Federal Aviation Administration

FINAL ENVIRONMENTAL ASSESSMENT FOR THE MIDLAND INTERNATIONAL AIR AND SPACE PORT CITY OF MIDLAND, MIDLAND COUNTY, TEXAS

SEPTEMBER 2014

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Final Environmental Assessment for the Midland International Air and Space Port, City of Midland, Midland County, Texas

AGENCY: Federal Aviation Administration (FAA), lead; National Aeronautics and Space Administration, cooperating agency.

ABSTRACT: This Final Environmental Assessment (EA) addresses the potential environmental impacts of the City of Midland's proposal to operate a commercial space launch site at the Midland International Airport (MAF) in Midland County, Texas and offer the site to XCOR Aerospace, Inc. (XCOR) for the operation of the Lynx horizontal take-off and horizontal landing reusable launch vehicle (RLV) and engine testing. To operate a commercial space launch site, the City of Midland must obtain a launch site operator license from the FAA. Under the Proposed Action addressed in this EA, the FAA would: (1) issue a launch site operator license to the City of Midland for the operation of a commercial space launch site at MAF, (2) issue experimental permits and/or launch licenses to XCOR that would allow XCOR to conduct launches of the Lynx RLV from MAF, and (3) provide unconditional approval to modify the existing Airport Layout Plan (ALP) to reflect the designation of a launch site boundary, installation of aboveground propellant storage tanks, and construction of a concrete pad for engine testing. Proposed launch operations would begin in 2014 and continue through 2018. The frequency of launch operations would initially be one launch per week, eventually increasing to two launches per day, five days a week. Fifty-two annual launch operations are proposed in 2014. The total number of annual launch operations would increase each year until 2018 when 520 annual launch operations are proposed.

Potential environmental impacts of the Proposed Action and the No Action Alternative analyzed in detail in this Final 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; natural resources and energy supply; hazardous materials, pollution prevention, and solid waste; and socioeconomics, environmental justice, and children's environmental health and safety. Potential cumulative impacts of the Proposed Action and the No Action Alternative are also addressed in this Final EA.

PUBLIC REVIEW PROCESS: In accordance with the National Environmental Policy Act of 1969, as amended (NEPA; 42 United States Code [U.S.C.] 4321, et seq.), Council on Environmental Quality NEPA implementing regulations (40 CFR Parts 1500 to 1508), FAA Order 1050.1E, *Environmental Impacts: Policies and Procedures, Change 1*, and FAA Order 5050. 4B, *National Environmental Policy Act (NEPA) Implementing Instructions for Airport Actions*, the FAA published a Notice of Availability of the Draft EA in the *Federal Register* on March 24, 2014, which started the 30-day public review and comment period. A Notice of Availability of the Draft EA was also published in the Midland Reporter-Telegram, Odessa American, and Big Spring Herald on March 30, 2014 and in the Big Lake Wildcat on April 3, 2014. The FAA mailed copies of the Draft EA to the following agencies:

- The State Historic Preservation Officer - Texas Historical Commission
- The U.S. Fish and Wildlife Service
- The Texas Parks and Wildlife Department

An electronic version of the Draft EA was also made available on the FAA website. In addition, the FAA printed and mailed a copy of the Draft EA to the following libraries:

- Midland County Library – 301 West Missouri Avenue, Midland, Texas 79701
- Ector County Library – 321 W. 5th Street, Odessa, Texas 79761
- Reagan County Library – 300 Courthouse Square Big Lake, Texas 76932

The FAA held an open house public meeting on April 8, 2014 from 5:30 pm to 8:30 pm at the University of Texas of the Permian Basin, Center for Energy and Economic Diversification (Foyer), located at 1400 North FM 1788, Midland, Texas (southeast corner of SH 191 and FM 1788), to solicit comments from the public concerning the scope and content of the Draft EA. Poster displays located throughout the open house provided information about the Proposed Action, the environmental effects, the role of the FAA, and how the public could participate in the NEPA process. In addition to poster displays, factsheets were provided. A stenographer was present to record verbal comments.

Interested parties were invited to submit comments on environmental issues and concerns. The public comment period ended on April 24, 2014. The FAA received two public comments on the Draft EA, both in support of the Proposed Action. No substantive changes have been made to this Final EA.

CONTACT INFORMATION: To request a copy of the Final EA, please contact Mr. Daniel Czelusniak, Office of Commercial Space Transportation, Federal Aviation Administration, 800 Independence Avenue, SW, Suite 325, Washington, DC 20591; email Daniel.Czelusniak@faa.gov; or phone (202) 267-5924.

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

Issued in Washington DC on: 9/9/2014

Dr. George C. Nield
Associate Administrator for
Commercial Space Transportation

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

Office of Commercial Space Transportation; Finding of No Significant Impact

AGENCY: Federal Aviation Administration (FAA)

ACTION: Finding of No Significant Impact (FONSI)

SUMMARY: The FAA prepared the attached Final Environmental Assessment (EA) in accordance with the National Environmental Policy Act (NEPA) of 1969, 42 United States Code (U.S.C.) § 4321-4347 (as amended), Council on Environmental Quality (CEQ) NEPA implementing regulations, 40 Code of Federal Regulations (CFR Parts 1500 to 1508), FAA Order 1050.1E, Change 1, *Environmental Impacts: Policies and Procedures,* and FAA Order 5050.4B, *National Environmental Policy Act (NEPA) Implementing Instructions for Airport Actions*, to evaluate the potential environmental impacts of the City of Midland's proposal to operate a commercial space launch site at the Midland International Airport (MAF) in Midland County, Texas and offer the site to XCOR Aerospace, Inc. (XCOR) for the operation of the Lynx horizontal take-off and horizontal landing reusable launch vehicle (RLV) and engine testing. To operate a commercial space launch site, the City of Midland must obtain a launch site operator license from the FAA.

After reviewing and analyzing currently available data and information on existing conditions and the potential impacts of the Proposed Action, the FAA has determined that the Proposed Action would not significantly impact the quality of the human environment. Therefore, preparation of an Environmental Impact Statement is not required, and the FAA is issuing this FONSI. The FAA made this determination in accordance with all applicable environmental laws. The Final EA is incorporated by reference in this FONSI.

FOR A COPY OF THE EA OR FONSI: Visit the following internet address: http://www.faa.gov/about/office_org/headquarters_offices/ast/environmental/nepa_docs/review/operator/ or contact Daniel Czelusniak, Office of Commercial Space Transportation, Federal Aviation Administration, 800 Independence Ave., SW, Suite 325, Washington, DC 20591; e-mail Daniel.Czelusniak@faa.gov; or phone (202) 267-5924.

PURPOSE AND NEED: The purpose of the FAA action in connection with the City of Midland's request for a launch site operator license is to fulfill the FAA's responsibilities under the Commercial Space Launch Act, 51 U.S.C. Subtitle V, Ch. 509 §§ 50901-50923, for oversight of commercial space launch activities, including issuing launch site operator licenses for the operation of commercial space launch sites, and experimental permits and launch licenses to operate reusable orbital and suborbital launch vehicles. The Proposed Action would be consistent with the objectives of the Commercial Space Launch Act.

The need for the FAA action of issuing a launch site operator license, experimental permits, and launch licenses 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 and reentry activities by the private sector in order to strengthen and expand U.S. space transportation infrastructure.

Additionally, the purpose and need of the FAA action in connection with the City of Midland's request to modify the existing Airport Layout Plan (ALP) is to ensure the proposed alterations to the airport do not adversely affect the safety, utility, or efficiency of the airport. Pursuant to 49 U.S.C. § 47107(a)(16), the FAA Administrator (under authority delegated from the Secretary of Transportation) must approve any revision or modification to an ALP before the revision or modification takes effect. The Administrator's approval reflects a determination that the proposed alterations to the airport, reflected in the ALP revision or modification, do not adversely affect the safety, utility, or efficiency of the airport.

The purpose of the City of Midland's proposal to operate a commercial space launch site is to allow the City of Midland to offer the site to XCOR to establish its research and development facilities in the City of Midland. The City of Midland's need for the proposed commercial space launch site is to further the City's goals, as established in the Midland Master Plan 2025, of diversifying the local economy and enhancing the region as a business and employment center. The City's strategy is to provide development areas that attract and accommodate the needs of new businesses. To be successful as a commercial space launch site, the area must meet the technical and operational requirements to accommodate a fleet of three or four Lynx horizontal take-off and horizontal landing RLVs. These requirements include: location within the City of Midland, location in an area of low population density in order to comply with 14 CFR Part 420; a runway with minimum length of 7,900 feet; and a minimum of 60,000 square feet of hangar space.

PROPOSED ACTION: Under the Proposed Action addressed in the attached EA, the FAA would: (1) issue a launch site operator license to the City of Midland for the operation of a commercial space launch site at MAF, (2) issue experimental permits and/or launch licenses to XCOR that would allow XCOR to conduct launches of the Lynx RLV from MAF, and (3) provide unconditional approval to modify the existing ALP to reflect the designation of a launch site boundary, installation of aboveground propellant storage tanks, and construction of a concrete pad for engine testing. Therefore, the Proposed Action analyzed in the Final EA includes the activities that would be authorized by the launch site operator license and/or experimental permits and launch licenses (i.e., the operation of the launch vehicle), the unconditional approval to modify the existing ALP, as well as the installation of aboveground propellant storage tanks, and construction of a concrete pad for engine testing. Proposed launch operations would begin in 2014 and continue through 2018.

ALTERNATIVES CONSIDERED: Alternatives analyzed in the Final EA include the Proposed Action and the No Action Alternative. Under the No Action Alternative, the FAA would not issue a launch site operator license to the City of Midland and thus would also not issue experimental permits and/or launch licenses

to XCOR for operation of the Lynx RLV at MAF. Also, there would be no need to update the ALP for MAF, and thus there would be no approval of a revised ALP. Existing commercial aviation and military operations would continue at MAF. Please refer to Section 1.1 of the Final EA for a brief discussion of existing commercial aviation and military operations at MAF.

ENVIRONMENTAL IMPACTS: The potential environmental impacts from the No Action Alternative and the Proposed Action were evaluated in the attached Final EA for each of the environmental impact categories identified in FAA Orders 1050.1E, Change 1, *Environmental Impacts: Policies and Procedures* and 5050.4B, *NEPA Implementing Instructions for Airport Actions*.

Chapter 3, Section 3.0, of the Final EA identifies those environmental impact categories that are not analyzed in detail, explaining why the Proposed Action would have no potential effect on those impact categories. Those categories are: Coastal Resources, Wild and Scenic Rivers, Farmlands, Light Emissions and Visual Impacts, and Secondary (Induced) Impacts.

Chapter 4 of the Final EA provides detailed evaluations of the environmental consequences of each Alternative for each of the remaining environmental impact categories (including the construction-related impacts in each category) and documents the finding that no significant environmental impacts would result from the Proposed Action. A summary of the documented findings for each impact category follows:

- Air Quality, Final EA Section 4.1. Air pollutant emissions that would result from the Proposed Action would not result in exceedence of any National Ambient Air Quality Standard. Therefore, the FAA has determined there would be no significant air quality impacts.
- Noise and Compatible Land Use, Final EA Section 4.2 and Appendix A. Based on noise analyses conducted with respect to rocket launch noise, including sonic booms, the FAA has determined the Proposed Action would result in no significant noise impacts and would not significantly impact land use compatibility.
- Department of Transportation Act, Section 4(f), Final EA Section 4.3. The FAA has determined that there would be no actual or constructive use of any Section 4(f) property within the region of influence of the Proposed Action and, therefore, no significant impacts.
- Historical, Architectural, Archaeological, and Cultural Resources, Final EA Section 4.4. In accordance with Section 106 of the National Historic Preservation Act and in consultation with the State Historic Preservation Officer – Texas Historical Commission, the FAA has determined that the Proposed Action would result in no effect on any historic or archaeological resource. In consultation with two Native American tribes with interests in the vicinity of MAF, the FAA has determined that the Proposed Action would not affect any cultural resources. See Final EA Section 3.4. Therefore, the FAA has determined that there would be no significant impacts in this category.
- Fish, Wildlife, and Plants, Final EA Section 4.5. The FAA has determined that the Proposed Action would not result in significant impacts to biological resources. In accordance with

Section 7 of the Endangered Species Act, the U.S. Fish and Wildlife Service has concurred with the FAA's determination that the Proposed Action *may affect, but is not likely to adversely affect* the northern aplomado falcon, black-capped vireo, least tern, whooping crane, and the lesser prairie-chicken.

- Water Quality, Final EA Section 4.6. No construction would occur within a floodplain, so there would be no impacts to floodplains. The FAA has determined that the Proposed Action would not result in any significant impacts to surface waters, groundwater, or wetlands; Best Management Practices would be implemented to prevent construction-related impacts.
- Natural Resources and Energy Supply, Final EA Section 4.7. The FAA has determined that there would be no significant impacts to natural resources and energy supply as a result of the Proposed Action.
- Hazardous Materials, Pollution Prevention, and Solid Waste, Final EA Section 4.8. Activities associated with the Proposed Action which would require the handling of hazardous materials, hazardous wastes, and solid wastes would be undertaken in accordance with Occupational Safety and Health Administration 29 CFR 1910, National Fire Protection Association 30 (Flammable and Combustible Liquids Code) and 55 (Compressed Gases and Cryogenic Fluids), and the Compressed Gas Association. In addition, all relevant and applicable Federal, State, and local regulations pertaining to hazardous materials, hazardous wastes, and solid wastes would be adhered to. Therefore, the FAA has determined that the Proposed Action would result in no significant impacts in this category.
- Socioeconomics, Children's Environmental Health Risks and Safety Risks, and Environmental Justice, Final EA Section 4.9. The FAA has determined that the Proposed Action would result in no significant socioeconomic impacts. Since Proposed Action would not result in environmental impacts that would adversely affect any population, the FAA has determined that there would be no disproportionately high or adverse impacts to children's environmental health and safety. Similarly, and in accordance with Executive Order 12898, the FAA has determined that there would be no disproportionately high or adverse impacts to low income or minority populations.

Please refer to Chapter 4 of the Final EA for a full discussion of the determination for each environmental impact category.

Chapter 5 of the Final EA provides an analysis of the potential cumulative impacts of the Proposed Action when added to other past, present, and reasonably foreseeable future actions. The FAA has determined that the Proposed Action would not result in significant cumulative impacts in any environmental impact category or with regard to greenhouse gas emissions.

The following measures will be implemented as part of the Proposed Action. Air emissions from construction of a concrete pad for engine test pad will be reduced and controlled using standard management practices such as routine sweeping and wetting. To prevent disturbed soils or pollutants from being carried off-site in stormwater runoff, the use of Best Management Practices such as

sediment traps, silt fences, straw bales, or fiber rolls would be incorporated into design and construction. In the unlikely event of a launch failure occurring at or within the vicinity of MAF, any potential impacts to water quality would be minimized by existing emergency response services. As the existing activities at MAF include 330,000 gallons of storage of hazardous materials, MAF has an Airport Emergency Plan in place to prevent pollution by avoiding spills and uncontrolled releases during all proposed operations. In addition, all hazardous materials, hazardous wastes, and solid wastes would be handled in accordance with all relevant and applicable Federal, State, and local regulations.

As part of Section 7 consultation, the applicant (MAF) proposed to monitor lesser prairie-chicken lekking sites to evaluate potential impacts, if any, to individual lesser prairie-chickens. In a July 14, 2014 letter from USFWS to FAA, USFWS supported MAF's proposed monitoring of the lesser prairie-chicken lekking areas during launch activities to evaluate if sonic booms affect individual lesser prairie-chickens. MAF will continue to work with the FAA and USFWS to identify lesser prairie-chicken lekking sites and develop an appropriate survey protocol that will adequately evaluate potential sonic boom disturbance and the effects, if any, to the lesser prairie-chicken.

DETERMINATION: An analysis of the Proposed Action has concluded that there would be no significant short-term, long-term, or cumulative effects to the environment or surrounding populations. Therefore, an Environmental Impact Statement for the Proposed Action is not required. After careful and thorough consideration of the facts contained herein, the undersigned finds that the proposed Federal action is consistent with existing national environmental policies and objectives as set forth in Section 101 of NEPA and other applicable environmental requirements and will not significantly affect the quality of the human environment or otherwise include any condition requiring consultation pursuant to Section 102(2)(c) of NEPA.

Issued in Washington, DC on: 9/9/2014

Dr. George C. Nield
Associate Administrator for
Commercial Space Transportation

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ACRONYMS AND ABBREVIATIONS

AAF	Army Airfield
ADT	average daily traffic
AGL	above ground level
ALP	Airport Layout Plan
ANSI	American National Standards Institute
APE	Area of Potential Effects
ARFF	Aircraft Rescue and Fire Fighting
ARTCC	Air Route Traffic Control Center
BMPs	Best Management Practices
CAA	Clean Air Act
CAF	Commemorative Air Force
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CH_4	methane
CO	carbon monoxide
dB	decibel
dBA	A-weighted decibels
DNL	day-night average noise level
EA	Environmental Assessment
EO	Executive Order
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FBO	fixed base operator
ft	feet
HAPs	Hazardous Air Pollutants
GAO	Government Accountability Office
GHG	greenhouse gases
HPWD	High Plains Water District
lb	pound
lbf	pound per foot
LH_2	liquid hydrogen
L_{max}	maximum sound level
LN_2	liquid nitrogen
LOS	level of service
LOX	Liquid Oxygen
MAF	Midland International Airport
MBTA	Migratory Bird Treaty Act
MOA	Military Operations Area
MSATs	Mobile Source Air Toxics
MSL	mean sea level
NAAQS	National Ambient Air Quality Standards
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NHPA	National Historic Preservation Act
NIOSH	National Institute for Occupational Safety and Health
NOTAMs	Notice to Airmen
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NRI	Nationwide Rivers Inventory
NWI	National Wetland Inventory
O_3	ozone
OASPL	overall sound pressure level
OSHA	Occupational Safety and Health Administration
pc/h/l	passenger cars per hour per lane
ppb	parts per billion
ppm	parts per million
psf	pound per square foot
RCRA	Resource Conservation and Recovery Act
RLV	Reusable Launch Vehicle
ROI	Region of Influence
SEL	Sound Exposure Level
SFHAs	Special Flood Hazard Areas
SHPO	State Historic Preservation Officer
SUA	Special Use Airspace
TCEQ	Texas Commission on Environmental Quality
THC	Texas Historical Commission
TPS	thermal protection system
TPWD	Texas Parks and Wildlife Department
TxDOT	Texas Department of Transportation
U.S.	United States
U.S.C.	United States Code
USFWS	U.S. Fish and Wildlife Service
VOCs	Volatile Organic Compounds
WWII	World War II
XCOR	XCOR Aerospace, Inc.

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1.0 INTRODUCTION

The City of Midland proposes to operate a commercial space launch site at the Midland International Airport (MAF) in Midland County, Texas and offer the site to XCOR Aerospace, Inc. (XCOR) for the operation of the Lynx horizontal take-off and horizontal landing reusable launch vehicle (RLV) and engine testing (Exhibit 1-1). To operate a commercial space launch site, the City of Midland must obtain a launch site operator license from the Federal Aviation Administration (FAA). Under the Proposed Action addressed in this Environmental Assessment (EA), the FAA would: (1) issue a launch site operator license to the City of Midland for the operation of a commercial space launch site at MAF, (2) issue experimental permits and/or launch licenses to XCOR that would allow XCOR to conduct launches of the Lynx RLV from MAF, and (3) provide unconditional approval to modify the existing Airport Layout Plan (ALP) to reflect the designation of a launch site boundary, installation of aboveground propellant storage tanks, and construction of a concrete pad for engine testing (see Section 2.1). Proposed launch operations would begin in 2014 and continue through 2018. The frequency of launch operations would initially be one launch per week, eventually increasing to two launches per day, five days a week. Fifty-two annual launch operations are proposed in 2014. The total number of annual launch operations would increase each year until 2018 when 520 annual launch operations are proposed.

The Proposed Action is 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 FAA is the lead Federal agency and is preparing this EA in accordance with NEPA, Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 Code of Federal Regulations [CFR] Parts 1500-1508), and FAA Order 1050.1E, Change 1, *Environmental Impacts: Policies and Procedures*, and FAA Order 5050.4B, *National Environmental Policy Act (NEPA) Implementing Instructions for Airport Actions*. The National Aeronautics and Space Administration (NASA) is a cooperating agency in the development of this EA.

This EA evaluates the potential direct, indirect, and cumulative environmental effects that may result from the Proposed Action. The successful completion of the environmental review process does not guarantee that the FAA would issue a launch site operator license to the City of Midland or experimental permits and/or launch licenses to XCOR. Nor does completion of the NEPA process guarantee the FAA would provide unconditional ALP approval. The project must also meet all FAA safety, risk, and financial responsibility requirements per 14 CFR Part 400 and not affect adversely the safety, utility, or efficiency of the airport per 49 USC § 47107(a)(16). Additional environmental analysis would be required for future proposed activities not addressed in this EA.

1.1 Background

1.1.1 MAF

MAF, owned by the City of Midland, is a commercial service aviation facility located on approximately 1,680-acres 8.5 miles southwest of the City of Midland, Midland County, Texas, north of Business Interstate 20 and east of State Highway 349/Farm-to-Market 1788 (Exhibit 1-2).

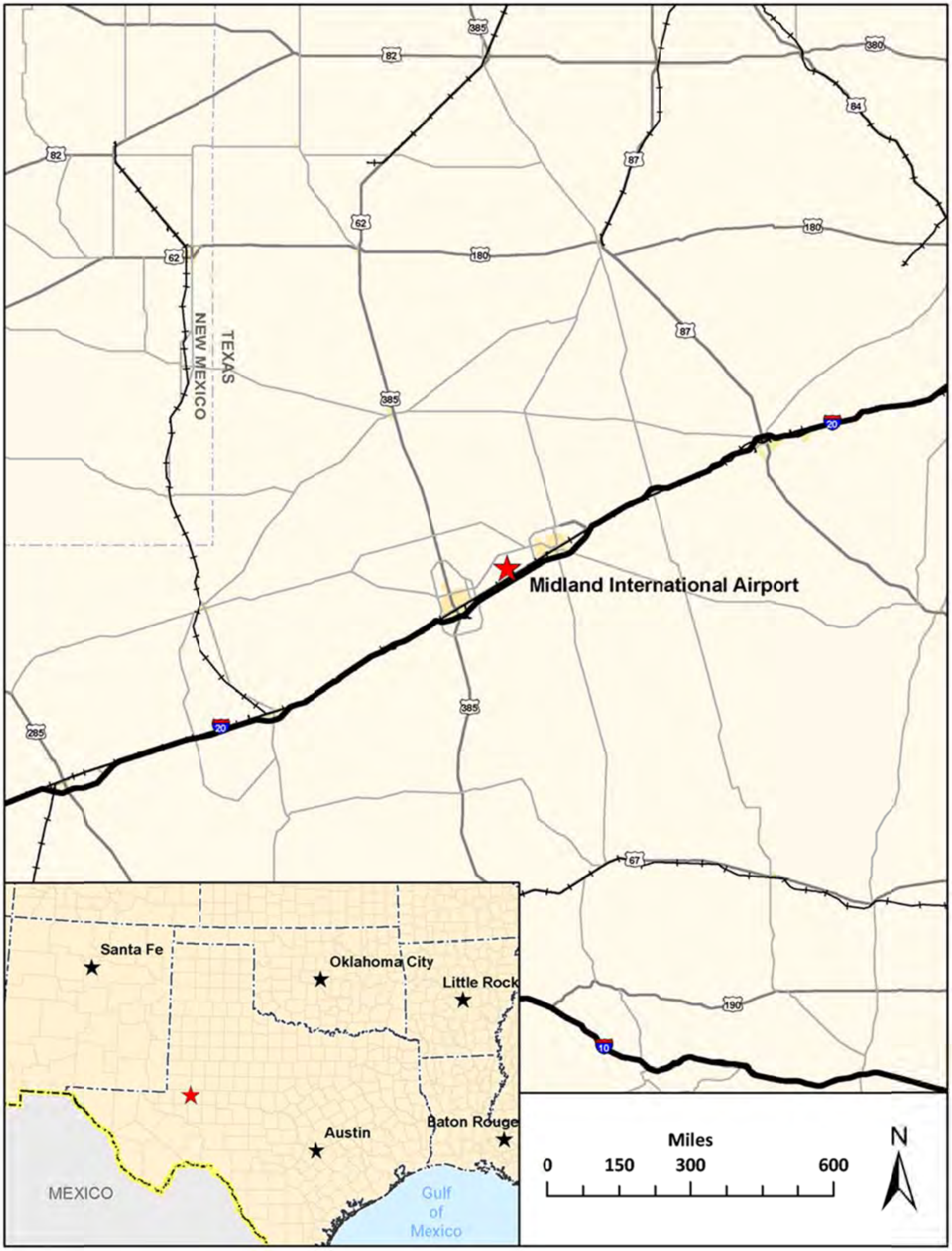

Exhibit 1-1. Regional Location of Midland International Airport

Exhibit 1-2. Location of Proposed Launch Site

MAF is classified by the FAA as a commercial primary small-hub airport and is currently certified for 14 CFR Part 139 operations. Under Part 139, the FAA issues airport operating certificates to airports that:

- Serve scheduled and unscheduled air carrier aircraft with more than 30 seats;
- Serve scheduled air carrier operations in aircraft with more than 9 seats but less than 31 seats; and
- The FAA Administrator requires to have a certificate (FAA 2013).

MAF currently supports a mix of aircraft operations. A yearly average total of 73,538 operations occurred at MAF between September 2010 and August 2012 (FAA 2012a). Of the 73,538 operations, 26,906 operations (37%) were performed by general aviation aircraft, and 25,468 operations (35%) were conducted by the military (FAA 2012a). Air taxis and air carriers conducted 12,977 (18%) and 8,187 (11%) of the total operations, respectively (FAA 2012a).

Airfield

The MAF property contains four runways and associated taxiways. The runways are identified as 4/22, 10/28, 16L/34R, and 16R/34L, and span 4,605 feet (ft), 8,302 ft, 4,247 ft, and 9,501 ft, respectively (Exhibit 1-3).

Landside Facilities

The airport property contains various facilities, including a passenger terminal building, a terminal apron, general aviation apron, Air Traffic Control Tower, Aircraft Rescue and Fire Fighting (ARFF) facility, corporate hangars, maintenance hangars, Fixed Base Operator (FBO) hangars, fuel storage facilities, airport maintenance, and access roadways (Exhibit 1-3). In addition, the airport contains United States (U.S.) Border Patrol facilities, U.S Customs, Commemorative Air Force (CAF) facilities, World War II (WWII) era bunkers, and natural areas. A freshwater pond is currently located on airport property at the end of 10/28 (Exhibit 1-3). The pond supplies water for the induced hydraulic fracturing (fracking) of oil wells located north and northwest of MAF.

Aviation fuel is presently stored in three locations on the airport. Five underground tanks, consisting of three 25,000-gallon Jet A tanks and two 25,000-gallon 100 lower lead (LL) tanks, are located in the North Hangar Development Area. Located in the South Hangar Development Area are six underground tanks: three 25,000-gallons Jet A tanks, one 10,000-gallon Jet A tank, and two 25,000-gallon 100 LL tanks. The East Hangar Development Area contains three underground tanks: two 25,000-gallon Jet A tanks and one 20,000-gallon 100 LL tank (Exhibit 1-3).

The airport facilities support three airlines: American Eagle, Southwest Airlines, United Express; one FBO, Avion of Deer Horne Aviation Ltd., Co.; three maintenance operators, all of which are subsidiaries of Deer Horne Aviation Ltd., Co. (Lone Star Propeller Services, Avion, and Deer Horne Maintenance, Paint & Interior); one terminal building; six rental car facilities; ARFF services; Transportation Security Administration; FAA facilities; and hangars for general aviation aircraft located near the terminal building and in the southeastern portion of the airport (see Exhibit 1-3).

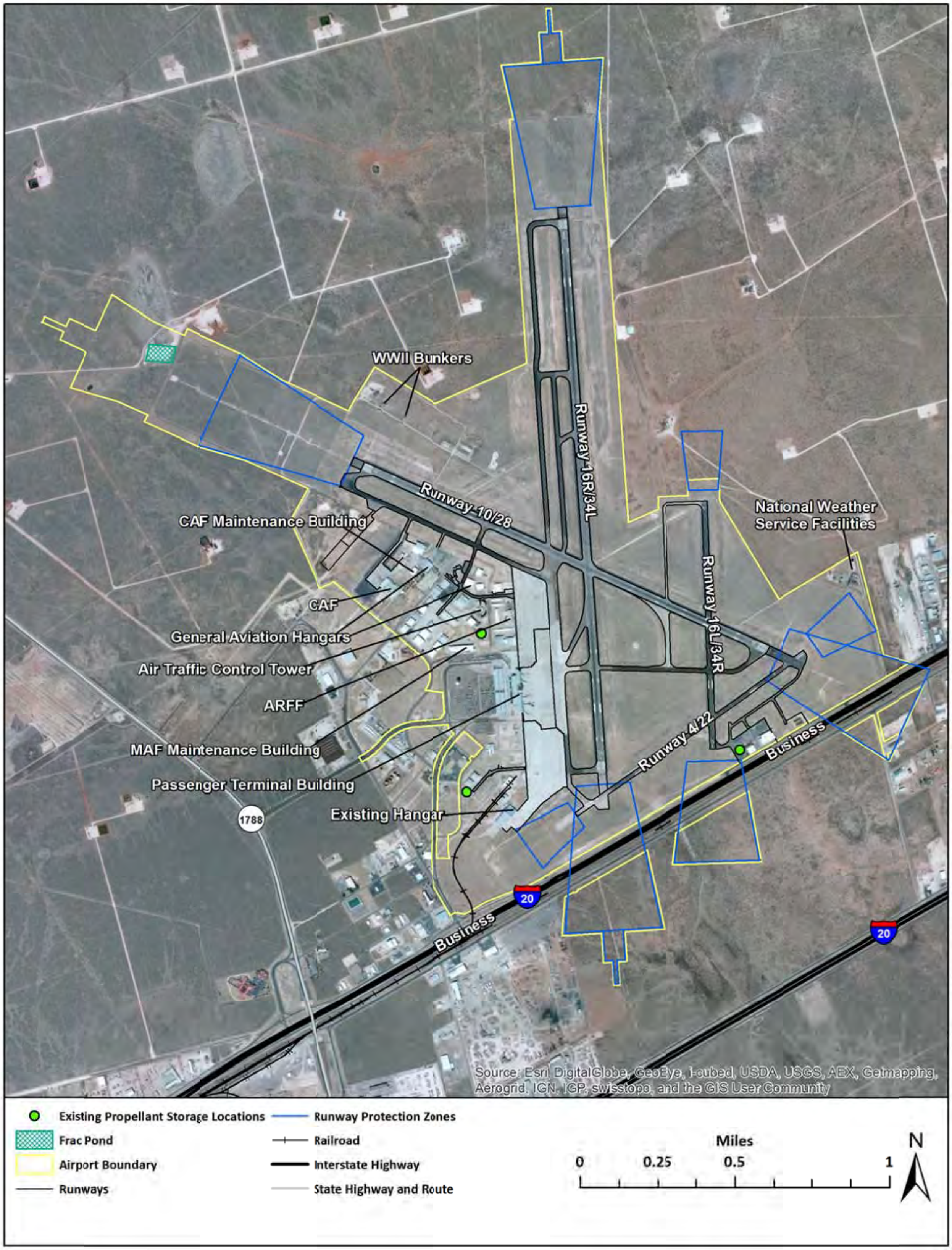

Exhibit 1-3. Existing Facilities at MAF

1.1.2 XCOR

XCOR is a small, privately held California corporation founded in 1999. XCOR is focused on the research, development, project management, and production of RLVs, rocket engines, and rocket propulsion systems. The Lynx RLV is a two-seat piloted, transport vehicle that would carry humans and payloads on a half-hour suborbital flight to 330,000 ft and then land on the take-off runway (Exhibit 1-4). Like an aircraft, Lynx is a horizontal take-off and horizontal landing vehicle, but instead of a jet or piston engine, Lynx uses its own fully reusable rocket propulsion system to depart a runway and makes a non-powered glide return and landing with the rocket engines off. The Lynx RLV is an all-composite airframe with a thermal protection system (TPS) on the nose and leading edges.

