV for this test. The helicopter would take off with the DragonFly RLV attached and reach an altitude up to 10,000 ft. Once at that altitude, the DragonFly RLV would be released from the tether and three main parachutes would be deployed. The engines would not fire until the vehicle descends to approximately 98 ft above ground level (AGL). The engines would fire for approximately 5 seconds, and the RLV would make a powered landing. This type of operation would last approximately 30 minutes from helicopter take-off to DragonFly RLV landing.

The test would be designed so that almost all fuel on board is used prior to landing. All fuel valves would shut automatically and retain any residual fuel in the capsule.

Full Propulsive Landing

For the full propulsive landing test, a helicopter (an Erickson E-model or equivalent) would arrive at the McGregor test site from Waco Regional Airport. The DragonFly RLV would then be tethered to the helicopter. A maximum of 300 gallons of propellant would be loaded into the DragonFly RLV for this test. The helicopter would take off with the DragonFly RLV attached and reach an altitude up to 10,000 ft. Once at that altitude, the DragonFly RLV would be released from the tether. There would be a period of free fall and then the engines would fire for approximately 5 seconds and the RLV would make a powered landing. This type of operation would last approximately 30 minutes from helicopter take-off to DragonFly RLV landing.

Propulsive Assist Hopping

Approximately 400 gallons of propellant would be loaded into the DragonFly RLV for this test. During a propulsive assisted hop test, the DragonFly RLV would launch from a launch pad and ascend to approximately 7,000 ft AGL (firing engines for 12.5 seconds). Two parachutes would be deployed for the descent, the engines would fire for 12.5 seconds, and the RLV would make a powered landing on the launch pad. This operation would last approximately 60 seconds.

Full Propulsive Hopping

Approximately 400 gallons of propellant would be loaded into the DragonFly RLV for this test. During a full propulsive hop test, the DragonFly RLV would launch from a launch pad and ascend to approximately 7,000 ft AGL (firing engines for approximately 12.5 seconds). The engines would then throttle down in order to descend (firing engines for an additional approximate 12.5 seconds), and the RLV would make a powered landing on the launch pad. This operation would last approximately 60 seconds.

2.1.2 DragonFly Launch Pad

In order to support the proposed activities of the DragonFly RLV under an experimental permit, SpaceX would construct a concrete launch pad. The proposed launch pad would be 40 ft by 40 ft located approximately 0.32 mile north of the Grasshopper launch pad (see Exhibit 2-1 for general location). The proposed launch pad location was based on the separation distance from SpaceX's existing major infrastructure (i.e., the tripod test stand) and the control center. The pad would be constructed at the end of an existing access road and would be built to comply with Texas code requirements for constructing on black clay. The launch pad would require approximately 24,003 cubic feet (889 cubic yards) of concrete, which would be supplied to the McGregor test site by approximately 99 concrete trucks in batches of 9 cubic yards. Construction of the launch pad would be expected to take 1–2 weeks. The proposed launch pad would be connected to existing infrastructure (i.e., water and electric) at the DragonRider test area.

2.2 No Action Alternative

Under the No Action Alternative, the FAA would not issue an experimental permit to SpaceX for the operation of the DragonFly RLV at the McGregor test site. Existing SpaceX activities would continue at the McGregor test site, which include engine testing for the Falcon 9 launch vehicle. SpaceX averages approximately five Merlin-1D tests per week as well as six Falcon 9 Stage 1 tests per year. The Falcon 9 is an expendable launch vehicle that uses highly refined kerosene, also known as rocket propellant-1 or refined petroleum (RP-1), and liquid oxygen (LOX) for propellants. Stage 1 of the Falcon 9 holds approximately 62,000 gallons of LOX and 38,000 gallons of RP-1. Stage 1 is powered by nine Merlin-1D engines, with each Merlin-1D engine producing 146,000 pounds of thrust. The Falcon 9 stage testing occurs on the tripod stand located at the site (see Exhibit 2-1 for general location). Additionally, SpaceX currently uses hypergolic propellants at the McGregor site, specifically at the Dragon Decon area, when conducting hypergolic testing in an enclosed vacuum chamber. Open air testing is also conducted at the DragonRider test area for the SuperDraco engine developments for a total of approximately four minutes per year.

NEPA requires agencies to consider a “no action” alternative in their NEPA analyses and to compare the effects of not taking action with the effects of the action alternative(s). Thus, the No Action Alternative serves as a baseline to compare the impacts of the Proposed Action. The No Action Alternative would not satisfy the purpose and need for the Proposed Action as stated above in Section 1.2.

2.3 Alternatives Considered but Not Carried Forward

In conjunction with SpaceX, the FAA considered assessing alternative sites to conduct test launches of the DragonFly RLV. However, due to the following reasons, alternative sites were dismissed from consideration:

- SpaceX's current operational McGregor test site and lease with the City of McGregor,
- SpaceX's ongoing engine testing at McGregor test site,
- SpaceX's existing launch pad and infrastructure that are available to support the proposed test program,
- The previously disturbed environment of the McGregor test site,
- The general uninhabited or sparse population surrounding the McGregor test site, and
- The general "uncrowded" airspace over the McGregor test site.

Therefore, there are no other reasonable alternatives to be evaluated in this EA. The preferred alternative is to conduct suborbital launches and landings of the DragonFly RLV from the McGregor test site.

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3.0 AFFECTED ENVIRONMENT

This Chapter provides a description of the environmental resources that would be affected by the Proposed Action, as required by CEQ regulations for implementing NEPA (40 CFR Parts 1500 to 1508). The level of detail provided in this Chapter is commensurate with the importance of the impact on these resources (40 CFR §1502.15).

The environment potentially affected by the Proposed Action is referred to as the Region of Influence (ROI). Each resource area discussed in this chapter has a distinct ROI, which is further described in each section.

Resources Not Analyzed in Detail

This EA does not analyze potential impacts to the following environmental resource areas in detail, for the reasons explained below:

- **Coastal Resources** – Proposed construction and operating areas are located inland, where coastal resources are not present.
- **Wild and Scenic Rivers** – There are no designated wild or scenic rivers, as defined by the Wild and Scenic Rivers Act, located within the McGregor test site where construction and operational activities would occur. The closest federally designated Wild and Scenic River is the Saline Bayou in Louisiana, over 300 miles from the McGregor test site (National Wild and Scenic River System 2013). Similarly, there are no rivers listed on the National Park Services' Nationwide Rivers Inventory (NRI) within or near the McGregor test site. The Colorado River in Hood County and the Brazos River on the western edge of Lampasas County, are approximately 64 miles north and 62 miles west of the McGregor Test site, respectively.
- **Farmlands** – There are no prime or unique farmlands or farmland of statewide or local importance as defined by the Farmland Protection Policy Act that would be affected by the project. Previous coordination with the Natural Resources Conservation Service for the McGregor test site indicated that soils at the McGregor test site are “prior converted” to urban uses, and are not prime or unique farmlands as defined by the Farmland Protection Policy Act (FAA 2011).
- **Secondary (Induced) Impacts** – The Proposed Action would not involve the potential for induced or secondary impacts to surrounding communities, such as shifts in population movement and growth, public service demands, and economic activity. The influx of 10 new personnel would not produce a measurable ripple effect of spending and re-spending in response to the direct effect (refer to Section 4.10). Therefore, this impact category was dismissed.

3.1 Air Quality

The Earth's atmosphere consists of four main layers: the troposphere, stratosphere, mesosphere, and ionosphere. For the purposes of this EA, the discussion of air quality within the lower troposphere is defined as at or below 3,000 ft AGL, which the U.S. Environmental Protection Agency (EPA) accepts as

the nominal height of the atmosphere mixing layer in assessing contributions of emissions to ground-level ambient air quality under the Clean Air Act (CAA) (EPA 1992). Although launch vehicle emissions from operations at or above 3,000 ft AGL would occur, these emissions would not result in appreciable ground-level concentrations. The mixing layer (sometimes referred to as the boundary layer) is the layer of air directly above the Earth that is relatively well mixed. This layer extends to a height referred to as the mixing height, above which the free troposphere extends up to the tropopause. The stratosphere, mesosphere, and ionosphere are not relevant for this analysis because the maximum flight altitude of the Dragonfly is 10,000 ft AGL, which lies within the troposphere. Typically, temperature and density decrease with altitude in the atmosphere up to the mixing height. However, at the mixing height, the temperature begins to increase with altitude and creates an inversion which prevents a parcel of air from spontaneously rising past the mixing height (Visconti 2001).

The proposed operation of the Dragon RLV would occur in McGregor, Texas which is located in parts of two counties, McLennan and Coryell. Therefore, the ROI for air quality is McLennan and Coryell counties (refer to Exhibit 2-1).

3.1.1 National Ambient Air Quality Standards

Under the Clean Air Act, the EPA established National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50) for specific pollutants of concern, which are referred to as criteria pollutants. The NAAQS represent the maximum levels of pollution that are considered acceptable, with an adequate margin of safety, to protect public health and welfare. Short-term standards (1-, 3-, 8-, and 24-hour periods) are established for pollutants contributing to acute health effects, while long-term standards (quarterly and annual averages) are established for pollutants contributing to chronic health effects. The Texas Commission on Environmental Quality (TCEQ), Office of Air, adopted the EPA-established NAAQS, which are presented in Table 3.1-1.

Table 3.1-1. National Ambient Air Quality Standards

Criteria Pollutant	Averaging Time	Primary Standards	Secondary Standards
Carbon monoxide	8-hour	9 ppm (10 mg/m ³)	None
	1-hour	35 ppm (40 mg/m ³)	
Lead	Rolling 3-month average	0.15 µg/m ³	Same as Primary
Nitrogen dioxide	Annual (arithmetic average)	53 ppb	Same as Primary
	1-hour	100 ppb	None
PM ₁₀	24-hour	150 µg/m ³	Same as Primary
PM _{2.5}	Annual (arithmetic average)	12.0 µg/m ³	15.0 µg/m ³
	24-hour	35 µg/m ³	Same as Primary
Ozone	8-hour	0.075 ppm	Same as Primary
Sulfur dioxide	3-hour	None	0.5 ppm
	1-hour	75 ppb	None

Source: (EPA 2012)

Notes: mg/m³ = milligrams per cubic meter; µg/m³ = micrograms per cubic meter; ppb = parts per billion; ppm = parts per million; PM₁₀ = particulate matter less than or equal to 10 microns in diameter; PM_{2.5} = fine particulate matter 2.5 microns or less in diameter

EPA designates areas having air quality within the NAAQS as being in “attainment.” The designation of attainment for any NAAQS is based on the evaluation of ambient air quality monitoring data collected through Federal, State and/or local monitoring networks. There are two TCEQ monitoring sites located

in McLennan County in the Waco area. One is located at the Waco Regional Airport (CAMS 5010) and collects meteorological data only. The second site (CAMS 1037) is located on Mazanec Road in Elm Mott, Texas. This site collects data on carbon monoxide, nitrogen oxides, ozone, PM_{2.5}, sulfur dioxide, temperature, wind, and solar radiation (TCEQ 2013). McLennan and Coryell counties are in attainment for all regulated criteria pollutants. Although there have been instances of exceedance (at CAMS 1037) above the old 24-hour NAAQS of 15 µg/m³ for PM_{2.5}, the area has not established a pattern of exceedance that would require designation as nonattainment. Because McLennan and Coryell Counties are in attainment for NAAQS, the CAA General Conformity Rule (40 CFR Part 93, Subpart B) does not apply and is not addressed in this EA.

Stationary point sources of air emissions at the McGregor test site include launch vehicle processing, fueling, and other point sources such as generators and storage tanks. Mobile sources of air emissions include support equipment, commercial transport vehicles, and personal motor vehicles. The McGregor test site operates under a TCEQ air quality permit (TCEQ 2007). This permit covers construction and operation of five rocket engine test stands, five new fuel storage tanks, and associated piping and equipment at the McGregor test site. It is a Permit by Rule, which TCEQ issues to facilities that produce more than a *de minimis* level of emissions but do not require a standard (i.e., New Source Review) TCEQ air quality permit, are not major sources as defined by the U.S. Clean Air Act, and that meet several TCEQ criteria including emissions limits. To meet these limits the facility's emissions must be less than 250 tons per year of CO or nitrogen oxides, 25 tons per year of SO₂ or volatile organic compounds, 15 tons per year of PM₁₀, and 10 tons per year of PM_{2.5}.

3.1.2 Hazardous Air Pollutants

In addition to the ambient air quality standards for criteria pollutants, national standards also exist for Hazardous Air Pollutants (HAPs). The National Emission Standards regulate 188 HAPs based on available control technologies (40 CFR Parts 61 and 63). The majority of HAPs are volatile organic compounds.

HAPs emitted from mobile sources are called Mobile Source Air Toxics (MSATs). MSATs are compounds emitted from highway vehicles and non-road equipment that are known or suspected to cause cancer or other serious health and environmental effects. In 2001, EPA issued its first Mobile Source Air Toxics Rule, which identified 21 compounds as being HAPs that required regulation (EPA 2001). A subset of six of these MSATs compounds were identified as having the greatest influence on health and included benzene, 1,3 butadiene, formaldehyde, acrolein, acetaldehyde, and diesel particulate matter. EPA issued a second Mobile Source Air Toxics Rule in February 2007, which generally supported the findings in the first rule and provided additional recommendations of compounds having the greatest impact on health. The rule also identified several engine emission certification standards that must be implemented (EPA 2007).

MSATs would be the primary HAPs emitted by mobile sources during construction and operations. The equipment used during construction of the launch pad would likely vary in age and have a range of emission controls. Construction equipment would be operated for approximately two weeks and would produce negligible ambient HAPs in a localized area. Operational equipment, including vehicles driven

by commuters, is anticipated to be primarily newer equipment that generate lower emissions and would also produce negligible ambient HAPs. Therefore, MSATs emissions are not considered further in this analysis.

3.1.3 Stationary Source Permitting

There are no stationary sources associated with implementing the Proposed Action. Therefore, none of the air quality regulations for stationary sources apply.

3.1.4 Greenhouse Gases

Greenhouse Gases (GHGs) are gas emissions that trap heat in the atmosphere. These emissions occur from natural processes and human activities. Scientific evidence indicates a trend of increasing global temperature over the past century due to an increase in GHG emissions from human activities. The climate change associated with this global warming is expected to produce negative economic and social consequences across the globe.

Although not required by FAA Order 1050.1E, the FAA has developed interim guidance for considering GHGs and climate under NEPA, as documented in a memorandum dated January 12, 2012 (FAA 2012). Additionally, in February 2010, the CEQ issued draft NEPA guidance for considering the effects of climate change and GHG emissions (CEQ 2010).

Research has shown there is a direct correlation between fuel combustion and GHG emissions. In terms of U.S. contributions, the Government Accountability Office (GAO) reports that "domestic aviation contributes about 3 percent of total carbon dioxide emissions, according to EPA data," compared with other industrial sources including the remainder of the transportation sector (20 percent) and power generation (41 percent) (GAO 2009). The International Civil Aviation Organization estimates that GHG emissions from aircraft account for roughly 3 percent of all anthropogenic GHG emissions globally (Melrose 2010). Climate change resulting from GHG emissions is a cumulative global phenomenon, so the affected environment is the global climate (EPA 2009a). Discussion of the estimated GHG emissions associated with the Proposed Action and the impact analysis can be found in cumulative impact analysis in Section 5.0.

