

APPENDICES

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Appendix A
Noise

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Blue Ridge Research and Consulting, LLC

Final Report

Noise Study in Support of the EA for Issuing an Experimental Permit to SpaceX for Operation of the DragonFly Vehicle at McGregor Test Site, Texas

November 12th, 2013 (R2014)

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Acronyms and Abbreviations

BRRC	Blue Ridge Research and Consulting, LLC
dB	Decibel
dBA	A-weighted Decibel Level
DNL	Day-Night Average Sound Level
DSM-1	Distributed Source Method 1
EA	Environmental Assessment
FAA	Federal Aviation Administration
ft	Foot/Feet
kg	Kilogram
lbf	Pound Force
lbm	Pound Mass
m	Meters
N	Newton
NEPA	National Environmental Policy Act
RLV	Reusable Launch Vehicle
RSRM	Reusable Solid Rocket Motor
sec	Second
SEL	Sound Exposure Level
SpaceX	Space Exploration Technologies Corp.
μ Pa	Micropascal

1 Introduction

Space Exploration Technologies Corp. (SpaceX) is proposing experimental testing of its DragonFly reusable launch vehicle (RLV) at its test facility in McGregor, TX. SpaceX intends to conduct tests of the DragonFly's vertical landing capability. These tests are currently scheduled to begin in 2014 and continue through 2015. SpaceX must obtain an experimental permit from the Federal Aviation Administration (FAA) to conduct these tests. As part of this permitting process, the FAA requires an assessment of the proposed operational noise impacts. This report documents the noise study performed to support SpaceX in obtaining an experimental permit for the proposed DragonFly operations at its McGregor test facility.

The issuance of an experimental permit license is considered a Federal action subject to environmental review under the National Environmental Policy Act (NEPA) of 1969 as amended (42 United States Code [U.S.C.] §4321, et seq.). The noise impact of the proposed future actions is evaluated based on the FAA Order 1050.1E, Change 1, *Environmental Impacts: Policies and Procedures* [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 dB[A] or more at or above DNL 65 dB[A] noise exposure when compared to the no action alternative for the same timeframe." Where DNL is defined as the Day-Night Average Sound Level (see Section 2).

This noise study describes the environmental noise associated with the proposed action. Section 2 summarizes the noise metrics discussed throughout this report; Section 3 describes the general methodology of the noise model; Section 4 describes the acoustic modeling input parameters; and Section 5 presents the noise modeling results. A summary is provided in Section 6 to document the notable findings of this noise study.

2 Noise Metrics

Noise is any unwanted sound. Sounds that interfere with normal activities or the natural environment are considered noise. Noise represents one of the most contentious environmental issues associated with flight operations and testing. Although many other sources of noise are present in today's communities, rocket noise is readily identifiable based on its uniqueness. An assessment of rocket noise requires a general understanding of how sound affects people and the natural environment, and how sound is measured.

The noise environment at SpaceX's McGregor test facility is normally composed of time-varying sounds generated by engine testing for the Falcon 9 launch vehicle. In this study, these operations would be conducted during an average annual day, which is defined by the total annual test and flight operations divided by the number of days in a year.

2.1 Day-Night-Level (DNL)

The federally accepted noise metric used for assessing long-term noise exposures in communities in the vicinity of flight operations is the Day-Night Average Sound Level (DNL) (which is sometimes denoted by Ldn), expressed as decibels (dB). DNL is an average sound level generated by all flight testing-related

operations during an average 24-hour period with sound levels of nighttime noise events adjusted by adding a 10 dB penalty. It is important to note that the daytime and nighttime definitions used in calculating DNL are the following: daytime is the period from 0700 to 2200 hours, and nighttime is the period from 2200 to 0700 hours the following morning. The 10 dB penalty accounts for the generally lower background sound levels and greater community sensitivity to noise during nighttime hours. DNL has been found to provide the best measure of long-term community reaction to transportation noises, especially aircraft noise [2] [3] [4] [5].

DNL employs A-weighted sound levels. “A-weighted” denotes the adjustment of the frequency content of a noise event to represent the way in which a human with average hearing senses the noise. Normal human hearing ranges from about 20 Hz to about 20,000 Hz. Human hearing is best in the frequency range from 500 to 5,000 Hz. Outside of this range, human hearing acuity diminishes.

3 Acoustic Modeling Methodology

The majority of the noise generated by a rocket launch/landing is created by the rocket plume, or jet exhaust, interacting with the atmosphere along the entire plume, and combustion noise of the propellants. The noise levels generated from commercial space launch vehicles are predicted by The Launch Vehicle Acoustic Simulation Model (RUMBLE), developed by BRRC. For environmental noise assessment, rocket noise modeling is composed of various physical components used to describe different facets of rocket noise. Rocket noise modeling involves three basic aspects: noise source characterization, atmospheric propagation, and reception. Components with each of these areas are described in the following discussion.

3.1 Rocket Source noise Characterization

3.1.1 Sound Power

Eldred’s Distributed Source Method 1 (DSM-1) [6] is utilized for the source characterization. The DSM-1 model determines the launch vehicle’s total sound power based on its total thrust, exhaust-velocity and the engine/motor’s acoustic efficiency. The acoustic efficiency of the rocket engine/motor was modeled using Guest’s variable acoustic efficiency [7]. For launch vehicles with multiple tightly clustered equivalent engines, the engines can be modeled as a single engine with an effective exit diameter and total thrust [6]. Therefore, the set of distributed sources are modeled as a compact source located at the nozzle exit with an equivalent total sound power and range of frequencies.

3.1.2 Source Directivity

Rocket noise is highly directive meaning the acoustic power is concentrated in specific directions, and the sound pressure observed will depend on the angle from the source to the receiver. NASA’s Project Constellation Program has made significant improvements in determining launch vehicle directivity of the reusable solid rocket motor (RSRM) [8]. The RSRM directivity indices incorporate a larger range of frequencies and angles than previously available data. These updated directivity indices are used for this analysis.

3.2 Atmospheric Propagation

3.2.1 Geometric Spreading

As sound propagates away from the source, it is spread over an ever-increasing area. As this area increases, the intensity of the sound decreases. This effect is called the inverse square law.

3.2.2 Atmospheric Absorption

As sound propagates through the atmosphere, air molecules absorb some of the acoustical energy through vibrational excitation. The level of atmospheric absorption is controlled by a complex relationship among frequency, propagation distance, temperature, barometric pressure, and relative humidity. Atmospheric absorption is calculated using formulae found in ANSI standard S1.26-1995 (R2004). For environmental modeling, average monthly temperatures, relative humidity, and barometric pressure are used to calculate the median absorption conditions at a given location.

3.2.3 Doppler Effect

The Doppler Effect is defined as the change in frequency of a wave for an observer moving relative to its source. During a rocket launch, an observer on the ground will hear a downward shift in the frequency of the sound as the distance and speed from the source to receiver increase. As the frequency is shifted lower, the A-Weighting filtering on the spectrum results in a decreased A-weighted sound level. For un-weighted overall sound levels, the Doppler Effect has no impact on the levels since all frequencies are accounted for equally.

3.3 Ground Interference: Reception

3.3.1 Ground Interference

Sound propagation using NASA SP-8072 results in the prediction of a free-field sound level at the receiver. However, sound propagation near the ground is most accurately modeled as the combination of a direct wave (source to receiver) and a reflected wave (source to ground to receiver). The acoustic model accounts for the attenuation of sound by the ground [9, 10] by including the effect of the ground on a receiver when estimating the received noise. To account for the random fluctuations of wind and temperature on the direct and reflected wave, atmospheric turbulence has also been included [9].

3.3.2 Received Noise

Combining these separate components, the received noise levels from individual events can be evaluated at a receiver location. The noise from these events is combined to calculate the DNL values at that location. Noise is calculated over a grid of points to assess the noise over the entire region of the proposed DragonFly RLV operations.

4 SpaceX McGregor Test Facility

4.1 Test Facility Description and Operating Areas

SpaceX's test facility is located in McGregor, TX straddling the border of McLennan and Coryell counties. The proposed operating area includes: Area L/M/E (SpaceX owned), Ag 1/2 (based on conversations

between SpaceX and Huffman), and Ag 3 (based on conversations between SpaceX and THC). The test facility contains three test areas, the Falcon 9 Tripod Test Stand, the DragonRider Site and the Grasshopper Pad, as shown in Figure 1. The longitude and latitude locations of the test areas are presented in Table 1.

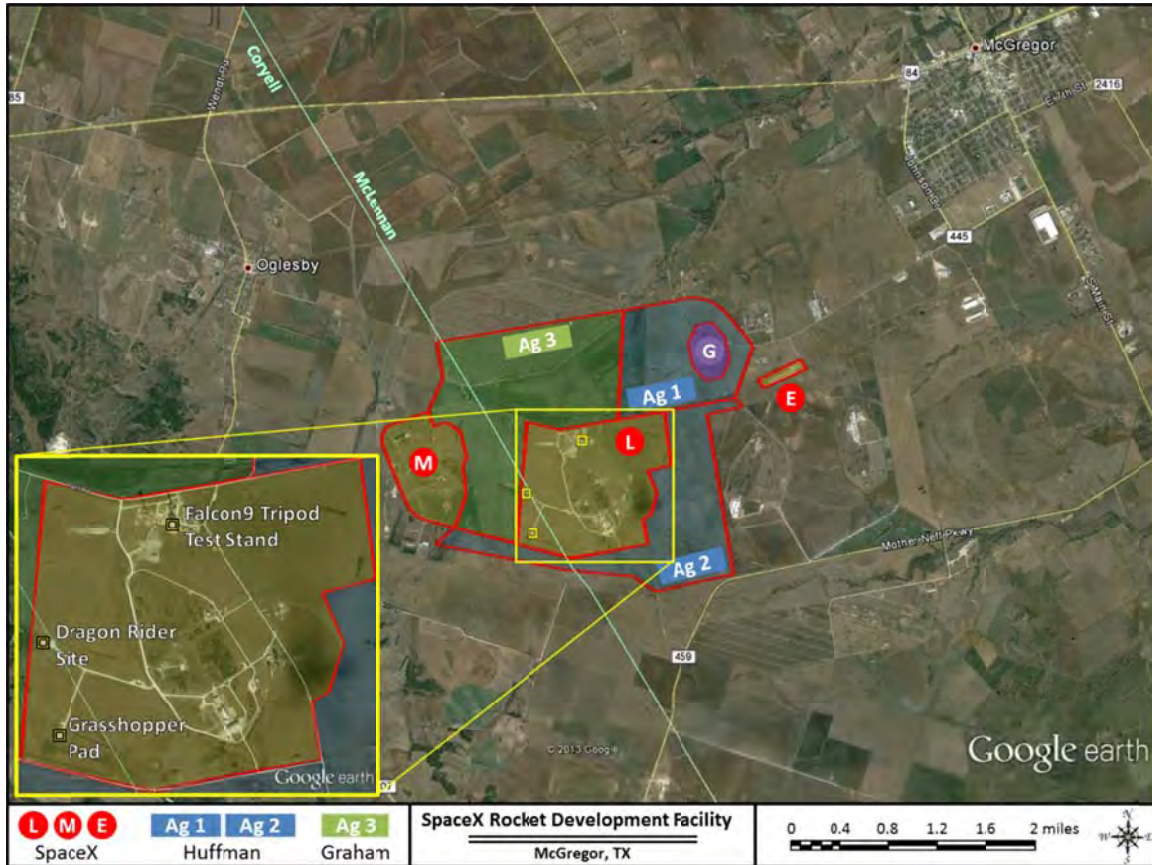


Figure 1. SpaceX Test Facility in McGregor, TX

Table 1. McGregor Facility Test Area Locations

Test Areas	Latitude	Longitude
Falcon 9 Test Stand	31°23'55.41" N	97°27'44.67" W
Grasshopper Pad	31°23'17.17" N	97°28'08.58" W
DragonRider Site	31°23'33.69" N	97°28'11.83" W

4.2 Baseline Input Parameters

The existing noise environment at the McGregor test site includes engine testing for the Falcon 9 launch vehicle. SpaceX conducts approximately five Merlin-1D tests per week as well as six Falcon 9 Stage 1 tests (powered by nine Merlin-1C engines) per year [11]. The Grasshopper RLV tests and Falcon 9 Reusable (F9-R) first stage firings are temporary projects and will be completed before the scheduled initiation of the DragonFly program. Therefore, when the DragonFly program is scheduled to begin, the

baseline conditions will only include engine testing for the Falcon 9 launch vehicle as described in Table 2, all of which occur during the acoustic day (0700 to 2200) from the Falcon 9 Tripod test stand. For this reason, the baseline noise contours presented in the 2011 EA, which exclude all Grasshopper RLV and F9R operations, are equivalent to the baseline noise environment proposed for this current effort. Figure 2 shows the baseline contours, generated based on Exhibit 3-5 from the 2011 EA [11]. Baseline noise contours were generated to approximate the contours shown in Exhibit 3-5, as the digital files have not been made available.