Source: XCOR 2012.

Exhibit 1-4. Lynx Mark I RLV

The Lynx Mark I (prototype) and II (production model) RLV wing area is sized for landing at touchdown speeds near 90 knots. It is approximately 30 ft in length with a double-delta wing that spans approximately 24 ft. The weight of the vehicle when fully fueled and ready for take-off would be between 10,700 and 11,000 pounds (lb). Table 1-1 lists the descriptions of the Lynx Mark I and II RLV configurations.

Table 1-1. Lynx Mark I and II RLV Descriptions

	Lynx I	Lynx II
Length (ft)	30	30
Span (ft)	24	24
Height (ft)	7.3	7.3
Gross weight (lb)	10,700	11,000
Altitude (ft)	200,000	330,000
Number of Engines	4	4

Notes: ft = feet/foot; lb = pound.

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

Pursuant to 49 U.S.C. § 47107(a)(16), the FAA Administrator (under authority delegated from the Secretary of Transportation) must approve any revision or modification to an ALP before the revision or modification takes effect. The Administrator's approval reflects a determination that the proposed alterations to the Part 139 airport, reflected in the ALP revision or modification, do not adversely affect the safety, utility, or efficiency of the airport.

1.2.1 FAA Licenses, Permits, and Approvals

The decision for the FAA to issue a launch site operator license, launch licenses, and/or experimental permits is considered a major Federal action under NEPA. The FAA is responsible for analyzing the potential environmental impacts associated with licensing and permitting commercial launch vehicles.

A license to operate a launch site authorizes a licensee to offer its launch site to a launch operator for each launch point, launch vehicle type, and weight class identified in the license application and upon which the licensing determination is based. Issuance of a license to operate a launch site does not relieve a licensee of its obligation to comply with any other laws or regulations, nor does it confer any proprietary, property, or exclusive rights in the use of airspace or outer space (14 CFR Part 420.41). A

launch site operator license remains in effect for five years from the date of issuance unless surrendered, suspended, or revoked before the expiration of the term and is renewable upon application by the licensee (14 CFR Part 420.43).

The FAA issues separate experimental permits and/or licenses for operation of launch vehicles. Therefore, XCOR would need to obtain individual experimental permits and/or launch licenses from the FAA before launching from MAF. The following paragraphs describe the experimental permits and launch licenses that could be obtained by XCOR:

- Experimental Permit – "[A]uthorizes launch and reentry of a reusable suborbital rocket" (14 CFR Part 437.7).
- RLV Mission Operator License – "[A]uthorizes a licensee to launch and reenter, or otherwise land, any of a designated family of RLVs within authorized parameters" (14 CFR Part 431.3[b]).
- RLV Mission-Specific License – "[A]uthorizes a licensee to launch and reenter, or otherwise land, one model or type of RLV from a launch site approved for the mission to a reentry site or other location approved for the mission" (14 CFR Part 431.3[a]).

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. An experimental permit is valid for one year and authorizes an unlimited number of launches and reentries of a reusable suborbital rocket from a U.S. launch site. A permittee can renew its permit by submitting an application to the FAA at least 60 days before the permit expires.

The FAA also issues launch licenses for the operation of RLVs (14 CFR Part 431). A launch license for a RLV is valid for a two-year renewable term and authorizes a licensee to launch and reenter, or otherwise land, any of a designated family of RLVs within authorized parameters, including launch sites and trajectories, transporting specified classes of payloads to any reentry site or other location designated in the license. A licensee can renew its license by submitting an application to the FAA at least 90 days before the license expires. An RLV mission-specific license authorizes a licensee to launch and reenter, or otherwise land, one model or type of RLV from a launch site approved for the mission to a reentry site or other location approved for the mission. An RLV mission-specific license expires upon completion of all activities authorized by the license or the expiration date stated in the reentry license, whichever occurs first.

1.2.2 Airport Layout Plan

An ALP is an FAA-approved plan that depicts both existing facilities and planned development for an airport. The ALP must depict the following:

- Boundaries and proposed additions to all areas owned or controlled by the sponsor for airport purposes;
- The location and nature of existing and proposed airport facilities and structures; and
- The location on the airport of existing and proposed non-aviation areas and improvements.

Exhibit 1-3 depicts existing facilities under the current ALP. Under the Proposed Action, the ALP for MAF would need to be modified to reflect the following actions (refer to Section 2.0, Exhibit 2-1):

- Designation of the launch site boundary;
- Installation of aboveground propellant storage tanks; and
- Construction of a concrete pad for engine testing.

The Federal actions for this EA include the unconditional approval of a modification to the ALP to reflect the actions listed above.

1.3 Purpose and Need

1.3.1 FAA Purpose and Need

The purpose of the FAA action in connection with the City of Midland's request for a launch site operator license is to fulfill the FAA's responsibilities under the Commercial Space Launch Act, 51 U.S.C. Subtitle V, Ch. 509 §§ 50901-50923, for oversight of commercial space launch activities, including issuing launch site operator licenses for the operation of commercial space launch sites, and experimental permits and launch licenses to operate reusable orbital and suborbital launch vehicles. The Proposed Action would be consistent with the objectives of the Commercial Space Launch Act.

The need for the FAA action of issuing a launch site operator license, experimental permits, and launch licenses 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 and reentry activities by the private sector in order to strengthen and expand U.S. space transportation infrastructure.

Additionally, the purpose and need of the FAA action in connection with the City of Midland's request to modify the existing ALP is to ensure the proposed alterations to the airport do not adversely affect the safety, utility, or efficiency of the airport. Pursuant to 49 U.S.C. § 47107(a)(16), the FAA Administrator (under authority delegated from the Secretary of Transportation) must approve any revision or modification to an ALP before the revision or modification takes effect. The Administrator's approval reflects a determination that the proposed alterations to the airport, reflected in the ALP revision or modification, do not adversely affect the safety, utility, or efficiency of the airport.

1.3.2 City of Midland's Purpose and Need

The purpose of the City of Midland's proposal to operate a commercial space launch site is to allow the City of Midland to offer the site to XCOR to establish its research and development facilities in the City of Midland. The City of Midland's need for the proposed commercial space launch site is to further the City's goals, as established in the *Midland Master Plan 2025*, of diversifying the local economy and enhancing the region as a business and employment center (City of Midland 2005). The City's strategy is to provide development areas that attract and accommodate the needs of new businesses. To be successful as a commercial space launch site, the area must meet the technical and operational requirements to accommodate a fleet of three or four Lynx horizontal take-off and horizontal landing RLVs. These requirements include: location within the City of Midland, location in an area of low

population density in order to comply with 14 CFR Part 420; a runway with minimum length of 7,900 ft; and a minimum of 60,000 square feet of hangar space.

1.4 Public Involvement

In accordance with NEPA, CEQ Regulations, FAA Order 1050.1E, Change 1, and FAA Order 5050. 4B, the FAA published a Notice of Availability of the Draft EA in the *Federal Register* on March 24, 2014, which started the 30-day public review and comment period. A Notice of Availability of the Draft EA was also published in the Midland Reporter-Telegram, Odessa American, and Big Spring Herald on March 30, 2014 and in the Big Lake Wildcat on April 3, 2014. The FAA mailed copies of the Draft EA to the following agencies:

- The State Historic Preservation Officer (SHPO) - Texas Historical Commission (THC)
- The U.S. Fish and Wildlife Service (USFWS)
- The Texas Parks and Wildlife Department (TPWD)

An electronic version of the Draft EA was also made available on the FAA website. In addition, the FAA printed and mailed a copy of the Draft EA to the following libraries:

- Midland County Library – 301 West Missouri Avenue, Midland, Texas 79701
- Ector County Library – 321 W. 5th Street, Odessa, Texas 79761
- Reagan County Library – 300 Courthouse Square Big Lake, Texas 76932

The FAA held an open house public meeting on April 8, 2014 from 5:30 pm to 8:30 pm at the University of Texas of the Permian Basin, Center for Energy and Economic Diversification (Foyer), located at 1400 North FM 1788, Midland, Texas (southeast corner of SH 191 and FM 1788), to solicit comments from the public concerning the scope and content of the Draft EA. Poster displays located throughout the open house provided information about the Proposed Action, the environmental effects, the role of the FAA, and how the public could participate in the NEPA process. In addition to poster displays, factsheets were provided. A stenographer was present to record verbal comments.

Interested parties were invited to submit comments on environmental issues and concerns. The public comment period ended on April 24, 2014. The FAA received two public comments on the Draft EA, both in support of the Proposed Action. No substantive changes have been made to this Final EA.

1.5 Other Environmental Requirements

In addition to NEPA, other laws, regulations, permits, and licenses may be applicable to the proposed construction, operation, and maintenance of facilities and infrastructure of a commercial space launch site at MAF. Specifically, the Proposed Action may require an air quality permit(s) issued by the Texas Commission on Environmental Quality (TCEQ) for air emission sources (Texas Clean Air Act).

2.0 PROPOSED ACTION AND ALTERNATIVES

2.1 Proposed Action

The City of Midland proposes to operate a commercial space launch site at MAF in Midland County, Texas and offer the site to XCOR for the operation of the Lynx RLV and engine testing. To operate a commercial space launch site, the City of Midland must obtain a launch site operator license from the FAA. Under the Proposed Action addressed in this EA, the FAA would: (1) issue a launch site operator license to the City of Midland for the operation of a commercial space launch site at MAF, (2) issue experimental permits and/or launch licenses to XCOR that would allow XCOR to conduct launches of the Lynx RLV from MAF, and (3) provide unconditional approval to modify the existing ALP to reflect the designation of a launch site boundary, installation of aboveground propellant storage tanks, and construction of a concrete pad for engine testing.

To be successful as a commercial space launch site, the area must meet the technical and operational requirements to accommodate a fleet of three or four Lynx horizontal take-off and horizontal landing RLVs. These requirements include: location in an area of low population density in order to comply with 14 CFR Part 420; a runway with minimum length of 7,900 ft; and a minimum of 60,000 ft^2 of hangar space. XCOR proposes to establish its research and development facilities at MAF and begin launch operations in 2014 and continue through 2018. This EA addresses the environmental impacts of the following:

- Operation of the Lynx RLV at MAF,
- Installation of aboveground propellant storage tanks,
- Construction and operation of an engine test pad, and
- New personnel required for XCOR operations at MAF.

2.1.1 Operation of the Lynx RLV at MAF

For the purposes of evaluating environmental impacts in this EA, the FAA in coordination with MAF has estimated a certain number of launch operations per year of the Lynx RLV from MAF between 2014 and 2018. Table 2-1 lists the maximum number of proposed annual launch operations analyzed in this EA.

Table 2-1. Proposed Launch Operations

Year	Frequency	Total Number of Launch Operations per Year[1]
2014	1 per week	52
2015	2 per week	104
2016	1 per day, 5 days a week	260
2017	1 per day, 5 days a week	260
2018	2 per day, 5 days a week	520
Total Number of Launch Operations from 2014 to 2018		**1,196**

Note: [1]One launch operation includes a launch and reentry.

Of the proposed number of annual launch operations, up to 5 percent per year could be night operations (between the hours of 10:00 p.m. and 7:00 a.m.). This would equate to approximately 3 night

operations in 2014 with a phased increase to approximately 26 night operations by 2018. The activities associated with the Lynx RLV operations include the following:

- Pre-flight activities (air traffic coordination; vehicle assembly; engine checkout; propellant, pilot, and passenger loading; and static run-up testing);
- Flight profile (take-offs, flights, and landings); and
- Post-flight activities (closing feed valves and depressurizing propellant tanks, removal of the RLV from the runway, pilot disembarking, and post-flight checkouts and inspections).

Existing infrastructure, including a hangar and runways, would be used to support launch operations at MAF. XCOR would lease hangar space from the Midland Development Corporation, which leases the hangar from MAF.

Pre-Flight Activities

Launch operators would be required to notify MAF before a planned launch. MAF would coordinate operations with the Fort Worth Air Route Traffic Control Center (ARTCC) and Midland ATC. Specifically, MAF would be required to obtain Letters of Agreement from the Fort Worth ARTCC and Midland Approach to operate the Lynx RLV in the proposed airspace before any launches could commence. The Letters of Agreement would include notification requirements, including requirements for the issuance of Notice to Airmen (NOTAMs), which provide notice of unanticipated or temporary changes to components of, or hazards in, the National Airspace System (NAS) (FAA Order JO 7930.2M, *Air Traffic Organization Policy*). The MAF launch site operator would notify the launch operator of other activities in the airport, resolve potential conflicts for commercial space launch site use, and notify other appropriate airspace scheduling agencies. Missions would be rehearsed with all flight and ground support crews prior to each launch.

The FAA would not alter the dimensions (shape and altitude) of the airspace. However, temporary closures of existing airspace may be necessary to ensure public safety during the proposed operations. Advance notice via NOTAMs would assist general aviation pilots in scheduling around any temporary disruption of flight activity at MAF. The numerous runways at MAF should also limit interference in the daily flight timetable. Additionally, launches would be infrequent (less than 1 percent of the total operations occurring at MAF), of short duration, and scheduled well in advance to minimize interruption of airport operations.

For the above reasons, environmental impacts from the temporary closure of airspace and the issuance of NOTAMs under the Proposed Action are not anticipated (see Appendix D, *Airfields and Airspace* for further information). Moreover, in accordance with FAA Order 1050.1E, Chapter 3 (*Advisory and Emergency Actions and Categorical Exclusions*), the issuance of NOTAMs is categorically excluded from NEPA review absent extraordinary circumstances.

The Lynx RLV uses a pressure-fed, bipropellant propulsion system with liquid oxygen (LOX) as the oxidizer and kerosene as the fuel. It also uses gaseous helium as the pressurant. Before launch, the unpowered Lynx RLV would be tugged out of its hangar and have the helium tank pressurized for flight.

It would then be loaded with the propellants, typically fuel first and then the oxidizer. The vehicle would then be tugged to the run-up area of runway 16R/34L for final check out activities and pilot boarding.

Prior to each launch, a brief hot-fire test of the engines, also termed 'static run-up' test, would last approximately 2 seconds per engine, for a total duration of 8 seconds. The static run-up test could occur on the north end of runway 16R/34L or on the south end of runway 16R/34L (see Exhibit 2-1). The hot-fire test would occur on one engine at a time. This testing is a last checkout of the propulsion system prior to launch. A top off of the propellants from mobile propellant transport vehicles may be conducted to ensure full flight capacities are achieved. The ground support tug vehicle would then pull the RLV into place for final flight preparations and systems check. Once final flight preparations are complete, the tug would disengage from the vehicle and all remaining equipment and support personnel would clear the area. Final flight preparations are expected to take approximately 5 - 7 minutes.

Flight Profile

The proposed flight profile for the Lynx RLV includes take-off, flight, and landing. Standard flight time for the Lynx RLV is expected to be 17 minutes. Once final pre-flight preparations are complete, and the Lynx RLV is cleared for take-off, the engines of the vehicle would be simultaneously ignited by the pilot, initiating the mission. The vehicle would take off horizontally from runway 16R/34L. Departure from runway 16R/34L would be at either a northern or southern trajectory (Exhibit 2-2). The northern trajectory would pass over portions of Midland, Ector, Andrews, and Gaines counties. The southern trajectory would take the vehicle over portions of Midland, Glasscock, and Reagan counties.

The vehicle would take off using approximately 1,800 ft of runway, enter its approved flight corridor, and then quickly transition to a climb angle of 75 degrees. It is expected to reach supersonic speed in about 1 minute at an altitude of approximately 50,000 ft above mean sea level (MSL). The vehicle would use a steep ascent trajectory until engine cutoff at 138,000 ft above MSL and approximately 22 nautical miles downrange from MAF. The vehicle would coast upwards on a parabolic trajectory to final apogee (the highest point) at approximately 35 nautical miles downrange from MAF. Apogee for the Lynx RLV would likely occur at altitudes between 200,000 and 330,000 ft.

After reaching apogee, the vehicle would glide to a pullout and energy management area, between 25 and 35 nautical miles downrange of MAF to expend excess energy before gliding back to MAF. The vehicle is launched with the planned propellant quantities needed to complete its suborbital mission with the expectation that only residual propellants would remain on board during approach and landing. The vehicle is intended to land completely unpowered for the typical mission but has the capability to restart the propulsion system if required. While the launch vehicle has the ability to restart its engines if needed to adjust the final approach, once that commitment is made, any excess oxidizer is vented prior to landing. Any remaining residual fuel would be kept on board the launch vehicle for future mission needs.

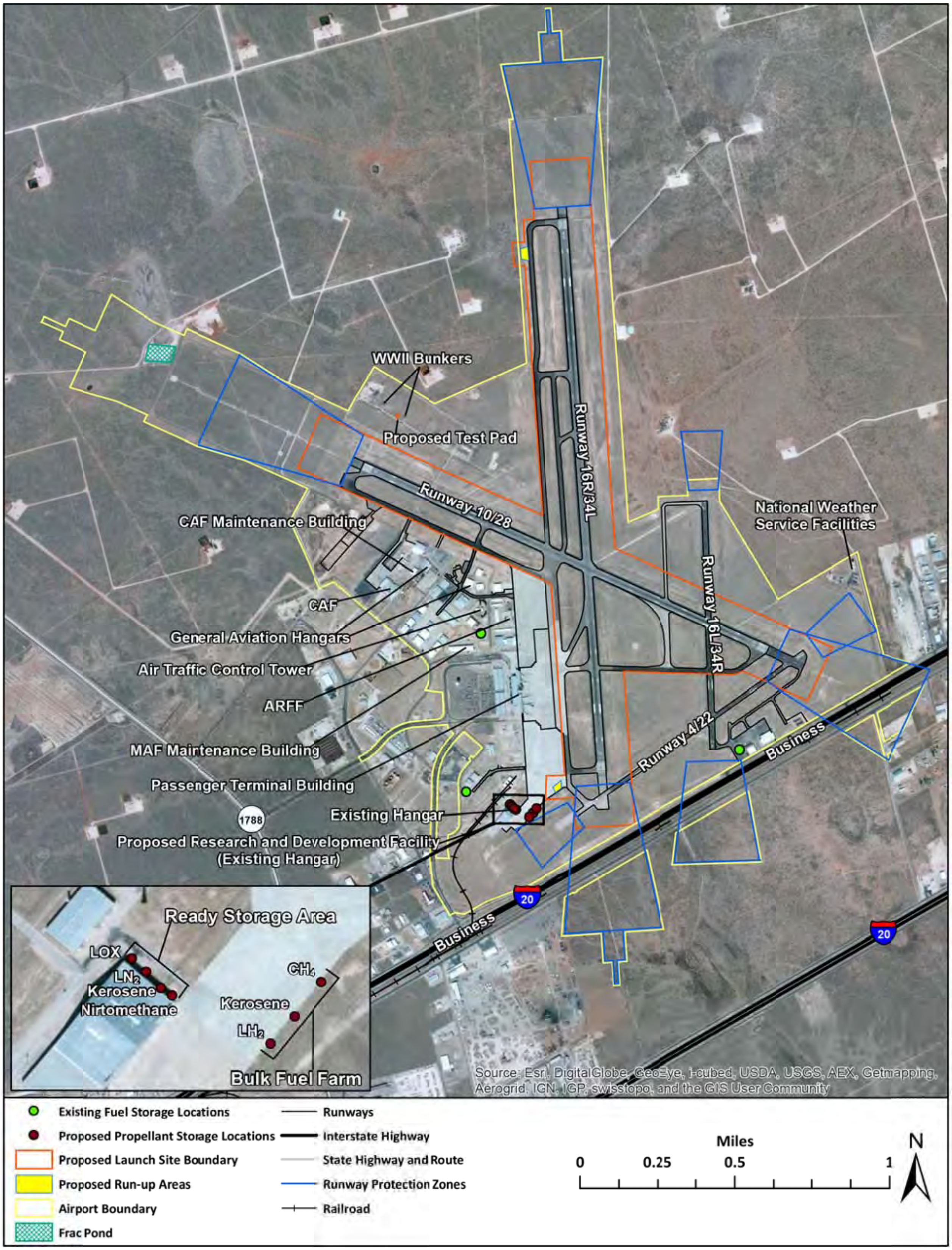

Exhibit 2-1. Existing and Proposed Facilities at MAF

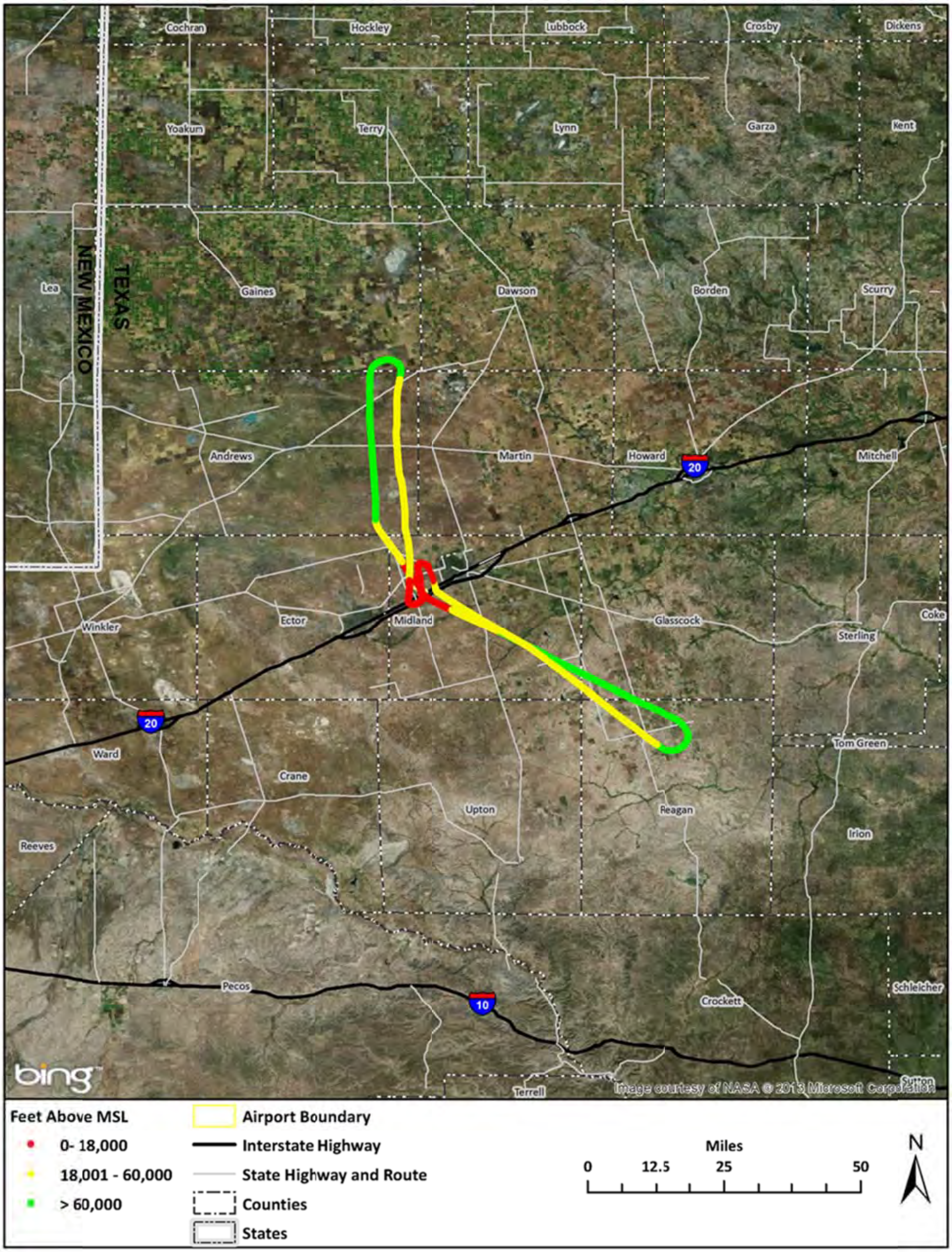

Exhibit 2-2. Northern and Southern Trajectories of the Lynx RLV

The Lynx Mark II (the production model of the Lynx Mark I) flies the same flight sequence as the Lynx Mark I, with the exception that Mark II is under thrust for a longer time, reaches a higher apogee, and takes longer to return to the ground. The typical Lynx Mark II mission profile provides a longer duration of low-acceleration and a lower minimum acceleration than the Lynx Mark I flight profile (XCOR 2012).

Post-Flight Activities

The Lynx RLV would land horizontally, unpowered, on runway 16R/34L and brake to a final stop. The pilot would begin procedures to safe the systems by closing various propellant feed valves and depressurizing the propellant tanks. The vehicle would be attached to a ground support tug vehicle and taken from the runway. Post-flight removal of the RLV from the runway is expected to take 5 - 7 minutes. Once the vehicle systems shut down, the pilot would disembark. Additional post-flight activities would take place prior to transporting the Lynx RLV back to the hangar for post-flight checkouts and inspections.

Potential Contingency Landing Sites

Runways 10/28, 16R/34L, 16L/34R, and 4/22 at MAF could accommodate the Lynx RLV for a contingency landing. The contingency landing site(s) would be defined prior to launch.

Launch Failures

For each mission, MAF would establish hazard areas to ensure public safety according to regulations in 14 CFR Part 431 or 437. FAA regulations as defined in 14 CFR Parts 431, 417, and 420 all require safety to the general public as their primary consideration in granting a license. In addition, as part of the licensing process and as part of maintaining safety of air traffic, the FAA would require MAF to establish agreements with the Fort Worth ARTCC and Midland Tower (i.e., "Midland Approach") to coordinate the use of the required airspace.

In terms of impact, for a nominal trajectory, the ground track does not include flights over populated areas. In the unlikely event of a launch failure, the debris impacts would be expected to be contained within the FAA approved hazard area. The potential impacts from launch failures are discussed under the following resources areas that could be potentially affected by a launch failure: Section 4.5, *Biological Resources,* Section 4.6, *Water Resources (Including Surface Waters, Groundwater, Wetlands, and Floodplains),* and Section 4.8, *Hazardous Materials, Pollution Prevention, and Solid Waste*.

2.1.2 Installation of Aboveground Propellant Storage Tanks

Three new aboveground permanent storage tanks would be needed to store propellant that would support the Lynx RLV. These proposed aboveground storage tanks would be constructed across from the hangar apron in an area designated as the "Bulk Fuel Farm." The three fuel storage tanks to be stored in this area are:

- Liquid hydrogen (LH_2) (6,000 gallons)
- Kerosene (8,800 gallons)
- Methane (CH_4) (17,000 gallons)

In addition, two permanent storage tanks for LOX (30,000-gallons each) (see Exhibit 2-3) and one storage tank for liquid nitrogen (LN_2) would be installed adjacent to the hangar in an area designated as the "Ready Storage Area." In addition, the Ready Storage Area would contain smaller quantities of kerosene and nitromethane. Kerosene storage would be limited to 7,500 lbs (20 each, 55-gallon drums) and nitromethane storage would be limited to approximately 1,500 lbs (3 each, 55-gallon drums). Cinder block storage alcoves are planned for the separation of these fuels. The storage tanks would be located outside the launch site boundary and beyond the debris dispersion radius computed in accordance with 14 CFR 420.21.

Proposed propellant storage locations would require modification of the ALP as depicted in Exhibit 2-1. The tanks would be filled from commercial tractor trailer tankers delivered by commercial providers and according to the providers transfer procedures. The launch vehicle would be fueled by transfer hoses either directly from the tanks or from smaller intermediate mobile transport tanks.

Exhibit 2-3. Typical LOX and LN_2 Storage Tank

2.1.3 Construction and Operation of an Engine Test Pad

In addition to XCOR's launching the Lynx RLV, MAF also proposes to construct a concrete test pad to support the static hot-fire testing of the XR-5K18 engine (Exhibit 2-4), which would require a modification of the ALP (Exhibit 2-1). The FAA does not license the vehicle itself or the ground tests of rocket engines, only the operation of the vehicle and the launch site. However, the potential

environmental impacts of the construction of the concrete pad and the engine tests are included in this document because they are a related activity.

The concrete pad to support engine testing would be constructed between the existing WWII era bunkers (see Exhibit 2-1). The test pad would be constructed of reinforced concrete and would be approximately 18 ft by 60 ft. The mobile test stand (Exhibit 2-4) would be fully autonomous with battery power for instrumentation and control. The mobile test stand would be configured in the hangar, and fueled at the "Bulk Fuel Farm" and/or the "Ready Storage Area" prior to testing. No additional permanent propellant storage tanks would be added to the static engine test pad area.

The XR-5K18 engine produces between 2,500 - 2,900 pounds per foot (lbf) of thrust by burning a mixture of LOX and kerosene. For the purposes of evaluating environmental impacts in this EA, the FAA has assumed a maximum of up to 100 static hot-fire tests per year, at a duration of 8 seconds per engine.

Source: XCOR 2012.

Exhibit 2-4. XR-5K18 Engine

2.1.4 Personnel Levels

It is anticipated that initially, approximately 40 new permanent, full-time employees would be on-site for XCOR operations at MAF. There may be an increase of up to 200 permanent, full-time employees on-site within 5 years of first operation. The new full-time permanent employees would work in the existing hangar and/or the terminal building. No new facilities or parking would be needed to accommodate the additional personnel.

2.2 Alternatives Considered

NEPA, the CEQ Regulations, and FAA Orders 1050.1E and 5050.4B require an analysis of alternatives that could satisfy the purpose and need for proposed activities. This serves as a basis for comparison of between alternatives and may prompt selection of an alternative that has fewer environmental effects. The following alternatives were considered.

2.2.1 No Action Alternative

Under the No Action Alternative, the FAA would not issue a launch site operator license to the City of Midland and thus would also not issue experimental permits and/or launch licenses to XCOR for operation of the Lynx RLV at MAF. Also, there would be no need to update the ALP for MAF, and thus there would be no approval of a revised ALP. Existing commercial aviation and military operations, as described in Section 1.1, would continue at MAF.

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 because it would not allow for operation of a commercial space launch site and would not satisfy the City of Midland's need to diversify the local economy and enhance the region as a business and employment center.

2.2.2 Alternatives Considered but Not Carried Forward

To be successful as a commercial space launch site, the area must meet the technical and operational requirements to accommodate a fleet of three or four Lynx horizontal take-off and horizontal landing RLVs including:

- a location within the City of Midland;
- a location in an area of low population density in order to comply with 14 CFR Part 420;
- a runway with minimum length of 7,900 ft; and,
- a minimum of 60,000 ft^2 of hangar space.

With these requirements in mind, alternatives sites were examined by the City of Midland. This section describes alternative sites considered by the City of Midland, which for the reasons given below, were found to be infeasible. These alternative sites were not carried forward for further analysis in the EA.

Midland Airpark

Midland Airpark is located on the northern side of the City, 20 minutes from downtown Midland, and is surrounded by populated areas. Midland Airpark serves the general aviation public, which includes business and corporate traffic. Midland Airpark has two runways: 7/25 and 16/34. The runway lengths are approximately 5,022 ft and 3,977 ft, respectively. Midland College, Railroad Commission, Windlands Park, and Tumbleweed Park are adjacent to Midland Airpark. The largest hangar at Midland Airpark is approximately 15,000 ft^2.

Midland Airpark does not meet the technical and operational requirements to accommodate XCOR for a commercial space launch site. It is not located in an area of low population density, does not have a runway with minimum length of 7,900 ft, and does not provide hanger space with a minimum of 60,000 ft^2. Therefore, this location was eliminated from further consideration.

Locations Outside of the City of Midland

All potential locations outside of the City of Midland would be outside of the City's jurisdiction, and as such, would not meet the requirements as stated above. Therefore, locations outside of the City of Midland were eliminated from further consideration.