SpaceX currently uses hypergolic propellants at the Dragon Decon area, when conducting hypergolic testing in an enclosed vacuum chamber. Open air testing is also conducted at the DragonRider test area for the SuperDraco engine developments for a total of approximately four minutes per year (see Section 2.2 for additional information on SpaceX's existing activities at the McGregor test site).

3.2 Noise and Compatible Land Use

Noise is considered unwanted or annoying sound that interferes with or disrupts normal human activities. Although exposure to very high noise levels can cause hearing loss, the principal human response to noise is annoyance. The response of different individuals to similar noise events is diverse and is influenced by the type of noise, perceived importance of the noise, its appropriateness in the setting, time of day, type of activity during which the noise occurs, and sensitivity of the individual.

The ROI for noise includes the McGregor test site and the area in the immediate vicinity of the test site that could be impacted by noise from construction and launch-related activities under the Proposed Action.

3.2.1 Noise Metrics

The decibel (dB) is a ratio that compares the sound pressure of the sound source of interest (e.g., a launch) to a reference pressure (i.e., the quietest sound that can be heard). A number of factors affect sound, as the human ear perceives it. These include the actual level of noise, the frequencies involved, the period of exposure to the noise, and changes or fluctuations in noise levels during exposure. In order to correlate the frequency characteristics from typical noise sources to the perception of human ears, several noise frequency weighting measures have been developed. The most common frequency measure is the 'A-weighted scale.' Since the human ear cannot perceive all pitches or frequencies equally well, these measures are adjusted or weighted to compensate for the human lack of sensitivity to low-pitched and high-pitched sounds. This adjusted unit is known as the A-weighted dB, or dBA. Exhibit 3.2-1 provides a chart of A-weighted sound levels from typical noise sources. Some noise sources (e.g., air conditioner, vacuum cleaner) are continuous sounds that maintain a constant sound level for some period of time. Other sources (e.g., automobile, heavy truck) are the maximum sound produced during an event like a vehicle pass-by. Other sounds (e.g., urban daytime, urban nighttime) are averages taken over extended periods of time.

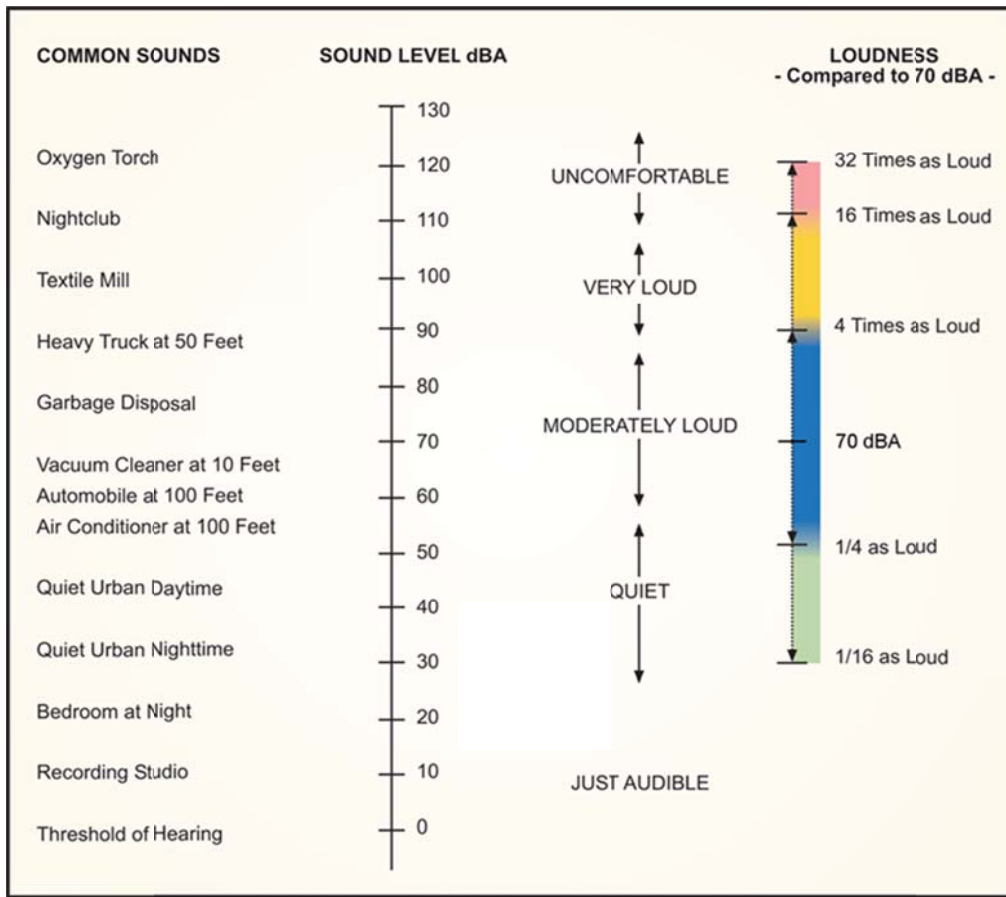
The day-night average noise level (DNL) is a cumulative noise metric that accounts for the Sound Exposure Level (SEL), which is the magnitude of a sound and its duration, of all noise events in a 24-hour period. SEL provides a cumulative noise exposure of the entire acoustic event, but it does not directly represent the sound level heard at any given time. Typically, DNL values are expressed as the level over a 24-hour annual average day. To account for increased human sensitivity to noise at night, a 10 dB penalty is applied to DNL for nighttime events (10:00 p.m. to 7:00 a.m.).

3.2.2 Noise Criteria

FAA Order 1050.1E, Change 1, requires the FAA to assess noise impacts on noise sensitive areas² using the DNL metric to determine if significant impacts would occur³.

² A noise sensitive area is an area where noise interferes with normal activities associated with its use. Normally, noise sensitive areas include residential, educational, health, and religious structures and sites, and parks, recreational areas (including areas with wilderness characteristics), wildlife refuges, and cultural and historical sites.

³ There are other Federal agency noise standards that pertain to hearing conservation (e.g., those established by the National Institute for Occupational Safety and Health and the Occupational Safety and Health Administration). Activities conducted under the Proposed Action would be in compliance with these standards.



Sources: Derived from Harris 1979 and Federal Interagency Committee on Aviation Noise (FICAN) 1997.
 Note: dBA = A-weighted decibel

Exhibit 3.2-1. A-Weighted Sound Levels from Typical Sources

Noise contour maps of noise metrics are used to assess the noise level and impact of noise on a community. Noise contours depict the area within which a certain noise level occurs, as predicted by a computer model. FAA Order 1050.1E, Change 1, guidance on noise indicates that a significant noise impact would occur if the action causes noise sensitive areas to experience an increase in noise of DNL 1.5 dBA or more at DNL 65 dBA noise exposure when compared to the existing conditions within the same time period.

The McGregor test site is a relatively isolated facility, surrounded by agricultural land. The closest residential communities to the proposed launch and landing pad locations are the City of McGregor, located approximately 5 miles to the northeast, and the City of Oglesby, located approximately 3 miles to the northwest. The McGregor test site is located in a small industrial park in the City of McGregor. Other noise sources at or near the McGregor test site include sources that are typical to a rural/agricultural setting, including farm machinery, automobiles, trains, and commercial vehicles (e.g., waste management trucks).

Noise sensitive areas near the proposed launch and landing pad locations include Oglesby School, located approximately 3.4 miles to the northwest, and McGregor High School, located approximately 4.5 miles to the northeast. In addition, a new primary school (grades K-1st grade) is being constructed adjacent to McGregor Elementary and McGregor High School. The closest business is the Crosslink Powder Company, located approximately 2.8 miles from the proposed launch and landing pad locations. The nearest residence is approximately 1.3 miles from the proposed launch and landing pad locations.

SpaceX currently conducts approximately five Merlin-1D engine tests per week at the McGregor test site. An average single engine test lasts approximately 100 seconds and produces noise levels of approximately 138 dBA within the test site boundary and approximately 97 dBA within 3 miles of the test site. SpaceX also conducts six Falcon 9 Stage 1 tests a year, consisting of nine engines firing simultaneously for up to 180 seconds. These infrequent Stage 1 tests increase noise levels for short periods of time to approximately 148 dBA at the test site and approximately 107 dBA 3 miles from the test site.

Based on the existing engine test noise levels and durations described above, the existing DNL 65 dBA noise contour extends approximately four miles from the test site and includes residential areas in the City of McGregor and Oglesby (see Exhibit 3.2-2). The exhibit represents the existing noise level of the McGregor test site.

3.2.3 Compatible Land Use

Land uses are frequently regulated by management plans, land use plans, comprehensive plans, and local zoning and ordinances. These plans and regulations are designed to identify where future development can occur, ensure consistency with surrounding land uses, and protect specially designated or environmentally sensitive uses. Compatible land use means the use of the land is normally compatible with the outdoor noise environment at the location.

SpaceX has leased the McGregor test site from the McGregor Industrial Park since 2003. Current SpaceX operations on the site include administrative services, storage, and support buildings; stands to conduct engine testing; the Grasshopper RLV launch pad; and Falcon 9 tripod test stand. The vacant land within the test site is also leased for livestock grazing, which is coordinated with launch and testing activities.

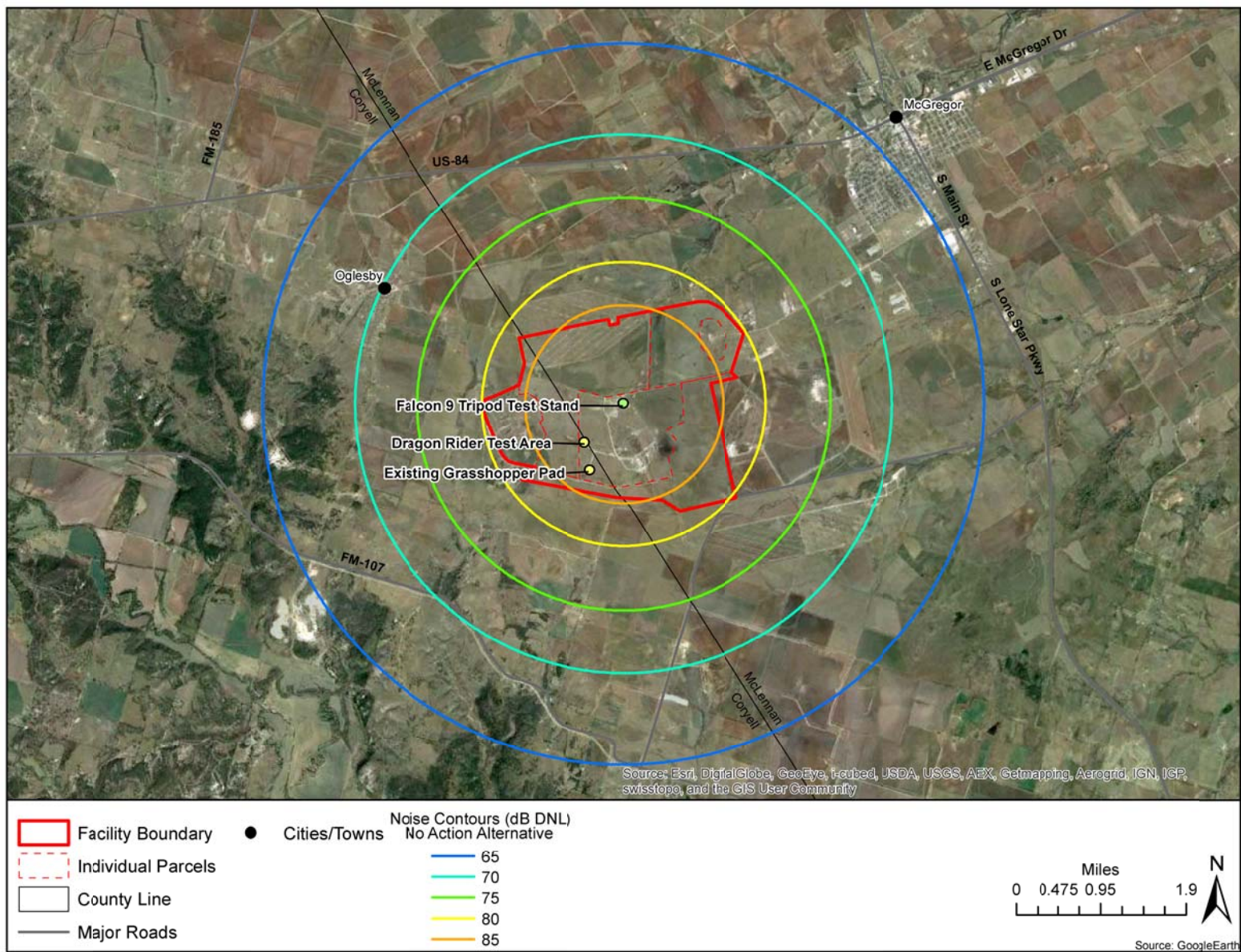
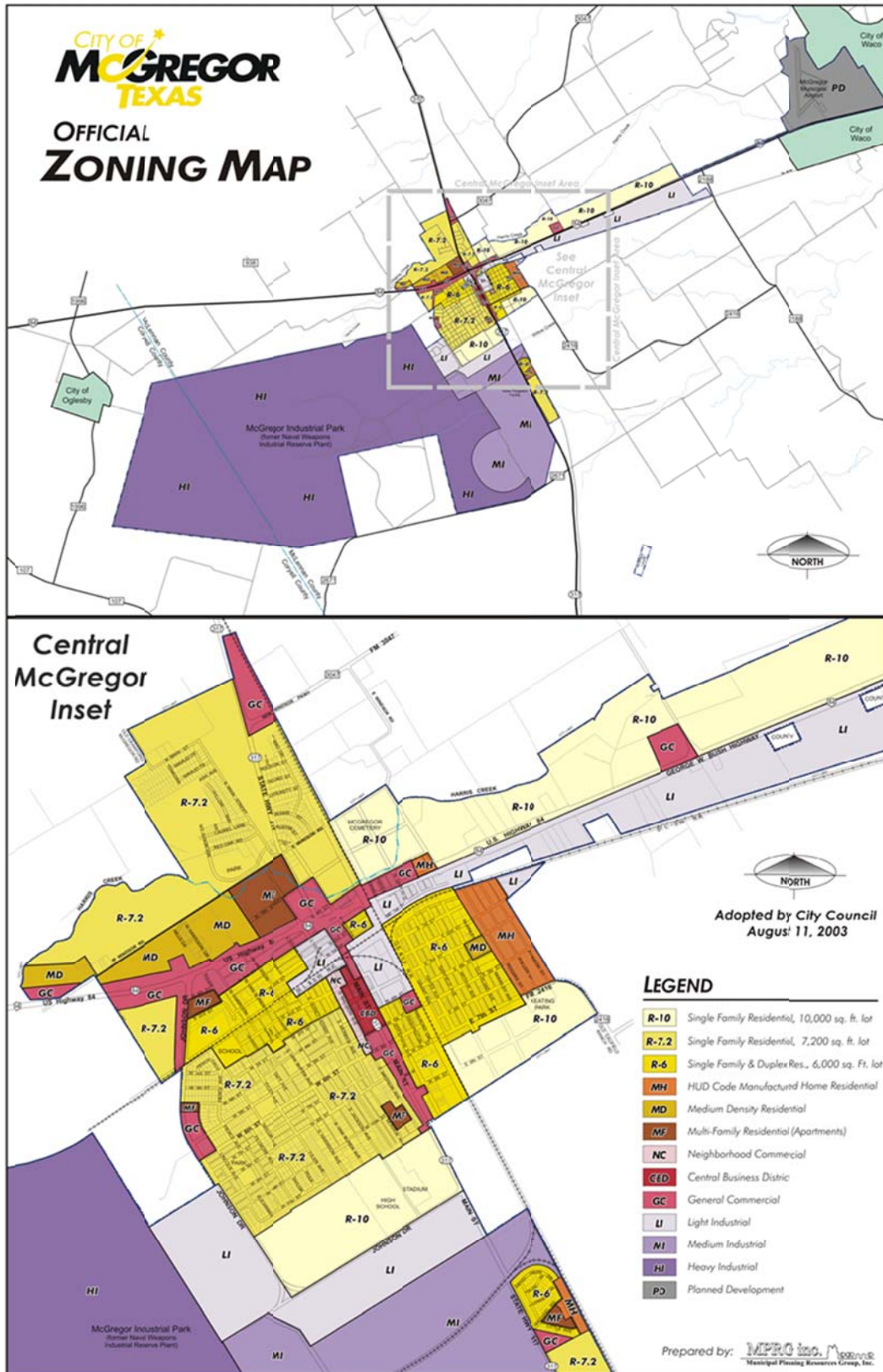


Exhibit 3.2-2. Existing Noise Contours

The McGregor test site is located within the 9,700 acre McGregor Industrial Park, which is the redeveloped McGregor NWIRP (EPA 2009b). The NWIRP was closed in 1995 and ownership was transferred to the City of McGregor in 1996 for development into an industrial park. In addition to SpaceX, other commercial/ industrial tenants of the industrial park include, but are not limited to, a rodeo arena, C3 Communications, Ferguson Plumbing Company, General Micrographics, In Situ Forms, and McLennan County Electrical Cooperative (EPA 2009b; MDEC 2013). The zoning designation of land within the McGregor Industrial Park is heavy industrial (City of McGregor 2003).