Table 2. Summary of Baseline Operations

Operation Type	Operations	Duration of Event
Merlin-1D Tests	Approximately 5 per week	100 seconds
Falcon 9 Stage 1 Tests	6 per year	180 seconds

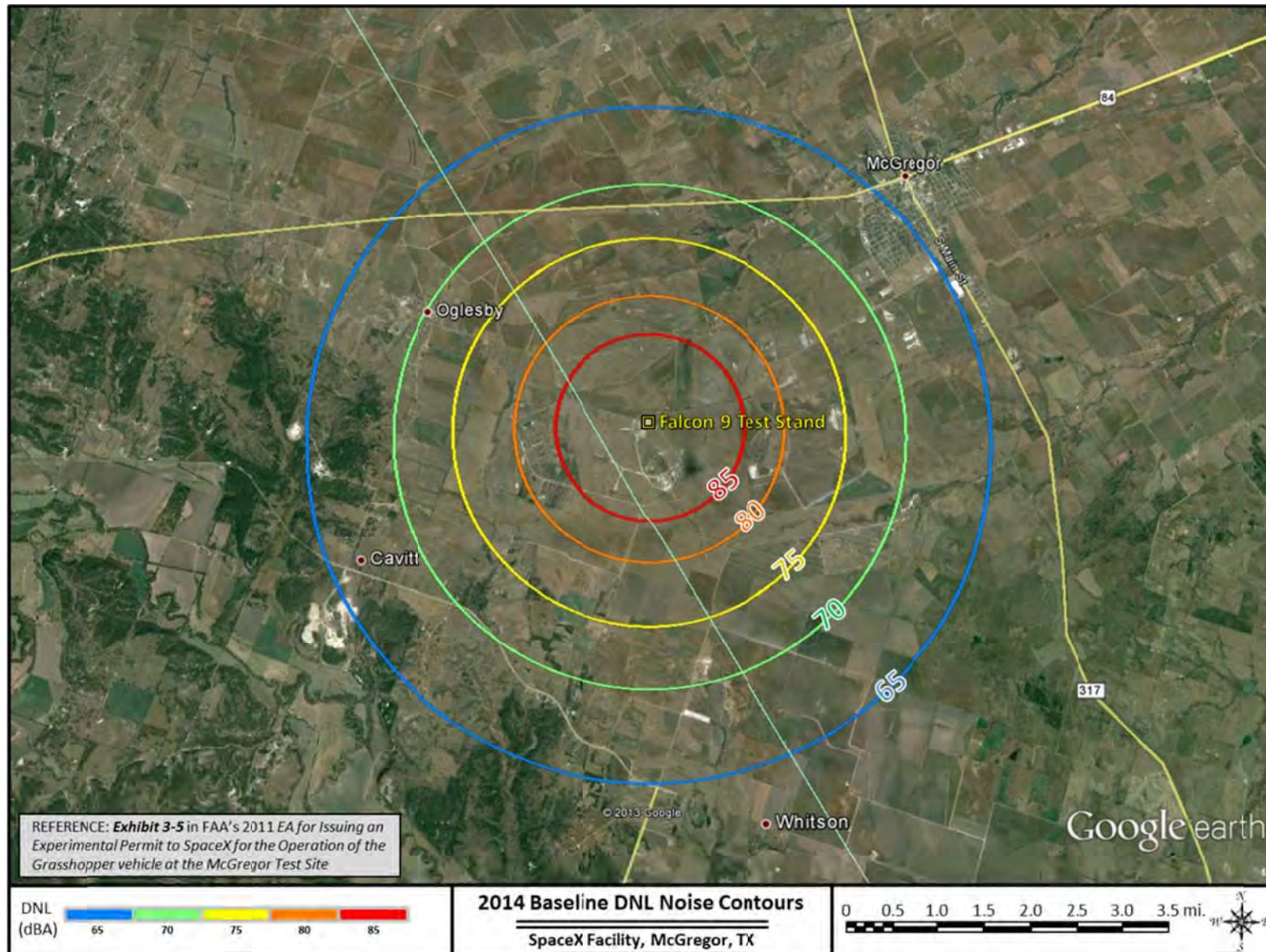


Figure 2. 2014 Baseline DNL Noise Contours (as Presented in the 2011 EA).

4.3 Proposed Action Input Parameters

The Proposed Action involves conducting experimental testing of the DragonFly RLV at SpaceX’s test facility in McGregor, TX. The purpose of the program, scheduled to begin in 2014, is to test the DragonFly’s vertical landing capability. The DragonFly is the Dragon capsule, shown in Figure 3, with an integrated trunk and four steel landing legs. The Dragon capsule is “a free-flying, reusable spacecraft designed to deliver both cargo and people to orbiting destinations” [12]. The vehicle’s size and weight is presented in Table 3.



Figure 3. SpaceX’s DragonFly Capsule(Photos Courtesy of SpaceX)

Table 3. Vehicle Parameters Utilized In Acoustic Modeling

Vehicle Parameters	DragonFly
Vehicle Manufacturer	Space Exploration Technologies (SpaceX)
Height with Trunk	7.2 m (23.6 ft)
Diameter	3.7 m (12.0 ft)
Total Payload Mass	Launch: 6,000 kg (13,228 lbs), Return: 3,000 kg (6,614 lbs)

The DragonFly is propelled by eight SuperDraco engines (Figure 4), manufactured by SpaceX. Although a SuperDraco engine can reach a maximum thrust of 16,400 lbf individually, the vehicle’s maximum thrust is limited to 122,600 lbf (15,325 lbf per engine) to maintain stability. The four engines are modeled as a single engine with an effective exit diameter, as per the acoustic modeling methodology described in Section 3. Table 4 presents the engine input parameters utilized in the acoustic modeling. These parameters are assumed to remain constant over the powered duration of the flight event. The acoustic efficiency of the SuperDraco engine, which was calculated using Guest’s variable acoustic efficiency model [7], is 0.3% based on the total mechanical power of the engine.

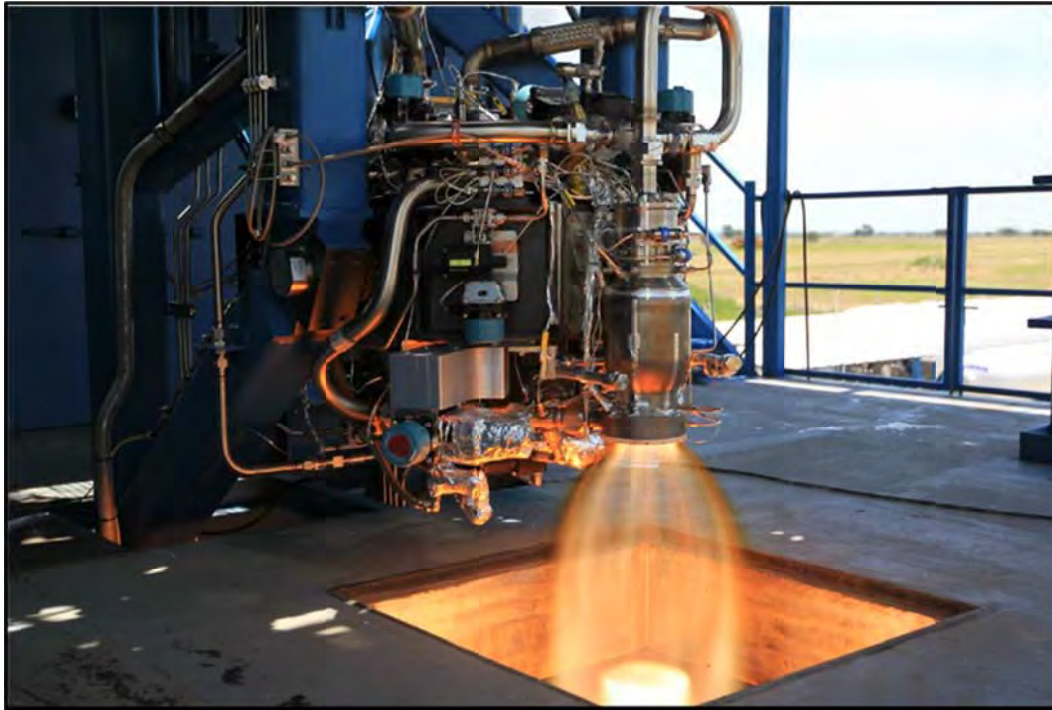


Figure 4. SuperDraco Engine at Full Throttle (Photo Courtesy of SpaceX)

Table 4. Engine Parameters Utilized in Acoustic Modeling

Engine Model:	SuperDraco
Engine Manufacturer	SpaceX
Number of Engines	8
Nozzle Exit Diameter	20 cm (8.0 in)
Propellant	Hypergolic
Exhaust Velocity	2,300 m/s (7,546 ft/s)
Thrust (S.L.)	68,169 N (15,325 lbf)* <i>*Although a SuperDraco engine can reach a maximum thrust of 16,400 lbf individually, the vehicle's maximum thrust is limited to 122,600 lbf (15,325 lbf per engine) to maintain stability.</i>
Mass Flow Rate	31 kg/s (68.5 lbfm/s)
Acoustic Efficiency	0.3%

Four different test types would be conducted as part of the program, as detailed in Table 5. A maximum of thirty annual operations are expected in each year of operation, distributed between the four test types, with all operations occurring during the acoustic day between the hours of 0700 and 2200. All DragonFly operations would occur from a single pad. SpaceX is currently considering two locations for the DragonFly tests within the McGregor Test Site: the Grasshopper Pad or the DragonRider Site (see Table 1 and Figure 1).

Table 5. DragonFly Proposed Operations

	Operation Type	Description	Annual Ops
1	Propulsive Assist	Drop from helicopter from up to 10,000 ft, deploy parachutes, land with SuperDracos, engines fire for 5 seconds.	2
2	Full Propulsive Landing	Drop from helicopter from up to 10,000 ft, land only with SuperDracos, engines fire for 5 seconds.	2
3	Propulsive Assist Hopping	Take off from pad, land with parachutes, and land propulsive, engines fire for 25 seconds.	8
4	Full Propulsive Hopping	Take off from pad, hover, and land propulsive, engines fire for 25 seconds.	18
Total Operations			30

As an initial assessment, a representative test type was developed during discussions with SpaceX to account for all the basic components of the four different test types. The representative test type includes both a takeoff and landing portion, although two of the four test types include only propulsive landings. The representative test type’s corresponding trajectory includes an extended burn time and increased maximum altitude to ensure a highly conservative noise estimate (i.e. model results will be louder than expected). Figure 5 displays the representative trajectory altitude with respect to time. The propagation is calculated assuming a receiver height of five feet along with a homogeneous soft ground surface.

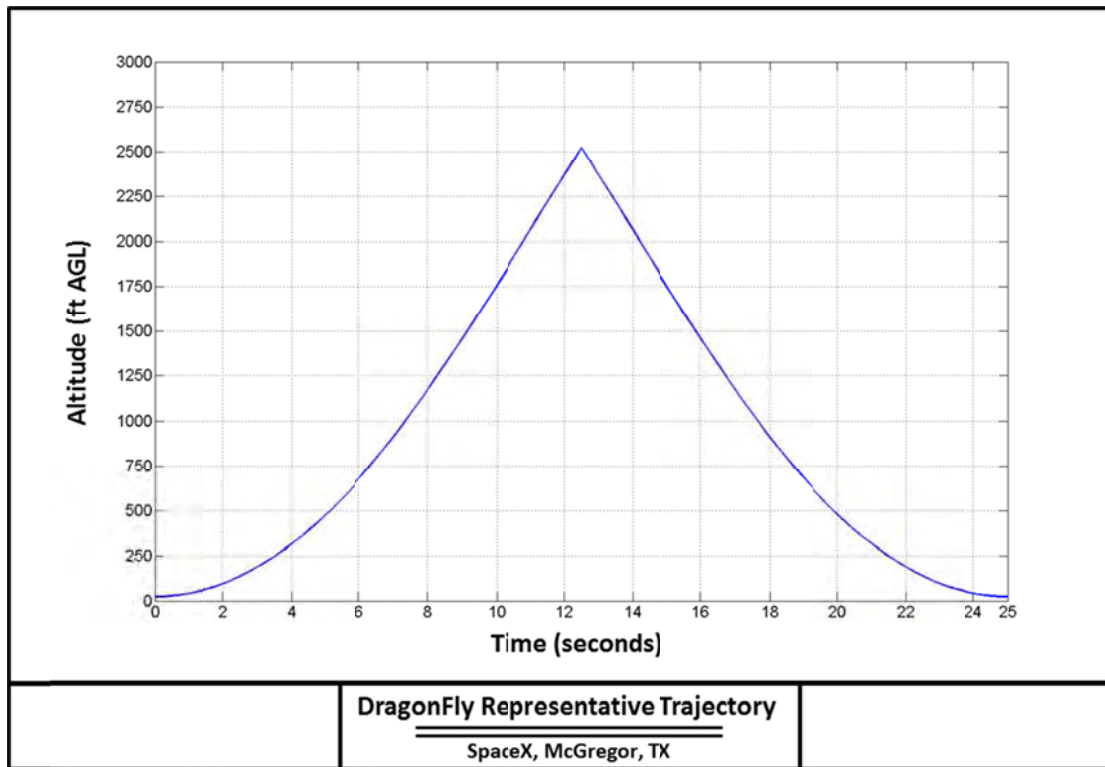


Figure 5. DragonFly Representative Trajectory

Several assumptions were made to utilize the approach outlined above:

- The SpaceX DragonFly follows a straight vertical trajectory from its pad origin;
- The DragonFly RLV's eight SuperDraco engines are modeled as a compact source with a total thrust equaling the sum of its individual thrusts ($15,325 \text{ lbf} * 8 = 122,600 \text{ lbf}$);
- Thrust is assumed constant over the duration of the event, although in practice it will be throttled down for most of the event;
- Atmospheric absorption is modeled using the daily average temperatures and relative humidity for each month (obtained from the National Weather Service Forecast Office) to determine the appropriate values to represent the nominal acoustic absorption for the given year. The appropriate values in the case of McGregor, TX are 63.5°F, 69% relative humidity and 101.325 kPa barometric pressure. These values represent the nominal acoustic absorption conditions of the atmosphere and not the average weather conditions for the area; and
- For modeling purposes, takeoff and landing portions are identical in maximum altitude and burn time. In practice, the vehicle would physically not be able to maintain maximum thrust for the burn time specified without running out of fuel. The conservative nature of these components should account for any significant differences between the two portions of the event, and result in an overestimation of the noise produced by either the takeoff or the landing.