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 – 1508), FAA Order 1050.1E, Change 1, and FAA Order 5050.4B. 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 analyzed in Chapter 3 and 4 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** – There are no coastal resources within the inland areas where proposed construction and operational activities would occur.
- **Wild and Scenic Rivers** – There are no wild and scenic rivers as designated by the Wild and Scenic Rivers Act located within MAF where construction and operational activities would occur. The nearest wild and scenic river segment is the Rio Grande, which is approximately 140 miles south of MAF (National Wild and Scenic Rivers System 2012). Similarly, there are no rivers listed on the National Park Services' Nationwide Rivers Inventory (NRI) within or near MAF. The nearest NRI-listed river segment is the Pecos River, which is approximately 90 miles southeast of MAF.
- **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. There are approximately 22.2 acres (1.7% of MAF property) of Stegall Loam soils that are considered "prime farmland if irrigated" on the southern end of MAF property. These soils are associated with drainage to an off-site wetland approximately 0.75 miles south of MAF. No irrigation occurs at MAF. The Natural Resources Conservation Service (NRCS) designates the soils on the remainder of MAF as "not prime farmland" (NRCS 2012).
- **Light Emissions and Visual Impacts –** There would be no visual impacts from the Proposed Action, because construction would consist of one ground-level concrete test pad and several new aboveground permanent storage tanks. Construction would occur during daytime hours and no additional lighting would be necessary. There would be no visual impacts associated with the proposed Lynx RLV because the launch vehicle would be similar in size, materials, and appearance as commercial and/or military aircraft that currently fly to and from MAF during the daytime and at night. No additional lighting would be required for launch operations.

- **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 40 personnel would not produce a measurable ripple effect of spending and re-spending in response to the direct effect. Therefore, this resource area was dismissed.

3.1 Air Quality

Air quality is defined by ambient air concentrations of specific pollutants determined by the U.S. Environmental Protection Agency (EPA) to be of concern related to the health and welfare of the general public and the environment. The primary pollutants of concern are called "criteria pollutants" and include: carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3), suspended particulate matter less than or equal to 10 microns aerodynamic diameter (PM_{10}), fine particulate matter less than or equal to 2.5 microns aerodynamic diameter ($PM_{2.5}$), and lead.

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 above ground level (AGL), which the 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. 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 ROI includes part of the Midland-Odessa-San Angelo Air Quality Control Region (40 CFR 81.137), which includes the following counties (refer to Exhibit 2-2): Andrews, Borden, Coke, Concho, Crane, Crockett, Dawson, Ector, Gaines, Glasscock, Howard, Irion, Kimble, Loving, Martin, Mason, McCulloch, Menard, Midland, Pecos, Reagan, Reeves, Schleicher, Sterling, Sutton, Terrell, Tom Green, Upton, Ward, and Winkler. Andrews, Ector, Gaines, Midland and Reagan are all counties within the Air Quality Control Region in which the flight path of the XCOR vehicle would pass over at heights ranging from 0 to 18,000 ft AGL (refer Exhibit 2-2). The air quality analysis focuses on Midland County because the bulk of the construction and operational air emissions would occur within this localized area.

3.1.1 National Ambient Air Quality Standards

Under the CAA, the EPA has established National Ambient Air Quality Standards (NAAQS) for criteria pollutants (40 CFR Part 50) (Table 3.1-1). 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 TCEQ, Office of Air, has adopted the NAAQS, which are presented in Table 3.1-1.

Table 3.1-1. National Ambient Air Quality Standards

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/m^3 = milligrams per cubic meter; μg/m^3 = micrograms per cubic meter; ppb = parts per billion; ppm = parts per million; PM_{10} = particulate matter less than or equal to 10 microns in diameter; $PM_{2.5}$ = fine particulate matter 2.5 microns or less in diameter

All of the Midland-Odessa-San Angelo Air Quality Control Region is in attainment for the NAAQS (40 CFR 81.344). Because the region is in attainment, the CAA General Conformity Rule (40 CFR Part 93) does not apply and is not addressed in this EA.

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 ambient air monitoring stations located in Ector County, which is adjacent to Midland County. These monitoring sites collect data representative of the air quality for the ROI. One is located at the Odessa Hays Elementary School, which is located approximately 12 miles southwest of MAF and collects data on $PM_{2.5}$, select volatile organic compounds (VOCs), and meteorological parameters (TCEQ 2009-2012). The second monitoring station is the Odessa Gonzalez site in Odessa, which is located approximately 10 miles southwest of MAF and collects $PM_{2.5}$ and meteorological data only (TCEQ 2009-2012). Although there have been instances of exceedance above the 24-hour NAAQS for $PM_{2.5}$, the area has not established a pattern of exceedance that would require designation as nonattainment. The 24-hour PM2.5 standard would be violated if the 98th percentile level of 24-hour measurements averaged over three years exceeded 35 μg/m^3. In December 2012, the EPA reduced the primary standard for 24-hour PM2.5 to 12 μg/m^3. Ambient air monitoring data will now be reviewed against the new standard. The closest location of monitoring sites for other criteria pollutants is El Paso, Texas, which is located

approximately 250 miles west of MAF. Due to the distance between El Paso and the ROI, pollutant concentrations measured in El Paso are not representative of MAF conditions.

3.1.2 Hazardous Air Pollutants

In addition to the ambient air quality standards for criteria pollutants, regulations exist for hazardous air pollutants (HAPs). The National Emission Standards for Hazardous Air Pollutants (NESHAP) regulates 188 HAPs for stationary sources based on available control technologies (40 CFR Parts 61 and 63). The majority of HAPs are VOCs.

HAPs emitted from mobile sources are called Mobile Source Air Toxics (MSATs). MSATs are compounds emitted from highway vehicles and non-road equipment which are known or suspected to cause cancer or other serious health and environmental effects. In 2001, EPA issued its first MSATs Rule, which identified 21 compounds as being HAPs that required regulation (EPA 2001). A subset of six of these MSAT 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 MSAT 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 would likely vary in age and have a range of pollution reduction effectiveness. Construction equipment, however, would be operated intermittently over a large area and would produce negligible ambient HAPs in a localized area. Operational equipment, including vehicles driven by commuters, is anticipated to be primarily newer equipment (post-2010 model year) that generate lower emissions and would also produce negligible ambient HAPs. Therefore, HAP 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. The primary GHGs of concern are carbon dioxide (CO_2), CH_4, and nitrous oxide (N_2O). 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.

The FAA has developed interim guidance for considering GHGs and climate under NEPA, as documented in a memorandum dated January 12, 2012 (FAA 2012b). Additionally, in February 2010, the CEQ issued draft NEPA guidance for considering the effects of climate change and GHG emissions (CEQ 2010).

Each GHG is assigned a global warming potential (GWP). The GWP is the ability of a gas or aerosol to trap heat in the atmosphere. The GWP rating system is standardized to CO_2, which has a value of one. For example, CH_4 has a GWP of 21, which means that it has a global warming effect 21 times greater than CO_2, on an equal-mass basis. The equivalent CO_2 rate is calculated by multiplying the emission of each GHG by its GWP and adding the results together to produce a single, combined emission rate representing all GHGs, and this value is represented by CO_2e, which is defined as the carbon dioxide equivalent.

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 CO_2 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 (human-induced) GHG emissions globally (Melrose 2010). Climate change due to GHG emissions is a global phenomenon, so the affected environment is the global climate (EPA 2009). 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.

3.2 Noise and Compatible Land Use

Noise is considered any unwanted sound that interferes with normal activities or the natural environment. Noise sources can be constant or of short-duration and contain a wide range of frequency (pitch) content. Determining the character and level of sound aids in predicting the way it is perceived. Both launch noise and sonic booms are classified as short-duration events.

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

3.2.1 Noise Metrics

The decibel 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). Standard weighting filters help to shape the levels in reference to how they are perceived. An “A-weighting” filter approximates the frequency response of human hearing, adjusting low and high frequencies to match the sensitivity of human hearing. For this reason the A-weighted decibel level (dBA) is commonly used to assess community noise.

The impact of noise can be described with the use of noise metrics, which depend on the nature of the event and who or what is affected by the sound. Individual time-varying noise events have two main characteristics: a sound level that changes throughout the event and a period of time during which the event is heard. The maximum overall sound pressure level (OASPL) (L_{max}), indicates the highest sound level that occurs over the duration of the event. 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.

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 areas[1] using the DNL metric to determine if significant impacts (as they relate to human annoyance) would occur. In addition to complying with FAA Order 1050.1E, this EA considers other Federal agency noise guidelines as they relate to hearing conservation and structural damage.

Human Annoyance

FAA Order 1050.1E, Change 1, states 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. DNL has been found to correlate well with adverse community impacts for regularly occurring events including aircraft, rail, and road noise (Schultz 1978; Finegold et al 1994). DNL is based on long-term cumulative noise exposure to the previously mentioned noise sources, which do not include launch vehicles (rockets). Thus, it is acknowledged that the suitability of DNL for launch vehicle noise is uncertain with respect to current research and dose response studies. DNL is provided as the FAA considers DNL the best available metric to estimate the potential long-term annoyance.

Hearing Conservation

FAA Order 1050.1E, Change 1 does not have guidance on hearing conservation; although, multiple Federal government agencies have provided guidelines on permissible noise exposure limits. These documented guidelines are in place to protect human hearing from long-term continuous daily exposures to high noise levels and aid in the prevention of noise-induced hearing loss. In terms of upper limits on the noise levels, the National Institute for Occupational Safety and Health (NIOSH) set the maximum exposure at 140 dBA, and the Occupational Safety and Health Administration (OSHA) set it at 115 dBA for steady-state event. In addition, the Department of Defense Occupational Hearing Conservation Program (Department of Defense Instruction 6055.12) states that the maximum allowable exposure to steady-state noise is 130 dBA. The EPA does not state a maximum level for non-impulsive noise. Therefore, a maximum noise level of 115 dBA (the OSHA maximum exposure) is used as an initial

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[1] 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.

conservative threshold to identify potential locations where hearing protection should be considered for a rocket launch. Additional information can be found in Appendix A, *Noise*.

Structural Damage

A National Aeronautics and Space Administration (NASA) technical memo found a relationship between structural damage claims and OASPL, where "the probability of structural damage [was] proportional to the intensity of the low frequency sound" (Guest and Sloane 1972). This relationship estimated that one damage claim in 100 households exposed is expected at an average continuous level of 120 dB, and one in 1,000 households at 111 dB. It should be noted that this relationship was obtained from static rocket firings, which generated longer noise exposures compared to actual rocket launches. Thus, L_{max} values of 120 dB and 111 dB are used as a conservative threshold for potential risk of structural damage claims.

A sonic boom is the sound associated with the shock waves created by a vehicle traveling through the air faster than the speed of sound. Sonic booms may cause damage to structures. Sonic boom noise levels are described in units of peak overpressure in pounds per square foot (psf). Most damage claims are for brittle objects, such as glass and plaster. In general, sonic boom levels below 2 psf would not result in damage to structures in good repair.

3.2.3 Aircraft Operations and Noise Exposure

A baseline noise analysis for MAF was completed to estimate existing community noise exposure without the Proposed Action due to commercial and military aircraft flight operations and can be found in Appendix A. Approximately 200 flights occur at MAF each day: 65 percent commercial and 35 percent military. Although military aircraft account for a smaller percentage of daily flights, military aircraft generate the majority of the community noise exposure at MAF. While commercial aircraft operations are projected to increase over the 2012 to 2018 study period, the combined commercial and military noise contours will remain essentially constant because the military aircraft operations will remain steady and dominate the overall community noise levels. The 2018 model year is based on the year projected that Proposed Action operations would be fully realized and represents the baseline from which impacts from the Proposed Action were analyzed.

Exhibit 3.2-1 depicts the MAF 2012 to 2018 baseline DNL contours. The DNL 65 dBA (outer) noise contour extends approximately 8,000 ft (or almost 1.5 miles) from the end of each runway. Whereas the DNL 65 and 70 dBA contours extend beyond the MAF airfield boundary, the higher level contours (DNL 75 and 80 dBA) are mostly contained within the MAF boundary.

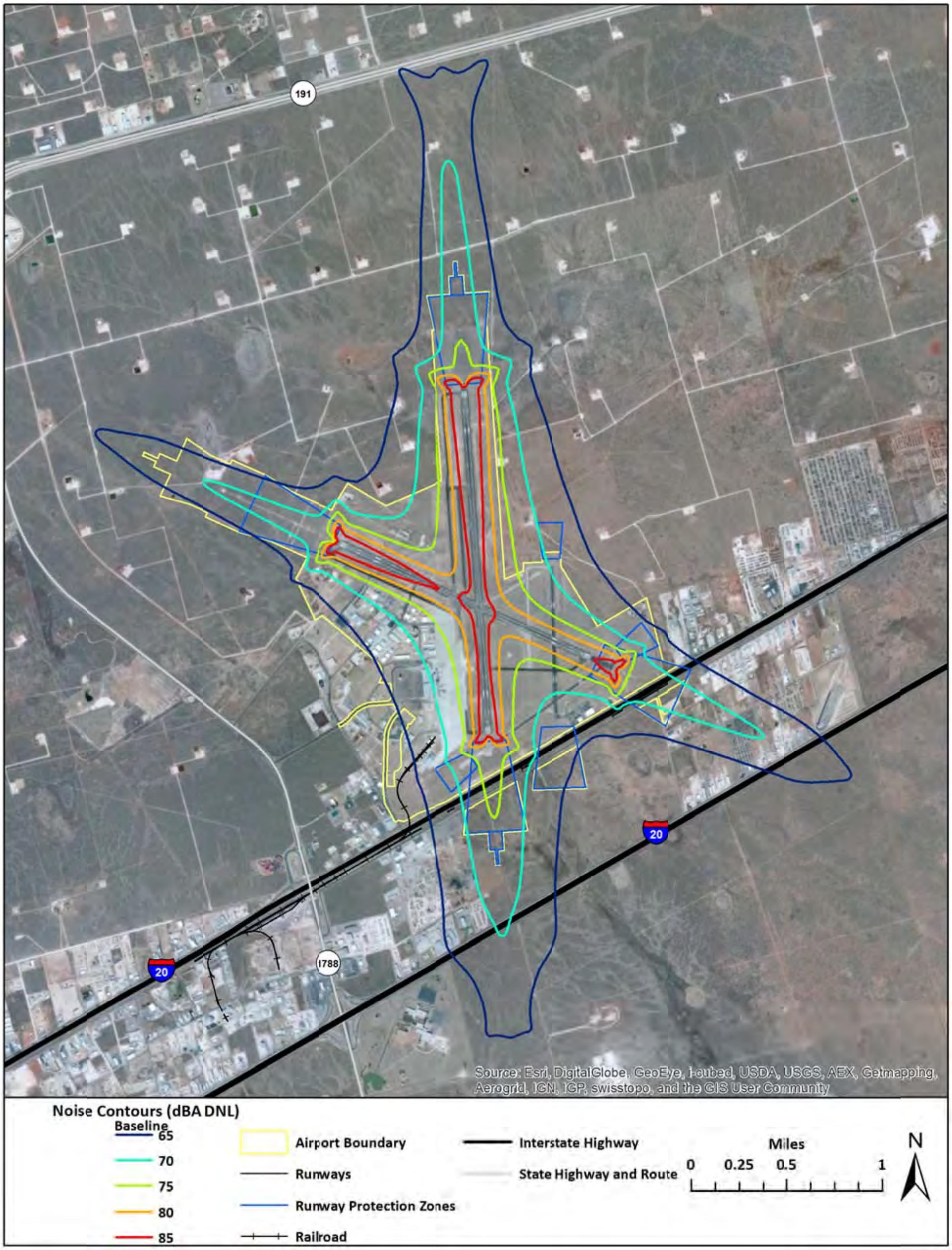

Exhibit 3.2-1. MAF Baseline 2012 – 2018 Day-Night Average Sound Level Contours

3.2.4 Compatible Land Use

Compatible land use occurs when the use of an adjacent property is not adversely affected by flight operations at an airfield and flight operations at an airfield are not adversely affected by the land use of the adjacent properties. Predominant land use in the areas adjacent to MAF consists of undesignated land use, meaning the city has not assigned the land a specific land use classification; however, the majority of this undesignated land use contains Texas General Lands Office oil and gas leases, and oil and gas wells are currently located within these areas (Exhibit 3.2-2). The remaining land use in the vicinity of the airport consists of vacant parcels, transportation, residential, community services, commercial services, office space, utilities, and industrial (City of Midland 2013a).

The Midland Master Plan 2025 provides guidance for future development within the City of Midland (City of Midland 2005). The master plan takes into consideration the importance of MAF in terms of the economic development outlined in the master plan. The Midland International Airport Business Development Plan and the Midland International Airport Master Plan Update were evaluated when the 2025 City of Midland Master Plan was developed. Future land use plans designate industrial and business park uses within and in the vicinity of MAF.

Table 3.2-1 depicts acceptable land use compatibility associated with yearly DNL. Based on the MAF baseline noise contours depicted in Exhibit 3.2-3, the airfield and the adjacent land use are currently compatible. Table 3.2-3 depicts the existing acreage of land use within the existing baseline noise contours.

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

	Yearly DNL Sound Level (decibels)					
Land Use	**<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

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

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 the public is received, office areas, noise sensitive areas or where the normal noise level is low.
[3]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.
[4]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.
[5]Land use compatible provided special sound reinforcement systems are installed.
[6]Residential buildings require an NLR of 25.
[7]Residential buildings require an NLR of 30.
[8]Residential buildings not permitted.

Table 3.2-2. Baseline Acreages for Land Use Noise Compatibility

Land Use Classification	DNL Contour (dBA)				
	65-70	70-75	75-80	80-85	>85
Transportation	120	42	5	0	0
Undesignated	1084	272	36	0	0
Residential	2.7	0	0	0	0
Commercial Services	5	0	0	0	0
Airport Facilities	327	418	270	295	114
Community Services	26	13	0	0	0
Office	1	0	0	0	0
Vacant	21	9	1	0	0

Notes: DNL = day-night average noise level; dBA = A-weighted decibels.

Exhibit 3.2-2. Oil and Gas Wells adjacent to MAF

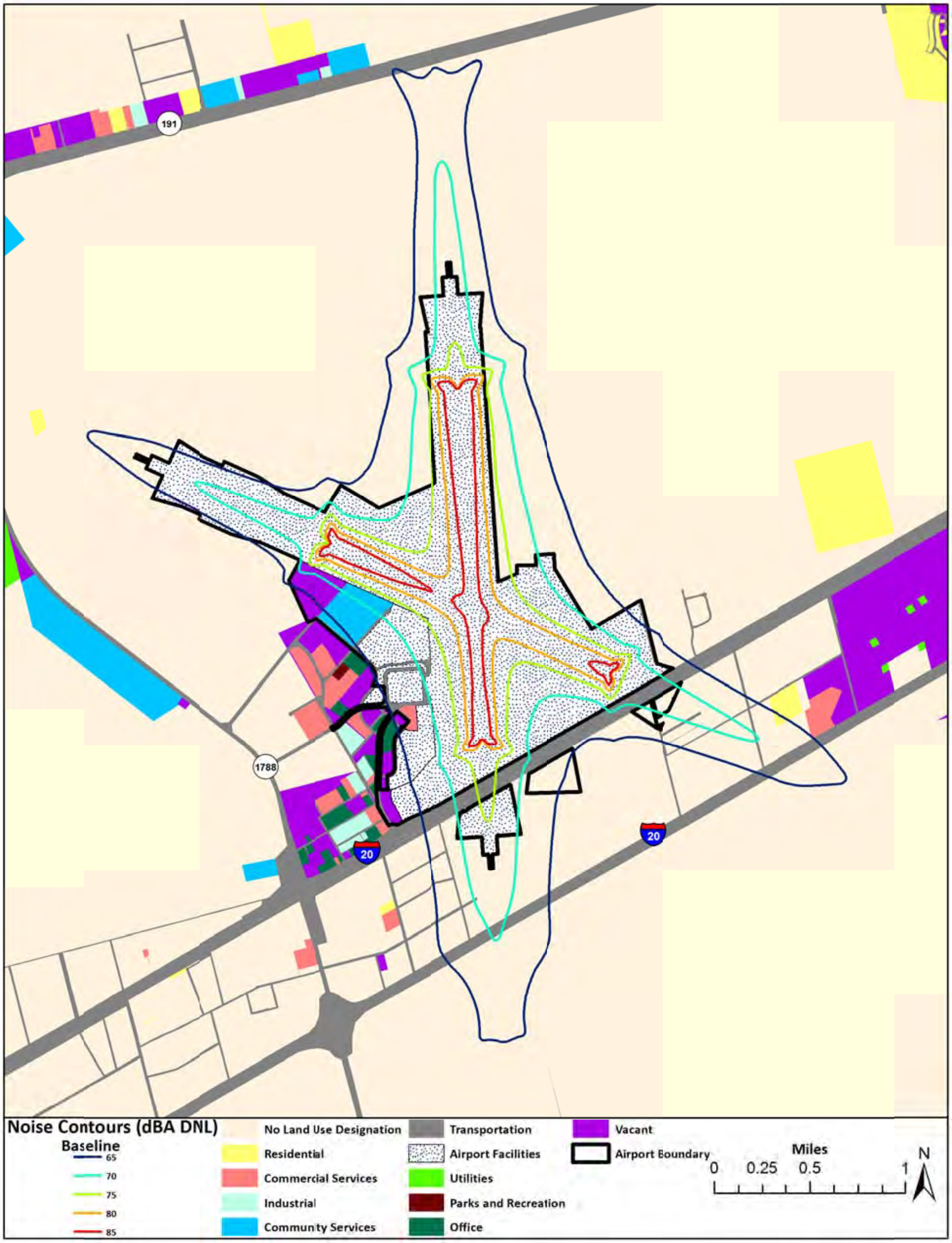

Exhibit 3.2-3. Existing Land Use and Noise Contours

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 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 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.

Public Parks, Recreation Areas, and Refuges

There are numerous public parks and recreation areas located within the ROI (the City of Midland and surrounding area). The closest parks and recreation areas to MAF are Beal Park, Grasslands Park, and C.J. Kelly Park (City of Midland 2006). Exhibit 3.3-3 depicts public parks and recreation areas within the City of Midland and surrounding area.

Several wildlife refuges and preserves are located within the ROI. These include the Interstate 20 Wildlife Refuge and Permian Basin East Loop of the Great Texas Wildlife Trails. The Permian Basin East Loop comprises several parks: Comanche Trail Park, Interstate 20 Wildlife Preserve, Wadley Barron Park, and Sibley Nature Center (Exhibit 3.3-3).

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 no historic or archaeological sites listed or eligible for listing on the NRHP within the ROI. Sections 3.4 and 4.4 discuss in detail historical, architectural, archaeological, and cultural resources.

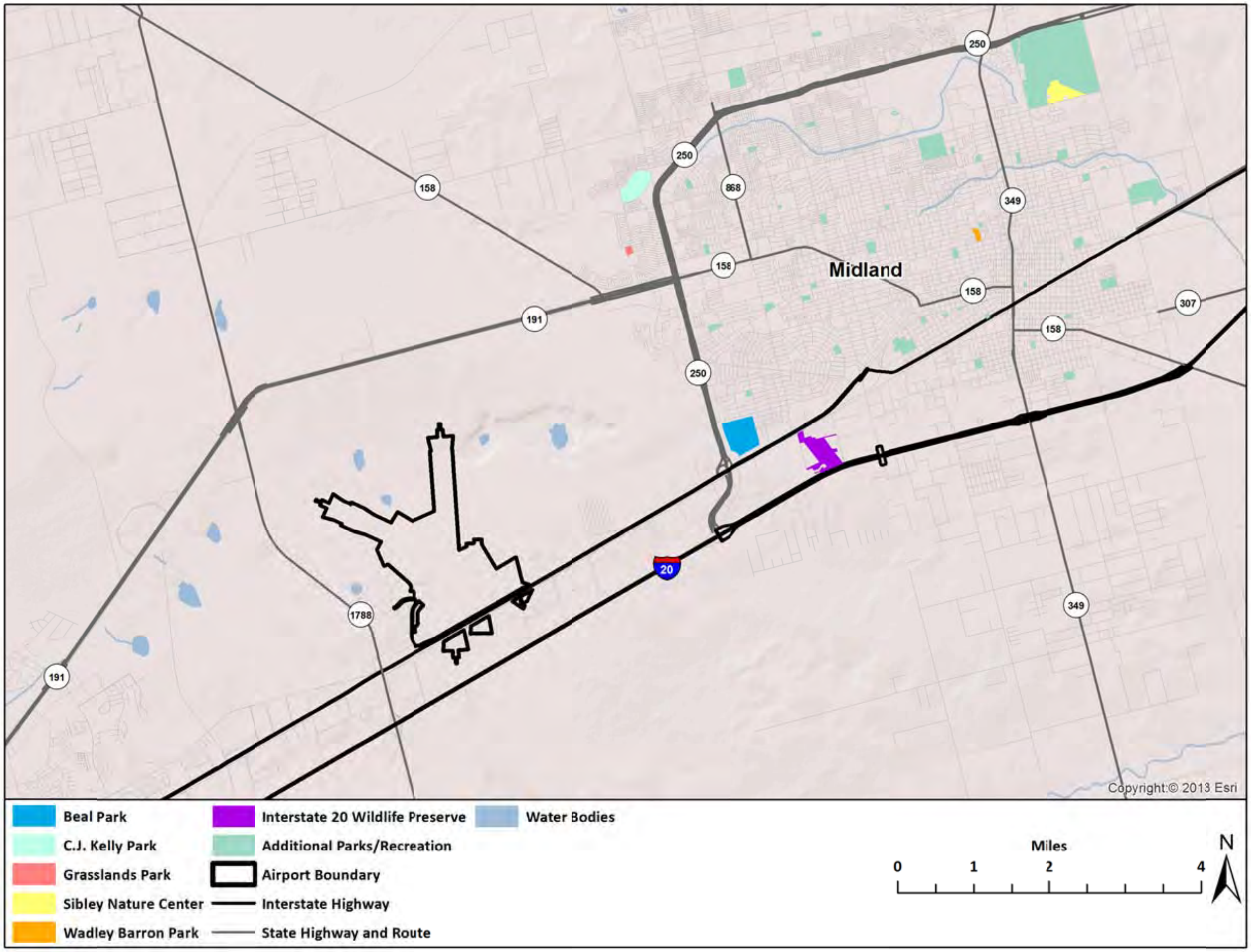

Exhibit 3.3-1. Section 4(f) Properties

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 on NRHP. Compliance with Section 106 requires consultation with the SHPO if there is a potential effect to historic properties listed or eligible for listing on the NRHP. The 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, in consultation with the THC, 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). Effects to archaeological resources, however, would be limited to the area within the APE where ground disturbance would occur from installation of the concrete pad and aboveground propellant storage tanks.

A review of the Texas Historic Sites Atlas, the NRHP online database, and other available resources revealed that there are no previously inventoried or NRHP-listed archaeological or architectural resources within the APE.

There are no known Traditional Cultural Properties identified within the APE; however, two tribes with interests in Midland County have been identified. These include the Comanche Nation of Oklahoma and the Tonkawa Tribe of Oklahoma. The FAA consulted with these tribes. In separate correspondence, both tribes indicated that no historic or cultural sites related to their respective Nation's heritage are in the APE (see Appendix C, *Agency Coordination*).

MAF was originally constructed as the Midland Army Airfield (AAF), a training center for bombardier cadets during WWII. Construction of the army airfield at and adjacent to Sloan Field, the City's municipal airport, began in July 1941 and was largely completed within six months. Midland AAF included two 6,500-ft-long asphalt runways, four hangars, aircraft maintenance shops, barracks, and other facilities (Ainsworth et al. 2008, B-66). Midland AAF became the largest bombardier training facility in the U.S. and pioneered the use of the secret Norden bombsight (Colwell 2013). A historical marker, issued by THC in 1968, commemorates the Midland Army Flying School. The historical marker has not been formally evaluated for the NRHP, but is considered to be not eligible because it does not meet Criteria Consideration G for exceptional significance for properties less than 50 years of age.

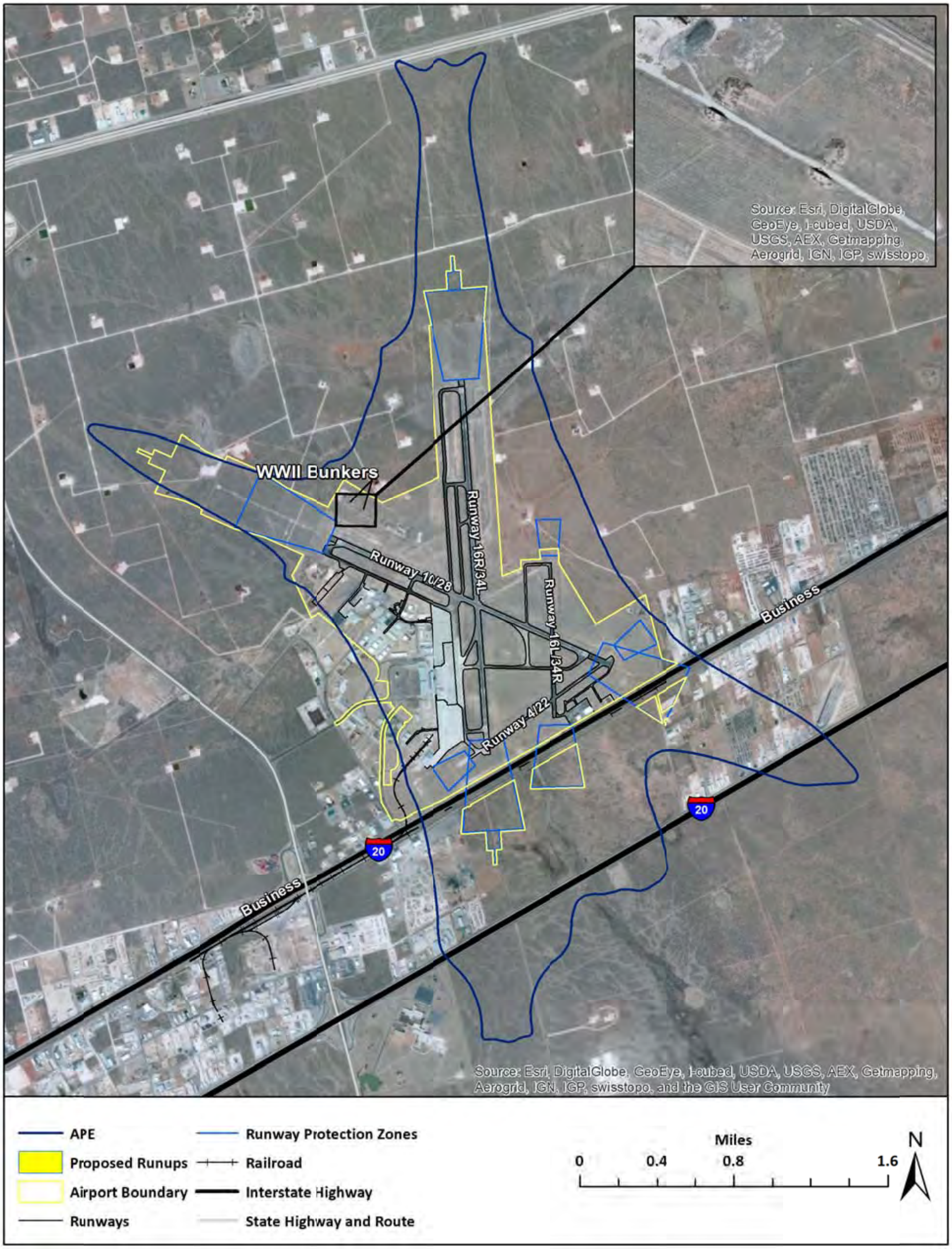

Exhibit 3.4-1. APE for Architectural Resources

The airport has been modernized and the majority of the WWII era buildings and structures have been demolished or heavily renovated and no longer retain historic integrity. Two WWII era igloo ammunition storage magazines are located on airport property. The igloos were associated with the military uses of this property during WWII and are located approximately 900 ft northeast of the northwest end of Runway 10/28 (see Exhibit 3.4-1). The two igloo ammunition magazines at MAF have been recommended not eligible for the NRHP. The FAA consulted with the THC on the determination of eligibility of the igloos. The THC concurred the igloos do not meet the NRHP criteria for eligibility (refer to Appendix C, *Agency Coordination*).