With the exception of the activities at the Industrial Park described above, the primary land use surrounding the McGregor test site is agricultural and undeveloped. Exhibit 3.2-3 shows the existing zoning within and adjacent to the McGregor test site as designated by the City of McGregor (City of McGregor 2003). The nearest town to the test site is Oglesby, three 3 miles to the northwest. The City of McGregor is five 5 miles northeast of the test site.

Table 3.2-1 depicts acceptable land use compatibility associated with annual DNL. According to Table 3.2-1, residential areas in the City of McGregor and Oglesby that are already exposed to 65 DNL or greater are incompatible for residential use.



Source: City of McGregor 2003

Exhibit 3.2-3. Existing Zoning Within and Adjacent to the McGregor Test Site

Table 3.2-1. Land Use Compatibility with Annual Day-Night Average Sound Levels (DNL)

Land Use	Yearly DNL Sound Level (decibels)					
	<65	65-70	70-75	75-80	80-85	>85
Residential						
Residential, other than mobile homes and transient lodgings	Y	N ¹	N ¹	N	N	N
Mobile home parks	Y	N	N	N	N	N
Transient lodgings	Y	N ¹	N ¹	N ¹	N	N
Public Use						
Schools	Y	N ¹	N ¹	N	N	N
Hospitals, nursing homes	Y	25	30	N	N	N
Churches, auditoriums, and concert halls	Y	25	30	N	N	N
Government Services	Y	Y	25	30	N	N
Transportation	Y	Y	Y ²	Y ³	Y ⁴	Y ⁴
Parking	Y	Y	Y ²	Y ³	Y ⁴	N
Commercial Use						
Offices, business and professional	Y	Y	25	30	N	N
Wholesale and retail-building materials, hardware, and farm equipment	Y	Y	Y ²	Y ³	Y ⁴	N
Retail Trade, general	Y	Y	25	30	N	N
Utilities	Y	Y	Y ²	Y ³	Y ⁴	N
Communication	Y	Y	25	30	N	N
Manufacturing and Production						
Manufacturing, general	Y	Y	Y ²	Y ³	Y ⁴	N
Photographic and Optical	Y	Y	25	30	N	N
Agricultural (except livestock) and forestry	Y	Y ⁶	Y ⁷	Y ⁸	Y ⁸	Y ⁸
Livestock farming and breeding	Y	Y ⁶	Y ⁷	N	N	N
Mining and fishing, resource production extraction	Y	Y	Y	Y	Y	Y
Recreational						
Outdoor sports arenas and spectator sports	Y	Y ⁵	Y ⁵	N	N	N
Outdoor music shells, amphitheaters	Y	N	N	N	N	N
Nature exhibits and zoos	Y	Y	N	N	N	N
Amusements, parks, resorts, and camps	Y	Y	Y	N	N	N
Golf courses, riding stables and water recreation	Y	Y	25	30	N	N
Source: 14 CFR Part 150, Appendix A, Table 1. The designations contained in this table do not constitute a Federal determination that any use of land covered by the program is acceptable or unacceptable under Federal, State, or local law. The responsibility for determining the acceptable and permissible land uses and the relationship between specific properties and specific noise contours rests with the local authorities. FAA determinations under part 150 are not intended to substitute federally determined land uses for those determined to be appropriate by local authorities in response to locally determined needs and values in achieving noise compatible land uses.						
Key to Table 3.2-1 Y (YES) – Land use and related structures compatible without restrictions. N (NO) – Land use and related structures are not compatible and should be prohibited. NLR – Noise Level Reduction (outdoor to indoor) to be achieved through incorporation of noise attenuation into the design and construction of the structure. 25,30 or 35 – Land use and related structures generally compatible; measures to achieve NLR of 25, 30, or 35 dB must be incorporated into design and construction of structure.						
¹ Where the community determines that residential or school uses must be allowed, measures to achieve outdoor to indoor Noise Level Reduction (NLR) of at least 25 dB and 30 dB should be incorporated into building codes and be considered in individual approvals. Normal residential construction can be expected to provide a NLR of 20 dB, thus, the reduction requirements are often stated as 5, 10, or 15 dB over standard instructions.						
² Measures to achieve NLR of 25 dB must be incorporated into the design and construction of portions of these buildings where						

Table 3.2-1. Land Use Compatibility with Annual Day-Night Average Sound Levels (DNL)

<p>the public is received, office areas, noise sensitive areas or where the normal noise level is low.</p> <p>Measures to achieve NLR of 30 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas or where the normal noise level is low.</p> <p>Measures to achieve NLR of 35 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas or where the normal noise level is low.</p> <p>Land use compatible provided special sound reinforcement systems are installed.</p> <p>Residential buildings require an NLR of 25.</p> <p>Residential buildings require an NLR of 30.</p> <p>Residential buildings not permitted.</p>

3.3 Department of Transportation Act, Section 4(f)

The FAA must consider land use impacts under Section 4(f) of the Department of Transportation (DOT) Act (49 U.S.C. § 303(c)). Section 4(f) properties include publicly owned parks, recreation areas, and wildlife or waterfowl refuges, or any publicly or privately owned historic site listed or eligible for listing on the National Register of Historic Places (NRHP). When private institutions, organizations, or individuals own parks, recreational areas, or wildlife and waterfowl refuges, Section 4(f) does not apply to these properties, even if such areas are open to the public. However, a privately owned property may be protected under Section 4(f) when it is located on long-term leased public land or a public easement.

In accordance with the FAA Order 1050.1E, Change 1, the FAA will not approve any program or project that requires the use of any Section 4(f) property determined by the officials having jurisdiction thereof, unless no feasible and prudent alternative exists to the use of such land and such program, and the project includes all possible planning to minimize harm resulting from the use. The ROI for Section 4(f) properties is the area encompassed by the DNL 65 dBA noise contour determined during noise modeling (see Section 4.2.1, Exhibit 4.2-1).

3.3.1 Public Parks, Recreation Areas, and Refuges

Public parks, recreation areas, and refuges that may be considered Section 4(f) properties, as defined by the Department of Transportation Act (49 U.S.C. § 303(c)), and located in the ROI are listed in Table 3.3-1. Seven parks and one Wildlife Management Area lay within 6 miles of the test site. The closest park, recreation area, or refuge is Oglesby Park which is 2.3 miles from the test site.

Table 3.3-1. Section 4(f) Public Parks, Recreation Areas, and Refuges in the Vicinity of the McGregor Test Site

Property	Distance/ Direction
Amsler Park	5.1 Miles Northeast
Iron Bridge National Wildlife Management Area	5.5 Miles South
Bewley Park	4.5 Miles Northeast
Bluebonnet Park	4.1 Miles Northeast
Kasting Park	5.6 Miles Northeast
Legacy Park	5.1 Miles Northeast
Mother Neff State Park	4.3 Miles South
Oglesby Park	2.3 Miles Northwest

3.3.2 Significant Historic Sites

The ROI for NRHP-listed or eligible resources protected under Section 4(f) is identical to the Area of Potential Effects (APE) defined for cultural resources under Section 106 of the National Historic Preservation Act (NHPA). The FAA defined the APE as the area encompassed by the DNL 65 dBA noise

contour determined during noise modeling (refer to Section 3.4). There are 14 historic properties listed, or eligible for listing, in the NRHP within the ROI. Sections 3.4 and 4.4 provide further discussion of the historical, architectural, archaeological, and cultural resources.

3.4 Historical, Architectural, Archaeological, and Cultural Resources

Cultural resources include prehistoric and historic archaeological sites, buildings, districts, structures, landscapes, or objects having historical, architectural, archaeological, cultural, or scientific importance. Section 106 of the NHPA requires a Federal agency to consider the effects of its undertaking (or action) on properties listed or eligible for listing in the NRHP. Compliance with Section 106 requires consultation with the State Historic Preservation Officer (SHPO) if there is a potential effect to historic properties listed or eligible for listing in the NRHP. The Texas Historical Commission (THC) serves as the SHPO office for the State of Texas.

In accordance with 36 CFR 800.4(a)(1), an APE needs to be established for the Proposed Action. The FAA has determined an APE in consideration of both potential direct and indirect effects to architectural and archaeological resources as a result of implementing the Proposed Action. The APE, also considered the ROI for this resource area, is defined as the area encompassed by the DNL 65 dBA noise contour determined during noise modeling (Appendix A). The THC concurred with this APE on April 7, 2014 (see Appendix B, *Agency Coordination*). Effects to archaeological resources, however, would be limited to the area within the APE where ground disturbance would occur from installation of the concrete launch pad.

A review of the Texas Historic Sites Atlas, the NRHP online database, and other available resources revealed that there are numerous previously recorded archaeological sites within the APE; however, none of them are in or near the area of the proposed launch pad.

There are no known Traditional Cultural Properties identified within the APE; however, two tribes with interests in McLennan and Coryell Counties have been identified. They include the Comanche Nation of Oklahoma and the Tonkawa Tribe of Oklahoma. The FAA is initiating consultation with these tribes (see Appendix B, *Agency Coordination*).

The APE includes 14 previously documented architectural resources (Table 3.4-1; Exhibit 3.4-1). The majority of these resources were part of the former NWIRP, which was originally constructed by the U.S. Navy in 1942 as a military ordnance plant. Prior to the transfer of the property from the Federal government to the City of McGregor, a survey of the plant's extant buildings and structures was completed. As a result of the survey, 14 individual resources and one historic district were determined to be eligible for inclusion in the NRHP (U.S. Navy 1998). However, since the survey's completion, four of the 14 individual resources have been demolished. Therefore, the APE includes 10 individual resources and one historic district from the former NWIRP that were determined eligible for listing in the NRHP. In 1998, the U.S. Navy, THC, City of McGregor, and Advisory Council on Historic Preservation executed a Programmatic Agreement (PA) to mitigate the adverse effect of the transfer of the property out of Federal ownership. The PA includes deed covenants requiring the preservation and maintenance of the historic architectural properties in accordance with the Secretary of the Interior's Standards for

Rehabilitation, and THC review of any undertaking that has the potential to affect the integrity of the NRHP-eligible resources.

The other historic properties in the APE include one NRHP-listed resource and two Recorded Texas Historic Landmarks. The Brown-Mann House in McGregor was listed in the NRHP in 1987 for its architectural significance as an intact Colonial Revival and Queen Anne-style residence with a Sullivanesque-style embellishment rare for domestic architecture in Texas. The Glenn and Mary Gullede Crain House in McGregor and the First Methodist Church of Oglesby are Recorded Texas Historic Landmarks, which are designated by the THC for properties that are at least 50 years old, historically and architectural significant, and possess architectural integrity. The Crain House is a rare example in Texas of a Shingle-style residence, and the First Methodist Church of Oglesby is a Queen Anne-style church dating to 1912.

Table 3.4-1. NRHP-Listed or -Eligible Architectural Resources in the APE

Resource Name	Description	Historic Status
Building 105	Telephone exchange	NRHP Eligible
Building 106	Administrative office	NRHP Eligible
Building 300	Police and fire station	NRHP Eligible
Building 404	Propulsion system laboratory	NRHP Eligible
Building 601	General storage	NRHP Eligible
Building 602	Line office and first aid	NRHP Eligible
Building 603	Change and power house	NRHP Eligible
Building 2301	Well house #1	NRHP Eligible
Building 2308	Pump house	NRHP Eligible
Building 2309	Spare pump house	NRHP Eligible
High Explosives Magazine Historic District	64 ammunition storage magazines (Buildings 8001 through 8064)	NRHP Eligible
Brown-Mann House	1890s Colonial Revival/Queen Anne-style residence with Sullivanesque influence	NRHP Listed
Crain, Glenn and Mary Gullede House	Circa 1892 Shingle-style residence	Recorded Texas Historic Landmark
First Methodist Church of Oglesby	1912 Queen Anne-style church	Recorded Texas Historic Landmark