Although there are variations between the test types, for simplicity, all 30 operations will be modeled utilizing the representative trajectory detailed above.

5 Results

Utilizing the operational parameters described in Section 4, BRRC’s rocket noise model produced the estimated DNL values for the proposed DragonFly RLV operations at the McGregor Facility. These DNL values were then combined with the baseline DNL values to generate the affected noise exposures. The Proposed Action of the DragonFly includes operations at two separate launch pads. The combination of the existing baseline operations and the proposed DragonFly operations result in the proposed action DNL contours. 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 dB difference. As such, the difference between the baseline and proposed action DNL contours is minimal, as exemplified by the total acreage of each of the contours presented in Table 6. The additional noise results in less than a 0.2% increase to the Baseline DNL contours.

Table 6. Summary of total contour acreage by scenario

Contour Level	Baseline Acres	Grasshopper Pad			Dragon Rider Site		
		Acres	+Acres	% Increase	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%

The proposed action DNL contours are shown in Figure 6 and Figure 7. The difference between the baseline and proposed action DNL contours is between less than one and fifty feet and is indiscernible from the graphics provided. It should be noted that the baseline DNL values also represent the No Action Alternative.

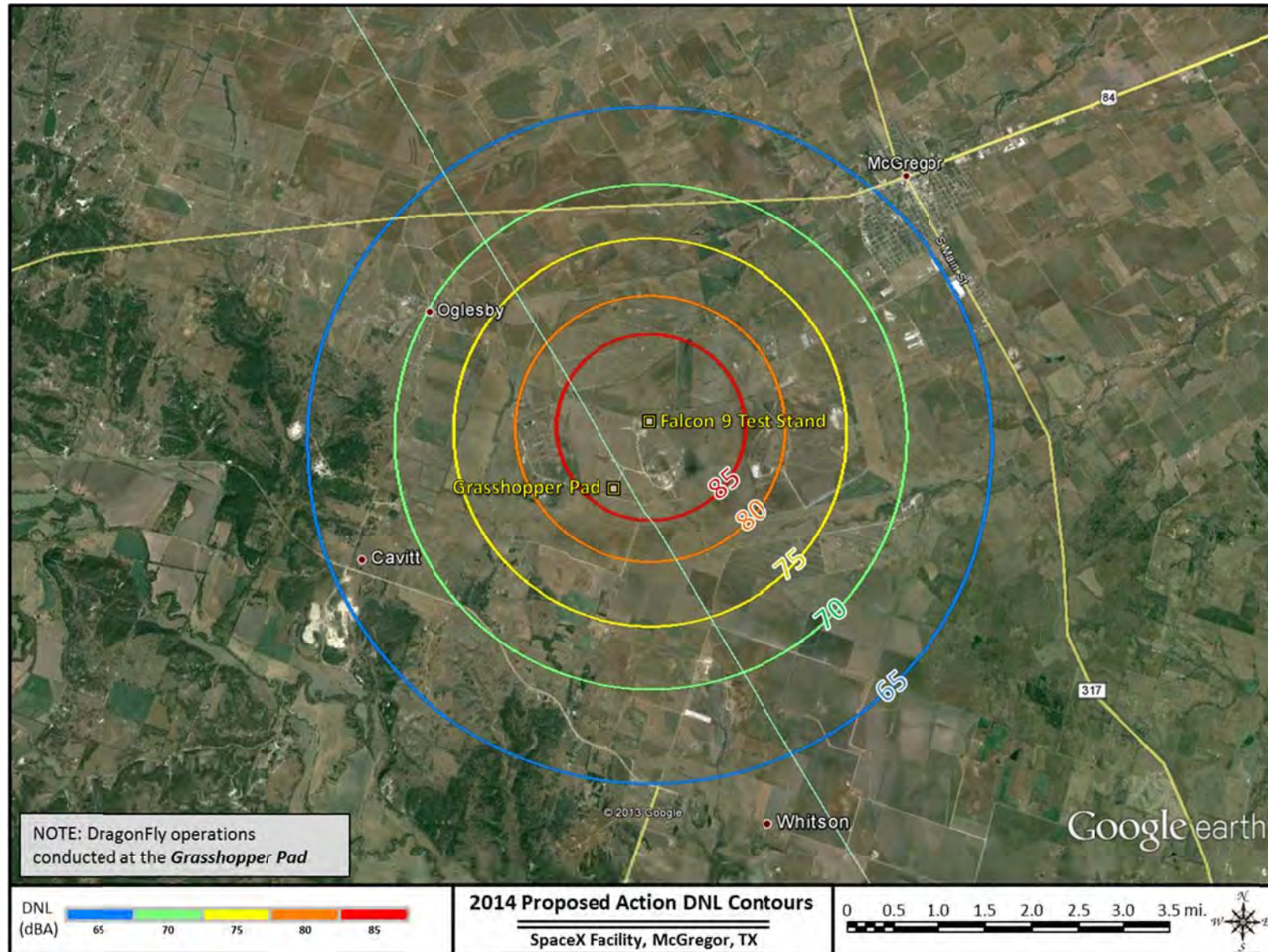


Figure 6. 2014 Combined Baseline and Proposed Action DNL Contours, with DragonFly Operating from the Grasshopper Pad

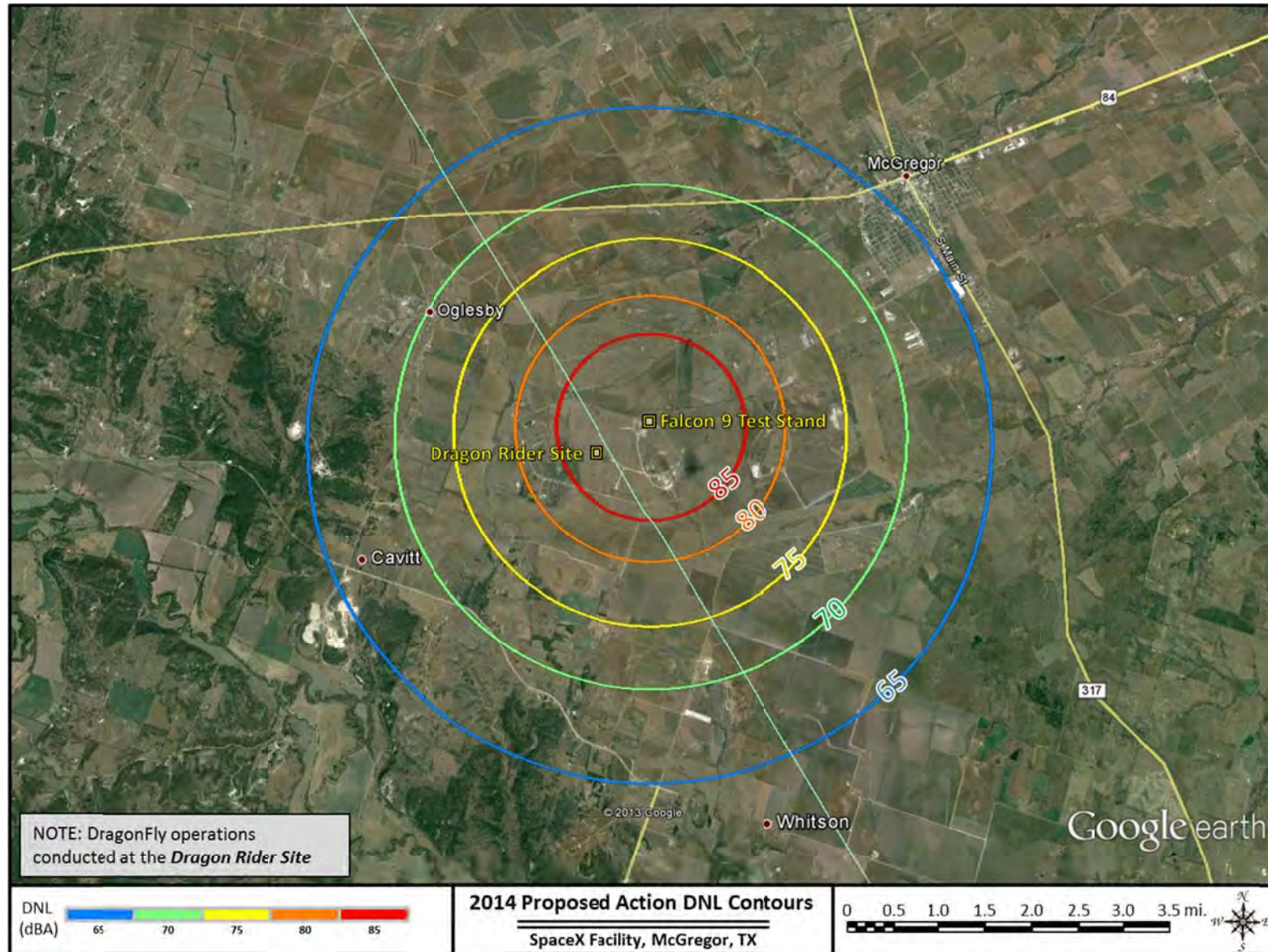


Figure 7. 2014 Combined Baseline and Proposed Action DNL Contours, with DragonFly Operating from the Dragon Rider Site

6 Summary

This noise analysis supports SpaceX in obtaining an experimental permit for the proposed DragonFly RLV operations at its McGregor test facility. The noise impact of the proposed action was evaluated based on the FAA Order 1050.1E, Change 1, *Environmental Impacts: Policies and Procedures* [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 combination of the existing baseline operations and proposed DragonFly RLV operations result in less than a tenth of a dB change to the DNL contours when compared to the No Action Alternative.

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800 Independence Ave., S.W.
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March 31, 2014

Daniel Czelusniak
Office of Commercial Space Transport
Federal Aviation Administration
800 Independence Ave. SW
Washington, DC 20591

Dear Daniel,

The Office of Environment and Energy (AEE) has reviewed the proposed non-standard noise modeling method for the launch noise associated with the Space Exploration Technologies Corp. (SpaceX) for the operation of the DragonFly reusable launch vehicle (RLV). This methodology is proposed to support the issuing of an experimental permit at the McGregor Test Site in McGregor, Texas. In order to operate the test types at the test site, an experimental permit from the Federal Aviation Administration (FAA) must be obtained. A noise analysis must be completed as part of the permit process. In accordance with FAA Order 1050.1e, all non-standard noise analysis must be approved by AEE. This letter serves as AEE's response to the proposed noise method for the SpaceX experimental permit request.

The methodology is a quantitative analysis based on the latest available methods for launch noise. The FAA does not currently have an approved model for launch vehicles and the document includes a proposed noise modeling methodology for the launch vehicle. The proposed noise modeling method is based on the best available research and understanding.

Given the proposed launch noise method is based on the best available research on vehicle launches, this approach is appropriate for the McGregor Test Site experimental permit for the DragonFly RLV. AEE concurs with the launch noise methodology used for this specific experimental permit request. Please understand that this approval is limited to this particular experimental permit request at the McGregor Test Site and the DragonFly RLV. Any additional projects using this or other launch noise methodologies or variations of the DragonFly RLV will require separate approval.

Sincerely,

Rebecca Cointin, Manager
AEE/Noise Division

Appendix B
Agency Coordination

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U.S. Department
of Transportation
**Federal Aviation
Administration**

Office of Commercial Space Transportation

800 Independence Ave., SW,
Washington, DC 20591 2014

MAR 13 2014

Mr. Mark Wolfe
State Historic Preservation Officer
Texas Historical Commission
108 W. 16th Street
Austin, TX 78701

MAR 13 2014

SUBJECT: Environmental Assessment for Issuing an Experimental Permit for Operation of the DragonFly Vehicle at McGregor Test Site, McGregor, Texas - Section 106 Consultation

Dear Mr. Wolfe:

In accordance with the National Environmental Policy Act, the Federal Aviation Administration (FAA) is preparing an Environmental Assessment (EA) to assess the potential environmental impacts of the Space Exploration Technologies Corp.'s (SpaceX's) proposal to conduct suborbital launches and landings of the DragonFly reusable launch vehicle (RLV) at the McGregor test site in McLennan and Coryell counties, Texas (see Enclosure 1).