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 property within the boundaries of MAF that would be subjected to ground-disturbing construction activities. The ROI for wildlife and special-status species includes the area within the boundaries and vicinity of MAF and areas within the sonic boom footprints (see Section 4.2, Exhibit 4.2-4).

3.5.1 Vegetation

MAF is located in Midland County, Texas, which is the southern extent of the High Plains ecoregion. The ROI is in the Llano Estacado sub-ecoregion of the High Plains ecoregion. This area is a generally treeless, elevated plain transitioning in southern Midland County to a different subregion of rangeland and more arid conditions (Griffith et al. 2004). Prior to human disturbances such as agriculture, the Llano Estacado sub-ecoregion was covered by shortgrass prairie consisting of species such as buffalograss (*Buchloe dactyloides*), blue grama (*Bouteloua gracilis*), sideoats grama (*Bouteloua curtipendula*) and silver bluestem (*Bothriochloa laguroides ssp. torreyana*). Other plant species characteristic of the region are western wheatgrass (*Pascopyrum smithii*), galleta (*Pleuraphis jamesii*), yellow Indiangrass (*Sorghastrum nutans*), tobosagrass (*Pleuraphis mutica*), sand bluestem (*Andropogon hallii*), sand dropseed (*Sporobolus cryptandrus*), scarlet globemallow (*Sphaeralcea coccinea*), and stiffstem flax (*Linum rigidum*). Tree cover in the region is minimal, and the vegetated areas surrounding MAF generally support mesquite scrub-shrub vegetation consisting of mesquite, lotebush (*Ziziphus obtusifolia*), four-winged saltbrush (*Atriplex canescens*), and vine ephedra (*Ephedra pedunculata*) (Griffith et al. 2004; MAF 2012).

In compliance with airport safety standards, vegetation within MAF is controlled to reduce wildlife attractants. Vegetated areas on the property primarily consist of mowed areas of grasses and herbs such as buffalograss, Bermudagrass (*Cynodon dactylon*), little bluestem (*Schizacharium scoparium*), plains bristlegrass (*Setaria Leucopila*), sand dropseed, and sideoats grama (MAF 2012).

Invasive species are plants or animals that are non-native to the ecosystem and may harm native ecological or economic conditions of a region once introduced. Under EO 13112 *Invasive Species*, Federal agencies whose actions may affect invasive species must, to the extent feasible within budgetary limits, prevent the introduction of invasive species and restore native species or habitats. Texas Administrative Code (4 TAC §19.300(a)) lists 26 noxious and six invasive plant species that have serious potential to cause economic or ecological harm to the state; none of the plants identified on MAF during the Wildlife Hazard Assessment are included on the list. Texasinvasives.org provides a database of plants and animals considered to be invasive in Texas. The database identified Bermudagrass as a potentially invasive species. No other plants identified on MAF during the Wildlife Hazard Assessment were included in the Texasinvasives.org database (Texasinvasives.org 2011).

3.5.2 Wildlife

Wildlife resources include mammals, reptiles, amphibians, birds, and sometimes invertebrate species or species groups such as mollusks or insects. Due to airport safety considerations related to aircraft striking wildlife, vegetation, surface water, and other potential habitat features within MAF are controlled to minimize presence of wildlife. Fencing is maintained around the airport which further limits wildlife presence within MAF property. Habitat in the ROI primarily consists of former shortgrass prairie that has been altered by agriculture, rangeland, and oil and gas production and is mixed with commercial, light industrial, and residential uses.

A *Wildlife Hazard Assessment for the Midland International Airport* conducted at MAF from November 2010 to October 2011 documented wildlife occurrences within MAF property and within a 5-mile radius. A total of 8,122 birds were documented within 5 miles of MAF (MAF 2012). The most abundant group of birds included blackbird/starlings (39.1%), followed by ground foragers such as larks and buntings (25.8%), pigeons and doves (19.8%), aerial insectivores such as swallows (9.0%), raptors (3.2%), shorebirds (1.9%), corvids such as ravens (0.6%), and waterfowl (0.5%). A pair of great horned owls (*Bubo virginianus*) and an American kestrel (*Falco sparverius*) were documented using the WWII bunkers as a roost. Of all the bird observations described above, 33 percent were observed within the airport perimeter fence, indicating that the majority of bird species was not located on the airfield, but rather in habitat surrounding MAF (MAF 2012). Two of the bird species identified, the European starling (*Sturnus vulgaris*) and Eurasian collared-dove (*Streptopelia decaocto*), are listed as invasive by the Texasinvasives.org (Texasinvasives.org 2011).

The Migratory Bird Treaty Act (MBTA) was designed to protect migratory birds (including their eggs, active nests, and bird parts). MAF is located within the Central Flyway, a major migratory route used annually by waterfowl, raptors, and other birds. Midland is not located within the most heavily utilized portion of the Central Flyway. However, large numbers of migratory birds have been documented moving through the area during the spring and fall (MAF 2012).

Cottontails and jackrabbits are the most abundant non-avian species within the ROI. Other mammal species documented in the ROI include hispid pocket mouse (*Chaetodipus hispidus*), Southern Plains woodrat (*Neotoma micropus*), gray fox (*Urocyon cinereoargenteus*), coyote (*Canis latrans*), striped skunk

(*Mephitis mephitis*), Mexican ground squirrel (*Spermophilus mexicanus*), mule deer (*Odocoileus hemionus*), and a plains hognose snake (*Heterodon nasicus nasicus*) (MAF 2012). No invasive non-avian species as listed by Texasinvasives.org were identified during the Wildlife Hazard Assessment (MAF 2012).

MAF has an active Wildlife Management Program and is developing a Wildlife Hazard Management Plan to reduce the risk of damage and injury due to aircraft strikes of avian and other wildlife. The Wildlife Management Program guides the efforts to disperse and control wildlife on the airport whenever necessary. Control efforts include "no feeding" policies, maintaining exclusion fencing, and removing habitat attractants within airport property. Airport personnel use a wildlife activity log to report wildlife observations or management activities carried out. Based on all recorded bird or animal strike data, 97 percent of reported strikes involved birds or bats (MAF 2012).

For the purposes of this EA, the ROI for wildlife also includes those areas potentially subject to sonic booms associated with the flight operations of the Lynx RLV. Two sonic booms would be generated during a launch – one during ascent and another during vehicle reentry. The sonic boom generated during ascent would not be heard on the ground due to the steep ascending flight path angle of the Lynx RLV. Sonic booms generated by the launch vehicle during reentry could be heard in several counties around MAF, including Midland County. Because the Lynx RLV has two proposed reentries/approaches onto Runway 16R/34L – from either a northern or southern trajectory – Exhibit 4.2-4 depicts two sonic boom contours. These contours overlie approximately 19,000 square miles to include 28 counties in Texas and one county in New Mexico, and constitute the ROI for the Proposed Action (Table 3.5-1).

Table 3.5-1. Counties within the ROI

Texas				New Mexico
Andrews	Gaines	Midland	Terrell	Lea
Borden	Glasscock	Mitchell	Terry	
Crane	Howard	Nolan	Tom Green	
Crockett	Irion	Pecos	Upton	
Dawson	Loving	Reagan	Ward	
Ector	Lynn	Scurry	Winkler	
Fisher	Martin	Sterling	Yoakum	

The affected environment encompasses the lands and resources within the sonic boom contours (Exhibit 4.2-4). This approximate 19,000 square mile area includes diverse habitats within four recognized ecological regions of Texas: Edwards Plateau, Rolling Plains, High Plains, and Trans Pecos.

The majority of the ecological regions within the project area originally consisted of grassland or open savannah plains, with tree or brushy species along stream bottoms and rocky slopes. Most of the tallgrasses have been replaced by mid- and shortgrasses. Many rangelands in this region have been invaded by annual and perennial forbs, legumes, and woody species due to historic livestock grazing practices and lack of naturally occurring fire on the landscape. Mesquite grasslands dominate vast areas. The region is currently primarily used for agriculture and cattle ranching. The wildlife community of the region consists of species suited to semi-arid environments. Representative species include coyote, pronghorn antelope, Sonoran Desert pocket mouse, kangaroo rats, desert mule deer, desert cottontail,

cactus wren, red-tailed hawk, mourning dove, greater roadrunner, American kestrel, Couch's spadefoot toad, Texas spotted whiptail lizard, Texas banded gecko, Trans-Pecos ratsnake, and western diamondback. Due to the arid nature of the region, reptile species are prevalent. Amphibians can be locally and temporally abundant, especially in ephemeral playas and similar areas after summer thunderstorms (Brown 1994; McNab and Avers 1994).

3.5.3 Special-Status Species

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 plant and animal species, and critical habitats in which they are found. 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 USFWS administers the ESA primarily for land and freshwater species and designates critical habitat for 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 listed 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.

Databases identifying threatened and endangered species within Midland County are available through the USFWS Southwest Region website (USFWS 2014) and the TPWD website (TPWD 2011). Based on these website results, three state-listed threatened animal species occur or potentially occur in Midland County: Texas horned lizard (*Phrynosoma cornutum*), bald eagle (*Haliaeetus leucocephalus*), and peregrine falcon (*Falcon peregrinus*) (TPWD 2011, 2013a; USFWS 2014). A project-specific review request was submitted to the TPWD Texas Natural Diversity Database. The database contained no records of any state or federally listed species potentially occurring within Midland County (TPWD 2013b).

The peregrine falcon and bald eagle are known to rest and nest in tall trees, cliffs, or other tall structures, and may be transient through the vicinity of MAF. In addition to being listed by the State of Texas as threatened, bald eagles are also protected under the Bald and Golden Eagle Protection Act and MBTA. The Texas horned lizard utilizes open, sparsely vegetated areas and may burrow into sandy or rocky soils, or utilize rodent burrows. Suitable habitat for the Texas horned lizard is not found within MAF. No state-listed species were observed in or in the vicinity of MAF during the Wildlife Hazard Assessment (MAF 2012).

As stated previously for wildlife (see Section 3.5.2), the ROI for special-status species includes only those areas potentially subject to sonic booms associated with the flight operations of the Lynx RLV. These contours overlie approximately 19,000 square miles of 28 counties in Texas and one county in New Mexico, and constitute the ROI for the Proposed Action.

Databases identifying threatened and endangered species underlying the sonic boom contours are available through the USFWS Southwest Region website (USFWS 2014) and the TPWD website (TPWD 2011). Based on these website results, four federally and state-listed endangered, two federally listed threatened, and five state-listed animal species occur or potentially occur within counties underlying the proposed sonic boom contours (Table 3.5-2) (TPWD 2011, 2013a, 2013c; USFWS 2014). Only those wildlife species that may be potentially impacted by sonic booms are included (i.e., birds and mammals). Plants, fish, reptiles, and amphibians are not addressed as they are not expected to be impacted by a sonic boom because the very short duration of a sonic boom would not impair such species ability to detect prey or avoid predators. The sonic boom sound would be a very brief noise event (less than 1 second) similar to a clap of thunder (see Section 4.2.1 for further information). The source would also be well removed from the receptor, and most animals react to a noise that is associated with the visual or physical presence of the noise source not just the noise). Although the sonic boom ROI includes a total of 29 counties, not all counties have occurrences of ESA-listed species.

Table 3.5-2. Federally and State-Listed Species Potentially Occurring within Counties underlying the Sonic Boom Contours

Common name (*Scientific name*)	Status*	
	State	Federal
Northern aplomado falcon (*Falco femoralis septentrionalis*)	E	E
Bald eagle *(Haliaeetus leucocephalus)*	T	-
Black bear (*Ursus americanus*)	T	T
Black-capped vireo (*Vireo atricapilla*)	E	E
Least tern (*Sterna antillarum*)	E	E
Lesser prairie-chicken (*Tympanuchus pallidicinctus*)[1]	-	T
Peregrine falcon *(Falco peregrinus)*	T	-
Reddish egret (*Egretta rufescens*)	T	-
Whooping crane (*Grus americana*)	E	E
Zone-tailed hawk (*Buteo albonotatus*)	T	-

Note: *E = endangered; T = threatened. [1]Lesser prairie-chicken listed as threatened on April 10, 2014 (79 FR 69).
Sources: TPWD 2011, 2013a, 2013c; USFWS 2014.

Although the golden-cheeked warbler is listed as occurring within Tom Green County, based on species habitat requirements, it would not be found within the area of Tom Green County within the action area. Nesting and foraging habitat for golden-cheeked warblers is found in live oak-ash juniper woodlands consisting of tall, closed canopy, dense, mature stands of Ashe juniper mixed with trees such as oaks, Texas ash, cedar elm, hackberry, bigtooth maple, sycamore, little walnut, and escarpment cherry. This type of woodland generally grows in relatively moist areas such as steep-sided canyons, slopes, and adjacent uplands (USFWS 2014). The habitat within the extreme northwestern portion of Tom Green County within the action area is mesquite-juniper shrub (TPWD 1984). The southeastern corner of Tom Green County is the only area within the county that contains suitable golden-cheeked warbler habitat (i.e., live oak-ash juniper parks and live oak-mesquite-ashe juniper parks; TPWD 1984)

and this area is outside of the ROI. Therefore, the FAA has determined that the Proposed Action would have no effect on the golden-cheeked warbler and the species is not addressed further.

3.6 Water Quality

Water resources include surface waters, groundwater, wetlands, and floodplains. 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. There are several Federal, State, and local laws and regulations that address water resources. At the Federal level, the CWA; Safe Drinking Water Act; Fish and Wildlife Coordination Act; Rivers and Harbors Act; EO 11990, Protection of Wetlands; and EO 11988, Floodplain Management serve to protect water resources. At the State level, TCEQ regulates wetlands and water quality through the state's water quality certification program (CWA 401). 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 Midland, Texas Code of Ordinances, Part 2 Municipal Code, Title XI-Planning and Development, Chapter 3 Flood Hazard Areas regulates floodplains within the City of Midland.

3.6.1 Surface Waters (Excluding Wetlands)

The ROI for surface waters is the MAF property. Midland County lies within the Colorado River Basin and Johnson Draw Sub-basin. There are no lakes, rivers, or streams located within the property boundary of MAF (Exhibit 3.6-1). In 2012, Diamondback Energies (formerly Windsor Energy) constructed a freshwater pond located on airport property off of the north end of Runway 10/28. This pond contains freshwater for use in the Diamondback Energies drilling operations. The FAA is allowing the pond to remain in place to allow MAF to manage the environment around the pond and exclude wildlife (Exhibit 3.6-1).

3.6.2 Groundwater

The ROI for groundwater is Midland County. Groundwater in Midland County, Texas is entirely within the Ogallala Aquifer, which is found throughout the Great Plains including: South Dakota, Nebraska, Wyoming, Colorado, Kansas, Oklahoma, New Mexico, and Texas (High Plains Water District [HPWD] 2013). The Ogallala Aquifer provides more water to users than any other in the state with approximately 95 percent of the water withdrawn from the aquifer used for irrigation purposes (TWDB 2011). Water quality associated with the aquifer is suitable for irrigation purposes. However, in some areas the water does not meet EPA drinking water quality standards. Sulfate, chloride, selenium, fluoride, nitrate, and total dissolved solids have been identified above EPA standards by some constituents (HPWD 2013).

Review of the Texas Water Development Board (TWDB) groundwater database report system indicates that there are eight registered groundwater wells within the MAF property boundary. These wells are not located near the proposed engine test pad or proposed propellant storage areas (TWDB 2013).

There are no designated Sole Source Aquifers within the region (EPA 2013b). Sole Source Aquifer designations are applied by the EPA to protect drinking water supplies in areas with few or no alternative sources to the groundwater resource.

3.6.3 Wetlands

The ROI for wetlands is the MAF property (refer to Exhibit 3.6-1). National Wetland Inventory (NWI) mapping and the Wildlife Hazard Assessment prepared for MAF indicate there are wetland areas located north of Runway 16R/34L and northwest of Runway 10/28. There is also a small wetland area located north of Runway 4/22 (USFWS 2013b; MAF 2012). Additionally, no streams, rivers, or lakes are present on site. Exhibit 3.6-1 depicts the NWI locations.

3.6.4 Floodplains

There are seven FEMA-mapped Special Flood Hazard Areas (SFHAs) within or partially within the ROI (MAF property) (Exhibit 3.6-1). Four of these SFHAs are associated with isolated NWI wetlands. All seven SFHAs are designated as Zone A (City of Midland 2013a), which is an area subject to inundation by the 1-percent -annual -chance flood event (100-year flood) (FEMA 2013).

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 Executive Orders 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*
- EO 13514, *Federal Leadership in Environmental, Energy, and Economic Performance*

The ROI for natural resources and energy supply includes the immediate vicinity of MAF. It is estimated that approximately one-half of the utility usage at MAF is associated with City of Midland facilities. The utility suppliers for MAF and the annual usage of these utilities by the City of Midland facilities are shown in Table 3.7-1 (MAF 2013a). In addition to the utility services to the airport, gasoline and other fuels are used for the operation of the facility vehicles within MAF.

Table 3.7-1. Utility Suppliers for Midland International Airport

Utility	Provider	Annual Utility Usage
Electricity	Reliant	5,839,426 KWH (kilowatt-hours)
Natural Gas	Atmos Energy	116,465 ccf (ccf – 100 cubic feet)
Potable Water Distribution	City of Midland	6,636,666 gallons
Wastewater Collection	City of Midland	5,000,000 gallons*

Notes: *Estimated based on the assumption that ¼ of the potable water is used for irrigation.
Source: MAF 2013a.

Exhibit 3.6-1. Water Resources

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 the Resource Conservation and Recovery Act (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, transport, treatment, storage, and disposal 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 Federal Oil Spill Prevention, Control, and Countermeasure Regulations are contained in 40 CFR Part 112.

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 Midland Sanitation Department is responsible for enforcing State and City regulations for general sanitation.

The ROI for hazardous materials, pollution prevention, and solid waste is limited to MAF and the immediate vicinity that could be affected by the materials transported, stored, and used, waste generated, or spills/releases that occur as a result of implementing the Proposed Action. The majority of the hazardous materials handled at MAF are aviation fuels. These fuels are stored in three locations at MAF. The North Hangar Development Area consists of five underground tanks including three 25,000-gallon Jet A tanks and two 25,000-gallon 100 LL tanks. In the South Hangar Development Area, there are six underground tanks, including three 25,000-gallon Jet A tanks, one 10,000-gallon Jet A tank, and two 25,000-gallon 100 LL tanks. In the East Hangar Development Area, there are three underground tanks, including two 25,000-gallon Jet A tanks and one 20,000-gallon 100 LL tank.

The potential for hazardous waste generation within the ROI is primarily associated with fuel spills and the washing of vehicles on-site. All vehicle washing activities are required to be performed in designated areas. These areas drain and collect hazardous wastes in the grease trap installed to prevent conveyance

of hazardous wastes into the environment or to the downstream wastewater treatment plant. Minor fuel spills (< 5 gallons) are collected with a sphagnum absorbent and discarded into the landfill with other solid wastes. The response methods for larger spills are addressed in the Airport Emergency Plan, currently in place (City of Midland 2011b).

Solid waste generated at MAF is contracted for pickup through the City of Midland Sanitation Department (MAF 2013b).

3.9 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). This section describes the basic attributes and resources associated with the human environment, particularly population, employment, income, housing, and community services.

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 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
- Employment and Income
- Housing
- Community Services

- Environmental Justice
- Children's Environmental Health and Safety

The ROI for the socioeconomics analysis is defined to include the area in which the majority of direct and secondary or indirect effects on socioeconomic variables arising from the Proposed Action's construction and operation are likely to occur. The ROI, unless otherwise noted, is the Midland Metropolitan Statistical Area (MSA) (Midland and Martin counties) and the Odessa MSA (Ector County). These two MSAs compose the Midland-Odessa Combined Statistical Area. Combined Statistical Areas can be characterized as representing regions that reflect broad social and economic interactions, such as wholesaling, commodity distribution, and weekend recreation activities (Office of Management and Budget 2009), in addition to the strong social and economic integration (as measured by commuting to work) with the urban areas that is captured by the MSAs.

The ROI for environmental justice and children's environmental health and safety risks includes Midland, Martin, and Ector counties, and the Census Tracts that encompass and abut MAF. MAF is located in Census Tract 9800. No people live in Census Tract 9800; therefore, it is not included in this analysis. Census Tracts 101.09 and 101.14 in Midland County 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.

3.9.1 Population

The 2010 U.S. Census reports a total population of 278,801 persons within the ROI (USCB 2012). Midland County has 152 persons per square mile, while Ector County has 96.3 persons per square mile. Martin County is the most rural, with 5.2 persons per square mile. Table 3.9-1 presents the population and population density figures from the 2010 Census.

Table 3.9-1. Population and Population Density, 2010

Jurisdiction/Region	Population	Population Density (persons per square mile)
United States	308,745,538	87.4
Texas	25,145,561	96.3
Midland County	136,872	152.0
Martin County	4,799	5.2
Ector County	137,130	96.3
ROI Total	278,801	-

Source: USCB 2012.

Table 3.9-2 shows the 2000-2010 population growth rates for the U.S., the State of Texas, and for the three counties within the ROI (USCB 2012). The Census estimates that the population growth rate in the ROI was 15.3 percent from 2000 to 2010. This rate is lower than the population growth rate for Texas but higher than the growth rate for the U.S. From 2011 to 2012, the cities of Midland and Odessa were among the fastest growing cities in the U.S. (USCB 2013a), attributable largely to a boom in oil and gas extraction industry. The population of the City of Midland has grown by approximately 8 percent since the 2010 Census (City of Midland 2013b).

Table 3.9-2. Population Growth Rates, 2000 - 2010

Jurisdiction/Region	Percent Growth
United States	9.7
Texas	20.6
Midland County	17.9
Martin County	2.8
Ector County	13.2
ROI Total	15.3

Source: USCB 2012.

3.9.2 Employment and Income

Table 3.9-3 summarizes the employment sectors and the percent of workers employed in those sectors from the Census American Community Survey 2007-2011 5-Year Estimates, the best consistent data for all the jurisdictions. The industries that employ the greatest numbers of people in the ROI are (1) Agriculture, Forestry, Fishing, Hunting, and Mining (includes Oil and Gas Extraction); (2) Educational Services, Health Care, and Social Assistance; and (3) Retail Trade. The ROI has been experiencing a boom in the oil and gas extraction industry since 2012 that has resulted in the development of supporting services such as accommodations and food service.

The ROI total civilian labor force is 138,694 (USCB 2013b). The Midland Development Corporation was appointed by the Midland City Council to promote and diversify the economy and increase employment. The Corporation offers incentives to qualified new and existing employers who create jobs in the community.

Table 3.9-3. Percent of Workers Employed by Industry, 2011

Industry	Midland County	Martin County	Ector County	Texas	United States
Agriculture, Forestry, Fishing, Hunting, Mining	16.8	24.5	11.4	2.9	1.9
Construction	7.4	8.3	8.7	8.3	6.8
Manufacturing	5.8	5.7	9.1	9.6	10.8
Wholesale Trade	4.5	0.5	4.5	3.2	2.9
Retail Trade	10.7	10.8	10.2	11.5	11.5
Transportation, Warehousing, Utilities	4.6	6.3	5.6	5.6	5.1
Information	1.9	0.3	1.8	2.1	2.3
Finance, Insurance, Real Estate	5.2	2.2	5.5	6.8	6.9
Professional, Scientific, Management, Administrative, Waste Management	8.3	4.4	6.5	10.6	10.5
Educational Services, Health Care, Social Assistance	17.6	21.1	18.2	21.2	22.5
Arts, Entertainment, Recreation, Accommodation, Food Services	8.1	2.2	9.0	8.3	9.0
Other Services	6.3	4.0	6.5	5.3	4.9
Public Administration	2.8	9.6	3.0	4.4	4.9

Source: USCB 2013b.

Unemployment rates for the ROI are shown in Table 3.9-4. Unemployment rates from 2011 to 2012 have declined in the ROI at a greater rate than in Texas and the nation. Unemployment rates in all three counties are below the state and national averages.

Table 3.9-4. Unemployment Rates

Jurisdiction	Unemployment Rate 2011 (%)	Unemployment Rate 2012 (%)	Percent Change in Unemployment Rate
United States	8.9	8.1	-9.0
Texas	7.9	6.8	-13.9
Midland County	4.4	3.5	-20.5
Martin County	5.3	4.3	-18.9
Ector County	5.8	4.2	-27.6

Source: Bureau of Labor Statistics 2013.

Table 3.9-5 presents a comparison of per capita income and median household income for the U.S., Texas, and the ROI. Midland County has a higher per capita and median household income than Texas and the U.S. While Ector County has a per capita income less than Texas, median household income is similar. Ector County per capita and median household income is less than the U.S. Martin County has the lowest per capita and median household income of the ROI, and is also lower than Texas and the U.S.

Table 3.9-5. Per Capita and Median Household Income, 2010

Jurisdiction	Per Capita Income	Median Household Income
United States	$27,334	$51,914
Texas	$25,548	$50,920
Midland County	$30,956	$54,945
Martin County	$19,695	$38,111
Ector County	$24,010	$50,056

Source: USCB 2012.

3.9.3 Housing

Housing profiles provide an indication of the capacity of an area to adjust to changes in population trends. The number of housing units in the ROI totaled 109,983 in 2010 and is listed for each county in Table 3.9-6. Homeowner vacancy rates in the ROI were below state and national averages. The rental vacancy rate in Midland County was lower than for Texas and the U.S. Martin County had the lowest homeowner vacancy rate and the highest rental vacancy rate. In Ector County, the rental vacancy rate was similar to that of Texas and greater than in the U.S.

Table 3.9-6. General Housing Profile, 2010

Jurisdiction	Total Housing Units	Vacant Housing Units	Homeowner Vacancy Rate (%)	Rental Vacancy Rate (%)
United States	131,704,730	14,988,438	2.4	9.2
Texas	9,977,436	1,054,503	2.1	10.8
Midland County	55,104	3,975	1.1	7.5
Martin County	1,852	203	0.3	13.9
Ector County	53,027	4,339	1.4	10.2

Source: USCB 2012.

With robust population growth in the cities of Midland and Odessa, demand has increased for temporary and permanent housing since 2010. This has resulted in a shortage of housing that has driven up housing costs. Because of difficulties in finding affordable housing in the area, the Midland Independent School District has implemented a program to assist school teachers with the cost of rental

housing and has had to set up temporary, pre-fabricated accommodations for teachers. The City of Midland has approved development projects for approximately 3,000 units of temporary and permanent housing and 1,700 hotel rooms to meet this demand (City of Midland 2013c). The City continues to receive permit applications for additional housing development (City of Midland 2013c) and housing starts of single-family housing in 2013 are more than 60 per month (USCB 2013c). The City of Odessa has had a population increase of 6.2% since 2010 and like Midland, housing starts have grown steadily, doubling since 2010 (USCB 2013c).

3.9.4 Community Services

Emergency Response

Emergency response services are provided by police, fire, and emergency medical technicians. Emergency response for the Proposed Action would be provided by MAF ARFF in accordance with the MAF Airport Certification Manual and Airport Emergency Plan. MAF pays the City of Midland for police and fire services. The Airport Certification Manual establishes operational and safety standards and provides for such things as firefighting and rescue equipment, in accordance with 14 CFR Part 139 (refer to Section 1.1.1).

The Airport Emergency Plan establishes responsibilities and measures to prevent and minimize personal injury and property damage at MAF. The plan does not include every possible scenario that may occur at MAF and is designed to serve as a guide to those responding to emergencies. This plan also indicates that the City of Midland Emergency Operations Center would be used if required by emergency.

The airport police are instructed by the Airport Police Lieutenant who reports to the City of Midland Chief of Police (City of Midland 2011a). The airport police are responsible for airport security. This includes such things as the inspection of secure areas, secure gates, monitoring of vehicular activities, regulation of traffic, and monitoring of parking areas. In addition, all City of Midland ordinances are enforceable by the airport police (City of Midland 2011a).

MAF is required to operate under an ARFF Index (City of Midland 2011a). The Index determines the type of ARFF equipment and quantity of fire extinguishing agent that the certificate holder must provide in accordance with 14 CFR Part 139. MAF operates under Index B, which is based on five or more scheduled departures per day for a Boeing 737 (City of Midland 2011a). Due to the potential use of the airport by larger aircraft and by military uses, MAF voluntarily operates under Index C (City of Midland 2011a).

The Director of Airports manages all aircraft emergencies outside of MAF within the city limits of Midland (City of Midland 2011a, 2011b). The ARFF Captain or Battalion Chief has direct control and direction during fire and rescue activities (City of Midland 2011b).

MAF is required to have at least one Emergency Medical Technician on duty when carrier operations are taking place (City of Midland 2011a).

Medical Facilities

The closest hospitals are Midland Memorial Hospital and Odessa Regional Hospital, approximately 8 miles and 13 miles from MAF, respectively, which provide approximately 1,000 beds (City of Midland 2011b). There are also home health care services based in the cities of Midland and Odessa within 5 to 10 miles of MAF.

Schools

MAF is located within approximately four miles of the city limits of both Midland and Odessa, the major population centers in the vicinity of MAF. It is assumed that most people employed at MAF live and send their children to school in these population centers. Therefore, the ROI for schools is Midland and Ector counties, specifically the City of Midland and City of Odessa.

There are 36 public schools serving 22,500 students in the Midland Independent School District (MISD 2013). The closest school is Henderson Elementary School, located 9 miles from MAF. The closest school in Odessa is LB Johnson Elementary, located 4 miles from MAF. Because of rapid population growth in Midland, the Midland Independent School District is planning to hire up to 150 new school teachers for the 2014 school year.

3.9.5 Ground Traffic and Transportation

MAF is located mid-way between the City of Midland and the City of Odessa, approximately 9 miles from each. The principal arterial roadways between these cities include State Highway 191 to the north of the airport and Interstate 20 to the south. Additionally, Interstate Business 20 is the minor arterial roadway running between the two cities that provides access to the airport. Direct access to the airport is provided by La Force Boulevard, which is the loop formed to provide access between the airport and Interstate Business 20.

Interstate Business 20 is a 4-lane divided highway. For a speed limit of 55-mph on a 4-lane divided highway, to maintain a level of service (LOS) A, the maximum flow rate cannot exceed 600 passenger cars per hour per lane (pc/h/l) (see Table 3.9-7). If the flow rate exceeds 600 pc/h/l the LOS would decrease indicating an increase in congestion.

Table 3.9-7. Maximum Flow Rate for Different Levels of Service

LOS	Maximum Flow Rate – Both Directions combined (passenger cars/hour/lane)
A	600
B	990
C	1430
D	1850
E	2100

Source: Goswami 2009.

The Texas Department of Transportation (TxDOT) conducts traffic counts for each district, approximately every 5 years. The latest available traffic counts for the district including the City of Midland were performed in 2007. This data indicates that the average daily traffic (ADT) along Interstate Business 20 in the vicinity of MAF is 16,210 (TxDOT 2007). Assuming the majority of the traffic takes place over an 18-

hour period and applying a Peak Hour Factor of 0.92, the calculated flow rate based on an ADT of 16,210 is 245 pc/h/l.

This is well below the maximum flow rate of 600 pc/h/l for LOS A, indicating this portion of Interstate Business 20 typically flows at LOS A. Although traffic counts are not available for the traffic accessing MAF directly, with the proximity of the available counts to the site, it is assumed that all the traffic in the vicinity is flowing at a comparable rate.

3.9.6 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 Alaskan 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. For the purposes of this EA, the term "meaningfully greater" is interpreted to be 20 percentage points greater than the geographic region of comparison. The geographical region of comparison in this analysis is the State of Texas.