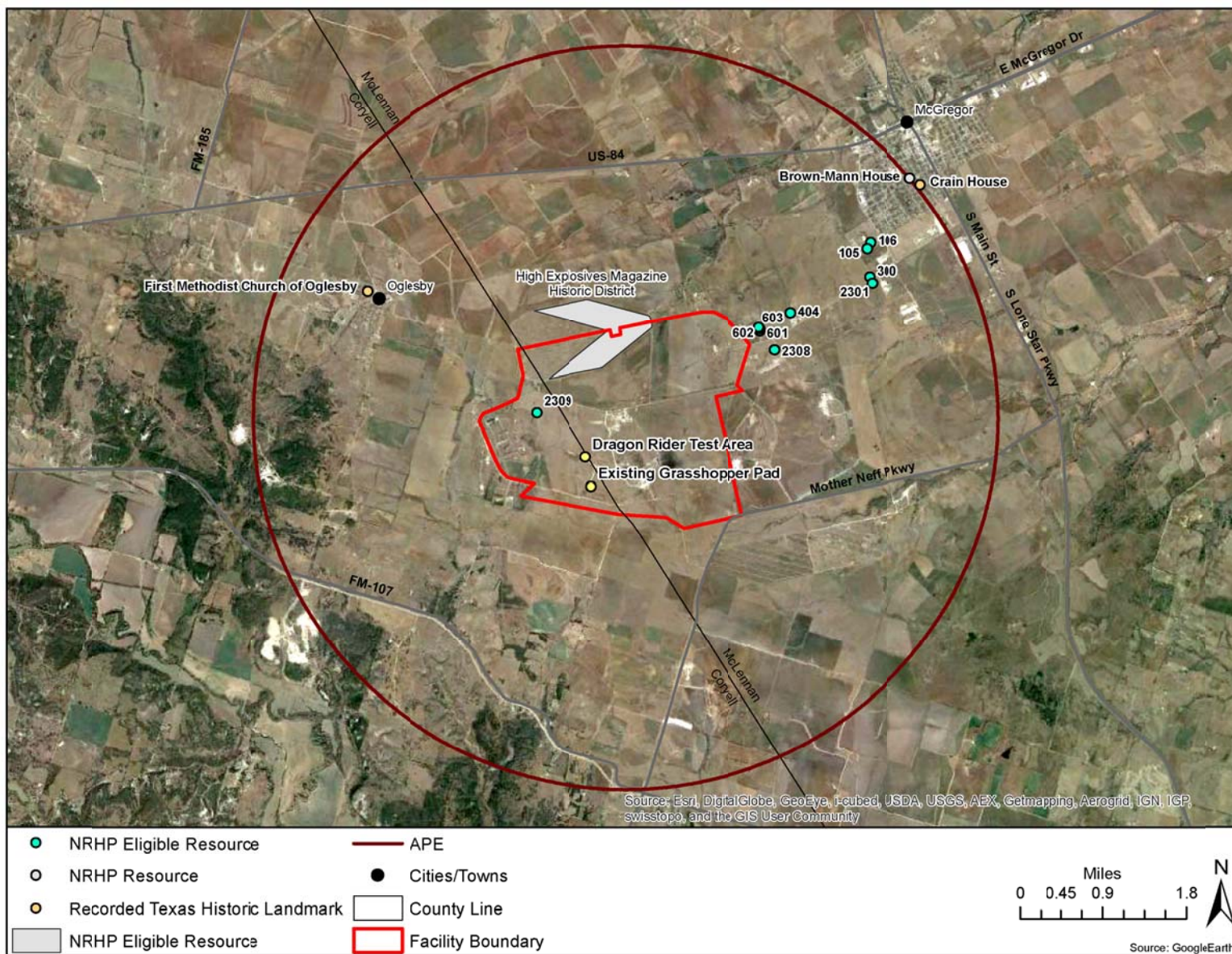


Exhibit 3.4-1. Historic Resources within the Area of Potential Effects

3.5 Fish, Wildlife, and Plants

Biological resources include plant and animal species and the habitats where they occur. Plant associations are referred to as vegetation and animal species are referred to as wildlife. Habitat can be defined as the resources and conditions present in an area that supports the existence of a plant or animal (Hall et al. 1997).

Although the existence and preservation of biological resources are intrinsically valuable, these resources also provide aesthetic, recreational, and socioeconomic values to society. This analysis focuses on species or vegetation types that are important to the function of the ecosystem, of special societal importance, or are protected under Federal or State law or statute. The ROI for vegetation includes the McGregor test site as depicted in Exhibit 1-2. The ROI for wildlife and special-status species includes the McGregor test site and the area encompassed by the DNL 65 dBA noise contour determined during noise modeling (see Section 4.2, Exhibit 4.2-1).

3.5.1 Vegetation

The McGregor test site is located within the Lampasas Cut Plain sub-region of the Cross Timbers and Prairies Ecological Region. The Cross Timbers and Prairies Ecological Region of North-central Texas is approximately 26,000 acres. The Lampasas Cut Plain sub-region generally consists of extensive grasslands punctuated by high, narrow, and wooded mesa-like divides. Vegetation in the region has been shaped by agricultural practices such as livestock and farming operations by reducing historic species with annual grass and forb species. Woody vegetation often consists of live oak and juniper species (Texas Parks and Wildlife Department [TPWD] 2011a).

Vegetated areas at the McGregor test site consist of rangelands and mowed industrial areas. Species generally include Bermuda grass, native grasses and live oaks. The areas of the test site subject to active grazing do not have significant amounts of woody vegetation (FAA 2011).

3.5.2 Wildlife

Wildlife resources include mammals, reptiles, amphibians, birds, and sometimes invertebrate species or species groups such as mollusks or insects. Common species that are expected to be found in the ROI include bobwhite quail (*Colinus virginianus*), mourning dove (*Zenaida macroura*), eastern cottontail (*Sylvilagus floridanus*), and whitetail deer (*Odocoileus virginianus*). Fish may be found in the local streams in the area, identified in Section 3.6.1, *Water Resources* (FAA 2011).

3.5.3 Special-Status Species

A species is considered endangered if it is in danger of extinction throughout all or a significant amount of its range. Threatened species are defined as those that are likely to become endangered in the foreseeable future. The Endangered Species Act (ESA) of 1973 (16 U.S.C. §1531 et seq.) and subsequent amendments require the conservation of federally listed threatened and endangered species of animals and plants, and critical habitats in which they are found. The U.S. Fish and Wildlife Service (USFWS) administers the ESA and designates critical habitat for each species protected under the ESA. Section 7 of the ESA requires all Federal agencies to consult with the USFWS, as applicable, before initiating any

action that may affect a listed species or designated critical habitat. Candidate species, which may be proposed for listing as threatened or endangered in the future, are not provided any statutory protection under the ESA.

The Texas legislature authorized the TPWD to establish a list of threatened and endangered plant and animal species, and to protect the species. TPWD regulations prohibit the taking, possession, transportation, or sale of any of the animal species designated by State law as endangered or threatened without a permit. Texas laws and regulations prohibit commerce in threatened and endangered plants and the collection of listed plant species from public land without a permit issued by TPWD.

Table 3.5-1 lists the Federal and State-listed threatened or endangered wildlife species potentially occurring in McLennan and Coryell counties. There are three federally listed endangered species, nine State-listed threatened species, and five State-listed endangered species that potentially occur in McLennan and Coryell counties.

Table 3.5-1. Federally and State-Listed Threatened and Endangered Species Potentially Occurring within McLennan and Coryell Counties

Common name (Scientific name)	Status	
	State	Federal
Reptiles		
Timber/canebrake rattlesnake (<i>Crotalus horridus</i>)	T	-
Texas horned lizard (<i>Phrynosoma cornutum</i>)	T	-
Birds		
Golden-cheeked warbler (<i>Setophaga chrysoparia</i>)	E	E
Peregrine falcon (<i>Falco peregrinus</i>)	T	-
Whooping crane (<i>Grus Americana</i>)	E	E
Bald eagle (<i>Haliaeetus leucocephalus</i>) ¹	T	-
Black-capped vireo (<i>Vireo atricapilla</i>) ²	E	E
Wood stork (<i>Mycteria americana</i>) ³	T	-
White-faced ibis (<i>Plegadis chihi</i>) ³	T	-
Interior least tern (<i>Sterna antillarum athalassos</i>) ³	E	-
Mammals		
Red wolf (<i>Canis rufus</i>)	E	-
Mollusks		
Smooth pimpleback (<i>Quadrula houstonensis</i>)	T	-
False spike mussel (<i>Quadrula mitchelli</i>)	T	-
Texas fawnsfoot (<i>Truncilla macrodon</i>)	T	-

Sources: TPWD 2011b, c; USFWS 2013 a, b.

Notes: E = Endangered, T = Threatened.

¹Bald and golden eagles are protected by the Bald and Golden Eagle Protection Act, which is administered by the USFWS. The Act prohibits unauthorized capture, purchase, or transportation of the birds, their nests, or their eggs. Any action that might disturb these species requires a permit from the USFWS.

²Listed only in Coryell County

³Listed only in McLennan County

The potential for occurrence of any of the listed species in Table 3.5-1 within the ROI for the Proposed Action is unlikely due to the absence of suitable habitat, ongoing agricultural activities, maintenance (e.g. mowing), and existing industrial and operational activities. In addition, coordination with the USFWS in 2011 for the *Final Environmental Assessment for Issuing an Experimental Permit to SpaceX for*

Operation of the Grasshopper Vehicle at the McGregor Test Site, Texas indicated that there are no federally listed species known to occur in the ROI.

However, coordination with the TPWD in the 2011 *Final Environmental Assessment for Issuing an Experimental Permit to SpaceX for Operation of the Grasshopper Vehicle at the McGregor Test Site, Texas* indicated that the test site is located near the center of a 200 mile-wide corridor used by whooping cranes for migration; 95 percent of whooping crane sightings during migration occur within this corridor. Suitable whooping crane migratory stop-over habitat includes shallow wetlands such as lake edges, small ponds, marshes, and some suitable rivers (TPWD 2011c). Four small ponds are located on the McGregor test site, as described in Section 3.6.1 below, that may provide suitable stopover habitat. However, the whooping crane has never been observed at the McGregor test site. The FAA is coordinating with TPWD regarding the Proposed Action (see Appendix B, *Agency Coordination*).

3.6 Water Quality

Water resources include surface waters, groundwater, wetlands, floodplains, and Wild and Scenic Rivers. Surface waters include streams, rivers, lakes, ponds, estuaries, and oceans. Groundwater is subsurface water that occupies the space between sand, clay, and rock formations. Wetlands are lowland areas covered with shallow and sometimes temporary or intermittent waters. Floodplains are lowland areas located adjacent to bodies of water in which the ordinary high water level fluctuates on an annual basis. As stated in Section 3.0, Wild and Scenic River resources are not present in the region and are not evaluated in this analysis. There are several Federal, State and local laws and regulations that address water resources. At the Federal level the Clean Water Act (CWA); Safe Drinking Water Act; Fish and Wildlife Coordination Act; Rivers and Harbors Act; Wild and Scenic Rivers Act; Executive Order (EO) 11990, Protection of Wetlands; and EO 11988, Floodplain Management.

The TCEQ has the responsibility for the majority of the State's environmental water quality and regulatory programs. As the State lead agency for water resources and environmental protection, the TCEQ administers both State and federally mandated (as mentioned above) programs. The Texas Legislature has authorized the TCEQ, the Texas Water Development Board (TWDB), and the Texas Parks and Wildlife Department (TPWD) to study, identify and delineate priority groundwater management areas, and initiate the creation of Groundwater Conservation Districts (GCDs) within those areas, for the purpose of managing the State's groundwater resources in areas where critical groundwater problems exist or may exist in the future. The primary management of groundwater in Texas is found at the local level through GCDs. The proposed project falls within two separate GCDs: (1) Middle Trinity Groundwater Conservation District (Coryell County) and (2) Southern Trinity Groundwater Conservation District (McLennan County). TCEQ is also responsible for administering the program and has created the Texas Pollutant Discharge Elimination System (TPDES) to regulate discharges of pollutants (TCEQ 2012). At the local level, the McGregor, Texas - Code of Ordinances, Part II, Chapter 22, Article II. Division 1 to 3, Sections 22-19 to 22-110, regulates floodplains within the City of McGregor, Texas. In addition, the National Flood Insurance Program regulates development in mapped 100-year floodplains for communities that participate in the program. The City of McGregor, McLennan County, and Coryell County, are all participating communities in the program.

3.6.1 Surface Waters (Non-wetlands Surface Waters)

The ROI for surface waters is the McGregor test site. The McGregor test site is located in the South Basque River Subwatershed within the larger Basque River Watershed. Surface waters of the South Basque River flow into Waco Lake, which is located approximately 13 miles northeast of the site (McFarland and Houck 1999). Four ponds and a stream that forms the headwaters of the South Basque River are located on the McGregor test site. The portion of the stream on the site is classified as intermittent, and develops into a perennial stream after it flows off-site (FAA 2011). The ponds appear to be potentially man-made: two are located in the southern portion of the site, east of the Grasshopper launch pad, and two are in the northern portion of the site, northeast of the Falcon 9 tripod test stand. Exhibit 3.6-1 depicts the locations of the streams and ponds. No surface waters located on-site are listed as impaired waters in the 2012 Texas Integrated Report of Surface Water Quality for CWA Sections 305(b) and 303(d) (TCEQ 2012).

Existing activities at the test site operate under a TPDES multi-sector general stormwater permit for stormwater discharge (Permit #TXR050000 issued July 22, 2011). The permit was issued November 3, 2010 and is currently active (FAA 2011).

3.6.2 Groundwater

The ROI for groundwater is the McGregor test site. The McGregor test site is located over the Trinity Aquifer, which is one of the most extensive and most utilized in Texas. Groundwater in the Trinity Aquifer is potable but considered hard; with dissolved solids, sulfate, and chlorides increasing with aquifer depth. It is used by municipalities as well as irrigation, livestock, and domestic consumers. The McGregor test site is in an area that has been designated as Priority Groundwater Management Area 10. TCEQ applies this designation to aquifers that have declining levels that can pose groundwater availability and quality issues to the region. Historically, groundwater withdrawals from the Trinity Aquifer generally exceeded the recharge rate of the aquifer. Water levels in the aquifer are still in decline, but the rate has slowed over the past decade due to changes in water sources (TWDB 2013; FAA 2011). No EPA designated Sole Source Aquifers are found at the McGregor test site.

Resource Conservation and Recovery Act (RCRA) investigations conducted as part of the NWIRP facility closure in the 1990s documented contamination of groundwater and soil. Perchlorate was identified in groundwater on northern side of the test site and the western side in a plume migrating southward, off-site. Remediation of the groundwater at off-site properties is ongoing and expected to be completed in 2023. Sampling results from groundwater wells in the immediate area of the existing launch pad indicate that contaminants are not migrating into the existing launch pad areas from neighboring areas (Naval Facilities Engineering Command [NAVFAC] 2007, U.S. Navy 2001; U.S. Navy 2008; FAA 2011). Prior to development as the McGregor Industrial Park, EPA had designated the NWIRP McGregor site as “Ready for Reuse,” indicating that the remediated conditions of the site are protective of human health and the environment for the anticipated use (EPA 2009b).