The DragonFly RLV (Enclosure 2) is SpaceX's Dragon capsule with an integrated trunk and four steel landing legs. It has eight SuperDraco engines, propellant tanks, pressurant tanks, a parachute system, and necessary avionics. SpaceX is proposing to conduct a testing program of the DragonFly RLV to further develop the capability for the Dragon capsule to land, so that it can be reused.

Since 2003, SpaceX has leased a 650-acre portion of the McGregor test site from the City of McGregor and uses the site to test engines that are used in other SpaceX launch vehicles. Proposed testing of the DragonFly RLV would begin in 2014 and last no more than two years. A maximum of 30 annual operations (launches and landings) are proposed in each year of operation. 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.

All operations would occur from a single launch pad. SpaceX is considering two locations within the McGregor test site for the launch pad: an existing pad currently used for the Grasshopper RLV test program or the DragonRider test area (Enclosure 3). SpaceX constructed a concrete launch pad and additional support infrastructure to support its Grasshopper operations after the FAA issued an experimental permit to SpaceX to conduct suborbital launches and landings of the Grasshopper RLV at the McGregor test site in October 2012. The Grasshopper RLV test program would be completed prior to the implementation of the Proposed Action.

To conduct the DragonFly test program, SpaceX must obtain an experimental permit from the FAA. An experimental permit is valid for one year and renewable upon request. Under the Proposed Action addressed in the EA, the FAA would 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. As part of the project, SpaceX might construct a 40 foot by 40 foot launch pad in the DragonRider test area, if necessary. As the DragonFly RLV program would require up to two years to complete (2014–2015), the Proposed Action considers one new permit and one potential permit renewal.

The issuance of an experimental permit is considered a federal undertaking under the regulations of the Advisory Council for Historic Preservation (36 CFR 800.16(y)) for Section 106 of the National Historic Preservation Act. This letter initiates consultation with your office regarding the proposed undertaking. The project Area of Potential Effects (APE), identification of historic properties, and assessment of effect are outlined below.

Area of Potential Effects

In accordance with 36 CFR 800.4(a)(1), an APE needs to be established for the proposed undertaking in consultation with your office. The FAA has determined an APE in consideration of both potential direct and indirect effects to archaeological and architectural resources as a result of implementing the proposed undertaking. The proposed APE is defined as the area encompassed by the Day-Night Average Sound Level (or DNL) 65 dBA noise contour determined by the noise studies for the EA (Enclosure 4). If SpaceX chooses to build a new launch pad in the DragonRider test area, then potential effects to archaeological resources from ground-disturbing activities would be limited to this area within the APE. For architectural resources, potential effects would extend to the boundary of the APE. The FAA requests your concurrence on the determination of the APE.

Identification of Historic Properties

A review of the Texas Historic Sites Atlas, the National Register of Historic Places (NRHP) online database, and other available resources revealed that there are numerous previously inventoried archaeological resources within the APE. None of them, however, are in or near the area for the proposed launch pad.

There are no known Traditional Cultural Properties (TCPs) within the APE; however, two tribes with interests in McLennan and Coryell counties have been identified. These include the Comanche Nation of Oklahoma and the Tonkawa Tribe of Oklahoma. We are initiating consultation with these tribes. Any comments received from them will be forwarded to the THC and included in the EA.

The APE includes 14 NRHP-listed or eligible architectural resources (Enclosure 4). Eleven of these resources were part of the Naval Weapons Industrial Reserve Plant (NWIRP), which was constructed by the U.S. Navy in 1942 as a military ordnance plant and in use until 1995. Prior to the transfer of the property from the Federal government to the City of McGregor, an architectural survey of the NWIRP resulted in the identification of 14 individual resources and one historic district as eligible for inclusion in the NRHP. 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. As you are aware, the U.S. Navy, THC, City of McGregor, and Advisory Council on Historic Preservation executed a Programmatic Agreement (PA) in 1998 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. 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.

Assessment of Effect

As part of the undertaking, a new concrete launch pad might 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.

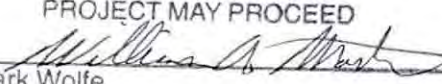
The launches and landings of the DragonFly RLV would result in a negligible increase in DNL. The additional noise associated with the proposed DragonFly operations produces less than a tenth of a dBA DNL difference. The DragonFly RLV would be visible from the historic properties in the APE during each launch, but the majority of the launch and landing operations would last only one minute. Only four of the 30 operations each year would last 30 minutes each. Operations would occur intermittently and for a short duration at a site that is currently used for suborbital launch vehicle testing and engine testing, and as such, would not alter any of the significant physical features or characteristics of any of the historic properties. The FAA requests your concurrence with the finding of no historic properties affected.

Please provide any comments you have regarding the APE, determination of eligibility, and finding of effect within 30 days. If you have any questions or need further information on the project, please contact Mr. Daniel Czelusniak, of my staff, at 202-267-5924 or at Daniel.Czelusniak@faa.gov. Thank you in advance for your input on this project.

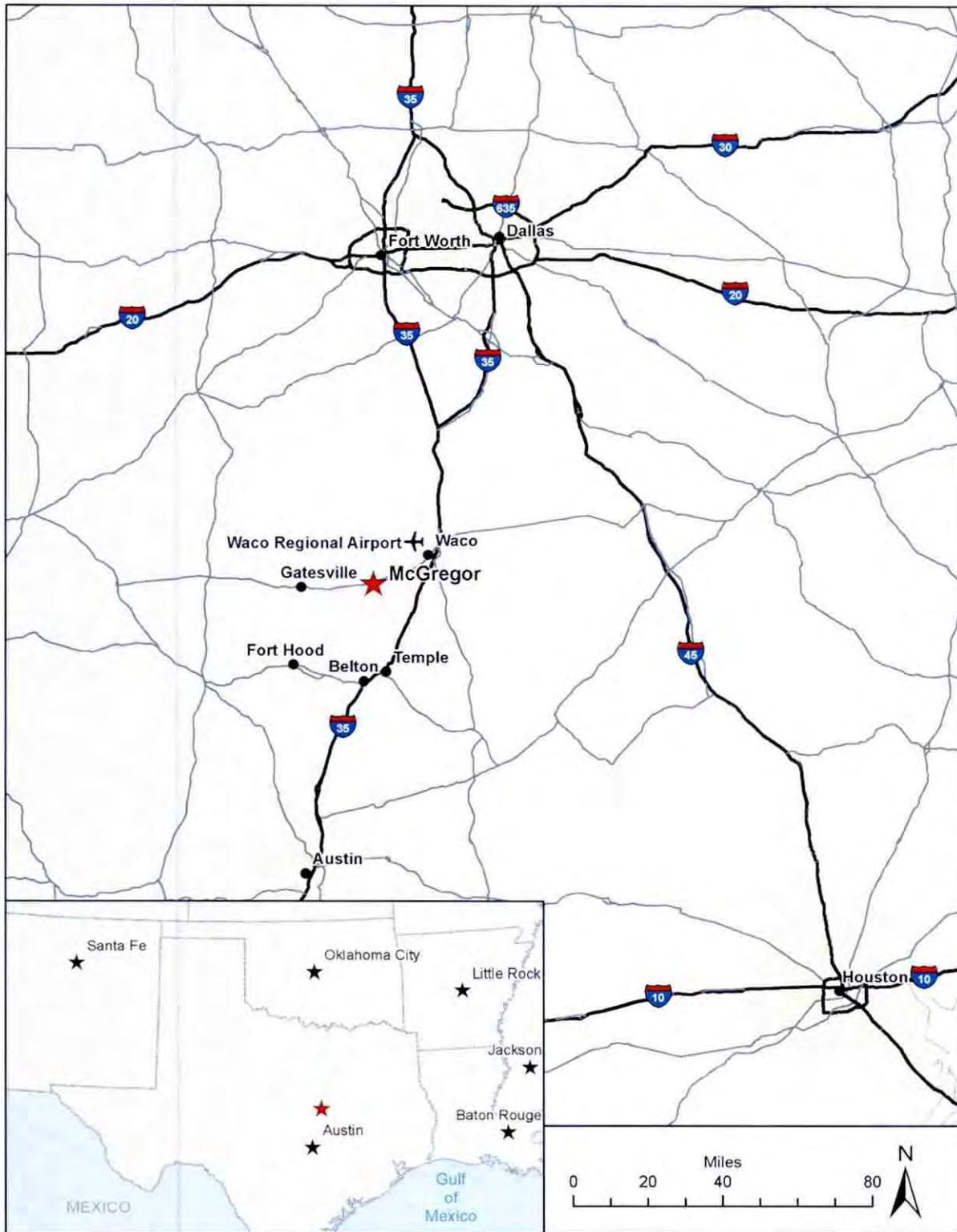
Sincerely,



Daniel Murray
Manager, Space Transportation Development Division

NO HISTORIC PROPERTIES AFFECTED PROJECT MAY PROCEED	
by	
for	Mark Wolfe
	State Historic Preservation Officer
Date	4/7/14
Track#	

- Enclosures:
1. Regional Location of Proposed Undertaking
 2. DragonFly Reusable Launch Vehicle
 3. Existing Grasshopper Launch Pad and DragonRider Test Area
 4. Area of Potential Effects for Cultural Resources



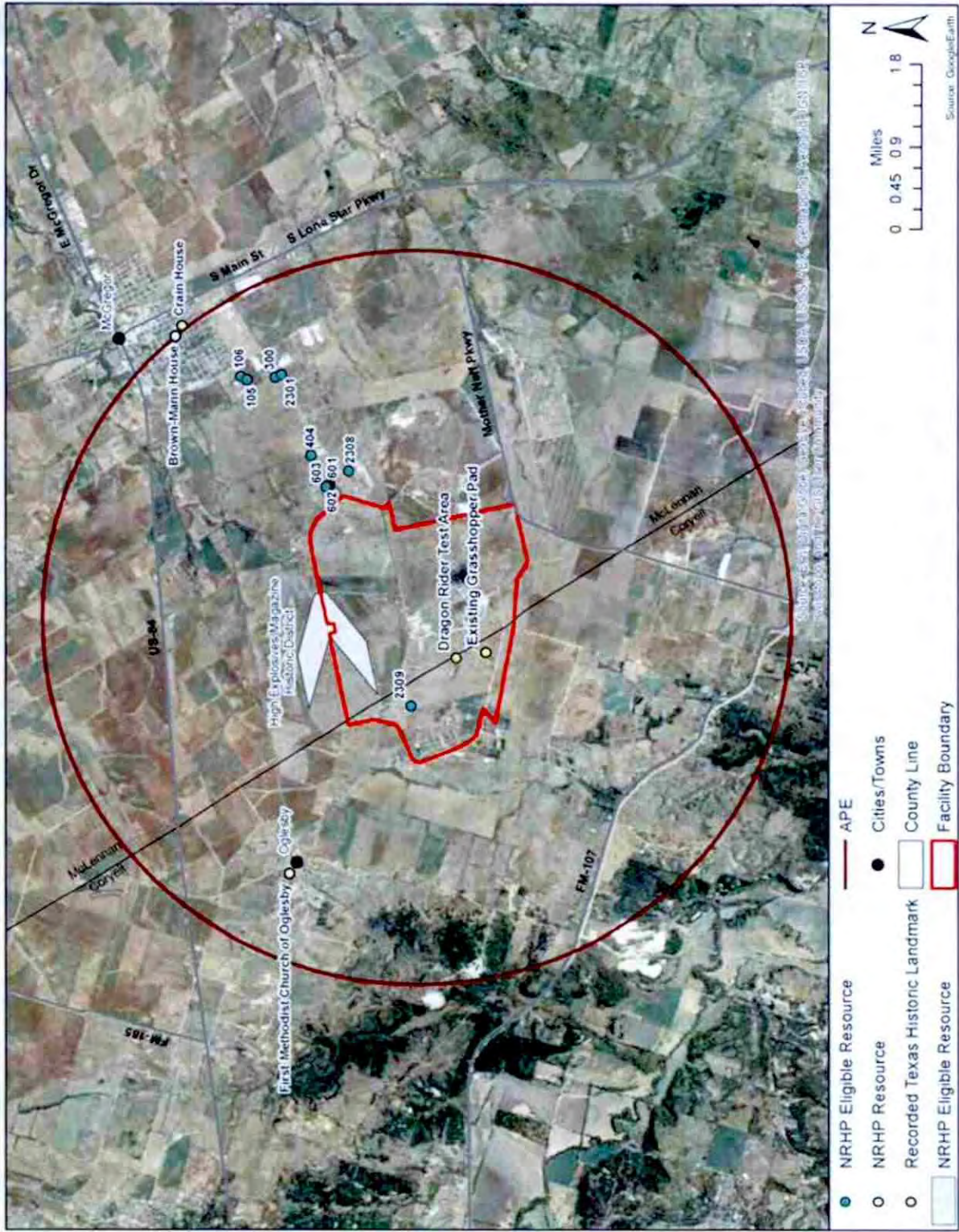
Enclosure 1. Regional Location of Proposed Undertaking



Enclosure 2. DragonFly Reusable Launch Vehicle



Enclosure 3. Existing Grasshopper Launch Pad and DragonRider Test Area



Enclosure 4. Area of Potential Effects for Cultural Resources



U.S. Department
of Transportation
**Federal Aviation
Administration**

Office of Commercial Space Transportation

800 Independence Ave., SW.
Washington, DC 20591

MAR 19 2014

Jonny Wauqua
Chairman
Comanche Nation of Oklahoma
HC-32, Box 1720
Lawton, OK 73502

SUBJECT: Environmental Assessment for Issuing an Experimental Permit for Operation of the DragonFly Vehicle at McGregor Test Site, McGregor, Texas – Section 106 Consultation

The Honorable Mr. Jonny Wauqua:

This letter initiates government-to-government consultation with the Comanche Nation of Oklahoma regarding the Space Exploration Technologies Corp.'s (SpaceX's) proposal to conduct suborbital launches and landings of the DragonFly reusable launch vehicle (RLV) at the McGregor test site in McLennan and Coryell counties, Texas (see Enclosure 1). The Federal Aviation Administration (FAA) is preparing an Environmental Assessment (EA) to assess the potential environmental impacts of this undertaking in accordance with the National Environmental Policy Act, and is respectfully requesting your comments on the proposed undertaking.