Table 3.9-8 shows the percent race and ethnicity in the ROI. Midland County has a lower percentage of minorities than Texas but greater than the nation. The percentage minority population in Census Tract 101.09 is about the same as Texas, while the rate for Census Tract 101.14 is lower than for Texas. Martin County has a lower minority population percentage than Texas. Ector County has a higher percentage of minority population than both Texas and the U.S. The racial minority population of the ROI is mainly Black or African American followed by Asian (USCB 2013b). The Hispanic and Latino ethnic minority population is between 22 and 54 percent of the ROI jurisdictions. For the purposes of this EA, Census Tract 101.09 and Ector County would be considered environmental justice populations.

Table 3.9-8. Percent Race and Ethnicity, 2011[a]

Jurisdiction	White (not Hispanic/Latino)	Total Minority[a]	Hispanic or Latino Origin[b]
United States	63.4	36.6	16.7
Texas	44.8	55.2	28.1
Midland County	52.2	47.8	38.8
Census Tract 101.09	44.6	55.4	53.2
Census Tract 101.14	72.7	27.3	22.9
Martin County	52.3	47.7	44.4
Ector County	39.9	60.1	53.9

Source: USCB 2012.
Notes: [a]Minority as defined for environmental justice populations: Black or African American, Asian or Pacific Islander, American Indian or Alaskan Native, other non-White races, or as being of Hispanic or Latino origin.
[b]Total percent Hispanic/Latino origin may be of any race and is reported separately for informational purposes.

Table 3.9-9 presents data for low-income families and individuals in the ROI whose annual income in the past 12 months was below the poverty level. Midland and Martin counties have a lower rate of families

below the poverty level than Texas and have the same rate as the nation. The poverty rate for individuals in Midland County is higher than for both Texas and the country. Martin County's poverty rate for individuals is less than both the State and U.S. Census Tracts 101.09 and 101.14 have lower rates of poverty than Texas and the U.S. The poverty rates in Ector County are similar to those for Texas and greater than those for the U.S.

Table 3.9-9. Families and Individuals below Poverty Level, 2011

	Percent Families Below Poverty Level	Percent Individuals Below Poverty Level
United States	10.1	13.8
Texas	13.0	16.8
Midland County	10.1	21.9
Census Tract 101.09	7.8	10.9
Census Tract 101.14	8.1	8.8
Martin County	10.1	11.5
Ector County	13.8	16.2

Source: USCB 2013b.

3.9.7 Children's Environmental Health Risks and Safety Risks

Table 3.9-10 summarizes the distribution of population by age for the ROI. The data indicate that the Under 18 Years and Over 65 Years population in Midland County is similar to Texas. Census Tract 101.09 has a younger population than Texas and the country. Census Tract 101.14 has a smaller percentage of the population less than 18 years than Texas and greater than the nation. Martin and Ector counties have a larger percentage of the population less than 18 years than Texas and the U.S.

Table 3.9-10. Percent Distribution of Population by Age, 2011

Region	Under 5 Years	Under 18 Years	65 and Older
United States	6.5	24.0	13.0
Texas	7.6	27.1	10.5
Midland County	8.2	27.4	10.9
Census Tract 101.09	10.5	28.4	8.9
Census Tract 101.14	9.8	25.8	13.2
Martin County	8.8	30.1	12.5
Ector County	9.0	29.1	10.1

Source: USCB 2013b.

There are several children's daycare centers in the cities of Midland and Odessa, within approximately 10 miles of MAF. The nearest daycare center is in Midland, 6.5 miles from MAF, and the nearest daycare center in Odessa is 13 miles from MAF. The closest school is Henderson Elementary School, located 9 miles from MAF. The closest school in Odessa is LB Johnson Elementary, located 4 miles from MAF.

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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. The analysis in this chapter is in accordance with FAA Order 1050.1E and 5050.4B. To evaluate potential impacts, the analyses presented in this chapter overlays the components of the Proposed Action described in Chapter 2 onto baseline 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 this chapter.[2]

4.1 Air Quality

Potential impacts on air quality were evaluated based on calculated direct and indirect emissions associated with implementation of the Proposed Action. Potential impacts to air quality could result from the proposed operation of the Lynx RLV at MAF, with maximum emissions resulting from conducting up to 520 launches per year. Significant air quality impacts would occur if the action would directly or indirectly result in the exceedance of one or more of the NAAQS. For criteria pollutant emissions, the emissions associated with the Proposed Action were compared to the 2008 National Emission Inventory (NEI) data for Midland County (EPA 2013a) to assess the action's contribution to the regional air emissions.

4.1.1 Proposed Action

Construction under the Proposed Action would be limited to a small 18 ft by 60 ft concrete pad to be used for static hot-fire testing, and installation of LOX and N_2 tanks, which would likely require the construction of some smaller concrete pads. These activities are not expected to require more than a few days of on-site activity and would involve few workers. Air emissions from construction would be reduced and controlled using standard management practices such as routine sweeping and wetting. There would be no significant air emissions associated with the construction activity.

The proposed Lynx RLV launch schedule reaches a maximum of 520 launches per year in 2018. On-ground static fire testing of engines would involve approximately 100 tests per year. In addition, up to 200 staff would be located at or near MAF. It is assumed that the average one-way commute distance for each worker would be 12 miles (from Midland or Odessa), or 24 miles per day roundtrip. Detailed emission calculations for the Lynx RLV operations, including launch operations, static hot-fire engine tests, and staff commuting trips are included in Appendix B. Emissions from refueling operations were not quantified in this EA due to the small size of the launch vehicle and modest fuel volume required per flight. Only minimal emissions would be generated from refueling operations.

The emissions from 520 annual launches are based on consumption of all of the propellant fuel, rather than only fuel consumed during the ascent from ground to 3,000 ft AGL. Therefore, for the purposes of

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[2] Rather than as a separate impact category, construction impacts are considered within each impact category (e.g., air quality) that could be affected by construction activities. See FAA Order 1050.1E, Appendix A § 5.

this analysis, the impact of emissions from all of the fuel is evaluated, even though only a portion of the fuel would be consumed below the 3,000 ft AGL mixing boundary. Consequently, this analysis presents the maximum emissions scenario. Estimated emissions are evaluated against the Midland County emissions. Table 4.1-1 summarizes the calculated results.

Table 4.1-1. Annual Operational Criteria Pollutant Emission Estimates, XCOR Operations at MAF, 2018

Activity	Tons/Year					
	VOCs	CO	NO_x	SO_2	PM_{10}	$PM_{2.5}$
520 Annual Launches	0.00	106.60	0.00	0.00	0.00	0.00
100 Static Fire Tests	0.00	0.85	0.00	0.00	0.00	0.00
Annual Commuter Emissions	0.70	20.39	2.86	0.01	0.12	0.11
Total	**0.70**	**127.87**	**2.86**	**0.01**	**0.12**	**0.11**
[1]Midland County Emissions, 2008	32,024.52	26,820.38	12,845.59	475.35	9,713.60	1,635.53
Percent (%) of County Emissions	0.003	0.48	0.02	0.0021	0.001	0.01

Source: [1]EPA 2013a.
Notes: VOCs = volatile organic compounds; CO = carbon monoxide; NO_x = nitrogen oxide; SO_2 = sulfur dioxide; PM_{10} = particulate matter less than or equal to 10 microns in diameter; PM2.5 = fine particulate matter 2.5 microns or less in diameter;

The largest concentration of pollutants emitted as a result of the Lynx RLV operations would be CO. The 2018 annual emissions from 520 launches, 100 static fire tests for the engines, and commuter emissions for 200 additional workers at MAF would, at a maximum, represent less than 0.5 percent of the CO emissions for Midland County in 2008. Thus, the analysis indicates that the emissions from the Proposed Action would not result in exceeding any NAAQS and therefore would not be significant.

4.1.2 No Action Alternative

Under the No Action Alternative, the FAA would not issue a launch site operator license to the City of Midland and thus would also not issue experimental permits and/or launch licenses to XCOR for operation of the Lynx RLV at MAF. The concrete engine test pad and propellant tank pads would not be constructed. Also, there would be no need to update the ALP for MAF, and thus there would be no unconditional approval of a revised ALP. The No Action Alternative would not result in emissions 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 Lynx RLV operations (e.g., launches, landings, pre-flight run-up testing, and static hot-fire testing) and construction activities. Intermittent noise would be generated by construction of a concrete test pad, aboveground storage tanks, and permanent storage tanks. These construction projects would take place near active runways, so that existing aircraft-related noise would likely dominate construction noise. No residential areas or other noise sensitive receptors are located in the vicinity of the proposed construction areas. Therefore, noise from the proposed construction activities would not be significant.

Airfield Operations and Noise Exposure

Because the approved models identified in FAA Order 1050.1E, Appendix A, Section 14.2b for modeling noise levels of proposed actions are not suitable for predicting rocket launch noise, the FAA implemented a non-standard noise methodology to predict noise levels of RLV launches (see Appendix

A, *Noise*, of this EA). On January 8, 2014, the FAA Office of Environment and Energy determined the methodology was appropriate for this analysis and provided its approval of the methodology, as required by FAA Order 1050.1E, Appendix A, Section 14.2b (see Appendix A, *Noise,* of this EA).

As described in Section 3.2.3, the 2018 model year is based on the year projected that Proposed Action operations would be fully realized and represents the baseline from which impacts from the Proposed Action were analyzed. The proposed Lynx RLV operations would result in slightly larger DNL noise contours when compared to the baseline DNL noise contours (Exhibit 4.2-1). The DNL noise contours extend over additional area along the Lynx RLV flight departure tracks, producing extended lobes outside the MAF boundary. The contour lobe following the Lynx RLV departure track from runway 16R extends farther than that on runway 34L due to the slower climb rate of the flight profile from runway 16R, as well as a larger number of operations attributed to this track. The proposed DNL 65 dBA contour appears to contain approximately three additional households located in the neighborhood (Spring Meadow Estates) east of the intersection of West County Road 116 and South County Road 1255, as shown on Exhibit 4.2-1. However, a significant noise impact is one in which the Proposed Action would cause noise sensitive areas to experience an increase in noise of DNL 1.5 dB or more at or above DNL 65 dB noise exposure when compared to the no action alternative for the same timeframe. The three households mentioned would not experience an increase of more than 1.5 dB, and the areas that will experience this increase appear to be unpopulated. Therefore, the noise impact in relation to DNL would not produce a significant impact to the existing population.

Two additional supplemental metrics, A-weighted L_{Amax} and unweighted L_{max}, were analyzed to present a complete study of the potential noise impacts from the proposed Lynx RLV operations. OSHA has set an upper limit noise level of 115 dBA as a guideline to protect human hearing from long-term continuous daily exposures to high noise levels and aid in the prevention of noise-induced hearing loss. To identify potential locations affected by noise levels greater than 115 dBA, the $L_{A,max}$ was predicted for each Lynx RLV event. Exhibit 4.2-2 depicts the composite 115 dBA contour associated with the Proposed Action, which encompasses the area affected by any of the Lynx RLV single events. The 115 dBA contour is dominated by the launch events and follows the Lynx RLV departure tracks from runways 16R and 34L. The 115 dBA contour extends farther along the track departing from 16R due to the slower climb rate of the flight profile. Although the 115 dBA extends outside the MAF boundary, this area does not appear to contain existing developments or population. Although the 115 dBA guideline may be a conservative limit when considering the relatively short-term increase to this level, it is recommended that MAF personnel wear sufficient hearing protection and/or stay indoors to reduce noise levels below the 115 dBA limit during a launch.

To assess the potential risk for structural damage claims, the 111 dB and 120 dB unweighted L_{max} was predicted for each Lynx RLF event (Exhibit 4.2-3). A NASA technical memo found a relationship between structural damage claims and OASPL, where “the probability of structure damage [was] proportional to the intensity of the low frequency sound” (Guest and Sloan 1972). The study estimated that 1 damage claim in 1,000 households exposed is expected at an average continuous level of 111 dB, and 1 in 100

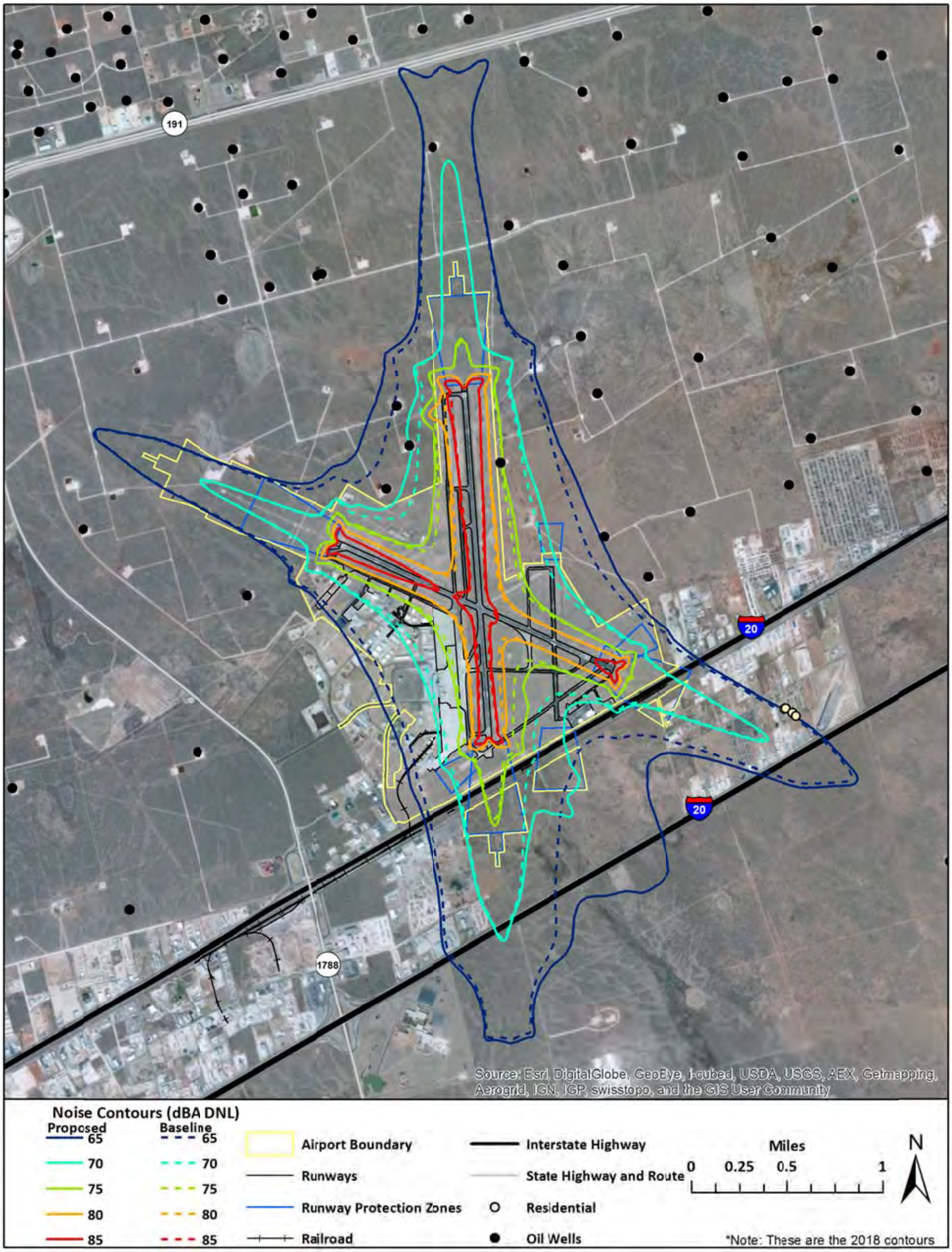

Exhibit 4.2-1. Projected 2018 Baseline and Proposed Noise Contours at MAF

Exhibit 4.2-2. Proposed 115 dBA Maximum A-weighted OASPL Noise Contour

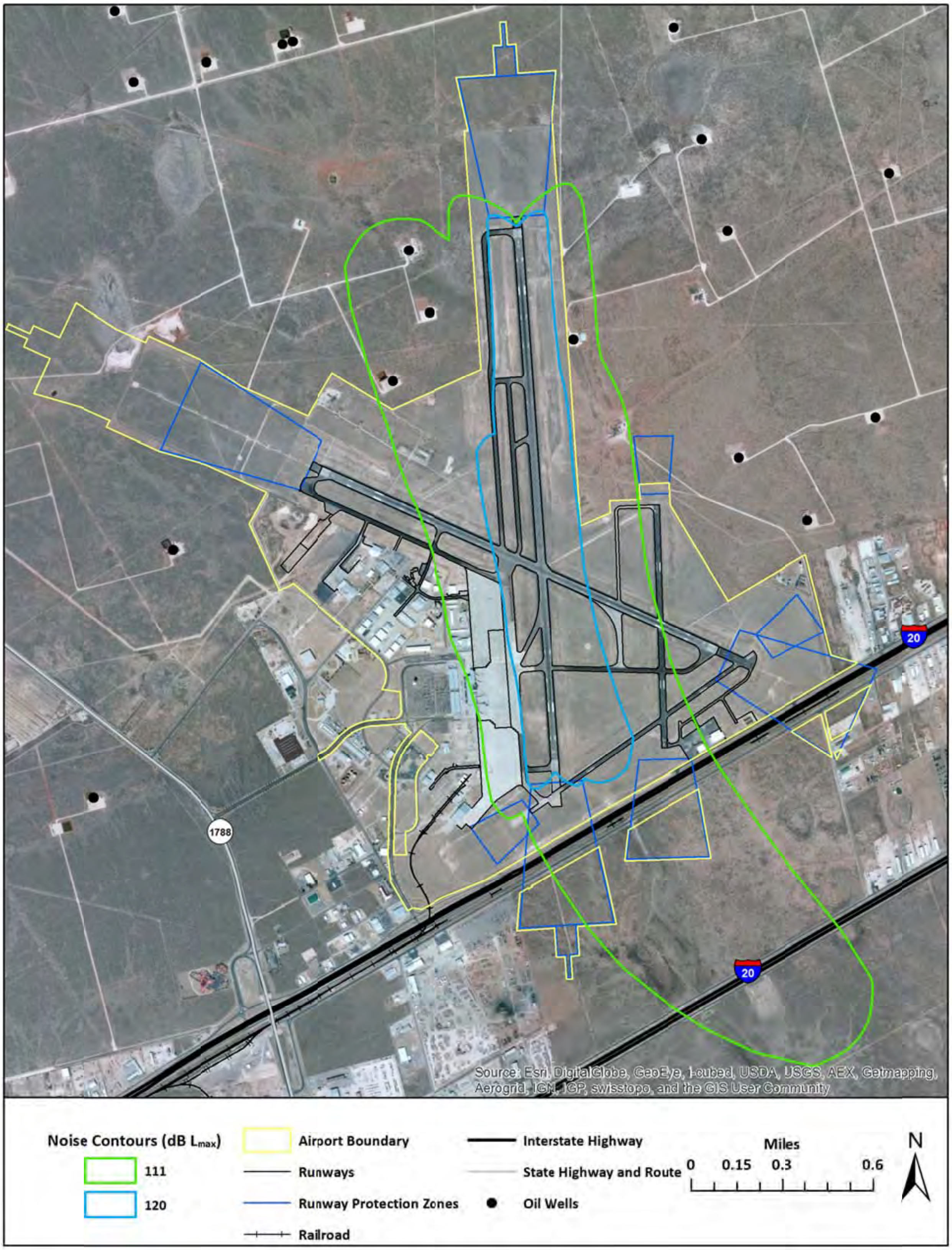

Exhibit 4.2-3. Proposed 111 dB and 120 dB Unweighted OASPL Noise Contours

households at 120 dB. Although both the 111 dB L_{max} and the 120 dB L_{max} contours extend slightly beyond the MAF boundary in certain directions, these affected areas are industrial in nature and contain buildings for aircraft storage along with the ARFF. A few oil wells would be located within the 111 dB L_{max}. Nonetheless, it is anticipated that there would be limited risk for structural damage impacts to these areas from noise related to Lynx RLV operations.

The Lynx RLV has the potential to create a sonic boom, an impulsive sound similar to thunder. A sonic boom is the sound associated with the shock waves created by a vehicle traveling through air faster than the speed of sound. The duration of a sonic boom is brief, less than a second, and the intensity is greatest directly under the flight path and weakens as distance from the flight track increases. The sonic boom resulting from the supersonic portion of the departure would not reach the ground due to the steep ascending flight path angle of the Lynx RLV, as the boom propagates along an angle that is unlikely to intercept the ground with any substantial impact. Sonic boom analysis was completed for the supersonic reentry portion of the two nominal Lynx RLV launch events arriving to runways 16R and 34L (see Appendix A). In general, for well-maintained structures, the threshold for damage from sonic booms is 2 psf, below which damage is unlikely and generally limited to 'bric-a-brac' or structural elements that are in ill-repair. Although the extent of the sonic boom footprint (Exhibit 4.2-4), defined as the area where a sonic boom may be heard, is approximately 19,000 square miles, the sonic boom overpressure is predicted to be at levels of less than 1 psf (or approximately 128 dB, peak sound pressure level (L_{peak}).

The peak overpressure level generated from the Lynx RLV would be similar in nature to a clap of thunder, which typically registers at about 120 dB in close proximity to the ground strike (National Lightning Safety Institute 2013). Therefore, the potential for damage or significant impact is negligible. The sonic boom "may" be heard up to 100 miles away from MAF in areas within Terry County to the north, Terrell County to the south, Fisher County to the east, and Lea County, New Mexico to the west. For the majority of this area, the sonic boom levels would likely be closer to 0.1 psf or 108 dB, L_{peak}, which is less than a typical thunder clap. The area with levels near 1 psf would be in a more concentrated area of approximately 2.5 square miles, in the vicinity of north Reagan County and south Glasscock County, for the modeled atmospheric conditions and nominal trajectory departing from Runway 16 and Runway 34, respectively. However, the location of the nominal impact point is variable in nature due to changes in atmospheric conditions or the vehicle flight trajectory.

The maximum noise exposure of the proposed Lynx RLV operations along with the maximum of 1 psf sonic boom is predicted to translate to an equivalent DNL of 63 dBA, using American National Standards Institute (ANSI) 12.9 Part 4 Annex B (ANSI 2005), which is compatible with residential areas. The noise impacts from potential sonic booms would not be significant since the maximum predicted levels are less than the 65 dBA noise exposure criteria. In addition, as discussed above, the duration of a sonic boom is brief, less than a second.

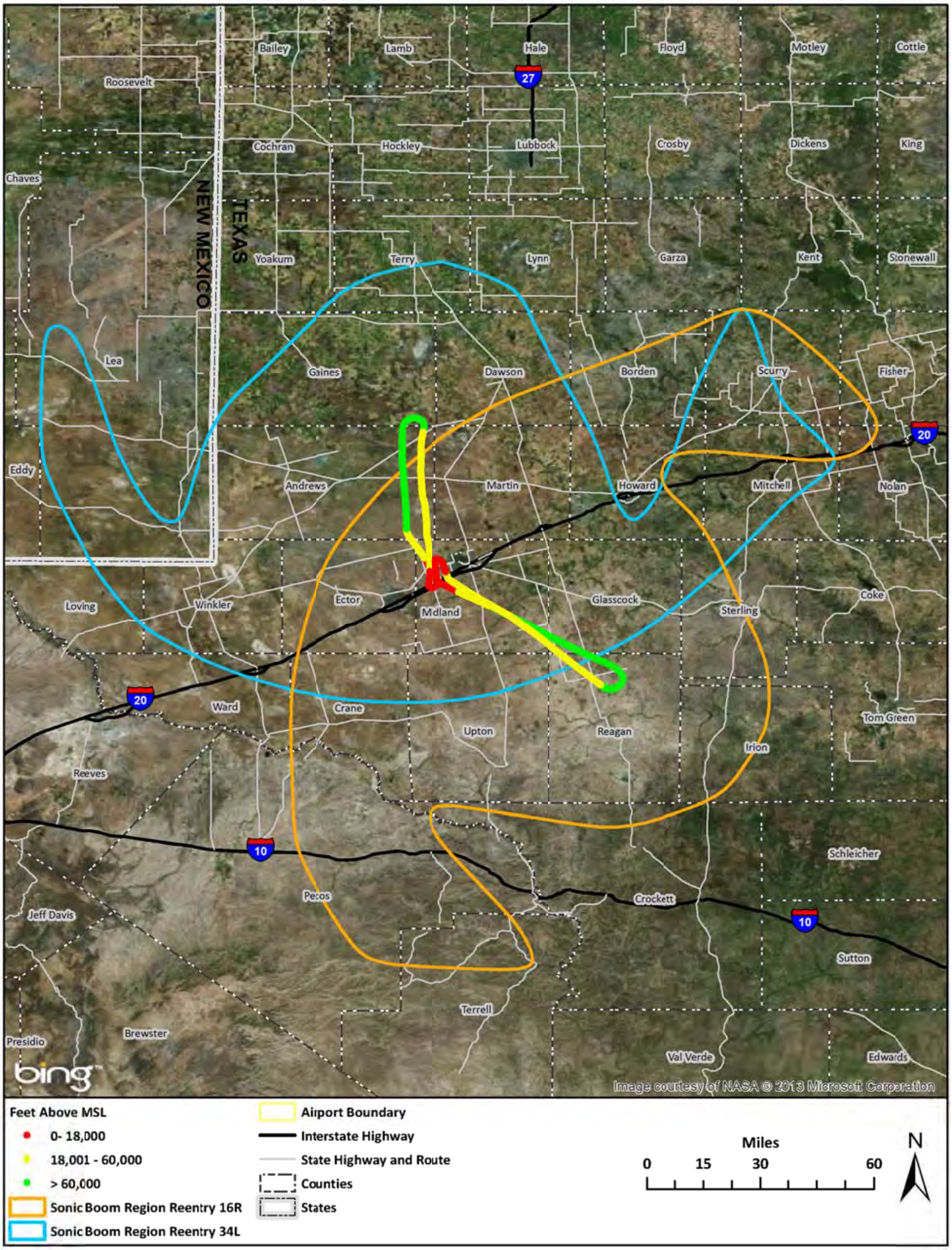

Exhibit 4.2-4. Sonic Boom Footprint

Sonic booms may be heard at public parks and wildlife refuges in the Midland area. However, these would only occur at a maximum of up to 2 times per day, five days per week and as described above, the maximum noise exposure of the proposed Lynx RLV operations is predicted to translate to an equivalent DNL of 63 dBA. Further information on Section 4(f) properties can be found in Section 4.3.

Compatible Land Use

Projected noise contours are compared to existing land uses for determining compatible land use. The Proposed Action would result in an increase in the area affected by noise (Exhibit 4.2-5). As indicated in Table 4.2-1, MAF land use categories affected by noise levels 65 dBA DNL and above would increase by 499 acres when compared to the baseline. Increases in noise levels would primarily be in areas classified as undesignated. Areas exposed to noise levels >85 dBA DNL would increase only for land use designated as airport facilities, which is considered compatible. Residential land uses are normally not considered compatible at levels above 65 dBA DNL. Residential land use exposed to noise levels 65-70 dBA DNL would increase by approximately one acre, which is considered incompatible but not significant, due to an increase of less than 1.5 dBA. As described above, this area contains approximately three additional households located in the neighborhood east of the intersection of West County Road 116 and South County Road 1255.

Table 4.2-1. MAF Acreages for Land Use Noise Compatibility

Land Use Classification	Area (acres) Within DNL Contour (dBA)															Total Acres		
	65-70 dBA DNL			70-75 dBA DNL			75-80 dBA DNL			80-85 dBA DNL			>85 dBA DNL					
	Baseline	Proposed	Change	Baseline	Proposed	Change	Baseline	Proposed	Change	Baseline	Proposed	Change	Baseline	Proposed	Change	Baseline	Proposed	Change
Transportation	120	142	+22	42	57	+15	5	7	+2	0	0	0	0	0	0	167	206	+39
Undesignated	1,084	1,408	+324	272	354	+82	36	50	+14	0	2	+2	0	0	0	1,392	1,814	+422
Residential	3	4	+1	0	0	0	0	0	0	0	0	0	0	0	0	3	4	+1
Commercial Services	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5	0
Airport Facilities	327	281	-46	418	434	+16	270	288	+18	295	295	0	114	143	+29	1,424	1,441	+17
Community Services	26	28	+2	13	15	+2	0	0	0	0	0	0	0	0	0	39	43	+4
Office	1	9	+8	0	0	0	0	0	0	0	0	0	0	0	0	1	9	+8
Vacant	21	29	+8	9	9	0	0	0	0	0	0	0	0	0	0	30	38	+8
Total	1,587	1,906	+319	754	869	+115	311	345	+34	295	297	+2	114	143	+29	3,061	3,560	+499

4.2.2 No Action Alternative

Under the No Action Alternative, the FAA would not issue a launch site operator license to the City of Midland and thus would also not issue experimental permits and/or launch licenses to XCOR for operation of the Lynx RLV at MAF. Also, there would be no need to update the ALP for MAF, and thus there would be no unconditional approval of a revised ALP. Current MAF activities and operations would continue, and noise conditions would remain as described in Section 3.2. Therefore, there would be no adverse effects to noise levels or compatible land use under this alternative.

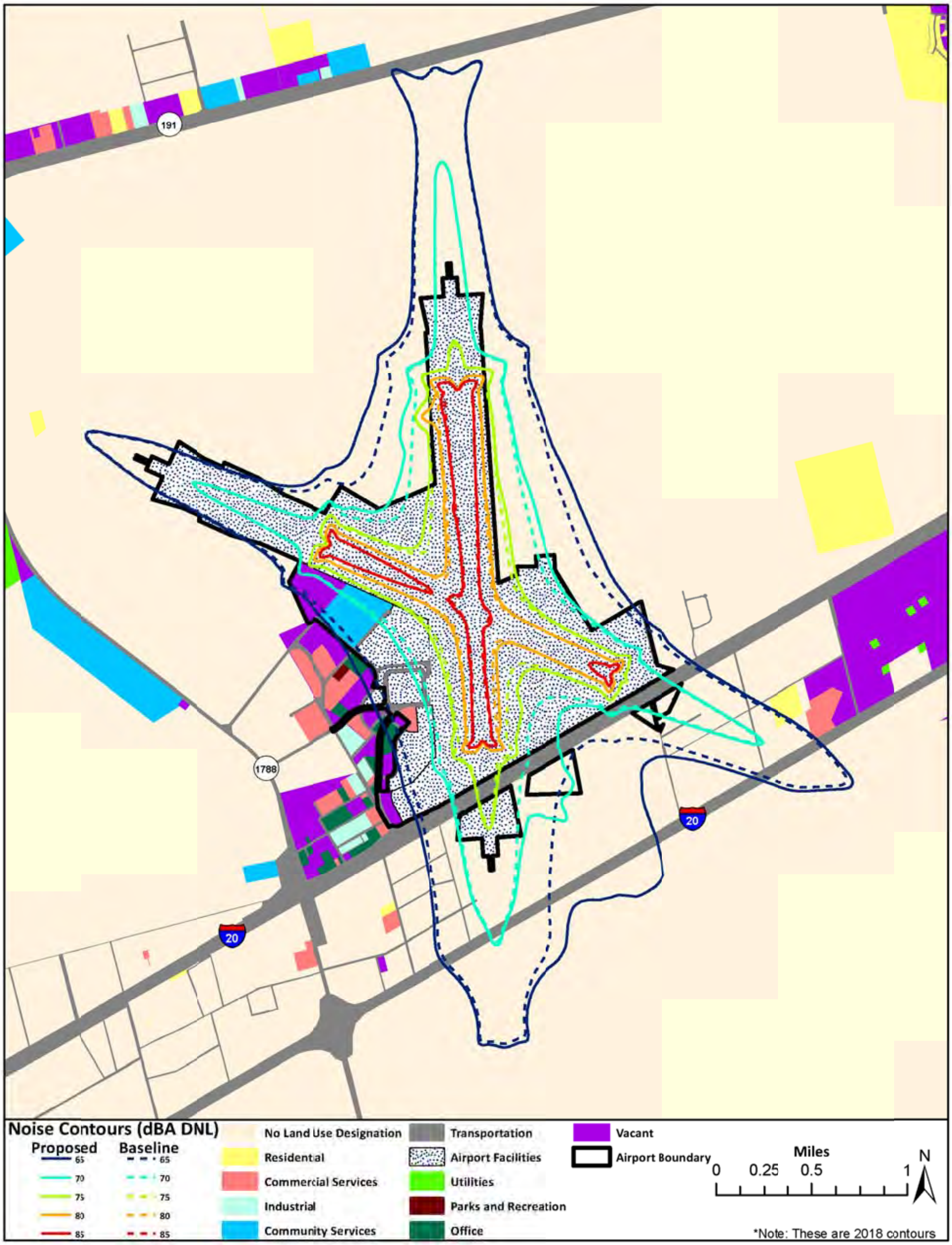

Exhibit 4.2-5. Baseline and Proposed Noise Contours and Existing Land Use

4.3 Department of Transportation Act, Section 4(f)

4.3.1 Proposed Action

Public Parks, Recreation Areas, and Refuges

As described in Section 3.3, a project cannot use a Section 4(f) property unless there is no feasible and prudent alternative to the use, and the project includes all possible planning to minimize harm resulting from the use. A use occurs when land is permanently incorporated into a transportation facility; there is a temporary occupancy of land that is adverse to the preservation of the property under the objectives of Section 4(f), or there is a constructive use of a property. A constructive use occurs when the proximity impacts of a project on an adjacent or near-by Section 4(f) property, after incorporation of impact mitigation, are so severe that the activities, features, or attributes of the resource that qualify the property for protection under Section 4(f) are substantially impaired, i.e., substantially diminished.