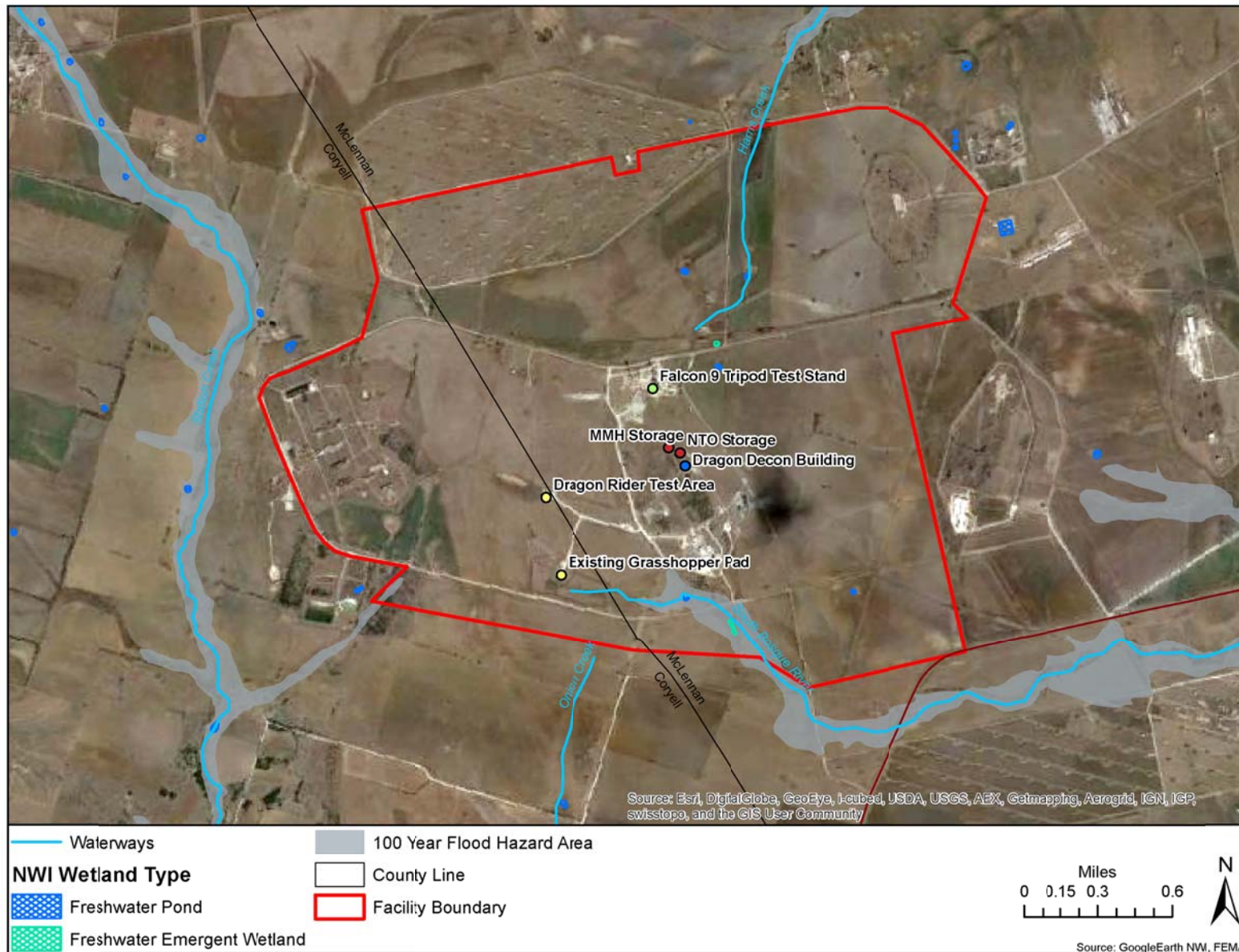


Exhibit 3.6.1. Surface Water in the Vicinity of the McGregor Test Site

3.6.3 Wetlands

The ROI for wetlands is the McGregor test site. Two areas of freshwater emergent wetlands within the boundary of the McGregor test site are identified on the National Wetlands Inventory (NWI) map (USFWS 2013c). One area is northeast of the Falcon 9 tripod test stand. The second area is on the southern portion of the site, southeast of the existing Grasshopper Pad (Exhibit 3.6-1).

3.6.4 Floodplains

The Federal Emergency Management Agency (FEMA) maintains data identifying 100-year and 500-year floodplains. Federal code identifies floodplains as “any land area susceptible to being inundated by waters from any source” (44 CFR Part 59). 100-year floodplains are further defined as having a 1 percent chance of being inundated in a one-year period. 500-year floodplains have a 0.2 percent probability of being flooded during a one-year period.

The ROI for floodplains is the McGregor test site. Exhibit 3.6-1 identifies floodplains within the ROI. There are approximately 44.92 acres of 100-year floodplains associated with the South Bosque River located in the southeast portion of the operating area and approximately 2.34 acres of floodplains associated with a tributary to Station Creek located in the southwest corner of the site (FEMA 2013). These floodplains are outside of the area of potential launch pad construction.

3.7 Natural Resources and Energy Supply

As an impact category, natural resources and energy supply provides an evaluation of a project’s consumption of natural resources and use of energy supplies. Whereas FAA Order 1050.1E acknowledges that there are no specific Federal requirements in place to regulate the consumption and use of natural resources and energy supply, it also emphasizes that it is the policy of the FAA to encourage the development of facilities that exemplify the highest standards of design including principles of sustainability. The following regulations provide guidance to Federal agencies regarding sustainable use of natural resources and energy:

- EO 13123, Greening the Government through Efficient Energy Management;
- EO 13423, Strengthening Federal Environmental, Energy, and Transportation Management ; and
- EO 13514, Federal Leadership in Environmental, Energy, and Economic Performance.

The ROI for natural resources and energy supply includes the immediate vicinity of the McGregor test site. Existing energy and water consumption at the McGregor test site is presented in Table 3.7-1. Water from a 10,000 gallon tank would also be used to occasionally wash the launch area and is available for fighting fires (SpaceX 2013).

Table 3.7-1. Utilities Suppliers for McGregor Test Site

Utility	Provider	Annual Utility Usage
Electricity/ Natural Gas	Hudson Energy Services, LLC	2.4 million kilowatt-hour (kW-hr)
Potable Water Distribution	City of McGregor water mains	1.5 million gallons

Source: SpaceX 2013.

3.8 Hazardous Materials, Pollution Prevention, and Solid Waste

Analysis of the presence, handling, storage, and disposal of hazardous materials, hazardous waste, and solid waste includes an evaluation of the following:

- Potential to encounter existing hazardous materials during the construction and operation phases of the project;
- Potential hazardous materials that could be transported and used during construction and operation of the proposed facilities, and applicable pollution prevention strategies and procedures;
- Potential to interfere with any ongoing remediation of existing contaminated sites, at the proposed project site or in the immediate vicinity; and
- Waste streams that would be generated by the project, potential for the wastes to impact environmental resources, and the impacts on waste handling and disposal facilities that would likely receive the wastes.

The handling and disposal of hazardous materials, chemicals, substances, and wastes are governed at various levels ranging from the Federal level to the local level. The two Federal statutes of most importance to the FAA are RCRA and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) and the Community Environmental Response Facilitation Act of 1992. RCRA governs the generation, treatment, storage, and disposal (TSD) of hazardous wastes. CERCLA provides for consultation with natural resources trustees and cleanup of any release of a hazardous substance (excluding petroleum) into the environment. The Federal Hazardous Materials Regulations are contained in 49 CFR parts 171 through 180.

The TCEQ enforces State laws and rules pertaining to municipal hazardous and solid wastes (Title 30 of the Texas Administrative Code [30 TAC], Chapter 330 and Chapter 335). The City of McGregor Sanitation Department is responsible for enforcing State and City regulations for general sanitation.

The ROI for hazardous materials, pollution prevention, and solid waste is the McGregor test site and the immediate vicinity that could be affected by the materials transported, stored, and used; waste generated; or spills/releases that may occur as a result of implementing the Proposed Action.. The McGregor test site has the capacity to store 260,000 gallons of LOX and 102,000 gallons of RP-1 to support existing operations related to the Falcon 9 and Grasshopper RLV testing. Additionally, SpaceX currently uses and stores hypergolic propellants (NTO and MMH) at the McGregor test site (see Section 2.2 for additional information on SpaceX's existing activities at the McGregor test site). Hypergolic testing occurs in an enclosed vacuum chamber at the DragonRider test area.

Existing operations produce hazardous waste at the McGregor test site through engine testing and maintenance at a rate of approximately 10,000 pounds annually. Hazardous wastes generated can include acetone, oily rages, paint wastes, hypergol waste (water mixed with MMH or NTO), oils, and batteries. Hazardous waste generated at the McGregor test site is removed and managed by an

independent contractor and taken to a permitted landfill for treatment and disposal. No treatment or disposal of hazardous wastes currently occurs at the McGregor test site (FAA 2011).

Hazardous materials were used as part of historic operations of the NWIRP prior to SpaceX lease of the site. Previous NWIRP operations at the site consisted of manufacturing shells and airplane bombs, munitions grade and fertilizer grade ammonium nitrate, and production of components for weapons. During this time, waste explosives, propellants, solvents, and solid wastes were stored on the site. Site investigations conducted in the 1990s for closure of the NWIRP detected contamination of groundwater and soils on the site. The contaminants of concern included industrial solvents, energetics, heavy metals, petroleum products, and perchlorate. A description of the groundwater contamination and remediation actions is provided in Section 3.6. A remediation and capping area for soils is located on the western side of the test site (EPA 2009b; FAA 2011; NAVFAC 2007; U.S. Navy 2001). Sampling results from groundwater wells in the immediate area of the existing launch pad indicate that contaminants are not migrating into the existing launch pad areas from neighboring areas (NAVFAC 2007; U.S. Navy 2001; U.S. Navy 2008; FAA 2011). EPA has designated the NWIRP McGregor site as “Ready for Reuse,” indicating that the remediated conditions of the site are protective of human health and the environment for the anticipated use (EPA 2009b).

Solid, non-hazardous wastes produced by operations at the test site are collected by an independent contractor and disposed of in the City of Waco landfill. Prior to collection, non-hazardous wastes are stored on-site in 2-cubic yard dumpsters that are emptied three times per week, or in 30-cubic yard roll-off dumpsters which are emptied as needed. Typical solid wastes generated at the test site include cardboard, plastic, and food containers (FAA 2011).

3.9 Light Emissions and Visual Impacts

As an impact category, light emissions and visual resources provide an evaluation of whether lighting associated with a project would annoy or interfere with activities of people in the vicinity of the project. For the purposes of this analysis, visual and aesthetic resources are defined as man-made or natural landscapes from which individuals develop their perceptions of an area. Examples of visually sensitive areas may be parks, coastlines, wilderness areas, or recreation areas; industrial or urban areas are generally considered less visually sensitive.

The ROI for light emissions and visual impacts is the McGregor test site and the vicinity within several miles from which facilities, lighting, and operations would be visible. The ROI is considered to have low visual sensitivity due to the existing industrial activities such as engine and rocket testing which produce noise and flames on-site, and industrial and commercial businesses located throughout the industrial park. Existing structures on the test site include the Grasshopper RLV launch pad, Falcon 9 tripod test stand, and associated tower which is 235 ft high and can be seen for several miles. Existing light sources at the McGregor test site consist of safety lighting and nighttime security lighting at the test stands, pads, and buildings located at the site. Various light industrial operations are located throughout the McGregor Industrial Park around the test site, limiting the sensitive visual resource receptors in the vicinity.

3.10 Socioeconomics, Environmental Justice, Children’s Environmental Health Risks and Safety Risks

The CEQ NEPA implementing regulations state that the human environment “shall be interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment” (40 CFR §1508.14). This means that economic or social effects are not intended by themselves to require preparation of an environmental analysis. When economic and social and natural or physical environment effects are interrelated, then the environmental analysis will discuss these effects on the human environment (40 CFR §1508.14). Socioeconomics describes the basic attributes and resources associated with the human environment, particularly population, employment, income, and housing.

EO 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations*, directs each Federal agency to “make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low income populations.” Subsequent Orders at the State and Federal level, including DOT Order 5610.2(a), *Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* (DOT 2012), have reinforced the directives outlined in EO 12898. CEQ, which oversees the Federal government’s compliance with EO 12898 and NEPA, also developed guidelines (CEQ 1997) to assist Federal agencies in incorporating the goals of EO 12898 into the NEPA process.

EO 13045, *Protection of Children from Environmental Health Risks and Safety Risks*, requires Federal agencies to identify disproportionately high and adverse impacts to children. Children may suffer disproportionately more environmental health and safety risks than adults because of various factors such as: children’s neurological, digestive, immunological, and other bodily systems are still developing; children eat more food, drink more fluids, and breath more air in proportion to their body weight than adults; children’s behavior patterns may make them more susceptible to accidents because they are less able to protect themselves; and children’s size and weight may diminish their protection from standard safety features.

Affected environment descriptions in this Section are categorized according to the following resource categories:

- Population and Housing
- Income, Poverty, and Employment
- Environmental Justice
- Children’s Environmental Health and Safety

The ROI for the socioeconomics analysis is McLennan County, Coryell County, the cities of Waco and McGregor in McLennan County, and the City of Oglesby in Coryell County. This ROI includes the area in which direct and secondary or indirect effects on socioeconomic variables arising from the Proposed Action’s construction and operation are likely to occur. The State of Texas and the U.S. serve as the geographic region for comparative analysis.

The ROI for environmental justice and children's environmental health and safety risks is the same as the ROI for the socioeconomic analysis and specifically includes Census Tracts 101.01 and 39 in McLennan and Coryell Counties, respectively. Census Tracts 101.01 and 39 are assessed because they represent the populated area most likely to experience any potential impacts caused by the construction and operation of the Proposed Action. The State of Texas serves as the geographic region for comparative analysis.

3.10.1 Population and Housing

Table 3.10-1 summarizes U.S. Census Bureau (USCB) data for population and housing trends in the vicinity of the McGregor test site at the local, county, and State level. The Cities of Waco and McGregor are located in McLennan County; Oglesby is located in Coryell County. McGregor is the second largest city in the vicinity of the test site, with 2012 data showing approximately 5,000 residents, followed by Oglesby which has less than 500 residents.

Based on the 2012 data, McLennan County (226.5 people per square mile) is more densely populated than Coryell County (71.7 people per square mile), the State of Texas (96.3 people per square mile), and the U.S. (87.4 people per square mile). 2010 data shows McLennan County, Coryell County, Oglesby, and Waco with a relatively lower percentage of vacant housing units than the State of Texas (10.6 percent vacant housing units) and the U.S. (11.4 vacant housing units). In 2010, the City of McGregor had a higher percentage of vacant housing units compared to the whole State of Texas but is a lower percentage than the U.S. (USCB 2012; USCB 2013a).

Table 3.10-1. Current Population and Housing Data in the Region of Influence

Jurisdiction	Total Population (2012 estimate)	Area (square miles)	Population Density (person/square mile)	Total Housing Units (2010) ¹	Vacant Housing Units (percent of total)
United States	313,914,040	3,531,905.43	87.4	131,704,730	11.4
Texas	26,059,203	261,231.71	96.3	9,977,436	10.6
McLennan County	238,707	1,037.10	226.5	95,124	8.7
Coryell County	77,231	1,052.07	71.7	25,178	10.5
City of McGregor	5,029	21.42	232.8	1,966	11.1
City of Oglesby ¹	484	0.5	968	207	9.2
City of Waco	127,018	88.96	1,402.9	51,452	9.8

Source: USCB 2013a.

Note: ¹USCB 2010 Demographic Data (USCB 2012).

3.10.2 Income and Employment

Table 3.10-2 summarizes U.S. Census Bureau income and employment data for the time period between 2007 and 2011. Median household and per capita income for McLennan County, Coryell County, McGregor, Oglesby, and Waco are lower than the State of Texas and United States. Waco, McGregor, and McLennan County also have a higher portion of the population living below the poverty level than the State of Texas and United States. The unemployment percentage varies among the cities and counties in the ROI. Oglesby has the lowest unemployment (2.6 percent) and Waco had the highest (9.1

percent). McLennan County (7.2 percent), City of McGregor (6.6 percent), and Oglesby had a lower percentage of unemployment than Texas or the United States (USCB 2013b).