The DragonFly RLV (Enclosure 2) is SpaceX's Dragon capsule with an integrated trunk and four steel landing legs. It has eight SuperDraco engines, propellant tanks, pressurant tanks, a parachute system, and necessary avionics. SpaceX is proposing to conduct a testing program of the DragonFly RLV to further develop the capability for the Dragon capsule to land, so that it can be reused.

Since 2003, SpaceX has leased a 650-acre portion of the McGregor test site from the City of McGregor and uses the site to test engines that are used in other SpaceX launch vehicles. Proposed testing of the DragonFly RLV would begin in 2014 and last no more than two years. A maximum of 30 annual operations (launches and landings) are proposed in each year of operation. 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.

All operations would occur from a single launch pad. SpaceX is considering two locations within the McGregor test site for the launch pad: an existing pad currently used for the Grasshopper RLV test program or the DragonRider test area (Enclosure 3). SpaceX constructed a concrete launch pad and additional support infrastructure to support its Grasshopper operations after the FAA issued an experimental permit to SpaceX to conduct suborbital launches and landings of the Grasshopper RLV at the McGregor test site in October 2012. The Grasshopper RLV test program would be completed prior to the implementation of the undertaking.

To conduct the DragonFly test program, SpaceX must obtain an experimental permit from the FAA. An experimental permit is valid for one year and renewable upon request. Under the Proposed Action addressed in the EA, the FAA would 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. As part of the project, SpaceX might construct a 40 foot by 40 foot launch pad in the DragonRider test area, if necessary. As the DragonFly RLV program would require up to two years to complete (2014–2015), the Proposed Action considers one new permit and one potential permit renewal.

The issuance of an experimental permit is considered a federal undertaking under the regulations of the Advisory Council for Historic Preservation (36 CFR 800.16(y)) for Section 106 of the National Historic Preservation Act. The FAA is inviting interested parties to submit comments to assist in the identification of significant cultural resources at the McGregor test site.

The FAA has determined an Area of Potential Effects (APE) in consideration of both potential direct and indirect effects to archaeological and architectural resources as a result of implementing the Proposed Action. The proposed APE is defined as the area encompassed by the Day-Night Average Sound Level (or DNL) 65 dBA noise contour determined during the noise studies for the EA (Enclosure 3). If SpaceX chooses to build a new launch pad in the DragonRider test area, then potential effects to archaeological resources from ground-disturbing activities would be limited to this area within the APE. For architectural resources, potential effects would extend to the boundary of the APE.

There are several previously recorded archaeological sites within the APE; however, none of them are located in or near the DragonRider test area.

The APE includes 14 architectural resources that are listed or determined eligible for listing in the National Register of Historic Places (NRHP) (Enclosure 3). Eleven of these properties are associated with the former World War II-era Naval Weapons Industrial Reserve Plant. The McGregor test site is a portion of the larger (approximately 9,700 acres) military ordnance plant built by the U.S. Navy in 1942, and in use until 1995. One property, the Brown-Mann House in the city of McGregor, is listed in the NRHP for its architectural significance. The remaining two properties in the APE, the Crain House in McGregor and the First Methodist Church of Oglesby, have been designated Recorded Texas Historic Landmarks for their historical and architectural significance and architectural integrity.

The launches and landings of the DragonFly RLV would result in a negligible increase in DNL. The additional noise associated with the proposed DragonFly operations produces less than a tenth of a dBA DNL difference. The DragonFly RLV would be visible from the historic district 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, the FAA finds that the undertaking would have no effects to historic properties.

The FAA is interested in determining any concerns that you may have regarding cultural resources issues related to the proposed undertaking, including the presence of archaeological sites, traditional cultural properties, sacred sites, graves, tribal resources, or any other matters of cultural importance to your tribe that may be affected by the proposed operations. All comments and concerns expressed to the FAA will

be taken into consideration during the analysis for this undertaking. We appreciate any input on this project.

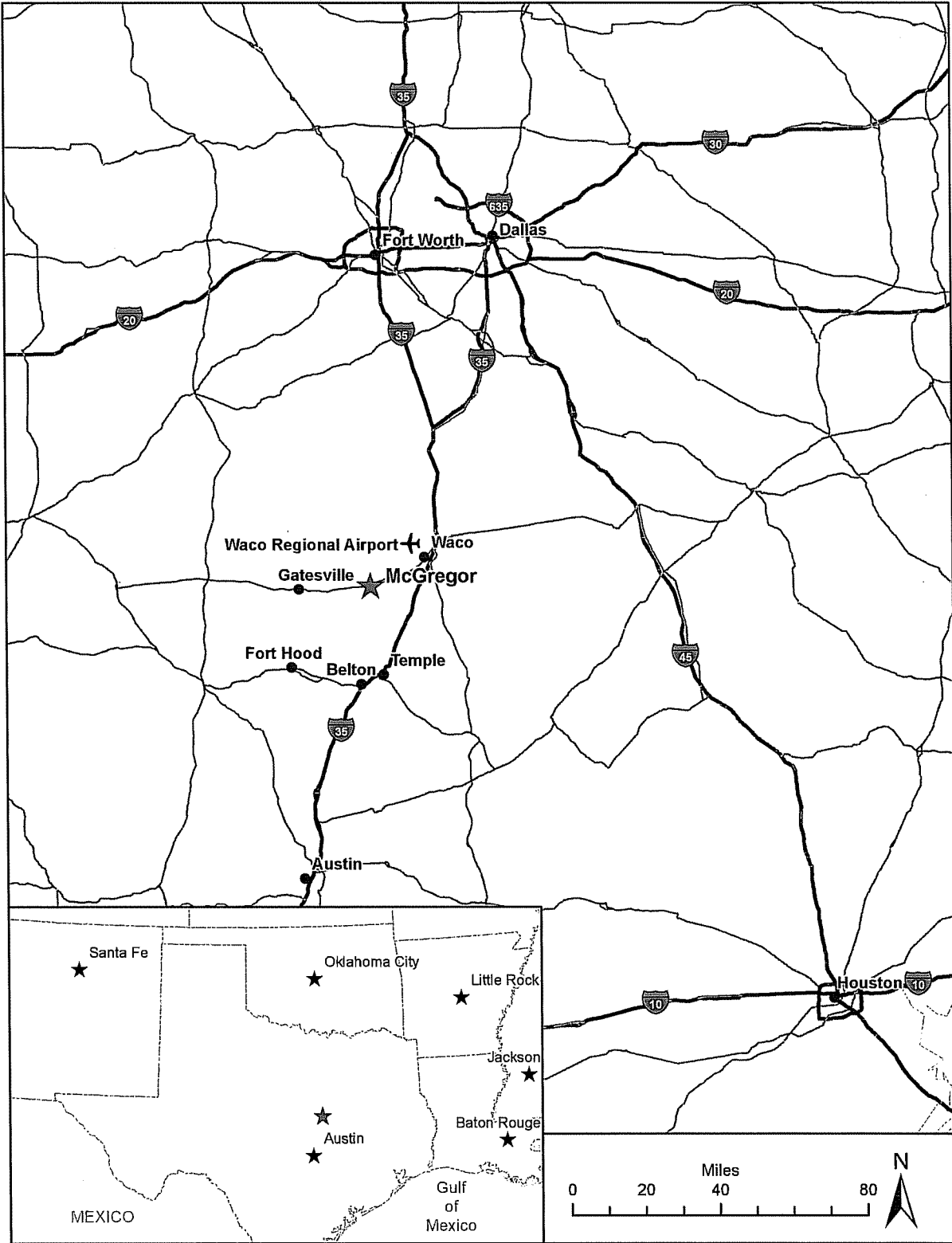
The FAA requests that you provide any comments you have regarding the proposed undertaking or finding of no historic properties affected within 30 days. Should no comments on the undertaking be received within the next 30 days, the FAA will proceed with a finding of no historic properties affected. If you have any questions or need further information on the project, please contact Mr. Daniel Czelusniak, of my staff, at 202-267-5924 or at Daniel.Czelusniak@faa.gov. Thank you in advance for your input on this project.

Sincerely,

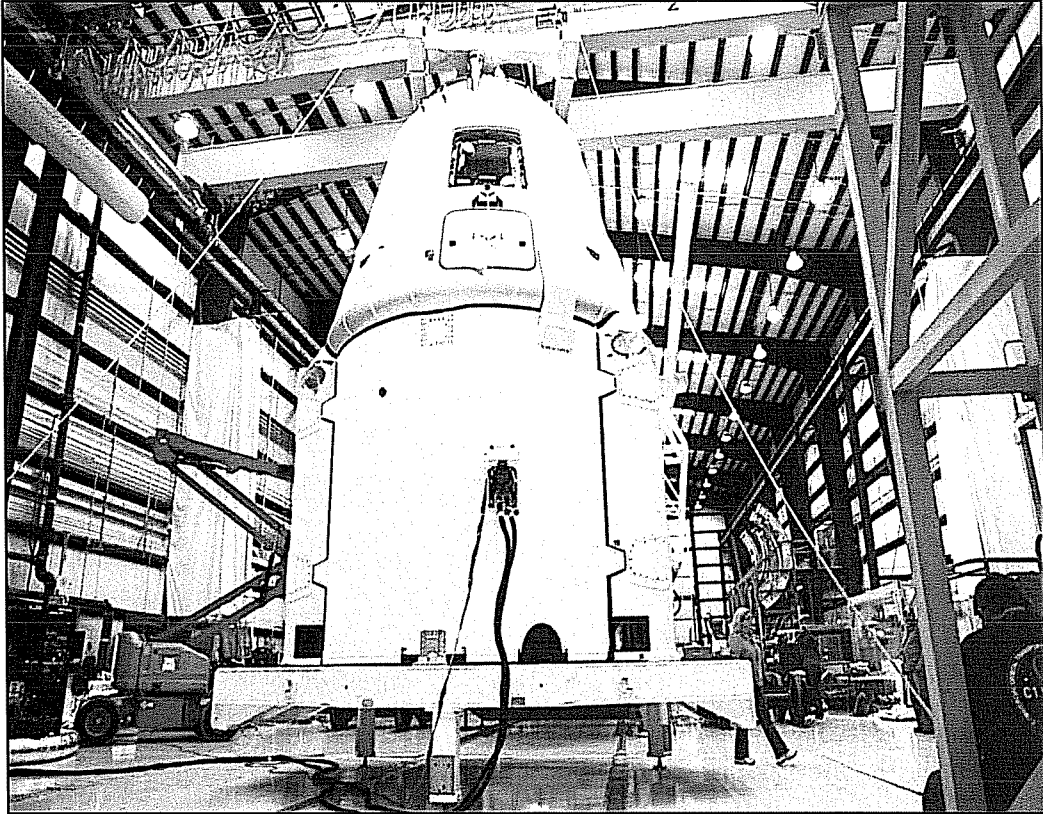
A handwritten signature in black ink, appearing to read "Daniel Murray". The signature is fluid and cursive, with the first name "Daniel" and last name "Murray" clearly distinguishable.