There would be no physical taking (permanent incorporation) or temporary occupancy of lands from the public parks or recreation areas in the ROI (also defined as the APE, refer to Section 3.3) as a result of the Proposed Action. Additionally, under the Proposed Action, the 65 dBA DNL noise contour would not extend to any public park or recreation area in the ROI. Therefore, the Proposed Action would not cause a substantial impairment, and thus a constructive use, of the public parks or recreation areas from noise impacts, as noise levels would not change from existing conditions (Exhibit 4.3-1). The sonic boom associated with the Lynx RLV would not result in impacts to structures associated with Beal Park or any other park or recreation area (refer to Section 4.2, *Noise and Compatible Land Use*).

Similarly, implementation of the Proposed Action would not result in the physical taking (permanent incorporation) or temporary occupancy of lands from wildlife refuges in the ROI. Additionally, the 65 dBA DNL noise contour would not extend to the area of the wildlife refuges; therefore, noise levels would not change from the existing condition and substantially impair the activities or attributes of the wildlife refuges. Sonic booms may be heard at wildlife refuges in the ROI. However, these would only occur at a maximum of up to 2 times per day, five days per week and the maximum noise exposure of the proposed Lynx RLV operations is predicted to translate to an equivalent DNL of 63 dBA. The noise would not substantially limit the use or diminish the quality of the refuges such that their value is impaired. Therefore, the Proposed Action would not constitute a constructive use of Section 4(f) properties. A detailed analysis of noise and associated impacts are included in Sections 3.2 and 4.2 and Appendix A of this EA.

Significant Historic Sites

There are no historic or archaeological sites listed or eligible for listing on NRHP within the ROI (also defined as the APE, refer to Section 3.3); therefore, no physical use, direct taking, temporary occupancy, or constructive use of a historic or archaeological site would occur. Sections 3.4 and 4.4 discuss in detail historical, architectural, archaeological, and cultural resources.

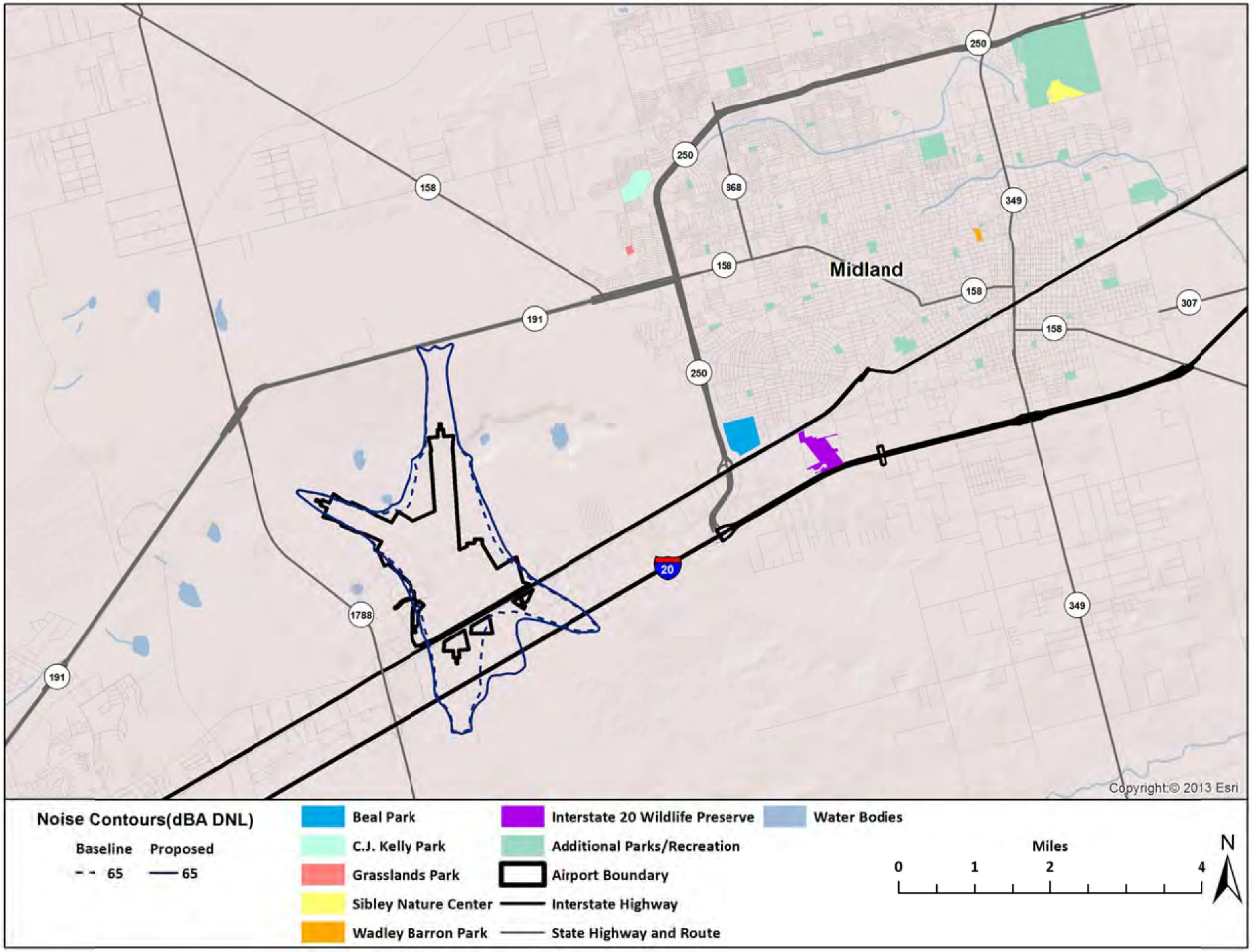

Exhibit 4.3-1: Section 4(f) Properties and Noise Contours

4.3.2 No Action Alternative

Under the No Action Alternative, the FAA would not issue a launch site operator license and thus would also not issue experimental permits and/or launch licenses to XCOR for operation of the Lynx RLV at MAF. The Lynx RLV would not be launched from MAF and no improvements at MAF would occur to support the Lynx RLV launches. Also, there would be no need to update the ALP for MAF, and thus there would be no unconditional approval of a revised ALP. Current MAF activities and operations would continue and land use conditions would remain as described in Section 3.3.

4.4 Historical, Architectural, Archaeological, and Cultural Resources

4.4.1 Proposed Action

There are no known NRHP-listed or eligible archaeological resources within the APE (as defined in Section 3.4); therefore, under the Proposed Action, there would be no effects from ground disturbance to archaeological resources. THC concurred with this finding of no effect on September 6, 2013 (refer to Appendix C for consultation correspondence).

Under the Proposed Action, existing infrastructure, including hangars and runways, would be used to support launch and landing operations at the facility. To support engine testing and provide propellant for testing and launches, a concrete pad and aboveground storage tanks would be installed. New construction is limited and is in keeping with current facilities. Minimal construction at a site that has been previously developed and functions as an airport would have no direct effect on cultural resources. Therefore, there would be no direct effects to architectural resources within the APE. The only structures remaining from the WWII era are two igloo ammunition magazines located to the north of Runway 10/28. Due to loss of integrity, these magazines have been recommended to be not eligible for the NRHP, and there would be no effect to them. THC concurred with this finding of no effect on September 6, 2013 (refer to Appendix C for consultation correspondence).

As described in Section 4.2, *Noise and Compatible Land Use*, the increase in noise would not be significant. There are no architectural resources on or eligible for listing on the NRHP within the APE that would be adversely affected by changes to the setting due to noise from the proposed airfield operations under the Proposed Action.

4.4.2 No Action Alternative

Under the No Action Alternative, the FAA would not issue a launch site operator license to the City of Midland and thus would also not issue experimental permits and/or launch licenses to XCOR for operation of the Lynx RLV at MAF. Also, there would be no need to update the ALP for MAF, and thus there would be no unconditional approval of a revised ALP. Existing commercial aviation and military operations would remain the same at the airport. Therefore, there would be no effects to cultural resources under this alternative.

4.5 Fish, Wildlife, Plants

4.5.1 Proposed Action

Vegetation

Proposed construction would primarily occur within undeveloped areas of MAF that have been previously disturbed and are actively mowed (see Section 3.5.1 for further description). The proposed aboveground storage tanks would be constructed on the east side of the hangar apron in an area designated as the "Bulk Fuel Farm." The engine test pad (18 ft by 60 ft) would be constructed on a maintained/mowed grass area. This area has already been disturbed, and therefore, this new construction is not expected to have any significant impacts. Engine testing and launches would not cause scorching and damage to vegetation because the area is mowed grass.

Wildlife and Special-Status Species within the Vicinity of MAF

Proposed construction activities would result in short-term increases in noise levels within the MAF boundaries temporarily displacing wildlife from the immediate area. While wildlife may experience short-term intermittent disturbance associated with noise from construction activities, this potential effect is lessened in context of the airfield environment, where the existing ambient noise and activity levels are high. Wildlife species, including migratory birds, in the ROI have adapted to a developed, urban setting and are therefore less likely to be affected by any short-term noise associated with the proposed construction activities. Due to their habituation to relatively high ambient noise levels and the limited area of habitat that would be impacted by proposed construction activities, there would be no significant impacts to wildlife with implementation of proposed construction activities under the Proposed Action.

Lynx RLV vehicles would be powered by rocket engines at take-off and land via un-powered glide. The primary emissions from the Lynx RLV would include CO_2 and water vapor and would not impact biological resources. There is the potential for Lynx RLV strikes of wildlife; however, XCOR would comply with the requirements of the MAF Wildlife Management Program, and also comply with the Wildlife Hazard Management Plan, to minimize the potential for striking wildlife. In the event of a launch failure, wildlife within the ROI may be impacted by falling debris, fire, and associated noise. However, the probability of launch failure is extremely low, and the potential for direct impacts to area wildlife is highly unlikely.

Noise levels within the airfield environment are expected to change with the proposed operation of the Lynx RLV at MAF. However, the proposed increase in airfield operations through 2018 would equal less than 1 percent of the total operations occurring at MAF, and would not result in an increase of more than 1.5 dB (Exhibit 4.2-1). Although there would be a change in the noise environment in the vicinity of the airfield, there would not be a significant impact on wildlife in the area due to the limited areas of suitable habitat within the airfield environment and because wildlife species are likely accustomed to current noise levels associated with ongoing aircraft operations at MAF.

The TPWD Texas Natural Diversity Database contained no records of any federally or state-listed species potentially occurring within Midland County, and no occurrences of federally or state-listed species

were documented in or within a 5-mile radius of MAF during the wildlife survey conducted from November 2010 to October 2011 (TPWD 2013b; MAF 2012). Based on the lack of suitable habitat at MAF for special-status species, no known species records at MAF or within Midland County, and the current airport activities taking place at MAF, there would be no impact to special-status species.

Wildlife and Special-Status Species within the Sonic Boom Footprint

The transmission of sonic booms during reentry of the Lynx RLV has the potential to impact wildlife. As stated in Chapter 2, reentry operations by the Lynx RLV would generate 1,196 sonic boom events over the proposed 5-year operating period at MAF. Sonic boom events would only occur 1-2 times per week during the first 2 years of proposed operations (2014-2015); increasing to 1 per day, 5 days a week during 2016-2017; and then 2 per day, 5 days a week in 2018.

The duration of a sonic boom is brief, less than a second, and the intensity is greatest directly under the flight path and weakens as distance from the flight track increases. The change in air pressure associated with a sonic boom is only a few psf greater than normal atmospheric pressure. This is about the same pressure change experienced by a change in elevation of 20-30 ft, or riding an elevator down two or three floors. This additional pressure above normal atmospheric pressure is called overpressure. It is the sudden onset of the pressure change that makes the sonic boom audible. Overpressures greater than 1.5 psf generally elicit public reaction (NASA 2005).

Under the Proposed Action, a sonic boom may be heard up to 100 miles from MAF in areas as far as Terry County to the north, Terrell County to the south, Fisher County to the east, and Lea County, New Mexico to the west. Although the extent of the sonic boom footprint (see Figure 3), defined as the area where a sonic boom may be heard, is approximately 19,000 square miles, the sonic boom overpressure is predicted to be at levels of less than 1 psf (or approximately 128 dB, peak sound pressure level [L_{peak}]). The peak overpressure level generated from the Lynx RLV would be similar in nature to a clap of thunder, which typically registers at about 120 dB in close proximity to the ground (National Lightning Safety Institute 2013). Within the majority of the action area, the sonic boom levels would be approximately 0.1 psf or 108 dB L_{peak}, which is less than a typical thunder clap. The area with levels near 1 psf would be in a more concentrated area of approximately 2.5 square miles, in the vicinity of north Reagan County and south Glasscock County, for the modeled atmospheric conditions and nominal trajectory departing from Runway 16R and Runway 34L, respectively. However, the location of the nominal impact point is variable in nature due to changes in atmospheric conditions or the vehicle flight trajectory.

Animal species differ greatly in their responses to noise. Noise effects on domestic animals and wildlife are classified as primary, secondary, and tertiary. Primary effects are direct, physiological changes to the auditory system, and most likely include the masking of auditory signals. Masking is defined as the inability of an individual to hear important environmental signals that may arise from mates, predators, or prey. There is some potential that noise could disrupt a species' ability to communicate or could interfere with behavioral patterns (Manci et al. 1988). Although the effects are likely temporal, aircraft noise may cause masking of auditory signals within exposed faunal communities. Animals rely on

hearing to avoid predators, obtain food, and communicate with, and attract, other members of their species. Aircraft noise may mask or interfere with these functions. Other primary effects, such as ear drum rupture or temporary and permanent hearing threshold shifts, are not as likely given the noise levels produced by aircraft overflights. Secondary effects may include non-auditory effects such as stress and hypertension; behavioral modifications; interference with mating or reproduction; and impaired ability to obtain adequate food, cover, or water. Tertiary effects are the direct result of primary and secondary effects, and include population decline and habitat loss. Most of the effects of noise are mild enough that they may never be detectable as variables of change in population size or population growth against the background of normal variation (Bowles 1995). Other environmental variables (e.g., predators, weather, changing prey base, ground-based disturbance) also influence secondary and tertiary effects, and confound the ability to identify the ultimate factor in limiting productivity of a certain nest, area, or region. Overall, the literature suggests that species differ in their response to various types, durations, and sources of noise (Manci et al. 1988; Bowles 1995).

Many scientific studies have investigated the effects of aircraft noise and sonic booms on wildlife, and some have focused on wildlife "flight" due to noise. Natural factors which affect reaction include season, group size, age and sex composition, on-going activity, motivational state, reproductive condition, terrain, weather, and temperament (Bowles 1995). Individual animal response to a given noise event or series of events also can vary widely due to a variety of factors, including time of day, physical condition of the animal, physical environment, the experience of the individual animal with noises, and whether or not other physical stressors (e.g., drought) are present (Manci et al. 1988). Consequently, it is difficult to generalize animal responses to noise disturbances across species.

One result of the Manci et al. (1988) literature review was the conclusion that, while behavioral observation studies were relatively limited, a general behavioral reaction in animals from exposure to aircraft noise is the startle response. The intensity and duration of the startle response appears to be dependent on which species is exposed, whether there is a group or an individual, and whether there have been some previous exposures. Responses range from flight, trampling, stampeding, jumping, or running, to movement of the head in the apparent direction of the noise source. Manci et al. (1988) reported that the literature indicated that avian species may be more sensitive to aircraft noise than mammals.

The following discussion presents a summary of some of the more relevant studies addressing the potential impacts to wildlife from sonic booms. Teer and Truett (1973) tested quail eggs subjected to sonic booms at 2, 4, and 5.5 psf and found no adverse effects. Heinemann and LeBrocq (1965) exposed chicken eggs to sonic booms at 3-18 psf and found no adverse effects. In a mathematical analysis of the response of avian eggs to sonic boom overpressures, Ting et al. (2002) determined that it would take a sonic boom of 250 psf to crack an egg. Bowles (1995) states that it is physically impossible for a sonic boom to crack an egg because one cannot generate sufficient sound pressure in air to crack eggs.

Teer and Truett (1973) examined reproductive success in mourning doves, mockingbirds, northern cardinals, and lark sparrows when exposed to sonic booms of 1 psf or greater and found no adverse

effects. Awbrey and Bowles (1990) in a review of the literature on the effects of aircraft noise and sonic booms on raptors found that the available evidence shows very marginal effects on reproductive success. Ellis et al. (1991) examined the effects of sonic booms (actual and simulated) on nesting peregrine falcon, prairie falcons, and six other raptor species. While some individuals did respond by leaving the nest, the response was temporary and overall there were no adverse effects on nesting. Lynch and Speake (1978) studied the effects of both real and simulated sonic booms on the nesting and brooding of eastern wild turkey (Meleagris gallopavo silvestris) in Alabama. Hens at four nest sites were subjected to between 8 and 11 combined real and simulated sonic booms. All tests elicited similar responses, including quick lifting of the head and apparent alertness for between 10 and 20 seconds. No apparent nest failure occurred as a result of the sonic booms.

Animal species exhibit a wide variety of responses to noise. It is therefore difficult to generalize animal responses to noise disturbances or to draw inferences across species, as reactions to jet aircraft noise and sonic booms appear to be species-specific. Consequently, some animal species may be more sensitive than other species and/or may exhibit different forms or intensities of behavioral responses.

The literature does suggest that common responses include the “startle” or “fright” response and, ultimately, habituation. It has been reported that the intensities and durations of the startle response decrease with the numbers and frequencies of exposures, suggesting no long-term adverse effects. The majority of the literature suggests that domestic animal species (cows, horses, chickens) and wildlife species exhibit adaptation, acclimation, and habituation after repeated exposure to jet aircraft noise and sonic booms.

Potential Proposed Action-related noise, such as sonic booms, are temporal, not sustained, and not fixed in location. The special-status species addressed in this analysis would experience an estimated maximum of 52 sonic booms in 2014 and up to 520 sonic booms in 2018. These events are expected to produce infrequent startle effects, similar to that of a thunder clap. Within the majority of the action area, the sonic boom levels would be approximately 0.1 psf, which is less than a typical thunder clap. As previous studies have found no adverse effects to wildlife when exposed to sonic booms greater than 1 psf, and given the number of proposed sonic boom events spread over a large area, the FAA concludes that the Proposed Action would not result in significant impacts to wildlife, including special-status species. As stated in the Draft EA, the FAA determined the Proposed Action *may affect, but is not likely to adversely affect* the ESA-listed northern aplomado falcon, black-capped vireo, least tern, and whooping crane. In accordance with ESA Section 7, the FAA entered into consultation with the USFWS and requested concurrence on the effects determination. In a November 19, 2013 letter (See Appendix C), the USFWS concurred that the Proposed Action *may affect, but is not likely to adversely affect* the northern aplomado falcon, black-capped vireo, least tern, and whooping crane within the ROI as defined in Section 3.5. Subsequent to publishing the Draft EA, the USFWS listed the lesser prairie-chicken as a threatened species on April 10, 2014. In accordance with ESA Section 7, the FAA determined the Proposed Action *may affect, but is not likely to adversely affect* the lesser prairie-chicken and consulted with USFWS. As part of this consultation, the applicant (MAF) proposed to monitor lesser prairie-chicken lekking sites to evaluate potential impacts, if any, to individual lesser prairie-chickens. In a July 14, 2014

letter, the USFWS concurred that the Proposed Action *may affect, but is not likely to adversely affect* the lesser prairie-chicken (see Appendix C). In the July 14, 2014 letter from USFWS to FAA, USFWS supported MAF's proposed monitoring of the lesser prairie-chicken lekking areas during launch activities to evaluate if sonic booms affect individual lesser prairie-chickens. MAF will continue to work with the FAA and USFWS to identify lesser prairie-chicken lekking sites and develop an appropriate survey protocol that will adequately evaluate potential sonic boom disturbance and the effects, if any, to the lesser prairie-chicken.

4.5.2 No Action Alternative

Under the No Action Alternative, the FAA would not issue a launch site operator license to the City of Midland and thus would also not issue experimental permits and/or launch licenses to XCOR for operation of the Lynx RLV at MAF. Also, there would be no need to update the ALP for MAF, and thus there would be no unconditional approval of a revised ALP. Current MAF activities and operations would continue and biological resources would remain as described in Section 3.5.

4.6 Water Quality

4.6.1 Proposed Action

Surface Waters (Excluding Wetlands)

With the exception of one freshwater pond located to the northwest of Runway 10/28, there are no surface waters located within the ROI as discussed in Section 3.6. Construction and operational activities associated with the engine test pad would not result in impacts to the pond. Additionally, to prevent disturbed soils from being carried off-site in stormwater runoff, Best Management Practices (BMPs) such as sediment traps, silt fences, straw bales, and fiber rolls would be implemented during construction. Therefore, no impacts to surface waters would occur as a result of the Proposed Action.

Groundwater

Construction activities associated with the test pad would not require blasting that would alter underlying geology that may affect the Ogallala aquifer (not a sole source aquifer, refer to Section 3.6). Potential impacts to groundwater could occur from spills or leaks from construction vehicles and machinery. An Airport Emergency Plan is in place and would minimize the potential for accidental releases of pollution substances from construction equipment. All materials would be carefully stored and handled and spills cleaned up immediately. Material handling and spill response BMPs would be implemented according to the Stormwater Pollution Prevention Plan developed for the test pad construction site. The Airport Emergency Plan would also outline measures to minimize hazards to human health and the environment from any unplanned sudden or non-sudden releases of oil or other contaminants that could impact groundwater.

Construction of the proposed test pad and propellant storage areas are not located near groundwater wells that are present within the MAF boundary. Therefore, construction of the proposed test pad and propellant storage areas would not impact groundwater wells within the MAF boundary. The propellant storage areas would have, at a minimum, secondary containment; therefore, impacts from leaking or

spills associated with the propellant storage areas would not have the potential for contaminating groundwater wells within the MAF boundary.

No impacts to groundwater recharge capabilities as a result of increases in impervious surface due to construction or operational activities at the test pad would occur. In the unlikely event of a launch failure occurring at or within the vicinity of MAF, any potential impacts to water quality would be minimized by existing emergency response services.

Wetlands

No wetlands are located at the site where the test pad would be constructed. BMPs would be implemented to prevent sediment from disturbed soils from entering the NWI wetlands within the ROI as defined in Section 3.6. Therefore, no impacts would occur to wetlands as a result of the Proposed Action.

Floodplains

No construction associated with the Proposed Action would occur within designated Zone SFHAs; therefore, there would be no impacts to these SFHAs.

4.6.2 No Action Alternative

Under the No Action Alternative, the FAA would not issue a launch site operator license to the City of Midland and thus would also not issue experimental permits and/or launch licenses to XCOR for operation of the Lynx RLV at MAF. Also, there would be no need to update the ALP for MAF, and thus there would be no unconditional approval of a revised ALP. MAF would continue with its current operations and no impacts to water resources would occur.

4.7 Natural Resources and Energy Supply

4.7.1 Proposed Action

The Proposed Action would result in the construction of a small concrete pad (18 ft x 60 ft) to support rocket engine testing and the installation of several aboveground tanks for the storage of propellants. These construction activities would have a minimal impact on demand for potable water and energy.

Approximately 40 new employees would be on-site, increasing to 200 employees within 5 years of first operations. With family members, the total increase in population in the Midland and Odessa areas would be 544. This level of new population would result in a minimal increase in demand for potable water, wastewater treatment, and energy.

There would be no new utility infrastructure required to meet this increase in utility demand. The Master Plan for the City of Midland indicates that the city is taking steps to ensure the water and wastewater systems will meet the future demands of population growth and economic development (City of Midland 2005). The demand for fuels and propellants as described in Section 2.1.2 2 would be met without difficulty. There would be no significant impacts to natural resources and energy supply as a result of the Proposed Action.

4.7.2 No Action Alternative

Under the No Action Alternative, the FAA would not issue a launch site operator license to the City of Midland and thus would also not issue experimental permits and/or launch licenses to XCOR for operation of the Lynx RLV at MAF. There would be no construction activities and no increases in staff associated with a commercial space launch site. Also, there would be no need to update the ALP for MAF, and thus there would be no unconditional approval of a revised ALP. Therefore, there would be no impacts to natural resources and energy supply.

4.8 Hazardous Materials, Pollution Prevention, and Solid Waste

4.8.1 Proposed Action

The Proposed Action includes the installation of a Bulk Fuel Farm and a Ready Storage Area. The Bulk Fuel Farm would be located across from the hangar apron and would include the storage of LH_2, kerosene, and CH_4. The permanent storage tanks in the Ready Storage Area would include the storage of LOX and LN_2. Additional 55-gallon drums of kerosene and nitromethane would also be stored in this area. The storage tanks would be located outside the launch site boundary and beyond the debris dispersion radius computed in accordance with 14 CFR 420.21. The proposed propellant storage locations are depicted on Exhibit 2-1.

As the existing activities at MAF include 330,000 gallons of storage of hazardous materials, MAF has an Airport Emergency Plan in place to prevent pollution by avoiding spills and uncontrolled releases. Activities associated with the Proposed Action, which would require the handling of hazardous materials, hazardous wastes, and solid wastes would be undertaken in accordance with OSHA 29 CFR 1910, National Fire Protection Association 30 (Flammable and Combustible Liquids Code) and 55 (Compressed Gases and Cryogenic Fluids), and the Compressed Gas Association. In addition, all relevant and applicable Federal, State, and local regulations pertaining to hazardous materials, hazardous wastes, and solid wastes would be adhered to; thus, no significant impacts are anticipated.

In terms of impact, for a nominal trajectory, the ground track does not include flights over populated areas. In the unlikely event of a launch failure, the debris impacts would be expected to be contained within the FAA approved hazard area. For each mission, MAF would establish hazard areas to ensure public safety according to regulations in 14 CFR Part 431 or 437. In addition, as part of the licensing process, the FAA would require MAF to establish agreements with the Fort Worth ARTCC and Midland Tower (i.e., “Midland Approach”) to coordinate the use of the required airspace. Any potential impacts would be minimized by existing emergency response procedures as outlined in the Airport Emergency Plan.

4.8.2 No Action Alternative

Under the No Action Alternative, the FAA would not issue a launch site operator license to the City of Midland and thus would also not issue experimental permits and/or launch licenses to XCOR for operation of the Lynx RLV at MAF. There would be no additional propellant storage tanks installed, and there would not be any additional hazardous waste or solid waste generated at MAF. Also, there would be no need to update the ALP for MAF, and thus there would be no unconditional approval of a revised

ALP. Therefore, there would be no impacts to hazardous materials, pollution prevention, and solid waste.

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

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

Socioeconomic impacts from projects involving construction and operational activities are often 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.

4.9.1 Proposed Action

Population

Initially, approximately 40 new employees would be on-site, increasing to 200 employees within 5 years of first operations. Under a maximum scenario, all XCOR personnel would move to the ROI. Using an average ROI household size of 2.72 (USCB 2012), these 200 workers would be accompanied by approximately 344 family members. The total population increase of approximately 544 directly resulting from the Proposed Action would represent less than one percent of the ROI population, which would not cause a change in population trends in the ROI that would be considered significant. Therefore, there would be no significant direct impacts to short- or long-term population trends.

Potential indirect population impacts are discussed below under *Employment and Income*.

Employment and Income

The increase of up to 200 additional workers at MAF would represent less than one percent of existing ROI employment. The increase in employment would also 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. The Proposed Action would not be expected to require temporary employees as there is limited construction proposed. The Proposed Action would not be expected to attract visitors to the ROI as this would be a research and development facility for XCOR. Therefore, spending would be limited to that generated by new employees and their families.

This spending would, in turn, generate additional indirect jobs and income and benefit the ROI economy. Given the less than one percent increase in direct MAF employment, it would be expected that any indirect positions added would be filled by unemployed local residents or would be within the annual fluctuation range. This level employment increase would not alter migration trends that could

result in significant demands on local infrastructure and services. Therefore, no significant indirect impacts associated with short- or long-term employment or population trends in the ROI would be expected as a result of indirect job growth. The minor effect on employment and income would not likely generate a level of demand for goods and services that would induce secondary development of retail or commercial establishments.

Construction of a concrete pad to support rocket engine testing and several new aboveground propellant storage tanks would be required to support the Proposed Action. The proposed construction spending would generate direct construction and indirect jobs. Given the relatively minor amount of new construction required, it would not be expected that additional construction workers would move into the ROI in response to the direct job impacts in construction. Further, it would be expected that most of the indirect positions would be filled by unemployed ROI workers or would be within annual fluctuations that would not alter migration or employment trends. Therefore, construction spending would not be expected to significantly affect employment and income or population trends.

Additional taxes would accrue to Federal, State, and local governments as a result of the increase in personnel and construction spending. These impacts would be beneficial.

The Proposed Action would be consistent with the economic goals of the City of Midland which include diversification of the economy, creation of jobs, and continued development of MAF (City of Midland 2005).

Housing

Under the Proposed Action, there would be an increase over a five-year period of up to 200 additional MAF workers by 2018. Under a maximum scenario, all 200 workers would seek housing in the local area. This would represent less than one percent of the total ROI housing units and approximately 2.4 percent of the ROI vacant units. However, this small demand would be in the context of recent increases in housing demand attributable to the oil and gas boom and other development that is inducing robust population growth in West Texas, and particularly in the Midland and Odessa areas. Development of new housing is ongoing in the area to meet the demand. Implementation of the Proposed Action would occur over five years resulting in a gradual and minimal effect on the ROI housing market. Therefore, there would be no significant impact to short- or long-term trends in the ROI housing market resulting from the Proposed Action. However, the minor effect of the Proposed Action would be experienced within the context of existing rapid growth in population and associated demand for housing currently being experienced in the Odessa and Midland area. The combined effects are discussed in Chapter 5, *Cumulative Impacts*.

Community Services

<u>Emergency Response</u>

Under the Proposed Action, police, fire, and emergency medical response services would continue to be provided by MAF ARFF. As described in Section 3.9.4, 14 CFR Part 139 requires that MAF meet the proper ARFF Index for airport operations. The operation of the Lynx RLV would not require an additional

increase in Index and should operate well within the operational capabilities of the current ARFF services provided.

The potential in-migration of 544 people to the ROI over a five year period (less than one percent of the population) would not be expected to strain the capacity or affect the quality of emergency response services. Therefore, there would be no significant impacts to emergency response services in the ROI.

Medical Facilities

Any medical emergencies resulting from the Proposed Action would be handled in accordance with the MAF Emergency Plan (City of Midland 2011b). Hospitals in Midland and Odessa have a total of over 1,000 beds and would be the primary treatment centers. Emergency medical care for the relatively small increase in employees, between 40 and 200 over 5 years, would not adversely affect medical facilities.

The potential in-migration of 544 people to the ROI (less than one percent of the population) would not be expected to strain the capacity or affect the quality of existing medical facilities.