Table 3.10-2. Income, Poverty, and Employment Data in the Region of Influence, 2007-2011

Jurisdiction	Median Household Income	Per Capita Income	Population Below Poverty Level (Percentage)	Total Number of People in Labor Force	Percent of Labor Force Unemployed
United States	\$52,762	\$27,915	14.3	156,456,694	8.7
Texas	\$50,920	\$25,548	17.0	12,285,284	7.3
McLennan County	\$41,656	\$21,630	21.7	113,049	7.2
Coryell County	\$48,920	\$19,218	14.1	34,273	9.3
City of McGregor	\$37,356	\$16,649	25.5	2,000	6.6
City of Oglesby	\$44,375	\$20,296	9.1	193	2.6
City of Waco	\$31,971	\$18,185	30.1	57,364	9.1

Source: USCB 2013b.

3.10.3 Environmental Justice

For the purpose of this evaluation, minority refers to people who identified themselves in the Census as Black or African American, Asian or Pacific Islander, American Indian or Alaska Native, other non-White races, or as being of Hispanic or Latino origin. Persons of Hispanic and Latino origin may be of any race (CEQ 1997). The CEQ identifies these groups as minority populations when either (1) the minority population of the affected area exceeds 50 percent or (2) the minority population percentage in the affected area is meaningfully greater than the minority population percentage in the general population or appropriate unit of geographical analysis. A low-income population is defined by DOT Order 5610.2(a), as “any readily identifiable group of low-income persons who live in geographic proximity.” While not defined by the CEQ, for the purposes of this EA, the terms “meaningfully greater” and “readily identifiable” are interpreted to be 20 percentage points greater than the geographic region of comparison. The geographic region for comparison in this analysis is the State of Texas.

Table 3.10-3 shows the poverty level and the percentage of total minority population (predominately Black/African American) and Hispanic population in the ROI (USCB 2012; USCB 2013b). The percentage of minority and Hispanic populations in McLennan County, Coryell County, the City of McGregor, Oglesby, Waco, Census Tract 39 and Census Tract 101.01 are not meaningfully greater (over 20 percentage points) than the State of Texas. The percentage of families living below poverty level in the ROI is also not meaningfully greater for these areas when compared to the State of Texas. The potentially affected area would not be considered an environmental justice population based on the percentage of minority populations.

**Table 3.10-3. Environmental Justice Statistics for the Region of Influence, 2012 estimate
(% of population)**

Jurisdiction	White	Total Minority ^a	Hispanic or Latino Origin ^b	Families Below Poverty Level
United States	72.4	27.6	16.9	10.5
Texas	70.4	29.6	38.2	13.2
McLennan County	69.8	30.2	24.4	15.1

**Table 3.10-3. Environmental Justice Statistics for the Region of Influence, 2012 estimate
(% of population)**

Jurisdiction	White	Total Minority ^a	Hispanic or Latino Origin ^b	Families Below Poverty Level
Coryell County	70.3	29.7	17.0	12.4
City of McGregor	68.3	31.7	37.1	21.4
City of Oglesby	87.0	13.0	18.8	8.9
City of Waco	59.2	40.8	29.6	22.2
Census Tract 101.01 - Coryell County	95.2	4.8	9.2	7.6
Census Tract 39 -McLennan County	87.2	12.8	17.9	13.0

Sources: USCB 2012; USCB 2013b.

Notes: ^aMinority is defined as: Black or African American, Asian or Pacific Islander, American Indian or Alaska Native, other non-White races. ^bTotal percent Hispanic/Latino origin may be of any race and is reported separately.**3.10.4 Children's Environmental Health Risks and Safety Risks**

Table 3.10-4 summarizes the locations of schools within the ROI, distance from the test site, and capacity. The nearest school is 3.5 miles northwest of the test site (Oglesby Independent School District [ISD] 2013; McGregor ISD 2013). The Central Texas Youth Rodeo Association (CTYRA) Arena is located on the eastern side of the McGregor Industrial Park, approximately 3 miles northeast of the site. The arena holds youth rodeo events multiple times per year. The rodeo events are typically held on Thursdays, Fridays, and Saturdays starting at 6:00 p.m. on Thursdays and Fridays, and 7:00 p.m. on Saturdays. The 2013-2014 CTYRA season consists of thirteen three-day events held at their arena at the McGregor Industrial Park between August 2013 and April 2014 (CTYRA 2013). There are eight parks in the ROI, listed in Table 3.3-1, that are likely to be frequented by children. There are no other schools, daycares facilities, playgrounds, or other places where children are concentrated within the vicinity of the McGregor test site.

Table 3.10-4. Schools Near the McGregor Test Site

School	Approximate Distance and Direction from Test Site	Number of Students
Oglesby School	3.5 miles NW	174
McGregor Prep High School	4.0 miles NE	2
McGregor High School	4.5 miles NE	404
McGregor Primary School ¹	4.5 miles NE	300
McGregor (T.H. Jenkins) Elementary	4.5 miles NE	595
Isbill Junior High School	4.5 miles NE	401

Source: Oglesby Independent School District 2013

McGregor Independent School District 2013

Note: ¹This primary school is currently under construction and is adjacent to the current McGregor Elementary and McGregor High Schools.

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4.0 ENVIRONMENTAL CONSEQUENCES

This chapter presents an analysis of the potential impacts upon various components of the environment that could result from implementation of the Proposed Action. To evaluate potential impacts, the analyses presented in this chapter overlays the components of the Proposed Action described in Chapter 2 onto existing conditions within the ROI for each environmental resource area presented in Chapter 3. Both direct and indirect impacts of construction and operations are considered in the EA.

The analysis in this chapter considers FAA's guidance on the analysis of environmental impact categories, found in Appendix A of FAA Order 1050.1E, which includes a description of how to analyze significance of impacts, and describes the FAA's significance thresholds.

4.1 Air Quality

Potential impacts to air quality could result from the proposed construction of a 1,600 ft² launch pad and proposed operations of up to 30 annual suborbital launches and landings of the DragonFly RLV from this new launch pad for the period 2014 – 2015. Significant air quality impacts would occur if implementation of any of the alternatives would directly or indirectly result in the exceedance of one or more of the NAAQS for any of the time frames analyzed.

4.1.1 Proposed Action

Construction under the Proposed Action would be limited to a 1,600 ft² concrete pad to be used for launching and landing the DragonFly RLV. Construction activities would involve excavating the area where the concrete launch pad would be poured, the laying of a gravel base, and the pouring of the pad itself. The construction is not expected to last for more than 10 days and would involve a minimal number of workers. Construction emissions were calculated using EPA's NONROAD model (EPA 2010a) emissions factors and equipment productivity data from National Estimator (Craftsman Book Company 2010). On road trucks are also included and emissions are based on EPA's MOVES model (EPA 2010b). Total construction emissions are presented in Table 4.1-1.

Table 4.1-1. Estimated Construction Emissions for Launch Pad in Tons

Volatile Organic Compounds	Nitrogen Oxides	Carbon Monoxide	Sulfur Dioxide	PM ₁₀	PM _{2.5}
0.01	0.03	0.09	0.00 ¹	0.00 ¹	0.00 ¹

Notes: PM₁₀ = particulate matter less than or equal to 10 microns in diameter; PM_{2.5} = fine particulate matter 2.5 microns or less in diameter.

¹rounded values less than 0.01

Air pollutant emissions generated by construction activities would be very small and would not have a significant impact on local or regional air quality.

The proposed DragonFly RLV test launch schedule involves a maximum of 30 launches per year in 2014 and 2015. In addition, up to 10 staff would be located at the McGregor test site to support the testing operations. It is assumed that the average one-way commute distance for each worker would be 12 miles, or 24 miles per day roundtrip. Commuter emissions were calculated using EPA's MOVES model

(EPA 2010b). Due to the small number of staff required to support the operation and the short commute required, the air emissions associated with commuting are minor.

Pre-flight activities include preparing the DragonFly RLV for launch and providing ground operations support for launch and landing. The DragonFly RLV would be transported by truck or tractor-trailer from its storage location at the McGregor test site to the launch pad, which would involve the limited use of the vehicle over a very short distance. Similarly, two trucks would be used to transport the propellants from the propellant storage area to the launch pad. SpaceX operations currently occurring at the McGregor test site already use the hypergolic propellants MMH and NTO. Transport and loading of the propellants would utilize the same equipment and protocols that are currently in place for engine testing using these propellants. Because of the small size of the launch vehicle, closed system used for fueling, and modest fuel volume consumed per flight, minimal emissions would be generated from the routine pre-flight activities, and these were not quantified. The use of these propellants for DragonFly RLV testing may result in a small number of increased deliveries from the supplier to the propellant storage location, but these emissions are minimal and were not quantified.

Emissions associated with the operations would be generated by the combustion of the NTO/MMH propellant and the combustion of fuel by the helicopter that would raise the DragonFly RLV up to 10,000 ft AGL for release. The primary combustion products of the propellants MMH and NTO used in the DragonFly RLV are nitrogen gas and water (Stuetzer 2013, Haas 1984); therefore, there are no significant criteria pollutants or GHG emissions associated with the operation of the DragonFly RLV.

The use of a helicopter four times a year would generate minimal pollutant emissions. Information on the emission factors for the H-47 Chinook, which uses two turboshaft engines of similar horsepower as the ones used on the Erickson S-64E, were used to estimate the helicopter emissions. Helicopter operations include taking off and landing from Waco Regional Airport, traveling to the SpaceX facility in McGregor Texas, which is approximately 16 miles away, and attaching and lifting the DragonFly RLV to 3,000 ft AGL, which is the vertical threshold for assessing ground-level pollutant impacts.

The total annual operational emissions, which include the helicopter operations and annual commuter emissions for 10 additional SpaceX staff, are presented in Table 4.1-2 and represent the estimates for each of the two years of testing (2014 and 2015).

Table 4.1-2. Estimated Annual Operation Emissions in Tons per Year (2014 and 2015)

Volatiles Organic Compounds	Nitrogen Oxides	Carbon Monoxide	Sulfur Dioxide	PM ₁₀	PM _{2.5}
0.01	0.02	0.03	0.00 ¹	0.01	0.01

Notes: PM₁₀ = particulate matter less than or equal to 10 microns in diameter; PM_{2.5} = fine particulate matter 2.5 microns or less in diameter.

¹ rounded value less than 0.01

Operational air emissions are very small and would not have a significant impact on local or regional air quality.

4.1.2 No Action Alternative

Under the No Action Alternative, the FAA would not issue an experimental permit to SpaceX for the operation of the DragonFly RLV at the McGregor test site. In addition, construction of the concrete launch pad at the DragonRider test area would not occur. The No Action Alternative would not result in the additional emission of any air pollutants. Therefore, there would be no impact to regional air quality.

4.2 Noise and Compatible Land Use

4.2.1 Proposed Action

Under the Proposed Action, potential noise impacts could occur from proposed construction activities and operations. Construction of the launch pad would be expected to take 1–2 weeks. Intermittent noise would be generated by construction equipment during construction of the concrete launch pad at the DragonRider area. Noise levels at a given receptor location would depend on the type and number of pieces of construction equipment being operated and the receptor's distance from the site. For example, the typical maximum noise level of an excavator at 50 ft would be approximately 77 dBA. This noise level is relatively low and because the construction noise would be temporary during daytime hours, adverse effects from construction noise would not be likely. Noise from the proposed construction activities would not be significant.

The noise analysis assumes a proposed maximum of 30 annual DragonFly operations consisting of propulsive assist, full propulsive landing, propulsive assist hopping, and full propulsive hopping, as described in Table 2.1-1. All operations would occur from a single pad between the hours of 7:00 a.m. and 10:00 p.m. SpaceX is currently considering one of two possible locations for DragonFly operations within the McGregor test site: the Grasshopper launch pad or the DragonRider test area (see Exhibit 2-1). The DragonFly is propelled by eight SuperDraco engines. Although a SuperDraco engine can reach a maximum thrust of 16,400 lbf individually, the vehicle's maximum thrust is limited to 122,600 pounds force (lbf) (15,325 lbf per engine) to maintain stability.

A representative operation type was developed to account for all the basic components of the proposed four different operation types. The representative operation type includes both a takeoff and a landing, although two of the four operation types include only landings. The representative operation type's corresponding trajectory follows a straight vertical trajectory from its pad origin, and includes an extended burn time and increased maximum altitude to ensure a highly conservative noise estimate (i.e., the maximum noise scenario). For further discussion of the noise modeling parameters refer to Appendix A.

A helicopter would release the DragonFly RLV from up to 10,000 ft above the ground during propulsive assist and full propulsive landing operations. These operations are proposed to occur only four times per year. The helicopter would travel 16 miles from Waco Regional Airport to the launch pad and tether to the DragonFly RLV. The helicopter would then lift the DragonFly RLV and ascend to approximately 10,000 ft. The helicopter would hover for a few seconds before releasing the RLV. These helicopter operations would generate noise, which may be noticeable in the surrounding area. The contribution of helicopter noise to the overall noise would be negligible because the duration, level, and tempo of the

helicopter noise is significantly lower than the DragonFly RLV. Therefore, the impact would be minor and was not included within the modeled representative operational type.

Noise levels generated by the DragonFly RLV were estimated to be approximately 116 dBA 0.3 miles from the launch pad and approximately 81 dBA 3 miles from the launch pad. The combination of the existing operations and the proposed DragonFly operations results in the DNL contours shown in Exhibit 4.2-1.

A significant noise impact is one in which the “proposed action will cause noise sensitive areas to experience an increase in noise of DNL 1.5 dBA or more at or above DNL 65 dBA noise exposure when compared to the no action alternative for the same timeframe.” The additional noise associated with the proposed DragonFly operations produces less than a tenth of a dBA DNL difference. As shown in Table 4.2-1, the Proposed Action’s DNL 65 dBA contour area is predicted to increase approximately 0.01 percent over the No Action Alternative which equates to less than 4 acres. The 4 acres do not include any additional sensitive noise receptors.

Table 4.2-1. Summary of Total Contours Acreage by Scenario (Proposed Action)

Contour Level	No Action Alternative Acres	Grasshopper Pad			Dragon Rider Site		
		Proposed Action Acres	+Acres ¹	Percent Increase	Proposed Action Acres	+Acres	% Increase
65 dBA	32691	32695	4	0.01	32694	3	0.01
70 dBA	18241	18244	3	0.02	18243	2	0.01
75 dBA	10729	10731	2	0.02	10731	2	0.02
80 dBA	5090	5093	3	0.06	5091	1	0.02
85 dBA	2476	2480	4	0.16	2478	2	0.08

Note: ¹Increase in land acres within the contour over the No Action Alternative noise condition.