Daniel Murray
Manager, Space Transportation Development Division

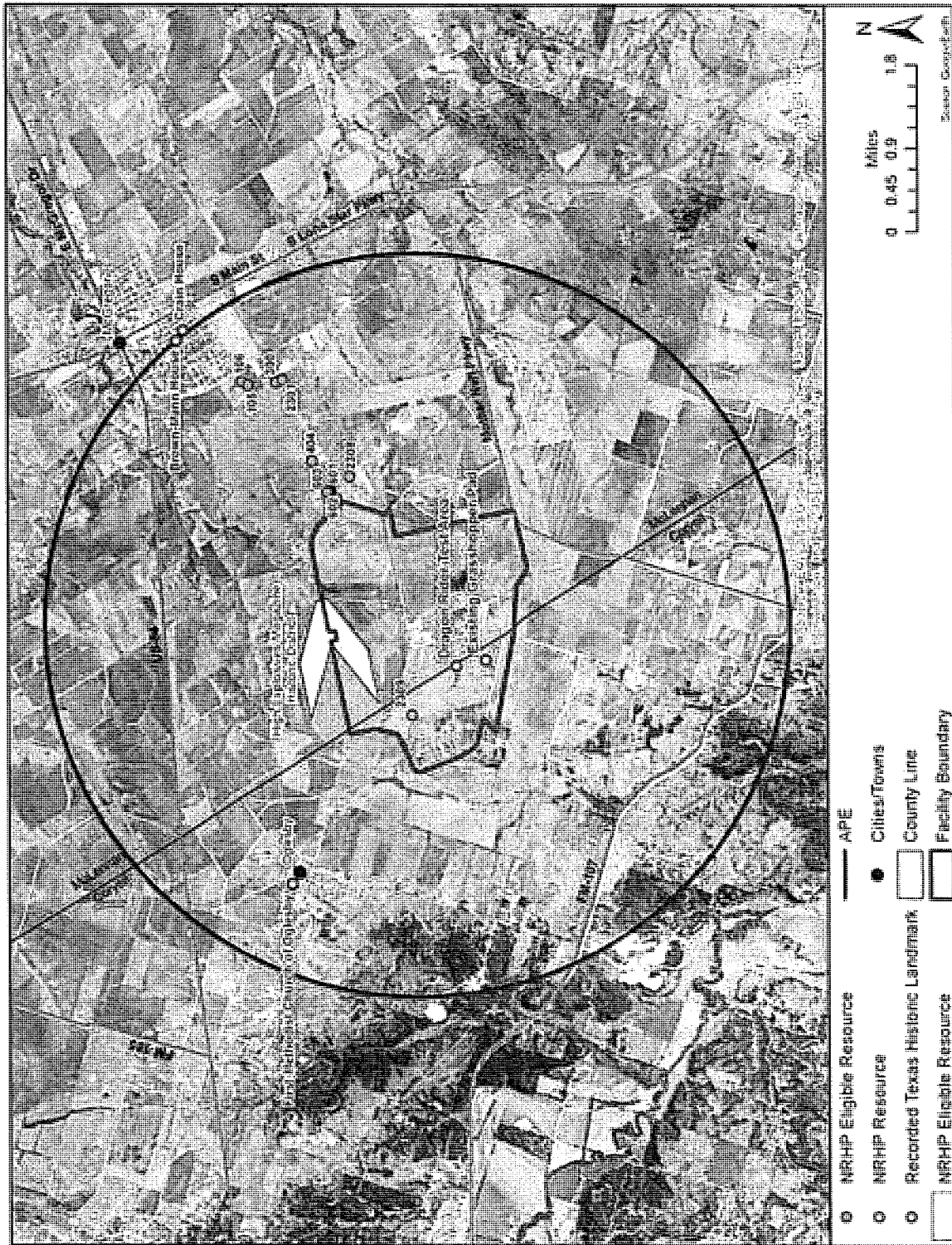
- Enclosures:
1. Regional Location of Proposed Undertaking
 2. DragonFly Reusable Launch Vehicle
 3. Existing Grasshopper Launch Pad and DragonRider Test Area
 4. Area of Potential Effects for Cultural Resources



Enclosure 1. Regional Location of Proposed Undertaking



Enclosure 2. DragonFly Reusable Launch Vehicle



Enclosure 4. Area of Potential Effects for Cultural Resources



U.S. Department
of Transportation
**Federal Aviation
Administration**

Office of Commercial Space Transportation

800 Independence Ave., SW.
Washington, DC 20591

MAR 13 2014

Miranda Allen
Executive, Museum and NAGPRA Assistant
Tonkawa Tribe of Oklahoma
1 Rush Buffalo Road
Tonkawa, OK 74653

SUBJECT: Environmental Assessment for Issuing an Experimental Permit for Operation of the DragonFly Vehicle at McGregor Test Site, McGregor, Texas – Section 106 Consultation

Dear Ms. Allen:

This letter initiates government-to-government consultation with the Tonkawa Tribe of Oklahoma regarding the Space Exploration Technologies Corp.'s (SpaceX's) proposal to conduct suborbital launches and landings of the DragonFly reusable launch vehicle (RLV) at the McGregor test site in McLennan and Coryell counties, Texas (see Enclosure 1). The Federal Aviation Administration (FAA) is preparing an Environmental Assessment (EA) to assess the potential environmental impacts of this undertaking in accordance with the National Environmental Policy Act, and is respectfully requesting your comments on the proposed undertaking.

The DragonFly RLV (Enclosure 2) is SpaceX's Dragon capsule with an integrated trunk and four steel landing legs. It has eight SuperDraco engines, propellant tanks, pressurant tanks, a parachute system, and necessary avionics. SpaceX is proposing to conduct a testing program of the DragonFly RLV to further develop the capability for the Dragon capsule to land, so that it can be reused.

Since 2003, SpaceX has leased a 650-acre portion of the McGregor test site from the City of McGregor and uses the site to test engines that are used in other SpaceX launch vehicles. Proposed testing of the DragonFly RLV would begin in 2014 and last no more than two years. A maximum of 30 annual operations (launches and landings) are proposed in each year of operation. 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.

All operations would occur from a single launch pad. SpaceX is considering two locations within the McGregor test site for the launch pad: an existing pad currently used for the Grasshopper RLV test program or the DragonRider test area (Enclosure 3). SpaceX constructed a concrete launch pad and additional support infrastructure to support its Grasshopper operations after the FAA issued an experimental permit to SpaceX to conduct suborbital launches and landings of the Grasshopper RLV at the McGregor test site in October 2012. The Grasshopper RLV test program would be completed prior to the implementation of the undertaking.

To conduct the DragonFly test program, SpaceX must obtain an experimental permit from the FAA. An experimental permit is valid for one year and renewable upon request. Under the Proposed Action addressed in the EA, the FAA would 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. As part of the project, SpaceX might construct a 40 foot by 40 foot launch pad in the DragonRider test area, if necessary. As the DragonFly RLV program would require up to two years to complete (2014–2015), the Proposed Action considers one new permit and one potential permit renewal.

The issuance of an experimental permit is considered a federal undertaking under the regulations of the Advisory Council for Historic Preservation (36 CFR 800.16(y)) for Section 106 of the National Historic Preservation Act. The FAA is inviting interested parties to submit comments to assist in the identification of significant cultural resources at the McGregor test site.

The FAA has determined an Area of Potential Effects (APE) in consideration of both potential direct and indirect effects to archaeological and architectural resources as a result of implementing the Proposed Action. The proposed APE is defined as the area encompassed by the Day-Night Average Sound Level (or DNL) 65 dBA noise contour determined during the noise studies for the EA (Enclosure 3). If SpaceX chooses to build a new launch pad in the DragonRider test area, then potential effects to archaeological resources from ground-disturbing activities would be limited to this area within the APE. For architectural resources, potential effects would extend to the boundary of the APE.

There are several previously recorded archaeological sites within the APE; however, none of them are located in or near the DragonRider test area.

The APE includes 14 architectural resources that are listed or determined eligible for listing in the National Register of Historic Places (NRHP) (Enclosure 3). Eleven of these properties are associated with the former World War II-era Naval Weapons Industrial Reserve Plant. The McGregor test site is a portion of the larger (approximately 9,700 acres) military ordnance plant built by the U.S. Navy in 1942, and in use until 1995. One property, the Brown-Mann House in the city of McGregor, is listed in the NRHP for its architectural significance. The remaining two properties in the APE, the Crain House in McGregor and the First Methodist Church of Oglesby, have been designated Recorded Texas Historic Landmarks for their historical and architectural significance and architectural integrity.

The launches and landings of the DragonFly RLV would result in a negligible increase in DNL. The additional noise associated with the proposed DragonFly operations produces less than a tenth of a dBA DNL difference. The DragonFly RLV would be visible from the historic district 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, the FAA finds that the undertaking would have no effects to historic properties.

The FAA is interested in determining any concerns that you may have regarding cultural resources issues related to the proposed undertaking, including the presence of archaeological sites, traditional cultural properties, sacred sites, graves, tribal resources, or any other matters of cultural importance to your tribe that may be affected by the proposed operations. All comments and concerns expressed to the FAA will

be taken into consideration during the analysis for this undertaking. We appreciate any input on this project.

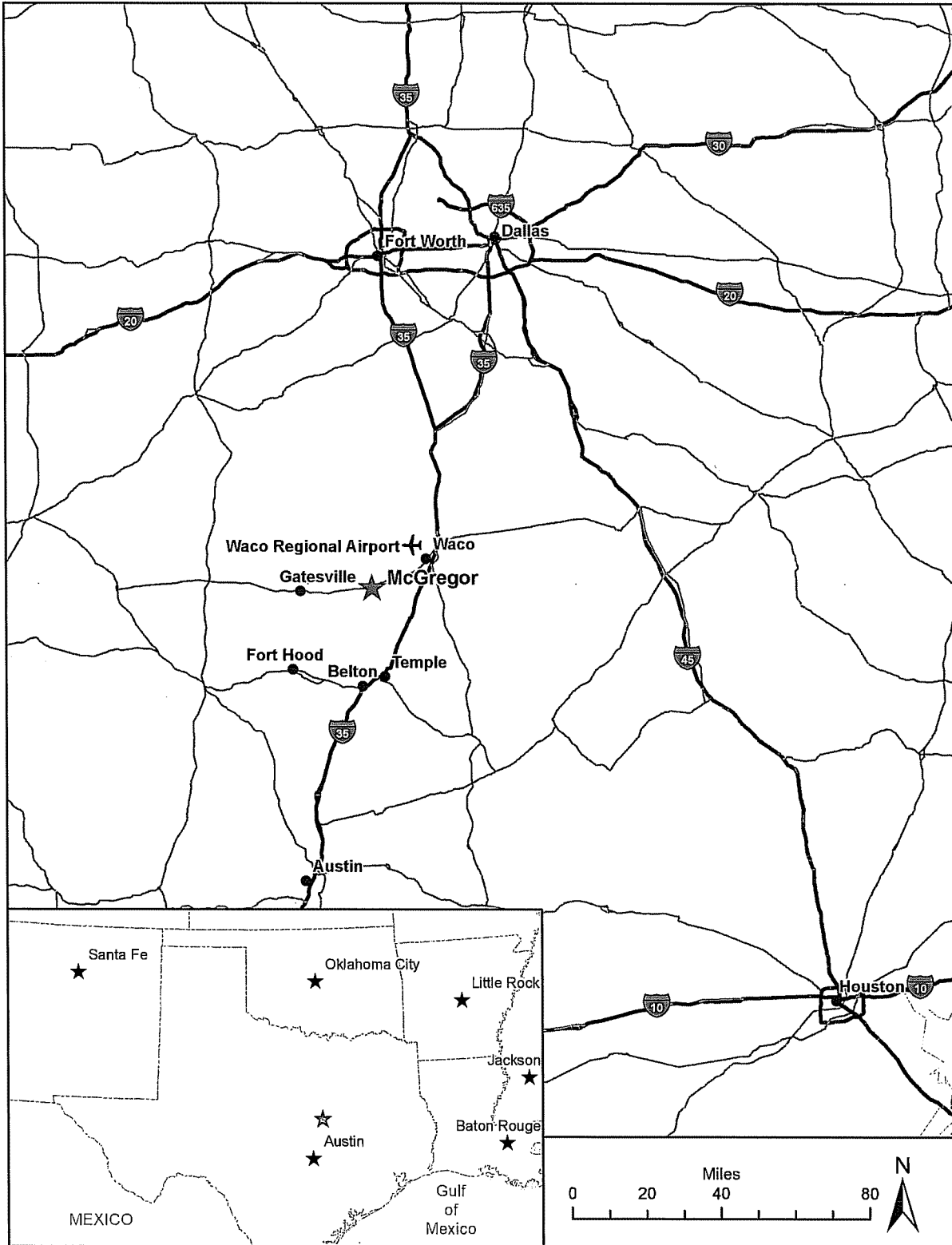
The FAA requests that you provide any comments you have regarding the proposed undertaking or finding of no historic properties affected within 30 days. Should no comments on the undertaking be received within the next 30 days, the FAA will proceed with a finding of no historic properties affected. If you have any questions or need further information on the project, please contact Mr. Daniel Czelusniak, of my staff, at 202-267-5924 or at Daniel.Czelusniak@faa.gov. Thank you in advance for your input on this project.