Schools

The estimated 344 family members expected to move to the ROI over a five-year period would include 44 school-age children, assuming two parents per family. Employees of the Proposed Action and their families would be expected to reside in the nearby population centers of the cities of Midland and Odessa. With a total student population between Odessa and Midland of 51,033 students, the increase of 44 additional children attending public schools would represent an increase of less than 0.09 percent of the student population. This effect on schools in the ROI would not be significant.

Based on the foregoing analysis of emergency response, medical facilities, and schools, the Proposed Action would not have significant impacts on community services. However, the minor effect of the Proposed Action would be experienced within the context of existing rapid growth in population and associated demand for community services currently being experienced in the Odessa and Midland area, as described in Section 3.9. The combined effects are discussed in Chapter 5, *Cumulative Impacts*.

Ground Traffic and Transportation

During the construction of the concrete pad and installation of the new propellant storage tanks, there would be truck traffic associated with the delivery of goods and pouring of the concrete, as well as the vehicular traffic associated with the construction personnel. As the delivery of goods and the number of construction personnel would be minimal, it is not anticipated that there would be any significant impacts to traffic associated with this type of traffic during construction.

Under the Proposed Action, the operations at MAF would include an increase in personnel as well as an increase in the shipments of propellants and other materials. Initially, there would be an increase of approximately 40 personnel, increasing to approximately 200 personnel within 5 years of operation. Since the maximum flow rate for LOS A is 600 pc/h/l and existing traffic is approximately 245 pc/h/l, it is not anticipated that the personnel traffic associated with increased operations would impact the LOS in the vicinity of MAF.

Environmental Justice

Environmental justice impacts 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 3.9, Census Tract 101.09 and Ector County are considered minority populations as defined by the CEQ and DOT Order 5610.2(a). However, the Proposed Action would not result in environmental impacts that would adversely affect any population; therefore, there would be no disproportionately high or adverse impacts to minority or low-income populations. There may be some beneficial impact to minority and low-income populations as a result of direct and indirect employment generated by the Proposed Action.

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. The Proposed Action would not result in environmental impacts that would adversely affect any population, including areas in which children are present. Therefore, there would be no disproportionately high or adverse impacts to children's environmental health and safety risk.

4.9.2 No Action Alternative

Under the No Action Alternative, the FAA would not issue a launch site operator license to the City of Midland and thus would also not issue experimental permits and/or launch licenses to XCOR for operation of the Lynx RLV at MAF. Also, there would be no need to update the ALP for MAF, and thus there would be no unconditional approval of a revised ALP. There would be no changes in current population, employment, income, or housing trends in the ROI. Further, there would be no disproportionately high or adverse human health or environmental effects to minority or low-income populations nor increased children's environmental health and safety risk.

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 NEPA 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 were identified by consulting the MAF Director of Airport, MAF airport engineer, and the cities of Midland and Odessa. Past, present, and reasonably foreseeable future actions at MAF and the surrounding area that may affect the same resources as the Proposed Action include ongoing airport operations, industrial and business development at MAF and the surrounding area, the oil and gas industry boom, development of hotels, residential housing, and retail.

In accordance with FAA Order 1050.1E, Change 1, FAA Order 5050.4B, and the CEQ NEPA implementing regulations, the FAA analyzed the potential cumulative impacts. The cumulative impacts analysis focuses on air quality, noise, and socioeconomics because as noted in Chapter 4, potential impacts to other resource categories are negligible. The FAA has determined that the Proposed Action in conjunction with other past, present, and reasonably foreseeable future actions would not have a cumulative impact on other resource areas described in Chapter 4. For this Proposed Action, the geographic boundaries for cumulative impacts are the same as the ROI considered for direct and indirect impacts for air quality, noise, and socioeconomics.

5.1 Past, Present, and Reasonably Foreseeable Future Actions

5.1.1 Past Actions

Midland T-Bar Well Line - A water supply pipeline was completed in 2013 from a well field on T-Bar Ranch west of Odessa to the City of Midland. The pipeline will supplement surface water supplies and provide Midland's needs through 2060 and beyond. The project spans 76 miles from Winkler County to Midland County, terminating approximately 4 miles northeast of MAF. Ensuring future city water supplies allows the city to proceed with ongoing and planned development that meets the demand of new population coming to the area for employment in the oil and gas industry and associated support services. Cumulative impacts could include socioeconomic effects including population, employment, housing, medical facilities, and schools.

5.1.2 Present and Reasonably Foreseeable Future Actions

EZ Rider Multimodal Facility – This facility will be located at FM 1788 and W. County Rd. 117, just west of the MAF in the transportation zone (refer to Exhibit 3.3-1). EZ Rider is moving from their facility currently located on Highway 80 that runs between Odessa and Midland. The 12,900 ft^2 maintenance building was completed in May 2013. An additional 8,800 ft^2 administrative facility is expected to be completed in the summer of 2014. Construction of the facility could have cumulative impacts with the proposed action when there is overlap in the construction time. Cumulative impacts could include short term noise impacts from construction activities, short-term impacts to air quality from construction equipment emissions, and short-term economic impacts from jobs associated with the project.

Temporary and Permanent Housing Development – Substantial development of housing is currently ongoing in the cities of Midland and Odessa. The City of Midland has approved development projects for approximately 3,000 units of temporary and permanent residential housing and 1,700 hotel rooms. The City continues to receive permit applications for additional housing development. Construction would occur mainly within the city limits of Midland east of MAF and it is likely some construction projects would occur at the same time as the Proposed Action. Sher Hospitality plans to construct a 120 room hotel at MAF in the commercial zone on the west side of the airport (refer to Exhibit 3.3-1). Housing construction in Odessa also continues to grow. The number of monthly housing starts in Odessa has doubled since 2010. These developments will fill the ongoing demand for temporary and permanent housing. Cumulative impacts could include short and long-term air emissions and socioeconomic effects including population, employment, housing, medical facilities, and schools.

Retail Development – In response to rapid population and housing growth, retail business developments are underway or planned in the Midland-Odessa area. One such development is within the commercial zone on Highway 191, 2 miles northwest of MAF. It is likely some construction projects would occur at the same time as the Proposed Action. Cumulative impacts could include long-term regional air emissions and socioeconomics.

MAF Airfield Lighting Cable – Removal and replacement of the airfield lighting cable serving the airfield lighting system. These cables run along Runways 10/28 and 16R/34L (see Exhibit 2-1). The existing cable located within conduit in the ground will be removed and new wire installed. Construction is planned to begin in summer 2014. This project has the potential to have short-term cumulative noise and air emissions impacts during construction and socioeconomic impacts from construction jobs and associated spending.

MAF Access Control Software and Cable Upgrade –Upgrade of the existing software/hardware for the airport access control system which controls doors and gates within the Terminal Building (refer to Exhibit 2-1) and perimeter security fence. The existing communications cable will be replaced with fiber optic cable and associated devices. It is anticipated that this construction will begin in summer 2014. This project has the potential to have short-term cumulative noise, air emissions, and socioeconomic impacts during construction.

MAF Entrance Road Pavement and Guidance Signage Rehabilitation – Repair and application of a surface seal to the existing asphalt vehicle entrance roadway to the Terminal Building located in the area west of the passenger terminal building. The guidance signage along the entrance roadway to the Terminal Building and Airport areas will be refaced and painted. It is anticipated that this construction will begin in summer 2014. This project has the potential to have short-term cumulative impacts on noise during construction, air from construction equipment and asphalt, and socioeconomic impacts from construction jobs.

Orbital Outfitters Building – Orbital Outfitters is a space and pressure suit manufacturing company. MAF has identified Orbital Outfitters as a potential future tenant of the airport. Orbital Outfitters would conduct pressure suit fabrication and testing, space vehicle mockup fabrication, and altitude chamber operations. An approximate 20,000 ft^2 metal hangar and office facility for Orbital Outfitters could be constructed. The project has the potential to have short-term cumulative impacts on noise during construction, air from construction equipment, and socioeconomics impacts from construction and operation jobs.

5.2 Cumulative Impacts

5.2.1 Air Quality: NAAQS

Temporary air emissions from the limited construction for the Proposed Action would be negligible and would not be cumulative with emissions from construction of other development projects. Operations under the Proposed Action would contribute a minor amount of emissions to Midland County annually, but would not exceed NAAQS. Annual emissions would be additive and cumulative with air emissions from other past, present and reasonably foreseeable future actions that generate construction, population growth, and associated vehicular traffic. Because the Midland-Odessa-San Angelo Air Quality Control Region is in attainment for NAAQS, this cumulative impact would not be significant.

5.2.2 Climate: GHG Emissions

CO_2 is the GHG emitted during launch vehicle operations. Annual GHG emissions associated with the proposed operations in 2018 are compared to U.S. 2011 GHG emissions in Table 5.1-1. The estimated GHG emissions from the Proposed Action essentially represent zero percent of the total GHG emissions generated by the U.S. in 2011.

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

Alternative	Metric Tons of CO_2 per Year
2018 Proposed Action	1,871
U.S. 2011 Total GHG Emissions	$6{,}708.3 \times 10^6$
% of U.S. Emissions	0.000028

Source: 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 methodology exists that would enable estimating the specific impacts (if any) that this increment of warming would produce. 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.

5.2.3 Noise

Residential land use exposed to noise levels 65-70 dBA DNL would increase by approximately one acre, which is considered incompatible. The residential land is east of the intersection of West County Road 116 and South County Road 1255, southeast of MAF and north of Interstate 20 (refer to Exhibit 4.2-1). There are no other past, present, or reasonably foreseeable future actions identified that have or would have a noise impact in this area; therefore, there would be no significant cumulative impact.

5.2.4 Socioeconomics

The Proposed Action would have minor impacts on population, housing, employment, income, and services, such as hospitals. The gradual increase to 200 employees over five years could result in a total population increase of approximately 544, directly resulting from the Proposed Action. This would represent less than one percent of the ROI population. These new residents would require housing, schools, and services and may generate a minor amount of indirect spending in ROI.

The socioeconomic impact of the Proposed Action, while minor, would be additive and cumulative with the impacts of the ongoing oil and gas boom and associated development. As discussed in Section 3.9, these actions have increased population and demands on housing, schools, and community services, and have induced development of supporting business in West Texas, particularly in the Midland and Odessa areas. Development of new housing is ongoing and planned in Midland and Odessa to meet the current and future demand (refer to Section 3.9.3). It is uncertain how far into the future this growth will continue and whether or not this condition would be overlapping in time with the full operation of the Proposed Action in 2018. Nevertheless, it is reasonably foreseeable that the Proposed Action would contribute cumulatively to existing impacts on population, housing, and schools. While the minor increase in employment and income with the Proposed Action would not likely generate a level of demand for goods and services that would induce secondary development of retail or commercial establishments, it would add cumulatively to the larger demands being generated by the rapid population growth in the area.

Because the cities of Midland and Odessa are taking steps to accommodate planned economic growth and job creation, it is unlikely that the cumulative socioeconomic impacts would be disruptive to the community or be inconsistent with local regulations or community planning. Therefore, there would be no significant cumulative socioeconomic impacts.

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APPENDICES

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Appendix A
Noise

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U.S. Department
of Transportation
Federal Aviation Administration

Office of Environment and Energy

800 Independence Ave., S.W.
Washington, D.C. 20591

January 8, 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 XCOR Aerospace, Inc. (XCOR) for the operation of the Lynx horizontal take-off and horizontal landing reusable launch vehicle (RLV) and other associated activities (e.g., engine testing). This methodology is proposed to support the City of Midland Launch Site Operator License, for Midland International Airport. The City of Midland is proposing to operate a commercial space launch site at the Midland International Airport (MAF) in Midland County. In order to operate a commercial space launch site, the City of Midland must obtain a commercial space launch site license from the Federal Aviation Administration (FAA). A noise analysis must be completed as part of the launch site license 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 City of Midland Launch Site Operator License.

The methodology is a quantitative analysis based on the latest available methods for launch noise. The sonic boom measurement was computed using the FAA approved model, PC Boom. The FAA does not currently have an approved model for horizontal 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 Midland Launch Site Operator License for the Lynx horizontal take-off and horizontal landing RLV. AEE concurs with the launch noise methodology used for this specific Launch Site Operator License request. Please understand that this approval is limited to this particular Launch Site Operator License request at MAF

and the Lynx horizontal take-off and horizontal landing RLV. Any additional projects using this or other launch noise methodologies or variations of the Lynx horizontal take-off and horizontal landing RLV will require separate approval.

Sincerely,

Rebecca Cointin, Manager
AEE/Noise Division

Blue Ridge Research and Consulting, LLC

Final Report

Noise Study in support of the City of Midland Launch Site Operator License, Midland International Airport

June 2013(R2014)

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Acronyms and Abbreviations

The following acronyms and abbreviations are used in the report:

AFCEE	Air Force Center for Engineering and Environment
AST	Office of Commercial Space Transportation
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
ESRL	Earth System Research Laboratory
FAA	Federal Aviation Administration
ft	foot/feet
INM	Integrated Noise Model
Kg	kilogram
Lbf	pound force
lbm	pound mass
$L_{A,max}$	maximum A-weighted OASPL
L_{max}	maximum unweighted OASPL
LOX	Liquid Oxygen
m	meters
MAF	Midland International Airport
N	newton
NEPA	National Environmental Policy Act
NIHL	noise-induced hearing loss
NIOSH	National Institute for Occupational Safety and Health
OASPL	overall sound pressure level
OSHA	Occupational Safety and Health Administration
psf	pounds per square foot
REL	recommended exposure limit
RLV	reusable launch vehicle
RSRM	reusable solid rocket motor
S.L.	sea level
sec	second
SEL	Sound Exposure Level
µPa	micropascal
XCOR	XCOR Aerospace, Inc.

1 Introduction

The City of Midland is proposing to operate a commercial space launch site at the Midland International Airport (MAF) in Midland County, and offer the site to XCOR Aerospace, Inc. (XCOR) for the operation of the Lynx horizontal take-off and horizontal landing reusable launch vehicle (RLV) and other associated activities (e.g., engine testing). In order to operate a commercial space launch site, the City of Midland must obtain a commercial space launch site license from the Federal Aviation Administration (FAA). The following report documents the noise study performed to support the City of Midland in obtaining a commercial space launch site operator's license for MAF.

The issuance of a launch site operator 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 2.1).

MAF is a public–use airport owned by the City of Midland, which provides commercial aircraft service by Southwest, American Eagle, and United Express Airlines [2]. Of the approximately 200 total daily flight operations, commercial operations comprise approximately 65 percent and military operations 35 percent. A noise study was performed [3] to determine the baseline DNL noise contours from the existing commercial aircraft operations at MAF, representing the No Action Alternative.

The Proposed Action of the Lynx RLV includes operations on two representative flight tracks broken down by north flow and south flow traffic, pre-flight run-ups, and engine hot-fire tests. The Lynx RLV launch operations would begin in 2014 and continue through 2018. The frequency of launch operations would initially be one launch per week (52 per year) in 2014, increasing each year to two launches per day, five days a week (520 per year) in 2018. The Proposed Action also includes 100 hot-fire engine tests per year. The community noise exposure of the Proposed Action (Lynx RLV plus existing aircraft operations), on a DNL basis, was then compared to the No Action Alternative to determine if a significant noise impact would occur as a result of the Proposed Action. Note, as the Lynx RLV operations will peak in 2018, the commercial aircraft operations were also projected out to 2018 for the community noise exposure comparison.

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 launch noise and sonic boom noise models; Section 4 describes the acoustic modeling input parameters for MAF; 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 and Criteria

2.1 Noise Metrics

Any unwanted sound that interferes with normal activities or the natural environment can be defined as noise. Noise sources can be continuous (constant) or transient (short-duration) and contain a wide range of frequency (pitch) content. Determining the character and level of sound aids in predicting the way it is perceived. Both launch noise and sonic booms are classified as transient noise events.

The decibel (dB) is a ratio that compares the sound pressure of the sound source of interest (e.g. the rocket launch) to a reference pressure (the quietest sound we can hear, 20 µPa (micropascal)). Standard weighting filters help to shape the levels in reference to how they are perceived. An “A-weighting” filter approximates the frequency response of human hearing, adjusting low and high frequencies to match the sensitivity of human hearing. For this reason, the A-weighted decibel level (dBA) is commonly used to assess community noise. However, if the structural response is of importance to the analysis, a “Flat-weighted” (unweighted) level is more appropriate.

The impact of noise can be described with the use of noise metrics, which depend on the nature of the event and who or what is affected by the sound. Individual time-varying noise events have two main characteristics: a sound level that changes throughout the event and a period of time during which the event is heard. The overall sound pressure level (OASPL) provides a measure of the sound level at any given time, while the maximum OASPL (L_{max}) indicates the maximum OASPL achieved over the duration of the event. Sound Exposure Level (SEL) represents both the magnitude of a sound and its duration. SEL provides a measure of the cumulative noise exposure of the entire acoustic event, but it does not directly represent the sound level heard at any given time. Mathematically, it represents the sound level of a constant sound that would, in one second, generate the same acoustic energy as the actual time-varying noise event. For sound generated by rocket launches, which last more than one second, the SEL is greater than the L_{max} because an individual launch can last for minutes and the L_{max} occurs instantaneously. Sonic boom noise levels are described in units of peak overpressure in pounds per square foot (psf).

The DNL is a cumulative noise metric that accounts for the SEL of all noise events in a 24-hour period. Typically, DNL values are expressed as the level over a 24-hour annual average day. In order to account for increased human sensitivity to noise at night, a 10 dB penalty is applied to nighttime events (occurring between the hours of 10:00 p.m. and 7:00 a.m.). Noise contour maps of these metrics are comprised of lines of equal noise level or exposure, and they serve as visual aids for assessing the impact of noise on a community.

2.2 Noise Criteria

Noise criteria have been developed in order to protect the public health and welfare of the surrounding communities. The following noise criteria address human annoyance, hearing conservation, and structural damage. The current study includes both single-event and cumulative analyses.

2.2.1 Human Annoyance

FAA Order 1050.1E, Change 1, states 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 or above DNL 65 dBA noise exposure when compared to existing conditions within the same time period. DNL has been found to correlate well with adverse community impacts for regularly occurring events including aircraft, rail, and road noise [4, 5]. DNL is based on long-term cumulative noise exposure to the previously mentioned noise sources, which do not include launch vehicles (rockets). Thus, it is acknowledged that the suitability of DNL for launch vehicle noise is uncertain with respect to current research and dose response studies. DNL is provided as the FAA considers DNL the best available metric to estimate the potential long-term annoyance. DNL contours are provided to estimate the potential annoyance in compliance with FAA requirements.

2.2.2 Hearing Conservation

Multiple federal government agencies have provided guidelines on permissible noise exposure limits. These documented guidelines are in place to protect one's hearing from long-term continuous daily exposures to high noise levels and aid in the prevention of noise-induced hearing loss (NIHL). The National Institute for Occupational Safety and Health (NIOSH) has standardized employee noise exposure requirements based on level and duration allowed during an 8-hour workday [6]. NIOSH recommendations are designed such that over a 40-year lifetime exposure, the excess risk of developing occupational NIHL is 8%. NIOSH established a recommended exposure limit (REL) for noise at 85 dBA with a 3 dB exchange rate, which means as the level increases by 3 dB the duration is reduced by a factor of two. The Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for noise starts at 90 dBA for an 8-hour period [7]. However, the OSHA exchange rate is 5 dB.

For the entire American public at all times rather than the American worker during his workday, the U.S. Environmental Protection Agency (EPA) has recommended an exposure limit of 70 dBA for 24 hours which provides a margin of safety [8]. EPA recommendations are designed such that over a 40-year lifetime exposure, the excess risk of developing occupational NIHL is 4% [8]. For exchange rates, the EPA recommends two separate rates for continuous and short exposure periods (less than 15 minute), 3 dB and 6 dB, respectively. In terms of upper limits on the noise levels, NIOSH set the maximum exposure at 140 dBA, and OSHA set it at 115 dBA for a steady-state event. The Department of Defense occupational Hearing Conservation Program states that the maximum allowable exposure to steady-state noise is 130 dBA [9]. The EPA does not state a maximum level for non-impulsive noise. Therefore, a maximum noise level of 115 dBA (the OSHA maximum exposure) will be used as an initial conservative threshold to identify potential locations where hearing protection should be considered for a rocket launch.

2.2.3 Structural Damage

Noise from Rocket launches has the potential to cause damage to buildings and other structures in the vicinity of a launch site. Generally, the most sensitive components of a structure to launch noise are windows, and infrequently, the plastered walls and ceilings. A NASA technical memo written by Guest and Sloan [10] found a relationship between structural damage claims and overall sound pressure level from rocket firings. The study was based on community responses to the 45 ground tests of the first and second stages of the Saturn V rocket system conducted in southern Mississippi over a period of five years. Guest and Sloan [10] determined that "the probability of structural damage [was] proportional to the intensity of the low frequency sound." The study estimated that one damage claim in 1,000 households exposed is expected at an average continuous level of 111 dB, and one in 100 households at 120 dB. The sound levels used to develop the criteria were mean modeled sound levels. It is important to highlight the difference between the static ground tests in which the probability of structural damage is based on and launch events. The ground tests occurred for durations much greater than the exposure duration expected for the proposed launch events. Additionally, during ground tests, the engine/motor remains in one position, which results in longer exposures compared to transient noise exposure from a moving vehicle during a launch event. However, the relationship between damage claims and level documented by Guest and Sloan [10] is the best available noise criteria regarding structural damage resulting from rocket noise. The locations at which the cited levels are exceeded are presented in this noise analysis to provide a general guideline for assessing potential risk to structural damage claims. In addition, a report from the Office of Naval Research on the "Guidelines for Preparing Environmental Impact Statements on Noise" [11] states that one may conservatively consider all sound lasting more than one second with levels exceeding 130 dB (unweighted) as potentially damaging to structures. However, this report is not specific to the low-frequency noise generated by large rockets.

2.2.4 Sonic Boom Impacts

A sonic boom is the sound associated with the shock waves created by a vehicle traveling through the air faster than the speed of sound. Sonic booms are commonly associated with structural damage. Most damage claims are for brittle objects, such as glass and plaster. Table 1 summarizes the threshold of damage that may be expected at various overpressures [12]. A large degree of variability exists in damage experience, and much damage depends on the pre-existing condition of a structure. Breakage data for glass, for example, spans a range of two to three orders of magnitude at a given overpressure. The probability of a window breaking at 1 psf ranges from one in a billion [13] to one in a million [14]. These damage rates are associated with a combination of boom load and glass condition. At 10 psf, the probability of breakage is between one in 100 and one in 1,000. Laboratory tests involving glass [15] have shown that properly installed window glass will not break at overpressures below 10 psf, even when subjected to repeated booms; however in the real world glass is not always in pristine condition.

Damage to plaster occurs at similar ranges to glass damage. Plaster has a compounding issue in that it will often crack due to shrinkage while curing or from stresses as a structure settles, even in the absence of outside loads. Sonic boom damage to plaster often occurs when internal stresses are high from these factors.

Some degree of damage to glass and plaster should thus be expected whenever there are sonic booms, but usually at the low rates noted above. In general, for well-maintained structures, the threshold for damage from sonic booms is 2 psf, below which damage is unlikely and generally limited to bric-a-brac or structural elements that are in ill-repair.

Table 1. Possible damage to Structures from sonic booms [12]

Sonic Boom Overpressure Nominal (psf)	Type of Damage	Item Affected
0.5 - 2	Plaster	Fine cracks; extension of existing cracks; more in ceilings; over door frames; between some plaster boards.
	Glass	Rarely shattered; either partial or extension of existing.
	Roof	Slippage of existing loose tiles/slates; sometimes new cracking of old slates at nail hole.
	Damage to outside walls	Existing cracks in stucco extended.
	Bric-a-brac	Those carefully balanced or on edges can fall; fine glass, such as large goblets, can fall and break.
	Other	Dust falls in chimneys.
2 - 4	Glass, plaster, roofs, ceilings	Failures show that would have been difficult to forecast in terms of their existing localized condition. Nominally in good condition.
4 - 10	Glass	Regular failures within a population of well-installed glass; industrial as well as domestic greenhouses.
	Plaster	Partial ceiling collapse of good plaster; complete collapse of very new, incompletely cured, or very old plaster.
	Roofs	High probability rate of failure in nominally good state, slurry-wash; some chance of failures in tiles on modern roofs; light roofs (bungalow) or large area can move bodily.
	Walls (out)	Old, free standing, in fairly good condition can collapse.
	Walls (in)	Inside ("party") walls known to move at 10 psf.
Greater than 10	Glass	Some good glass will fail regularly to sonic booms from the same direction. Glass with existing faults could shatter and fly. Large window frames move.
	Plaster	Most plaster affected.
	Ceilings	Plaster boards displaced by nail popping.
	Roofs	Most slate/slurry roofs affected, some badly; large roofs having good tile can be affected; some roofs bodily displaced causing gale-end and will-plate cracks; domestic chimneys dislodged if not in good condition.
	Walls	Internal party walls can move even if carrying fittings such as hand basins or taps; secondary damage due to water leakage.
	Bric-a-brac	Some nominally secure items can fall; e.g., large pictures, especially if fixed to party walls.

3 Acoustic Modeling Methodology

The majority of the noise generated by a rocket launch is created by the rocket plume, or jet exhaust, interacting with the atmosphere along the entire plume, and combustion noise of the propellants. Launch noise occurs in the region surrounding the launch pad and radiates in all directions. However, it is highly directive meaning that a significant portion of the source's acoustic power is concentrated in a specific direction. Additionally, the level of noise received depends on the distance from the source. Noise decreases as the distance from the source increases, for example, there is a 6 dB decrease in OASPL per doubling of distance when described by spherical spreading.

In addition to the launch noise, a launch vehicle can create sonic booms as a result of the shock waves created from supersonic flight, when the vehicle travels faster than the speed of sound. The perception of a sonic boom depends on the distance from the vehicle to the observer as well as the physical characteristics of the vehicle and the atmospheric conditions. The noise is perceived as a deep double boom, with most of its energy concentrated in the low frequency range. Although sonic booms generally last less than one second, their potential for impact may be considerable.

3.1 Far-Field Launch Noise Modeling

The acoustic model developed to predict far-field noise from launch vehicles is based on Eldred's Distributed Source Method 1 (DSM-1) reported in NASA SP-8072 [16]. The noise level observed depends on the vehicle specific sound power and the location of the observer in reference to the vehicle's noise source. Sound power is a measure of the acoustic energy per unit of time. The DSM-1 model determines the launch vehicle's total sound power based on its total thrust and exhaust-velocity. 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 [16].

The modeled noise source comprises a range of frequencies, each of which contains a portion of the total sound power. The portion of sound power contained in each frequency band is not equal and the distribution depends on the ratio of the nozzle exit diameter to exhaust exit velocity [17]. The modeled noise source is actually represented by a set of noise sources distributed along the vehicle exhaust plume, hence the name "Distributed Source Method." The defining feature of the DSM-1 is that each noise source corresponds to a unique frequency. The location of each source influences the distance and angle to the observer. However, for far-field observer locations, the variation in distance and angle from each source to the observer is minimal. Therefore, the set of distributed sources can be modeled as a compact source located at the nozzle exit with an equivalent total sound power and range of frequencies.

The sound pressure level observed is a function of the sound power generated by the engine/motor and the location of the observer in reference to the noise source. The observed sound pressure level decreases as the distance from the source increases. The noise source radiates sound in all directions, however, it is highly directive meaning the acoustic power is concentrated in a specific direction and the sound pressure observed will depend on the angle from the noise source to the observer location. Section 3.1.2 describes the source directivity in more detail.

3.1.1 Acoustic Efficiency

The acoustic efficiency, defined as the ratio of the sound power to the exhaust mechanical power, determines the percentage of energy in the exhaust that is converted to acoustic energy. The launch vehicle's total sound power depends on the acoustic efficiency of the engine/motor. The acoustic efficiencies of rocket engines/motors generally range from 0.2% to 1.0%, with 1.0% considered a conservative upper bound and 0.5% the most probable [16]. The acoustic efficiency of the rocket engine/motor was modeled using the best available methods. Guest's [18] variable acoustic efficiency model predicted an acoustic efficiency based on the total mechanical power of the motor.

3.1.2 Source Directivity

Directivity is the measure of the focusing of the noise source's sound power and its value depends on the frequency and the angle to the observer. Eldred's report [16] includes a set of directivity indices based on the best available data at the time. NASA's Project Constellation Program has made significant improvements in determining launch vehicle directivity, which resulted from measurements taken of the static firings of the reusable solid rocket motor (RSRM) of NASA Ares I – Crew Launch [19]. The RSRM directivity indices incorporate a larger range of frequencies and angles then previously available data. These updated directivity indices are used for this analysis.

3.1.3 Doppler Effect

Doppler effect is defined as the change in frequency of a wave for an observer moving relative to its source. It is commonly heard when a vehicle sounding a siren or horn approaches, passes, and recedes from an observer. The perceived frequency is related to the actual frequency by the speed of the source and receiver and the speed of the waves in the medium. The received frequency is higher (compared to the emitted frequency) during the approach, it is identical at the instant of passing by, and it is lower during the recession. The relative changes in frequency can be explained as follows. When the source of the waves is moving toward the observer, each successive wave crest is emitted from a position closer to the observer than the previous wave. Therefore each wave takes slightly less time to reach the observer than the previous wave. Therefore the time between the arrival of successive wave crests at the observer is reduced, causing an increase in the frequency. While they are travelling, the distance between successive wave fronts is reduced; so the waves "bunch together". Conversely, if the source of waves is moving away from the observer each wave is emitted from a position farther from the observer than the previous wave, so the arrival time between successive waves is increased, reducing the frequency. The distance between successive wave fronts is increased, so the waves "spread out". This spreading effect is illustrated in Figure 1 for an observer in a series of images, where a) the source is stationary, b) the source is moving less than the speed of sound, c) the source is moving at the speed of sound, and d) the source is moving faster than the speed of sound. During a rocket launch an observer on the ground will hear a downward shift in the frequency of the sound as the rocket increases its speed relative to the observer. In this case, the difference in observed frequency to emitted frequency increases as the distance from the source to receiver increases. As the frequency is shifted lower the A-Weighting filtering on the spectrum results in a decreased A-weighted sound level. Note there would be no change in the unweighted sound levels.

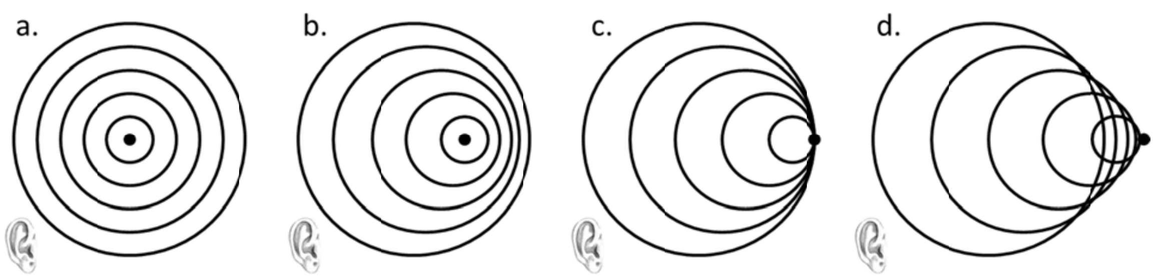

Figure 1. Effect of expanding wavefronts (decrease in frequency) that an observer would notice for higher relative speeds of the rocket relative to the observer for: a) stationary source b) source velocity < speed of sound c) source velocity = speed of sound d) source velocity > speed of sound

3.1.4 Ground Interference

Sound propagation using NASA SP-8072 [16] 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) shown in Figure 2. The ground will reflect sound energy back toward the receiver. Depending on the frequency of the wave and the geometry, this reflected wave may interfere with the direct wave causing constructive or destructive interference. Additionally, the ground may absorb a portion of the sound energy causing the reflected wave to propagate a smaller portion of energy to the receiver. The acoustic model accounts for the attenuation of sound by the ground [20, 21] 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 [20].