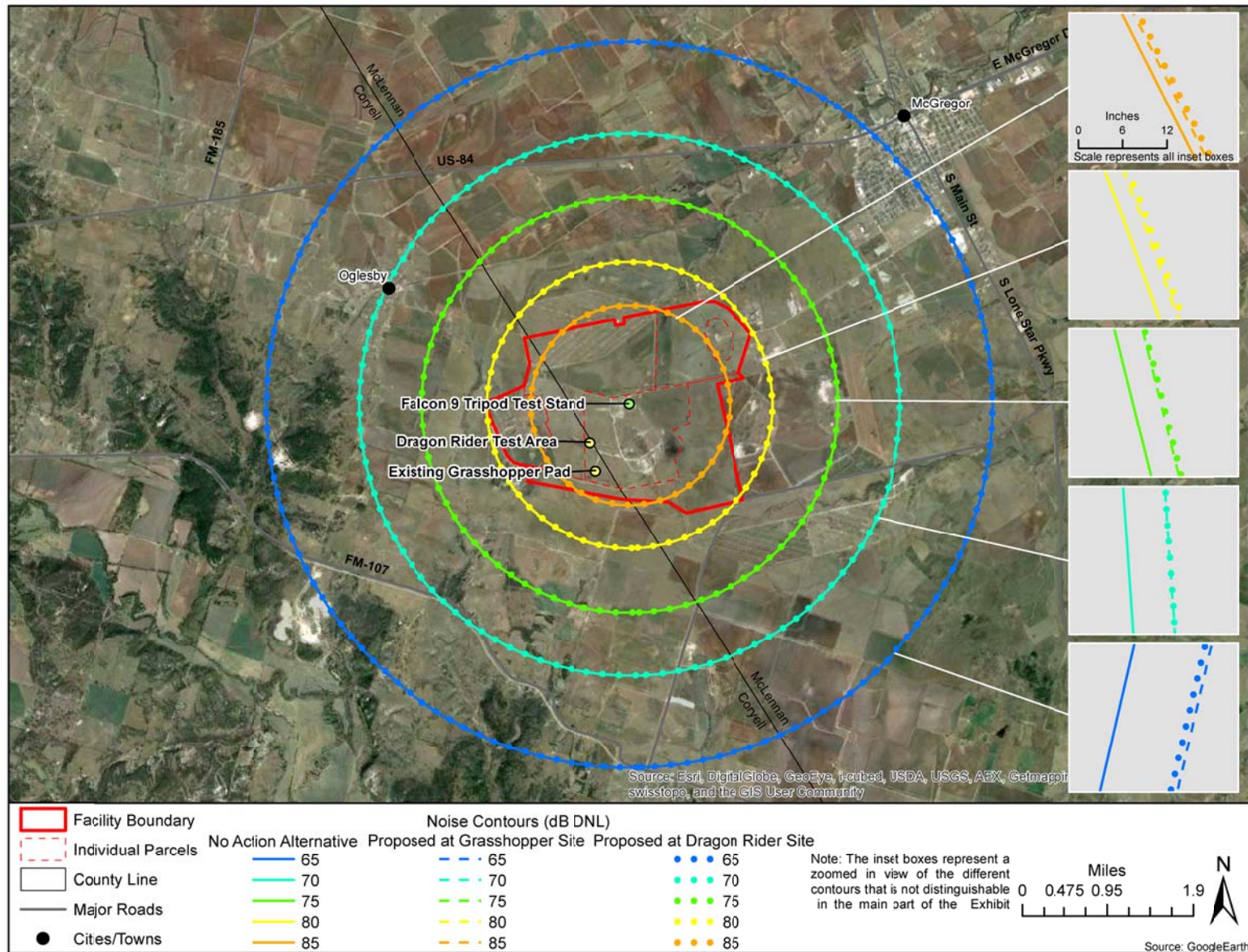


Exhibit 4.2-1. No Action Alternative and Proposed Action Noise Contours

Compatible Land Use

The Proposed Action includes the construction of a concrete launch pad at the DragonRider test area. This construction would be consistent with the current land use. Operations associated with the Proposed Action would primarily rely on existing infrastructure within the McGregor test site. The Proposed Action is consistent with existing land use and zoning designations at the McGregor Industrial Park and vicinity. The vicinity of the industrial park is zoned by the city as “heavy industrial” and no changes to land use practices or zoning would have to occur for initiation of the Proposed Action.

Projected noise contours are compared to existing land uses for determining compatible land use. The McGregor test site lies within the City of McGregor’s industrial park and is zoned “heavy industrial” (City of McGregor 2003). The McGregor test site is currently used to conduct engine testing, including tests of the Falcon 9 Stage 1. Therefore, noise associated with the construction of the proposed concrete launch pad as well as the operation of the DragonFly RLV would be compatible with the existing land use on the site. Adjacent land use is agricultural, which is not considered a noise-sensitive area as defined in Section 3.2. In addition, SpaceX has an existing agreement with the Charles Graham Cattle Company regarding use of respective parcels of land on days when rocket/engine tests are scheduled. The noise levels in residential areas in the City of McGregor and Oglesby are not compatible with existing land uses under the existing condition. The Proposed Action would have only minimal effects above the existing conditions. Therefore, the Proposed Action would not result in significant compatible land use impacts.

4.2.2 No Action Alternative

Under the No Action Alternative, the FAA would not issue an experimental permit to SpaceX for the operation of the DragonFly RLV at the McGregor test site. In addition, construction of the concrete launch pad at the DragonRider test area would not occur. Existing SpaceX activities, as described in Section 2.2 would continue at the McGregor test site. Therefore, there would be no adverse effects to noise levels or compatible land use under this Alternative.

4.3 Department of Transportation: Section 4(f)

4.3.1 Proposed Action

Public Parks, Recreation Areas, and Refuges

The FAA must assess if land use impacts to Section 4(f) properties are either *de minimis* or if a Section 4(f) evaluation is required. A *de minimis* impact on public parks, recreation areas, and public wildlife and waterfowl refuges, is defined as an impact that will not adversely affect the activities, features, or attributes of the public resource. The McGregor test site is 2.3 miles from the nearest public park or recreation area, and there would be no physical use, direct taking, or temporary occupancy of property belonging to public parks or recreation areas as a result of the Proposed Action. Implementation of the Proposed Action would not result in the physical use, direct taking, or temporary occupancy of wildlife refuges. The nearest wildlife management area is 5.5 miles from the test site.

Because significant increases in noise levels can impair the value of a 4(f) property, proposed actions with potential to increase noise levels significantly may be considered a “constructive use” of a Section

4(f) property. As described in Section 4.1.2 above, DragonFly RLV test launches may generate noise levels that would be outside of the test site, potentially at Section 4(f) properties. However, these areas are already exposed to audible noise from current SpaceX activities (as described in Section 2.2) and other noise sources (e.g., trains). As discussed in Section 4.2, the noise level associated with DragonFly RLV launches would produce less than a tenth of a dB difference from current operations, with a difference between the No Action Alternative and Proposed Action DNL contours of less than 4 acres. Changes in noise conditions at 4(f) properties would not be significant; therefore, potential noise-related impacts on Section 4(f) properties would be *de minimis*. A detailed analysis of noise and associated impacts are included in Section 4.2 and Appendix A of this EA.

Significant Historic Sites

Implementation of the Proposed Action would not result in the physical use, direct taking, or temporary occupancy of historic sites. The location of the proposed launch pad is approximately 0.75 of a mile from the nearest historic property.

Constructive use of Section 4(f) properties would occur if the proposed operations increased noise levels significantly and introduced visual elements that would significantly alter the use, character, or substantially impair the value of the historic properties. As described in Section 4.4.1, operations under the Proposed Action would be expected to produce a negligible increase in noise compared to existing conditions. The DragonFly RLV would be visible from the historic properties in the APE during each launch, but the annual operations would be intermittent and of short duration and similar in scope and magnitude to current SpaceX testing operations. Therefore, impacts from operations under the Proposed Action on Section 4(f) historic sites would be *de minimis*.

4.3.2 No Action Alternative

Under the No Action Alternative, the FAA would not issue an experimental permit to SpaceX for the operation of the DragonFly RLV at the McGregor test site. In addition, construction of the concrete launch pad at the DragonRider test area would not occur. Existing SpaceX activities would continue at the McGregor test site. Therefore, there would be no adverse effects to land use under this alternative.

4.4 Historical, Architectural, Archaeological, and Cultural Resources

4.4.1 Proposed Action

The APE, as defined in Section 3.4), includes 14 NRHP-listed or eligible historical resources. Under the Proposed Action, a new concrete launch pad would be constructed in the DragonRider test area, in proximity to the existing Grasshopper launch pad. There are no known NRHP-listed or eligible archaeological resources in this area. Therefore, there would be no direct effects to historic properties from construction under the Proposed Action. The launches and landings of the DragonFly RLV would result in a negligible increase in noise (refer to Section 4.2, *Noise and Compatible Land Use*). The DragonFly RLV would be visible from the historic properties in the APE during each launch, but the majority of the launch and landing operations would last only one minute each. Only four of the operations each year, two propulsive assist and two full propulsive landings, would last 30 minutes each.

Operations under the Proposed Action would occur intermittently and for a short duration at a site that was recently developed and used for suborbital testing, and as such, would not alter any of the significant physical features or characteristics of any of the historic properties. Therefore, there would be no effects to historic properties from implementation of the Proposed Action. THC concurred with this finding of no effect on April 7, 2014 (refer to Appendix B, *Agency Coordination*).

4.4.2 No Action Alternative

Under the No Action Alternative, the FAA would not issue an experimental permit to SpaceX for the operation of the DragonFly RLV at the McGregor test site. Existing SpaceX activities would continue at the McGregor test site. As a lessee of the city-owned property, SpaceX would continue to comply with the protective covenants and other applicable stipulations identified in the PA. Therefore, there would be no effect to historic properties under this alternative.

4.5 Fish, Wildlife, and Plants

4.5.1 Proposed Action

Vegetation

The Proposed Action includes potential construction of a new 1,600 ft² launch pad. Because the DragonRider test area and the Grasshopper launch pad are previously disturbed and are currently mowed industrial land (see Section 3.5.1 for further description), construction would not impact vegetation.

During a nominal launch, the DragonFly RLV would land either back on the launch pad or in a predetermined targeted site within the operating area in the vicinity of launch pad. The areas of the test site subject to active grazing do not have significant amounts of woody vegetation; therefore, the Proposed Action would not result in significant impacts to vegetation.

Wildlife

The potential construction of a new launch pad would not have impacts on terrestrial wildlife, and there is no anticipated permanent displacement of wildlife present at the McGregor test site. As no water bodies are in the vicinity of the potential launch pad, aquatic species would not be impacted.

Impacts to wildlife from DragonFly RLV launch operations would be similar to existing disturbances at the McGregor test site such as startling and flushing of birds and other wildlife during test launches and landings. Based on the relative infrequency of DragonFly RLV test launches, approximately 30 launches annually, overall impacts to regional wildlife populations are not anticipated. As discussed in Section 4.2 above, there would be no significant noise impacts from operations. Therefore, the Proposed Action would not significantly impact wildlife.

Special-Status Species

As discussed in Section 3.5, coordination with the USFWS in 2011 for the *Final Environmental Assessment for Issuing an Experimental Permit to SpaceX for Operation of the Grasshopper Vehicle at the McGregor Test Site, Texas* indicated that there are no federally listed species known to occur in the ROI.

Under the Proposed Action, a new concrete launch pad would be constructed approximately 0.32 mile north of the existing Grasshopper RLV launch pad. None of the State-listed species that have potential to occur in the ROI are known to occur at the proposed launch pad site. Therefore, there would be no direct effects to listed species from construction activities associated with the Proposed Action.

The launches and landings of the DragonFly RLV would result in a negligible increase in noise above the existing conditions. The DragonFly RLV would be visible from the surrounding area during each launch, but the majority of the launch and landing operations would last only one minute each. Only four of the annual operations would last 30 minutes each. Operations under the Proposed Action would occur intermittently and for a short duration at a site, which is currently already used for suborbital testing.

Previous coordination with TPWD indicated that there may be suitable stop-over habitat for migrating whooping cranes within the test site (TPWD 2011c). In response to TPWD recommendations, SpaceX developed a whooping crane monitoring plan to be implemented when operations are conducted during the whooping cranes' northern migration (approximately late March through early June) and southern migration (approximately mid-September through late December). Under the existing FAA experimental permit, potential stop-over habitat located within the operational area of the McGregor test site are currently monitored for the presence of whooping cranes approximately 1-2 hours prior to conducting activities during the fall and spring migration periods. Similarly, as appropriate, whooping crane monitoring would also be conducted by SpaceX for DragonFly operations. Although whooping cranes have not been observed at the designated monitoring sites, if whooping cranes are observed, SpaceX must notify the FAA, USFWS, and TPWD, and cease activities covered under the experimental permits until the cranes have left the area. Based on the very rare occurrence of whooping cranes within the operational area of the McGregor test site and with the implementation of the whooping crane monitoring plan, the FAA has determined that the Proposed Action would have *no effect* on the whooping crane.

4.5.2 No Action Alternative

Under the No Action Alternative, the FAA would not issue an experimental permit to SpaceX for the operation of the DragonFly RLV at the McGregor test site. Existing SpaceX activities would continue at the McGregor test site. Therefore, there would be no adverse effects to biological resources under this alternative.

4.6 Water Quality

4.6.1 Proposed Action

Surface Waters (Non-wetlands Surface Waters)

Construction activities related to the Proposed Action would include excavating, grading, and filling in preparation for constructing of a 1,600 ft² launch pad at the DragonRider test area. Construction of the launch pad would not result in direct impacts to surface waters. A TPDES construction permit would not be required because the construction of the pad would disturb less than 1 acre. To prevent disturbed soils or pollutants from being carried off-site in stormwater runoff, the use of Best Management

Practices (BMPs) such as sediment traps, silt fences, straw bales, or fiber rolls would be incorporated into design and construction. During project operations, stormwater discharges from new impervious surfaces of the launch pad could potentially convey stormwater with low levels of pollutants to adjacent wetlands and other surface waters. Typical pollutants could include sediment and petrochemicals. However, the Proposed Action would not substantially alter existing stormwater runoff patterns. Vegetated buffers surrounding these features, which help prevent indirect impacts to or degradation of streams, would be maintained.

Although the probability is low, a launch failure could potentially impact surface waters. Potential impacts would be minimized and mitigated by emergency response and clean-up procedures. Due to minimal surface waters present within the operations area, and management practices in place to prevent releases, no adverse impacts to surface waters are expected as a result of the Proposed Action.

Groundwater

Construction activities associated with the launch pad would not require blasting that would alter underlying geology and affect the Trinity Aquifer. Construction of the launch pad would not require significant quantities of groundwater. Construction vehicles and machinery could potentially impact groundwater if spills or leaks occur. Storage and handling of chemicals and fuel used during construction activities would follow SpaceX's Spill Response Procedure, which would minimize the potential for accidental releases of pollution substances from construction equipment. All construction materials would be carefully stored and handled and spills cleaned up immediately. The increase in impervious surface associated with the potential launch pad would be minimal; therefore, no impacts to groundwater recharge capabilities would occur.

Water for the McGregor test site is supplied via pipeline from a groundwater well at the City of McGregor water plant. Water demand for operations of the Proposed Action is minimal and would not be anticipated to significantly increase existing groundwater demand. Propellants that would be used in operations for the Proposed Action are currently stored at the test site, and are managed as per the SpaceX Spill Response Procedure. Therefore, spills would not be expected to enter or impact groundwater resources.

Ongoing groundwater remediation projects are occurring in nearby areas because of contamination originating from former NWIRP site uses, as described in Section 3.6. Investigations by the Navy indicated that contaminated groundwater does not underlay or originate from the areas associated with the proposed launch pad locations or proposed construction area (EPA 2009b). Additionally, EPA has granted the former NWIRP site a "Ready for Reuse" designation indicating that the remediated conditions of the site are protective of human health and the environment for the anticipated use (EPA 2009b).