Sincerely,

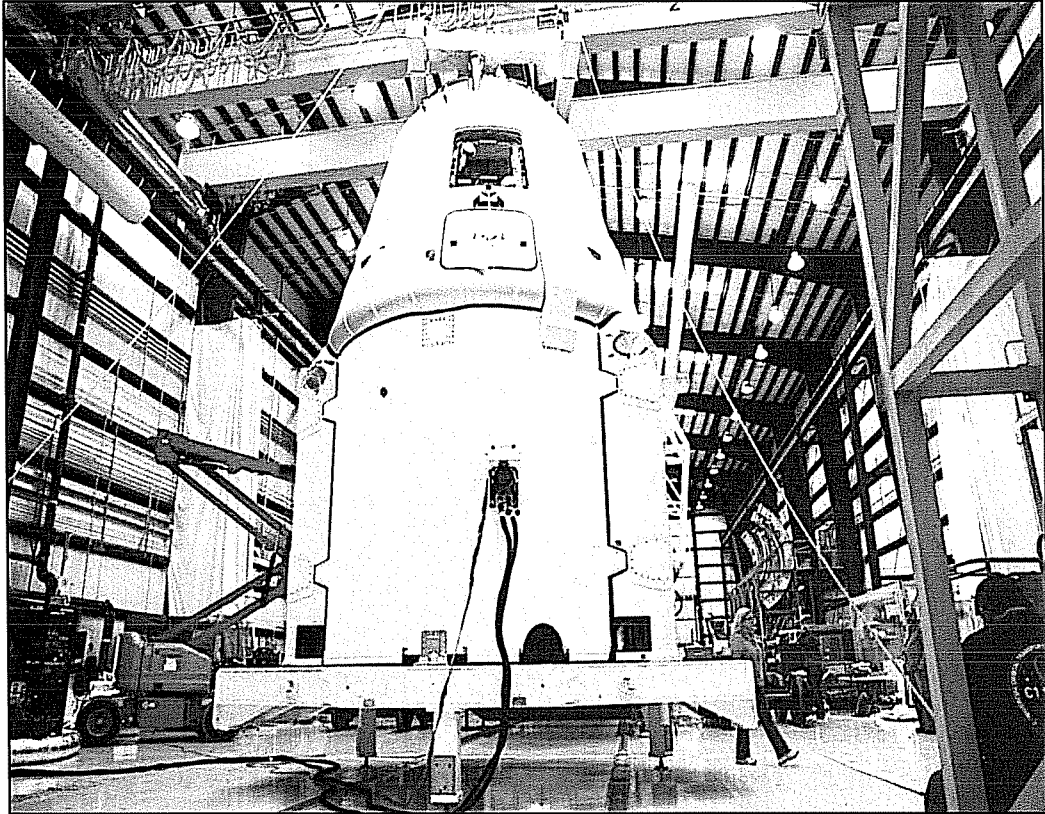


Daniel Murray
Manager, Space Transportation Development Division

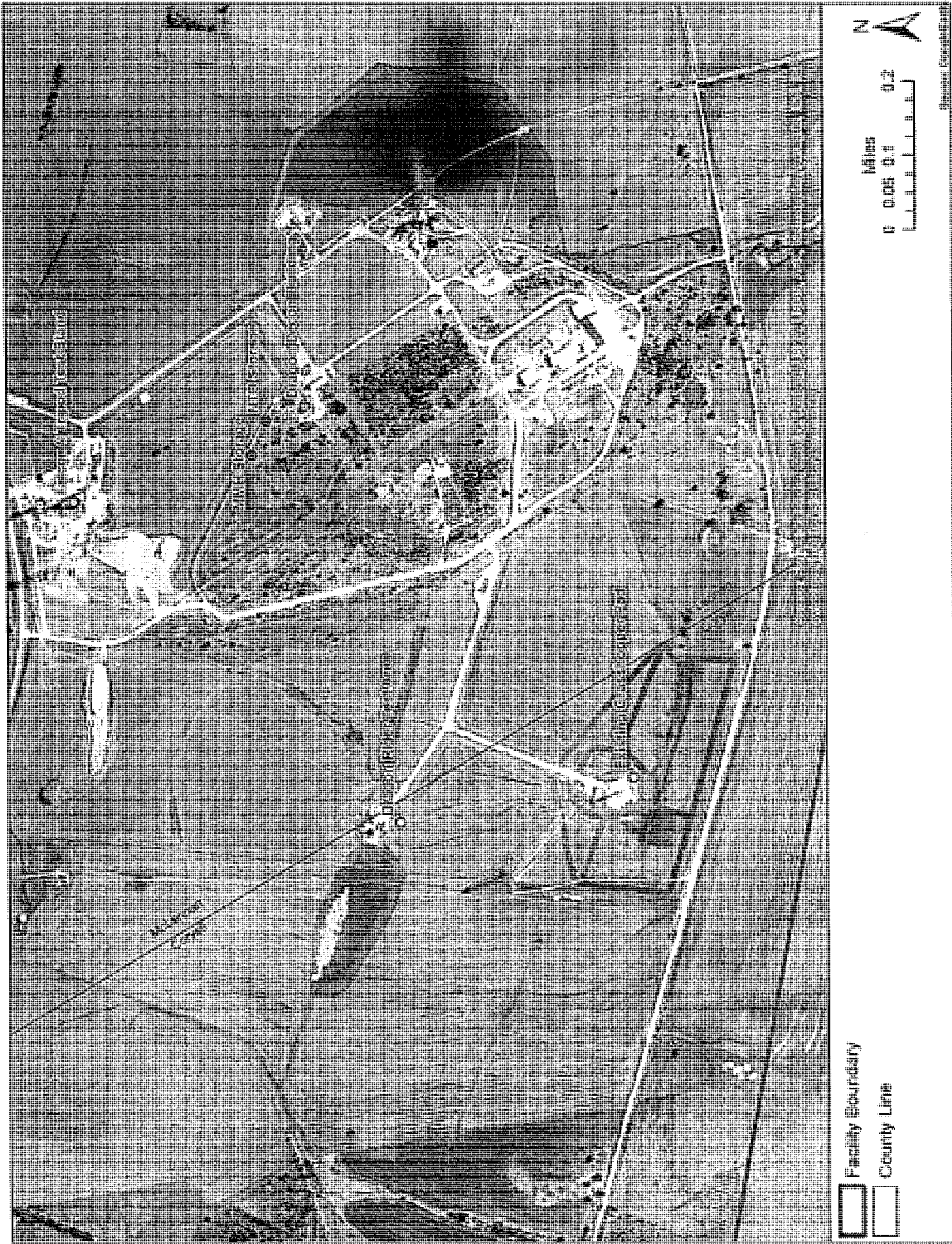
- Enclosures:
1. Regional Location of Proposed Undertaking
 2. DragonFly Reusable Launch Vehicle
 3. Existing Grasshopper Launch Pad and DragonRider Test Area
 4. Area of Potential Effects for Cultural Resources



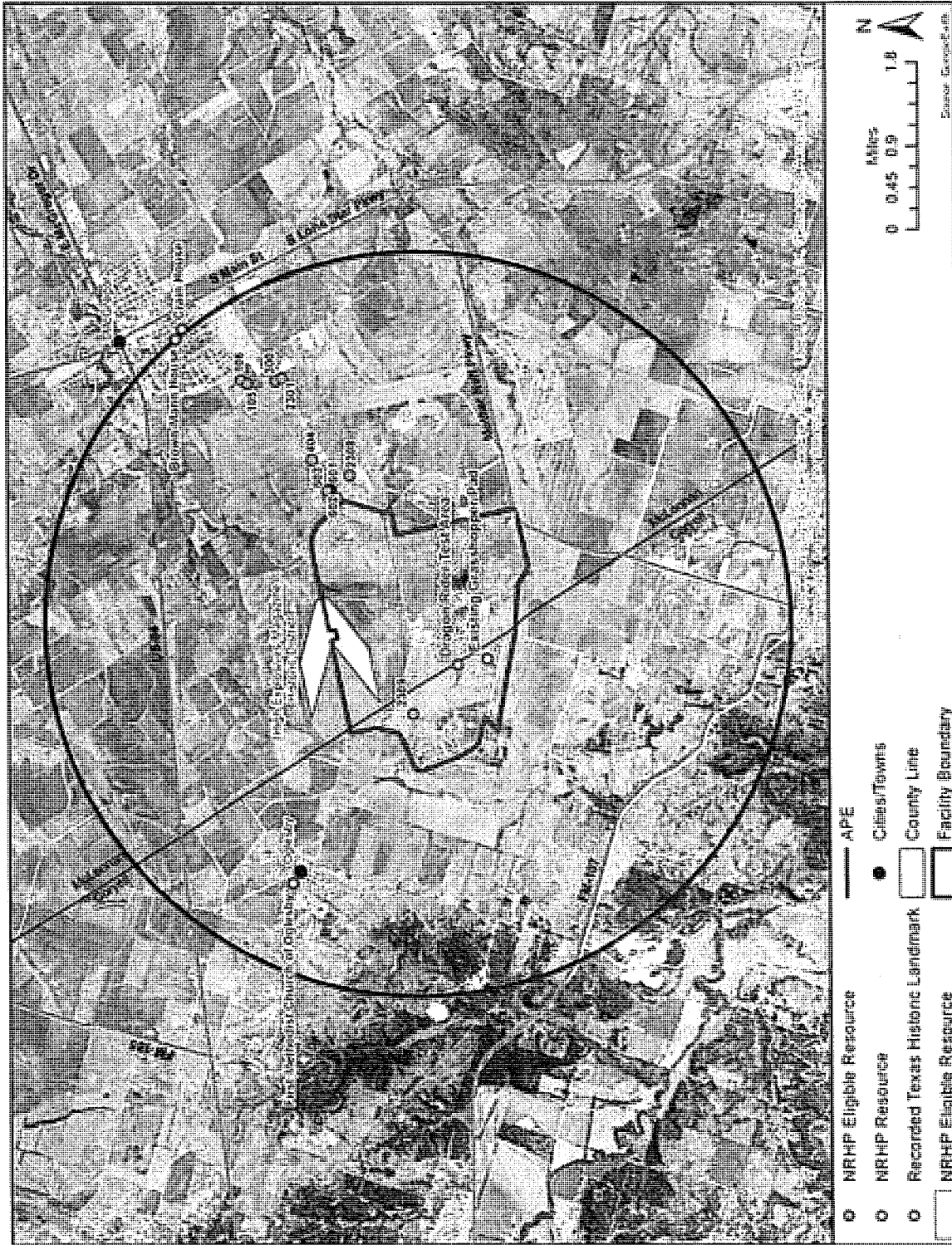
Enclosure 1. Regional Location of Proposed Undertaking



Enclosure 2. DragonFly Reusable Launch Vehicle



Enclosure 3. Existing Grasshopper Launch Pad and DragonRider Test Area



Enclosure 4. Area of Potential Effects for Cultural Resources



U.S. Department
of Transportation
**Federal Aviation
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Office of Commercial Space Transportation

800 Independence Ave., SW.
Washington, DC 20591

MAR 13 2014

Julie Wicker
Habitat Assessment Biologist
Texas Parks and Wildlife Department
Wildlife Division, Wildlife Habitat Assessment Program
4200 Smith School Road
Austin, Texas 78744

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

Dear Ms Wicker:

In accordance with the National Environmental Policy Act (NEPA), the Federal Aviation Administration (FAA) is preparing an Environmental Assessment (EA) to assess the potential environmental impacts of the Space Exploration Technologies Corp.'s (SpaceX's) proposal to conduct suborbital launches and landings of the DragonFly reusable launch vehicle (RLV) at the McGregor test site in McLennan and Coryell counties, Texas (see Enclosure 1). The DragonFly RLV (Enclosure 2) is SpaceX's Dragon capsule with an integrated trunk and four steel landing legs. It has eight SuperDraco engines, propellant tanks, pressurant tanks, a parachute system, and necessary avionics. SpaceX is proposing to conduct a testing program of the DragonFly RLV to further develop the capability for the Dragon capsule to land, so that it can be reused.

Since 2003, SpaceX has leased a 650-acre portion of the McGregor test site from the City of McGregor and uses the site to test engines that are used in other SpaceX launch vehicles. Proposed testing of the DragonFly RLV would begin in 2014 and last no more than two years. A maximum of 30 annual operations (launches and landings) are proposed in each year of operation. 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. All operations would occur from a single launch pad. SpaceX is considering two locations within the McGregor test site for the launch pad: an existing launch pad currently used for the Grasshopper RLV test program or the DragonRider test area (Enclosure 3). SpaceX constructed a concrete launch pad and additional support infrastructure to support its Grasshopper RLV operations after the FAA issued an experimental permit to SpaceX to conduct suborbital launches and landings of the Grasshopper RLV at the McGregor test site in October 2012. The Grasshopper RLV test program would be completed prior to the implementation of the Proposed Action.

To conduct the DragonFly test program, SpaceX must obtain an experimental permit from the FAA. An experimental permit is valid for one year and renewable upon request. Under the Proposed Action addressed in the EA, the FAA would 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.

As part of the project, SpaceX might construct a 40 foot by 40 foot launch pad in the DragonRider test area, if necessary. As the DragonFly RLV program would require up to two years to complete (2014–2015), the Proposed Action considers one new permit and one potential permit renewal.

Pursuant to NEPA, we are reviewing information regarding state-listed threatened and endangered species that may be present in the project area. The project area for wildlife and special-status species includes the McGregor test site and the surrounding area in McLennan and Coryell counties that may experience potential noise impacts from construction and operations. We have prepared a list of state-listed species we plan to include in our NEPA analysis (Table 1). The list is based on Texas Parks and Wildlife Department’s (TPWD) most current threatened and endangered species list for McLennan and Coryell Counties. Table 1 also includes species listed under the federal Endangered Species Act.