In the event of a launch failure (for which the probability is low), any potential impacts to groundwater would be minimized by emergency response and clean-up procedures. Therefore, adverse impacts to groundwater from the Proposed Action are not expected.

Wetlands

Two areas of emergent wetlands are located on the McGregor test site, but no wetlands are located at the proposed location for launch pad construction. To minimize the occurrence of short-term impacts to wetlands from pollutants and sediment carried in stormwater runoff from the proposed construction, BMPs would be implemented. In the event of a launch failure (for which the probability is low), any potential impacts to wetlands would be minimized by emergency response and clean-up procedures. Therefore, no adverse impacts to wetlands are expected to occur as a result of the Proposed Action.

Floodplains

There are approximately 44.92 acres of 100-year floodplains associated with the South Bosque River located in the southeast portion of the McGregor test site boundary and approximately 2.34 acres of 100-year floodplains associated with a tributary to Station Creek in the southwestern corner of the McGregor test site. These floodplains are outside of the area of the proposed launch pad construction. BMPs would be implemented during design and construction to prevent impacts to floodplains. BMPs would also be implemented to prevent any releases or contaminants from operations from impacting floodplains. If a launch failure does occur during operations, potential floodplain impacts would be mitigated and minimized through emergency response and clean-up procedures. No adverse impacts to floodplains are expected from the Proposed Action.

4.6.2 No Action Alternative

Under the No Action Alternative, the FAA would not issue an experimental permit to SpaceX for the operation of the DragonFly RLV at the McGregor test site. Existing SpaceX activities would continue at the McGregor test site. Therefore, there would be no adverse effects to water resources under this alternative.

4.7 Natural Resources and Energy Supply

4.7.1 Proposed Action

Expansion of the existing facilities based on the Proposed Action is limited to the potential construction of a 1,600 ft² launch pad, and is not expected to significantly increase demand or use of natural resources and energy. Launches of the DragonFly RLV are expected to require approximately 50 kW-hr of additional energy, which would be provided via existing utilities at the test site.

The planned test launches of the RLV would use a propellant mixture of NTO and MMH. The demand for fuels and propellants as described in Section 2.1.1 would be met without difficulty. Potential construction and maintenance washing of the launch pad would consume water from the water truck, and relatively minimal amounts of concrete and other natural resources would be consumed if the launch pad is constructed. The Proposed Action is not expected to have significant impact on natural resources or energy supply.

4.7.2 No Action Alternative

Under the No Action Alternative, the FAA would not issue an experimental permit to SpaceX for the operation of the DragonFly RLV at the McGregor test site. Existing SpaceX activities would continue at the McGregor test site. Therefore, there would be no adverse effects to natural resources and energy supply under this alternative.

4.8 Hazardous Materials, Pollution Prevention, and Solid Waste

4.8.1 Proposed Action

Solid waste is likely to be produced during the potential launch pad construction and operations associated with the Proposed Action. The amount of solid waste produced by the Proposed Action is not expected to be a significant increase over current levels produced by site activities. All solid wastes would be managed and disposed of according to existing practices described in Section 3.8.

The DragonFly RLV propulsion system uses a propellant mixture of NTO and MMH, which are hazardous materials. NTO and MMH are currently used and stored on-site for testing purposes. All propellant would be shipped to the McGregor test site in DOT-certified tanker trucks. Oils, batteries, and other materials associated with engine maintenance are also used and stored on-site. Propellants, oils, and all hazardous materials and wastes would be stored and used in compliance with Federal regulations at 14 CFR §420.67 for liquid propellants.

Appropriate engineering and administrative controls would be implemented to avoid releases of any hazardous materials or wastes. SpaceX has adopted a Chemical Emergency Response Plan and Spill Response Procedures for the McGregor test site to be followed in the event of a release to minimize hazards to employees and the environment. The policies and procedures outlined in the Chemical Emergency Response Plan fulfill the requirements of the Hazardous Waste Operations and Emergency Response Plan (29 CFR Part 1910.120(q)), RCRA Hazardous Waste Contingency Plan (40 CFR 265, Subpart D), and Sanitary Sewer Accidental Release Prevention Plan.

Remediation for groundwater and soil contamination originating from prior NWIRP uses has occurred on the site. Remediation is also ongoing for groundwater at neighboring properties. As described in Sections 3.6 and 4.6, investigations indicate that groundwater and soils underlying the areas proposed for launch pad construction are not contaminated. EPA has granted the former NWIRP site a “Ready for Reuse” designation indicating that the remediated conditions of the site are protective of human health and the environment for the anticipated use (EPA 2009b). Therefore, the Proposed Action is not expected to have any adverse impact due to past contamination. Implementation and operation of the Proposed Action would comply with all applicable Federal, State, and local regulations regarding hazardous materials, hazardous waste management, solid waste, and pollution prevention. Therefore, no adverse impacts are expected.

4.8.2 No Action Alternative

Under the No Action Alternative, the FAA would not issue an experimental permit to SpaceX for the operation of the DragonFly RLV at the McGregor test site. Existing SpaceX activities would continue at

the McGregor test site. Therefore, there would be no adverse effects to hazardous materials, pollution prevention, and solid waste under this alternative.

4.9 Light Emissions and Visual Impacts

4.9.1 Proposed Action

The McGregor test site is located in an operational industrial park, and the test site operations include past testing of the Grasshopper RLV, the F9R, and current testing of the Falcon 9 engines. Similar to the current launch operations, DragonFly launches and landings would be visible for several miles around the test site, up to 30 times per year. The DragonFly RLV would be taken to a specified elevation and released or launched from a launch pad, depending on which type of test described in Section 2.1.1.2 is planned. The DragonFly RLV would emit a combustion light source (flame) as engines fire. These light emissions would be smaller in visual impact compared to light emissions produced by the Grasshopper RLV, F9R, and Falcon 9 engine tests. Although DragonFly RLV launches might have the potential to be seen from the nearby cities of McGregor and Oglesby, engine firing would only occur for 5 to 25 seconds during each test. Light emissions from engine firing would be more visible during night time operations. Visual impacts from DragonFly RLV operations would be short-term and infrequent, because the engine firing would be of short duration and launches would be relatively infrequent at a rate of 30 annually.

The Proposed Action may require the construction of a launch pad. Potential construction of the launch pad would be consistent with existing structures and landscape of the test site and industrial park, and would not be a significant impact to visual resources. The Proposed Action would not substantially degrade the existing visual character or quality of the site and its surroundings. The Proposed Action is not expected to significantly impact light emissions or visual resources.

4.9.2 No Action Alternative

Under the No Action Alternative, the FAA would not issue an experimental permit to SpaceX for the operation of the DragonFly RLV at the McGregor test site. Existing SpaceX activities would continue at the McGregor test site. Therefore, there would be no adverse effects to light emissions and visual resources under this alternative.

4.10 Socioeconomics, Environmental Justice, Children's Environmental Health Risks and Safety Risks

This socioeconomic analysis focuses on potential increases in employment and construction expenditures. The assessment examines how the Proposed Action would affect population, employment, income, and housing characteristics in the ROI.

Socioeconomic impacts, particularly impacts such as those being evaluated in this EA, may be mixed: beneficial in terms of gains in jobs, expenditures, tax revenues, etc., and potentially adverse in terms of growth management issues such as demands for housing and community services.

This analysis also identifies potential environmental justice issues. Impacts to environmental justice populations are identified where high and adverse human health or environmental effects may

disproportionately affect minority or low-income populations. Impacts to children would occur if there was an increased disproportionate environmental health or safety risk to children.

4.10.1 Proposed Action

Population and Housing

The Proposed Action would require the addition of 10 new employees to the McGregor test site for the duration of the 2-year program. Under a maximum scenario, all new personnel would move permanently to the ROI. Using an average ROI household size of 2.60 (USCB 2012; USCB 2013a), these 10 workers would be accompanied by approximately 16 family members. The total population increase of approximately 26 people would represent less than 0.01 percent of the ROI population. Therefore, there would be no significant impacts to short- or long-term population trends.

The City of McGregor has a higher percentage of available housing compared to Texas. Coryell and McLennan Counties have a minimum of 8.7 percent available housing units (USCB 2012; USCB 2013a). The available housing units are adequate to accommodate the conservative estimate of 10 new households that may move into the ROI. Therefore, the use of vacant housing units by potential new employees moving into the ROI would be a minor beneficial impact to housing.

Construction of the launch pad for the Proposed Action, if necessary, would be contracted through local construction companies and is not expected to require new construction workers to move into the area. There would be no adverse impacts to supply and demand for local housing as a result of the Proposed Action. Additionally, there would be no impacts to short- or long-term population trends.

Income and Employment

The Proposed Action would require the addition of 10 new employees to the McGregor test site, which would represent less than one percent of the existing ROI employment rate (USCB 2013b). However, the slight increase in employment would translate into an increase in earnings in the ROI. Some of these increased earnings would be paid to taxes, and some would be saved and invested, but most would be spent on consumer goods and services in the ROI.

Although limited, this spending may indirectly support existing jobs and income in the ROI economy in retail, food, and services, resulting in a minor economic benefit. Given the less than 0.01 percent increase in direct employment, the Proposed Action would be expected to support a negligible increase in these indirect jobs, and would not be expected to generate associated population in-migration.

Construction of a launch pad may be required to support the Proposed Action. The proposed construction spending would support direct construction jobs and other related jobs induced by construction spending. Given the relatively minor amount of new construction required, it would not be expected that additional construction workers would move into the ROI for the construction. Further, it would be expected that most of the induced jobs would be filled by unemployed ROI workers. Therefore, construction spending would not be expected to significantly affect population or employment trends.

Additional taxes would accrue to Federal, State, and local governments as a result of the increase in construction spending and slight increase in employment. These impacts would be beneficial; however, they would be minor due to the small size of the construction project and scale of hiring.

Environmental Justice

Impacts to environmental justice populations are evaluated in terms of the presence of minority and low-income populations in the affected environment and the potential for high and adverse environmental consequences resulting from the project to disproportionately affect these populations. As discussed in Section 3.10, there are no Census Tracts that are considered minority or low-income environmental justice populations based on income or demographics as defined by the CEQ and DOT Order 5610.2. Therefore, there would be no disproportionately high and adverse impacts on low-income or minority populations and thus no adverse environmental justice impacts.

Children's Environmental Health and Safety Risks

Impacts to children's environmental health and safety are evaluated in terms of the potential for high and adverse environmental consequences resulting from the project to disproportionately affect children. There are five schools, eight parks, and the CTYRA youth rodeo arena located between 3 to 5 miles from the proposed launch pad location. Noise impacts analyses discussed in Sections 4.2 of this document indicate that the Proposed Action would have no significant impacts on children's environmental safety and health. Coryell and McLennan Counties are in attainment for NAAQS and emissions standards. The Air Quality analyses summarized in Section 4.1 indicates that operations related to the Proposed Action would not cause emissions to exceed NAAQS. Because no significant impacts from noise or air pollution are expected, the Proposed Action would not pose disproportionate high or adverse impacts to children's environmental health or safety.

4.10.2 No Action Alternative

Under the No Action Alternative, the FAA would not issue an experimental permit to SpaceX for the operation of the DragonFly RLV at the McGregor test site. Existing SpaceX activities would continue at the McGregor test site. Therefore, there would be no adverse effects to socioeconomic conditions under this alternative.

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5.0 CUMULATIVE IMPACTS

Cumulative impacts are defined by the CEQ in 40 CFR §1508.7 as:

The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions.

The CEQ regulations further require that NEPA environmental analyses address connected, cumulative, and similar actions in the same document (40 CFR 1508.25).

Additionally, the CEQ further explained in Considering Cumulative Effects under the National Environmental Policy Act that “each resource, ecosystem and human community must be analyzed in terms of its ability to accommodate additional effects, based on its own time and space parameters.” Therefore, a cumulative effects analysis normally would encompass geographic boundaries beyond the immediate area of the Proposed Action, and a time frame, including past actions and foreseeable future actions, in order to capture these additional effects.

Past, present, and reasonably foreseeable future actions at McGregor test site include the ongoing SpaceX programs for Grasshopper RLV test program and Falcon 9 Stage 1 engine testing, plus the F9R testing. Past and present actions at the McGregor Industrial Park and vicinity include the commercial operations at the Park including pipe and plumbing supply distribution, C3 Communications, the CTYRA rodeo arena, and agricultural practices/cattle grazing on undeveloped portions of the test site and industrial park. Reasonably foreseeable future actions include further development at the industrial park, including the potential future lease of the largest building at the industrial park which has the capacity to house an operation with approximately 500 employees. A new primary school is being constructed adjacent to McGregor Elementary School and is scheduled to be open by August 2014.

The Proposed Action does not impact natural, cultural, or socioeconomic resources evaluated in this EA; therefore, there would be no cumulative impacts to these resources when combined with other past, present, and reasonably foreseeable future projects at the McGregor test site, McGregor Industrial Park, or surrounding area. The Proposed Action is expected to have the most impact on air quality and noise; therefore, these resource areas are the focus of the cumulative impacts analysis.

5.1 Air Quality

As discussed in Section 4.1.2, the DragonFly RLV testing operations would result in a very small increase in criteria pollutant emissions in the vicinity of the McGregor test site. As part of their ongoing engine testing operations, SpaceX has begun an engine test program where they fire hypergolic propellants in open air for a maximum total of four minutes per year, and may have no open air testing at all in some years. The normal combustion products that result from the combustion of the hypergols, MMH and NTO, are primarily nitrogen gas and water that would have no effect on air quality. No other existing or planned emissions sources were identified in the vicinity of the McGregor test site that would produce notable cumulative air quality impacts.

Currently, there are no formally adopted or published NEPA thresholds of significance for GHG emissions stemming from Proposed Actions. Formulating such thresholds is problematic, as it is difficult to determine what level of proposed emissions would substantially contribute to global climate change.

Annual GHG emissions associated with the proposed operations in each year of testing are composed of carbon dioxide emissions, and these are compared to U.S. 2011 GHG emissions in Table 5.1-1. The estimated carbon dioxide emissions from the Proposed Action essentially represent zero percent of the total GHG emissions generated by the United States in 2011.

Table 5.1-1. Comparison of Proposed Action GHG Emissions to U.S. 2011 GHG Emissions¹

Alternative	Metric Tons CO ₂ per Year	Percent of U.S. 2011 GHG Emissions
Annual Operational Emissions	9.67	1.44 X 10 ⁻⁷
U.S. 2011 Total GHG Emissions	6,708.3 x 10 ⁶	

Note: ¹ EPA 2013b

The small quantity of GHG emissions from the Proposed Action alone would not cause appreciable global warming that would lead to climate changes. However, these emissions would increase the atmosphere's concentration of GHGs, and, in combination with past and future emissions from all other sources, contribute incrementally to the global warming that produces the adverse effects of climate change. At present, no practical methodology exists that would enable meaningful estimation of the specific impacts (if any) that this increment of warming would produce locally or globally.

5.2 Noise

The noise generated from DragonFly launch operations would be 30 times annually and would be similar to the types of noise routinely generated at the McGregor test site. Noise from the Grasshopper RLV test program and the F9R test program would not be additive because those test programs would be complete before the DragonFly RLV operations begin. When the Proposed Action is combined in conjunction with past, present, and reasonably foreseeable future actions at the McGregor test site and the surrounding area, no significant impacts would be expected.

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