Table 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>)	T	- ¹
Black-capped vireo (<i>Vireo atricapilla</i>)	E ²	E
Wood stork (<i>Mycteria americana</i>)	T ³	-
White-faced ibis (<i>Plegadis chihi</i>)	T ³	-
Interior least tern (<i>Sterna antillarum athalassos</i>)	E ³	-
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 Rare, Threatened, Endangered Species of Texas: McLennan and Coryell Counties (http://www.tpwd.state.tx.us/gis/ris/es/ES_Reports.aspx?county=McLennan; http://www.tpwd.state.tx.us/gis/ris/es/ES_Reports.aspx?county=Coryell; Last updated: January 22, 2014). USFWS Ecological Services, Southwest Region: Species Lists (http://www.fws.gov/southwest/es/ES_ListSpecies.cfm; Last updated: January 21, 2014).

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.

²Listed only in Coryell County.

³Listed only in McLennan County.

Previous coordination with the TPWD for the Grasshopper RLV project in 2011 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. Four small ponds are located on the McGregor test site that may provide suitable stopover habitat. In response to TPWD recommendations, SpaceX developed a whooping crane monitoring plan to be implemented when operations are conducted during the fall and spring migration periods. Similarly, as appropriate, whooping crane monitoring would also be conducted for the Proposed Action. Whooping cranes have not been observed at the designated monitoring sites. There is minimal, if any, suitable habitat at the McGregor test site for the other species listed in Table 1.

Under the Proposed Action, a new concrete launch pad might be constructed approximately 0.32 mile north of the Grasshopper launch pad at the DragonRider test area (Enclosure 3). None of the species listed in Table 1 are known to be present in this area. Therefore, there would be no effects to listed species from construction under the Proposed Action.

The launches and landings of the DragonFly RLV would result in a negligible increase in DNL. The additional noise associated with the proposed DragonFly operations produces less than a tenth of a dBA DNL difference. The DragonFly RLV would be visible in the surrounding area during each launch, but the majority of the launch and landing operations would last only one minute. 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 that is currently used for suborbital launch vehicle testing and engine testing. As such, launch operations would have no effect to listed species. If whooping cranes were observed prior to launch operations, SpaceX would cease activity and notify the FAA. The FAA then would consult the U.S. Fish and Wildlife Service.

Please identify concerns, if any, you may have regarding the proposed project or list of species presented in Table 1. If you have any questions or need further information on the project, please contact Mr. Daniel Czelusniak, of my staff, at 202-267-5924 or at Daniel.Czelusniak@faa.gov. Thank you in advance for your input on this project.

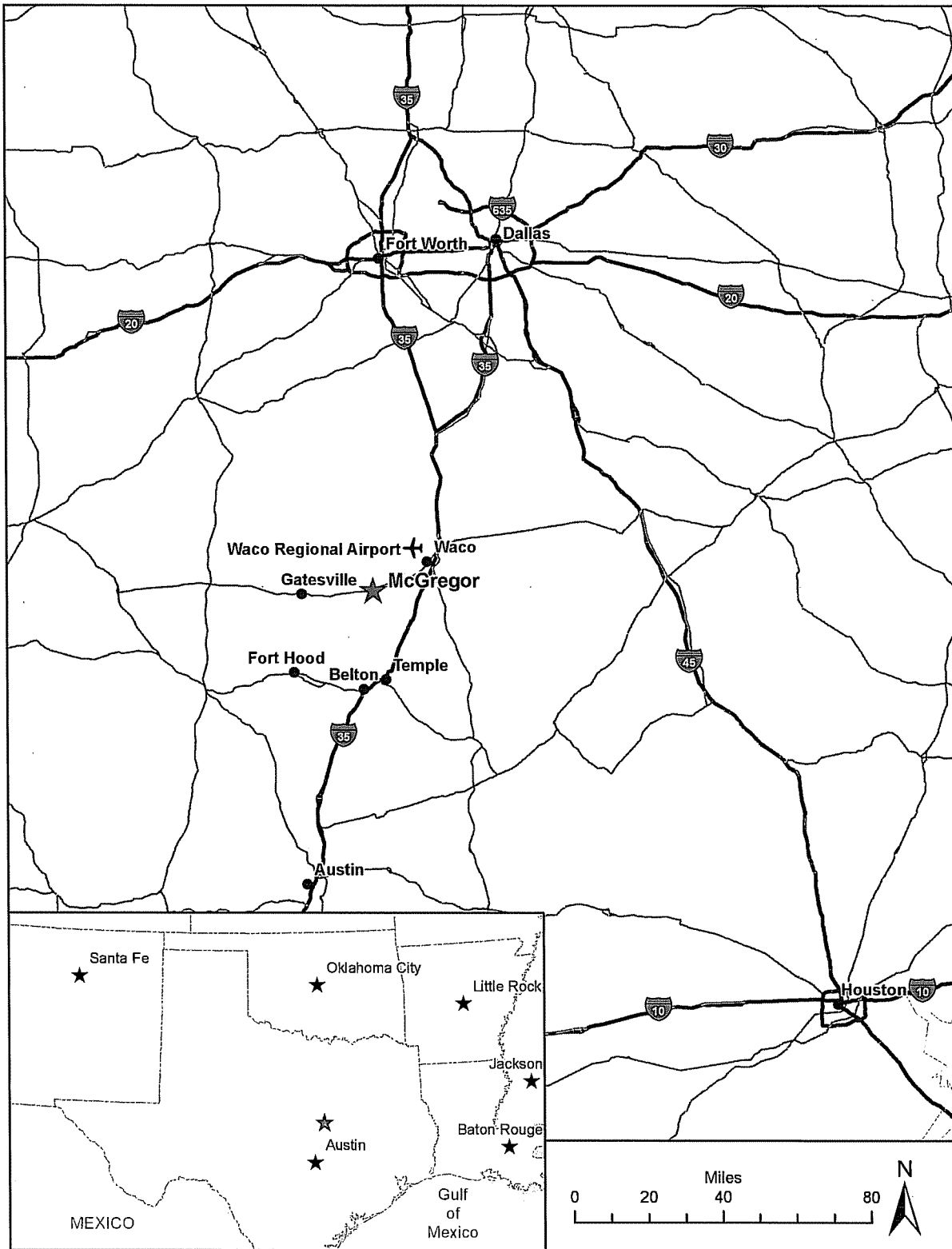
Sincerely,



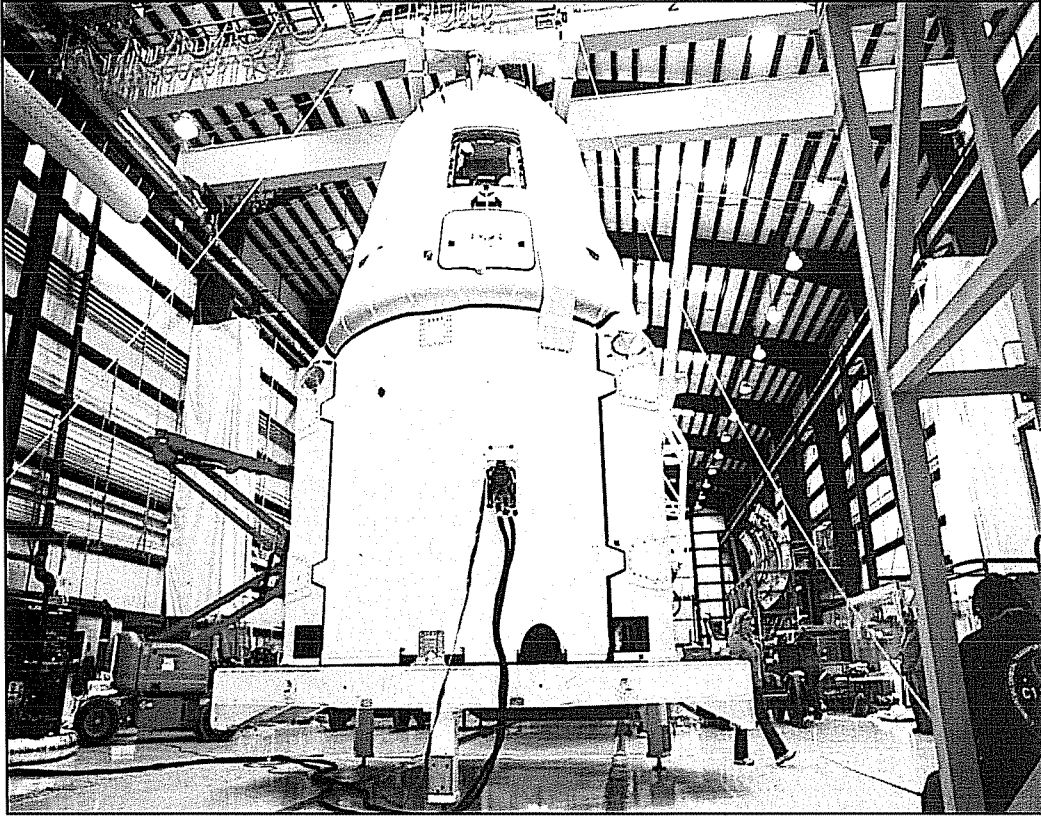
Daniel Murray
Manager, Space Transportation Development Division

Enclosures: 1. Regional Location of McGregor, Texas
2. DragonFly Reusable Launch Vehicle
3. Existing Grasshopper Launch Pad and DragonRider Test Area

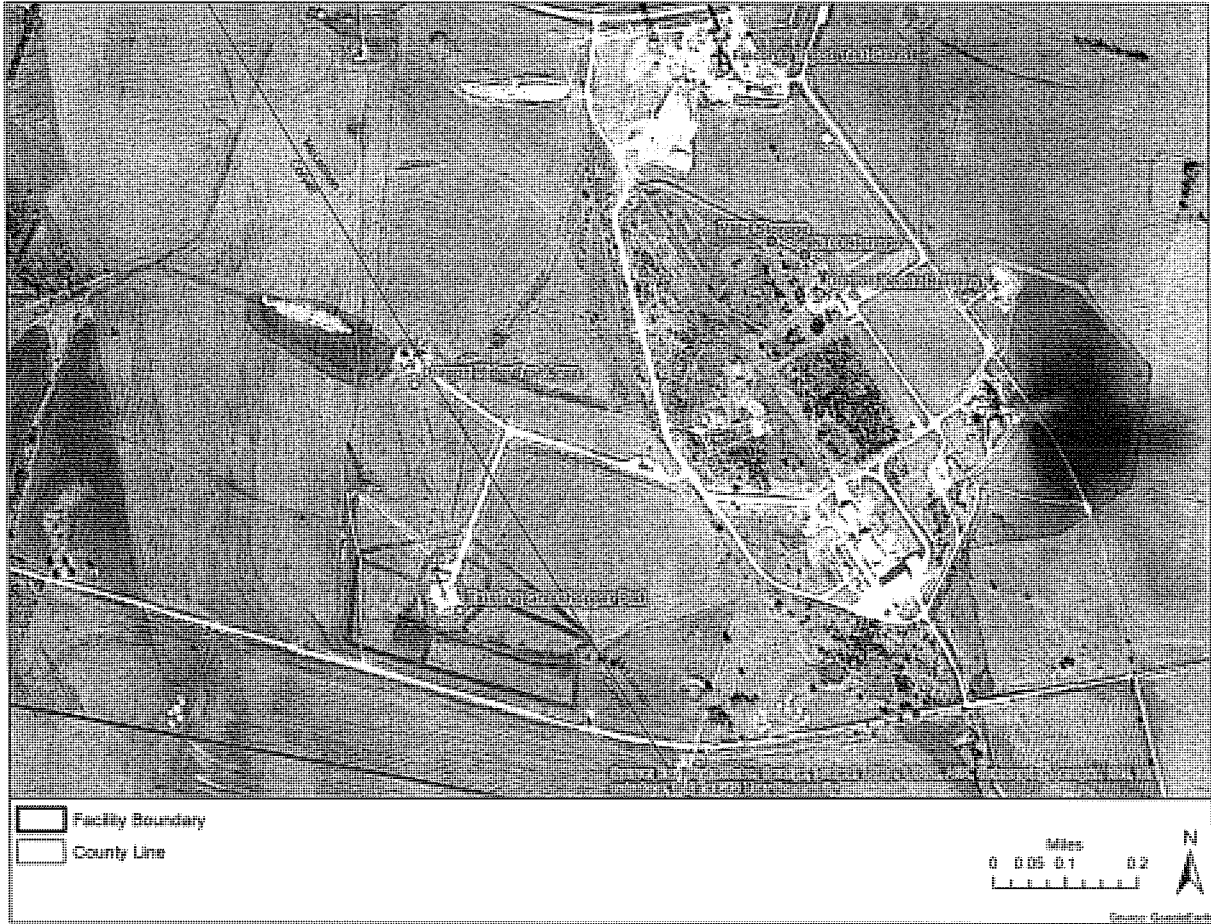
cc: Tanya Sommer, Branch Chief, U.S. Fish and Wildlife Service, Austin Ecological Services Field Office



Enclosure 1. Regional Location of McGregor, Texas



Enclosure 2. DragonFly Reusable Launch Vehicle



Enclosure 3. Existing Grasshopper Launch Pad and DragonRider Test Area

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