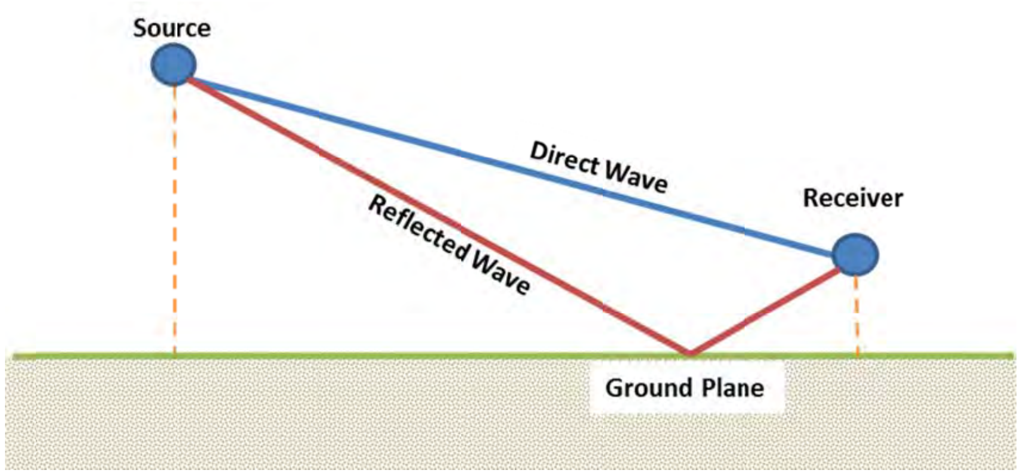

Figure 2. Sound propagation near the ground is modeled as the combination of a direct wave (blue) and a reflected wave (red) from the source to the receiver.

3.1.5 Atmospheric Absorption and Nonlinear Effects

Atmospheric absorption is a measure of the sound attenuation due to the temperature, pressure and relative humidity of the air. The attenuation of sound due to atmospheric absorption generally increases with frequency and distance. For large rockets, due to the distortion of high-pressure sound waves as they travel through the medium, nonlinear propagation effects may counteract the effect of atmospheric absorption at certain distances. However, the Lynx family of vehicles would be categorized as “small rockets” and as such; the effect of atmospheric absorption is considered significant and is included in the modeling of the launch noise. The atmospheric absorption is calculated using formulas found in ANSI standard S1.26-1995 (R2004) [22]. The result is a sound-attenuation coefficient, which is a function of frequency, atmospheric conditions, and distance from the source. To compute the sound-attenuation coefficients due to atmospheric absorption, an atmospheric profile is required that includes the temperature, humidity, and pressure as a function of height above the ground. The amount of absorption depends on the parameters of the atmospheric layer and the distance that the sound travels through the layer. The total sound attenuation is the sum of the absorption experienced from each atmospheric layer.

3.2 Sonic Boom Modeling

When an aircraft moves through the air, it pushes the air out of its way. At subsonic speeds, the displaced air forms a pressure wave that disperses rapidly. At supersonic speeds, the aircraft is moving too quickly for the wave to disperse, so it remains as a coherent wave. This wave is a sonic boom. When heard at ground level, a sonic boom consists of two shock waves (one associated with the forward part of the aircraft, the other with the rear part) of approximately equal strength and (for fighter aircraft) separated by 100 to 200 milliseconds. For rockets, the separation can be extended because of the volume of the plume. Thus, their waveform durations can be as large as one second. When plotted, this pair of shock waves and the expanding flow between them has the appearance of a capital letter "N," so a sonic boom pressure wave is usually called an "N-wave." An N-wave has a characteristic "bang-bang" sound that can be startling. Figure 3 shows the generation and evolution of a sonic boom N-wave under the aircraft. Figure 4 shows the sonic boom pattern for an aircraft in steady, level supersonic flight. The boom forms a cone that is said to sweep out a "carpet" under the flight track. The boom levels vary along the lateral extent of the "carpet" with the highest levels directly underneath the flight track and decreasing as the lateral distance increases to the cut-off edge of the "carpet." When the vehicle is maneuvering, the sonic boom energy can be focused in highly localized areas on the ground. This focusing will cause the N-wave boom to be amplified and transformed into a U-wave.

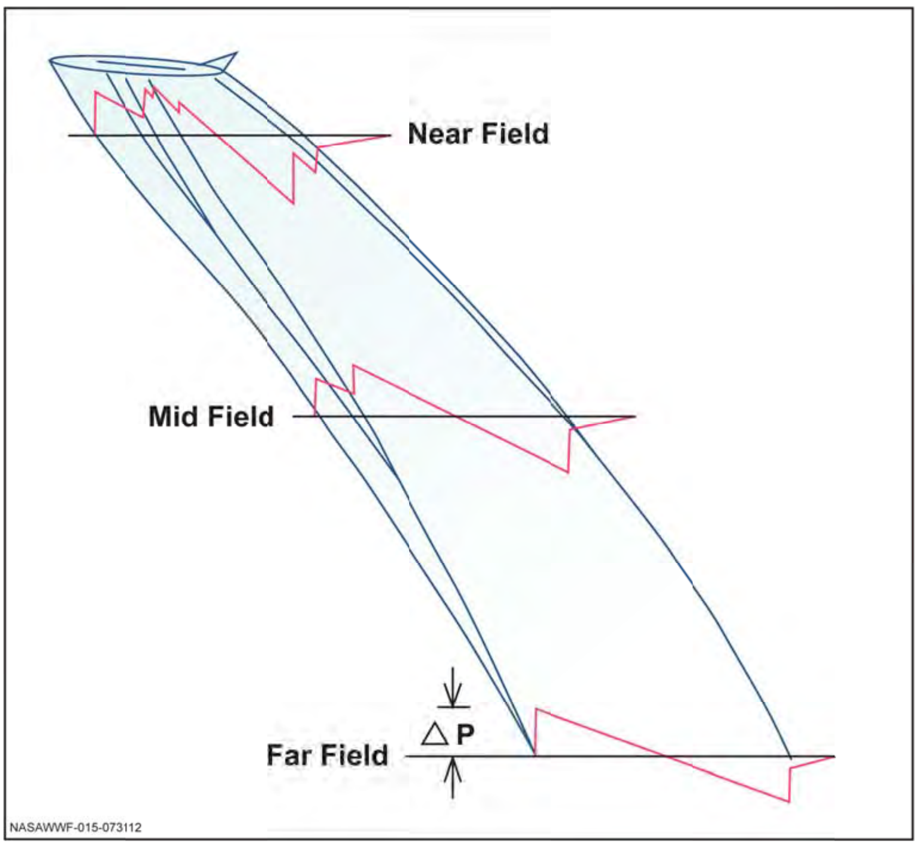

Figure 3. Sonic boom generation and evolution to N-wave

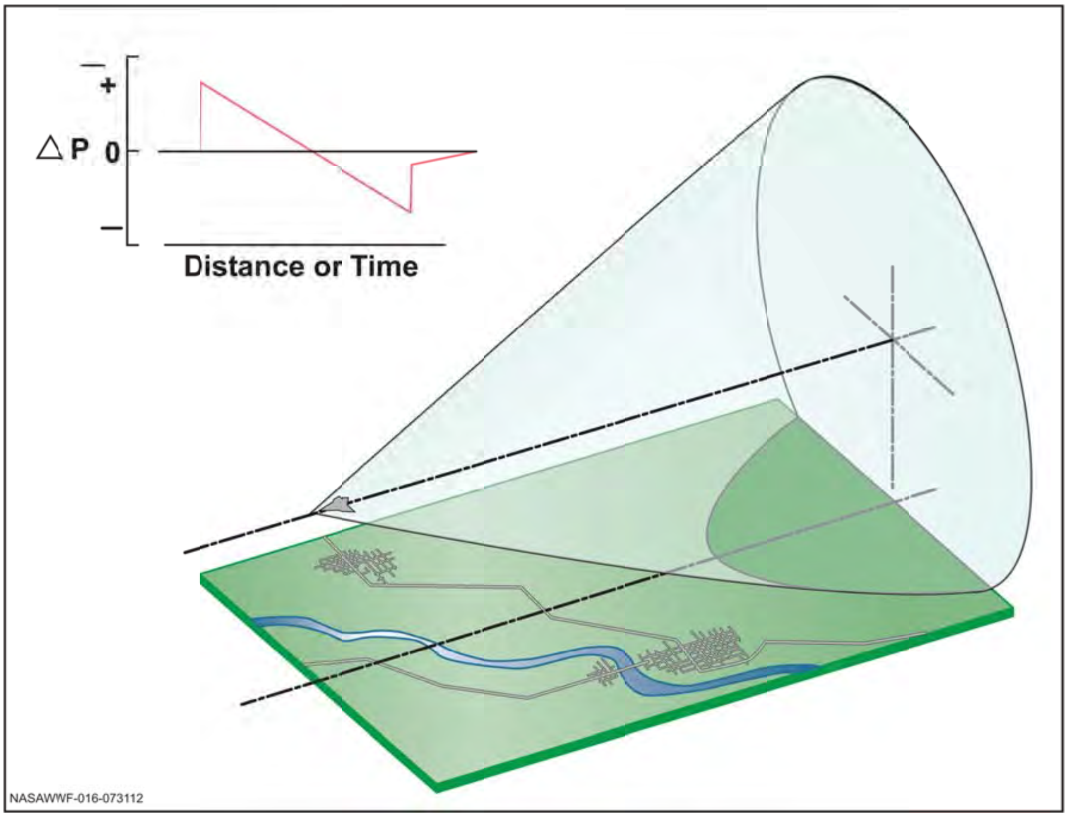

Figure 4. Sonic boom carpet in steady flight

The complete ground pattern of a sonic boom depends on the size, shape, speed, and trajectory of the vehicle. Since aircraft fly supersonically with relative low horizontal angles, the boom is directed toward the ground. However, for rocket trajectories, the boom is directed laterally until the rocket rotates significantly away from vertical as shown in Figure 5. This difference causes a sonic boom from a rocket to propagate much further downrange compared to aircraft sonic booms. This extended propagation usually results in relatively lower sonic boom levels from rocket launches. For aircraft, the front and rear shock are generally the same magnitude. However, for a rocket the plume provides a smooth decrease in the vehicle volume, which diminishes the strength of the rear shock. During reentry of a rocket body, the vehicle can also generate sonic boom on the ground as the body descends back toward the airport. The sonic booms are somewhat reduced as the vehicle is decelerating. For this case the propagation is direct toward the ground, so the boom is concentrated around the impact site as shown in Figure 6, which is for a sounding rocket.

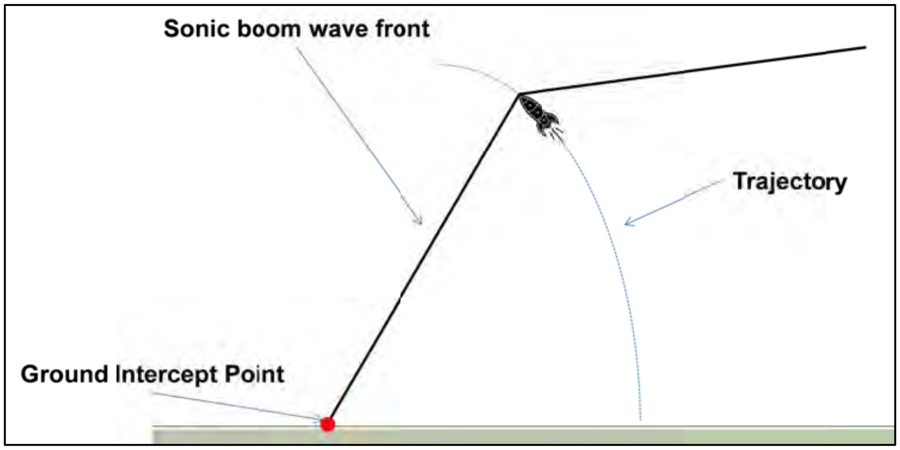

Figure 5. Sonic boom propagation for rocket launch

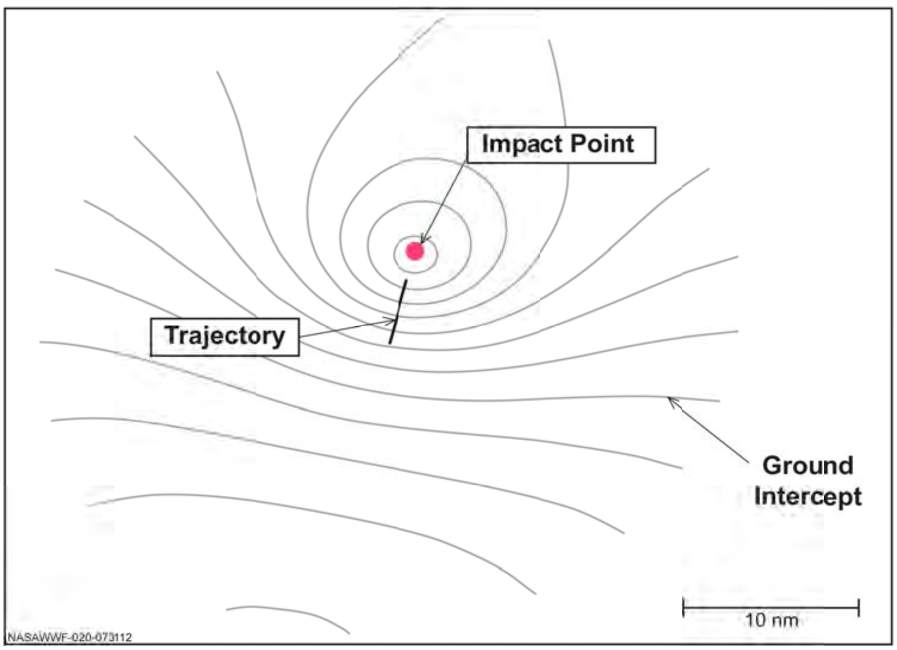

Figure 6. Sonic boom ground intercepts for reentry of a sounding rocket

The single-event prediction model, PCBoom4 [23, 24, 25], provided by the Air Force Center for Engineering and Environment (AFCEE) is used to predict the sonic boom footprint. PCBoom4 calculates the magnitude and location of sonic boom overpressures on the ground from supersonic flight. Several inputs are required to calculate the sonic boom impact, including the aircraft model, the trajectory path, the atmospheric conditions and the ground surface height. Predicted sonic boom footprints are in the form of constant pressure contours.

4 Midland International Airport

4.1 Airfield Description

MAF is a public–use airport owned by the City of Midland, Texas, which provides commercial aircraft service by Southwest, American Eagle, and United Express Airlines [2]. Of the nearly 200 total flight operations per day, commercial operations comprise approximately 65 percent and military operations 35 percent. MAF contains four operating runways, shown in Figure 7. The longitude and latitude start and end points of the MAF runways 4, 10, 16L, 16R, 22, 28, 34L, and 34R are included in Table 2.

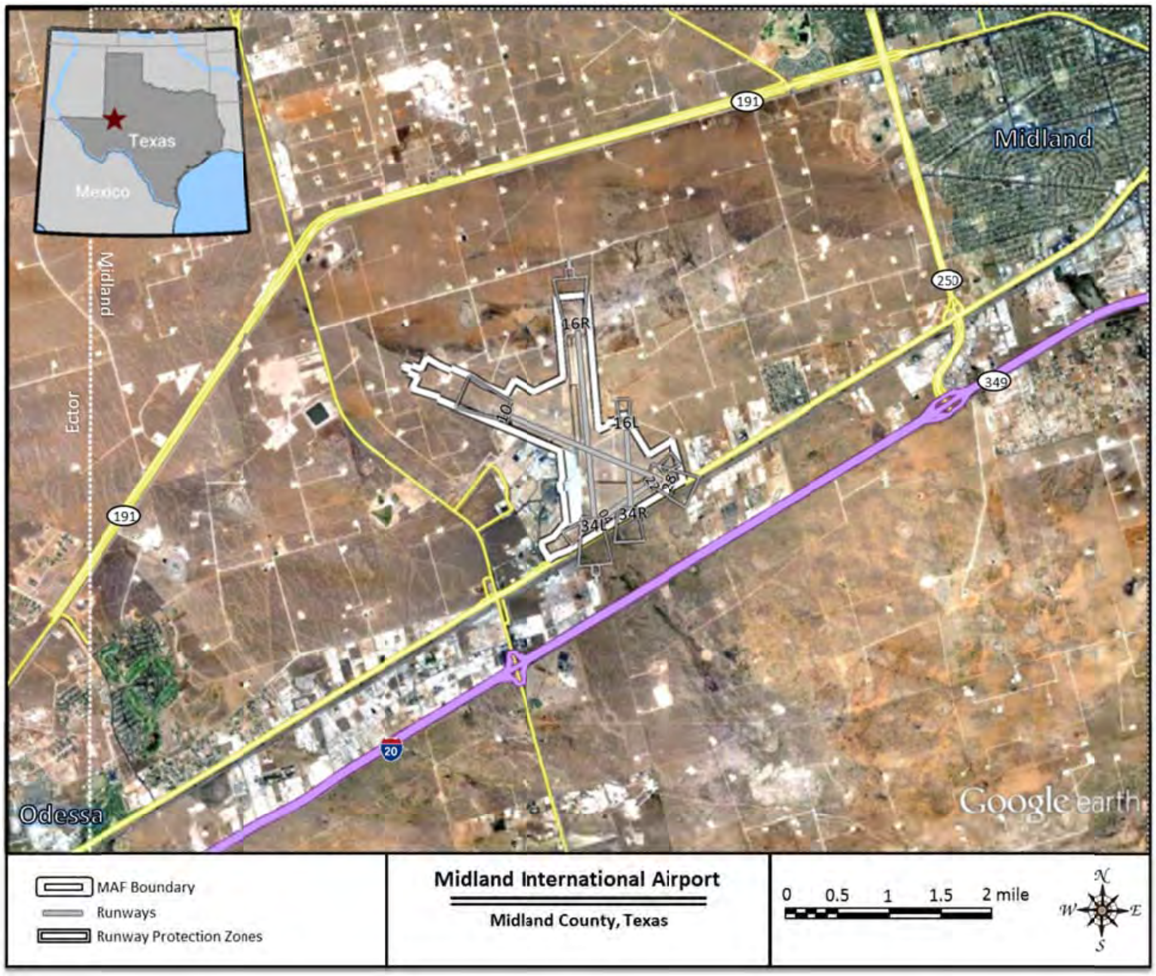

Figure 7. MAF boundary and runways

Table 2. MAF runway start and end point locations

Runway Pair	Active (Y/N)	Runway	Latitude	Longitude	Runway	Latitude	Longitude
16R/34L	Y	16R	N31°57.56'	W102°12.33'	34L	N31°56.00'	W102°12.17'
10/28	Y	10	N31°56.86'	W102°12.98'	28	N31°56.31'	W102°11.51'
4/22	Y	4	N31°55.90'	W102°12.23'	22	N31°56.35'	W102°11.51'
16L/34R	Y	16L	N31°56.77'	W102°11.85'	34R	N31°56.07'	W102°11.81'

The average monthly temperature, humidity, and pressure used to model the aircraft operations included in the baseline noise exposure case is displayed in Table 3. To model the projected rocket launch noise, an atmospheric altitude profile is necessary in order to model the atmospheric absorption from propagation at higher altitudes. Figure 8 shows the average annual atmospheric profile at MAF. The atmospheric profile was calculated using detailed radiosonde data collected from the NOAA Earth System Research Laboratory (ESRL) Radiosonde Database [26] for the Midland, Texas station located at 31.93°N, 102.2°W. As the NOAA/ESRL Radiosonde data was limited to altitudes below 20 miles, the profile was extended using the U.S. Standard Atmosphere (1976).

Table 3. Average monthly temperature, humidity, and pressure

Month	Temperature (˚F)	Humidity (%)	Pressure (in Hg)
January	47.5	52	27.1
February	49.2	54	27.1
March	61.1	50	27
April	71.8	39	26.9
May	76.1	52	27
June	84.4	43	26.9
July	83.6	49	27
August	84.3	46	27
September	76.6	53	27.1
October	66.9	58	27.1
November	54.4	47	27.1
December	41.9	69	27.1

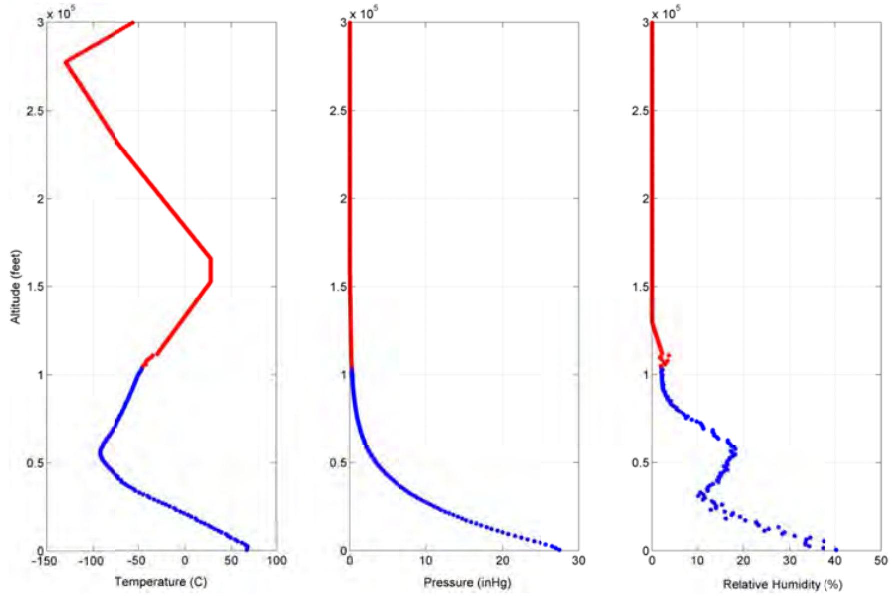

Figure 8. Annual average atmospheric profile for Midland, TX. NOAA/ESRL data in red and U.S. Standard Atmosphere (1976) extension in blue.

4.2 Baseline Input Parameters

A baseline noise analysis for MAF was conducted by Blue Ridge Research and Consulting, LLC (BRRC), to estimate community noise exposure due to commercial and military aircraft flight operations projected to 2018. MAF has both commercial and military aircraft operations with most of the community noise exposure generated by the military operations; these include the F-18, C-5A, T-38 and T-1 aircraft. BRRC used the Department of Defense's Noisemap program [27] to model the noise from military aircraft operations and used the FAA's Integrated Noise Model (INM) [28] to model the noise from commercial aircraft operations. The noise exposure result is a combination of the individual noise results for military and commercial aircraft operations.

The data used to document the aircraft operations at MAF were developed from historical Air Traffic Activity Reports. Summarized in Table 4 are the operational data from these reports which include the average yearly operations by aircraft group. Table 4 was used to scale the aircraft operations for the average daily operations, and it also provides the percentage of acoustic day (07:00 a.m. to 10:00 p.m.)/acoustic night (10:00 p.m. to 07:00 a.m.) operations, which were developed from a combination of the posted daily commercial operational schedule and an average of the detailed Air Traffic Activity reports over a two day period. The aircraft noise model input used for 2018 is identical to the model input developed for 2012 except there is an increase in commercial operations of 2.1 percent annually [29], between 2012 and 2018; military operations over this period remain unchanged [30]. Although military aircraft account for a smaller percentage of daily flights, military aircraft generate the majority of the community noise exposure at MAF. While commercial aircraft operations are projected to increase over the 2012 to 2018 study period, the combined commercial and military noise contours remain essentially constant because the military aircraft operations remain steady and dominate the overall noise exposure. The modeled runway utilization, shown in Table 5, was provided by MAF Air

Traffic Control personnel. Note that the runway utilization is the same for all aircraft with the exception of the Cessna 208, which utilizes additional Runways 04, 16L, 22, and 34R. A detailed description of the Baseline noise exposure input parameters, including flight track and flight profile descriptions, can be found in the BRRC Noise Analysis Report [3].

Table 4. Average yearly 2012 air traffic for MAF

Group	Avg. Yearly	Group %	Representative Aircraft	Within Group %	Itinerant ATC Ops	Local ATC Ops	Total ATC Ops	Day %	Night %
Civil									
Air Carrier	8,187	11%	B737	1	8187	0	8187	89	11
Air Taxi	12,977	18%	Embraer 145	0.87	11290	0	11290	94	6
			Embraer 120	0.13	1687	0	1687	100	0
GA	26,906	37%	Citation 500 (Business Jet)	0.34	8179	969	9148	98	2
			Super King Air (Twin Prop)	0.31	7457	884	8341	94	6
			Cessna 208 (Single Prop)	0.29	6976	827	7803	94	6
			Helicopter	0.06	1443	171	1614	62	38
Military									
Military	25,468	35%	C-5A	0.02	400	100	500	100	0
			T-1	0.74	8964	9892	19355	100	0
			T-38	0.17	2058	2271	4329	100	0
			F-18	0.07	848	935	1783	100	0
Total	73,538	100%	Total Modeled		57,489	16,049	73,538		

Table 5. MAF runway utilization

Runway	All Aircraft (Except Single Prop)	Single Prop (Cessna 208)
4	0.0%	15.0%
10	20.0%	15.4%
16R	55.0%	42.4%
16L	0.0%	3.5%
22	0.0%	0.5%
28	10.0%	7.7%
34R	0.0%	4.0%
34L	15.0%	11.5
TOTAL	100%	100%

4.3 Proposed Action Input Parameters

The Proposed Action involves the operation of a commercial space launch site at MAF, offering a site for XCOR to operate the Lynx horizontal take-off and horizontal landing RLV and other associated activities (e.g., engine testing). The Lynx, shown in Figure 9, is a two-seat manned commercial RLV designed to transport payloads up to a designated apogee. Table 6 presents the vehicle input parameters utilized in the acoustic modeling.

Figure 9. Artist's rendition of the XCOR Lynx vehicle (photo courtesy of XCOR)

Table 6. Vehicle parameters utilized in acoustic modeling

Vehicle Parameters	Lynx
Vehicle Manufacturer	XCOR Aerospace, Inc.
Length	335 inches (8.51 m, 27.9 ft)
Gross Weight	5000 kg (11,023 lbm)

The Lynx is propelled by four XR-5K18 engines, shown in Figure 10, manufactured by XCOR. The largest envisioned thrust for each engine is 3,335 lbf (14,835 N). The four engines are modeled as a single engine with an effective exit diameter, as per the acoustic modeling methodology described in Section 3.1. Note that the model utilizes the actual single engine diameter for pre-flight run ups and hot-fire engine tests, which only operate one engine at a time. Table 7 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 XR-5K18 engine is 0.23%, which was calculated using Guest's [18] variable acoustic efficiency model, based on the total mechanical power of the engine. The acoustic efficiencies of rocket engines/motors generally range from 0.2% to 1.0%, with 1.0% considered a conservative upper bound and 0.5% the most probable [16]. The smaller acoustic efficiency can be attributed to the relatively small amount of thrust produced by the XR-5K18 engine.

Figure 10. XR-5K18 engine (Photo courtesy of XCOR)

Table 7. Engine parameters utilized in acoustic modeling

Engine Model:	XR-5K18
Engine Manufacturer	XCOR Aerospace, Inc.
Number of Engines	4
Nozzle Exit Diameter	16.4 cm (6.45 in)
Propellant	Liquid Oxygen (LOX)/ Kerosene
Exhaust Velocity	2,900 m/s (9,514 ft/sec)
Thrust (S.L.)	3,335 lbf (14,835 N) Largest envisioned thrust value used to represent future engines. Currently thrust is 2400-2900 lbf for each engine [31]. Future engines may have 15% higher thrust.
Mach Number *at nozzle exit	3.0 – 3.25
Acoustic Efficiency	0.23%

The Proposed Action of the Lynx RLV includes operations on two representative flight tracks broken down by north flow and south flow traffic, pre-flight run-ups, and engine hot-fire tests. The representative flight tracks operate from runways 16R and 34L, described in Table 2. Pre-flight run-up and engine hot-fire tests are conducted at the pad locations displayed in Table 8.

Table 8. Static pad locations

Static Pad	Latitude	Longitude	Direction of Plume
Runway 16R Run-up	31˚ 57' 27.34" N	102˚ 12' 27.23" W	175˚
Runway 34L Run-up	31˚ 55' 57.51" N	102˚ 12' 19.15" W	175˚
Rocket Engine Test Site	31˚ 57' 00.00" N	102˚ 12' 52.00" W	33˚

Figure 11 shows the flight track departing from runway 16R in green and the flight track departing from 34L in blue. The launch noise analysis only considers the first portion (highlighted in orange in Figure 11) of the vehicle's launch, in which the vehicle is under thrust. The sonic boom analysis only considers the re-entry portion of the launch event in which the vehicle is supersonic, highlighted in red in Figure 11. The altitude, velocity and flight path angle with respect ground distance are presented in Figure 12, depicting the flight profile parameters that affect the propagation of noise from source to receiver. Note that Figure 12 only displays the flight profile parameters for the portion of each trajectory utilized in the launch noise analysis. The propagation is calculated assuming a receiver height of five feet along with a homogeneous soft ground surface.

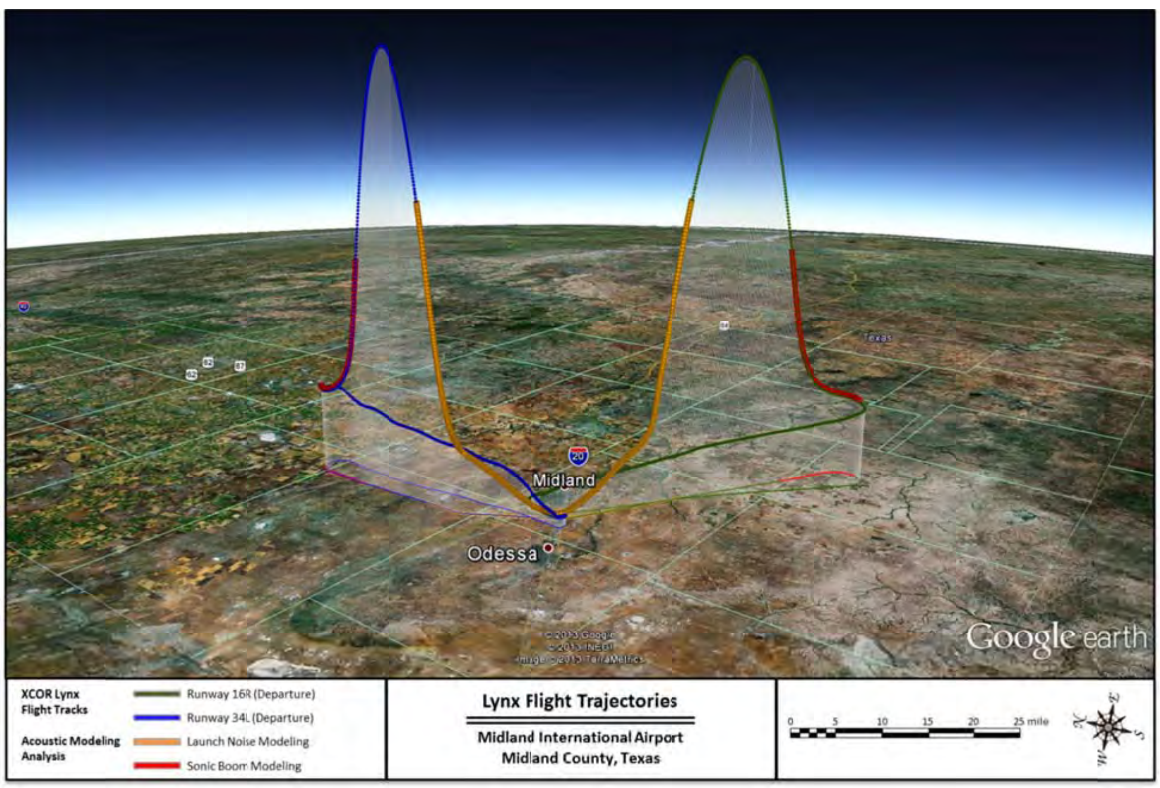

Figure 11. Lynx RLV flight trajectory paths

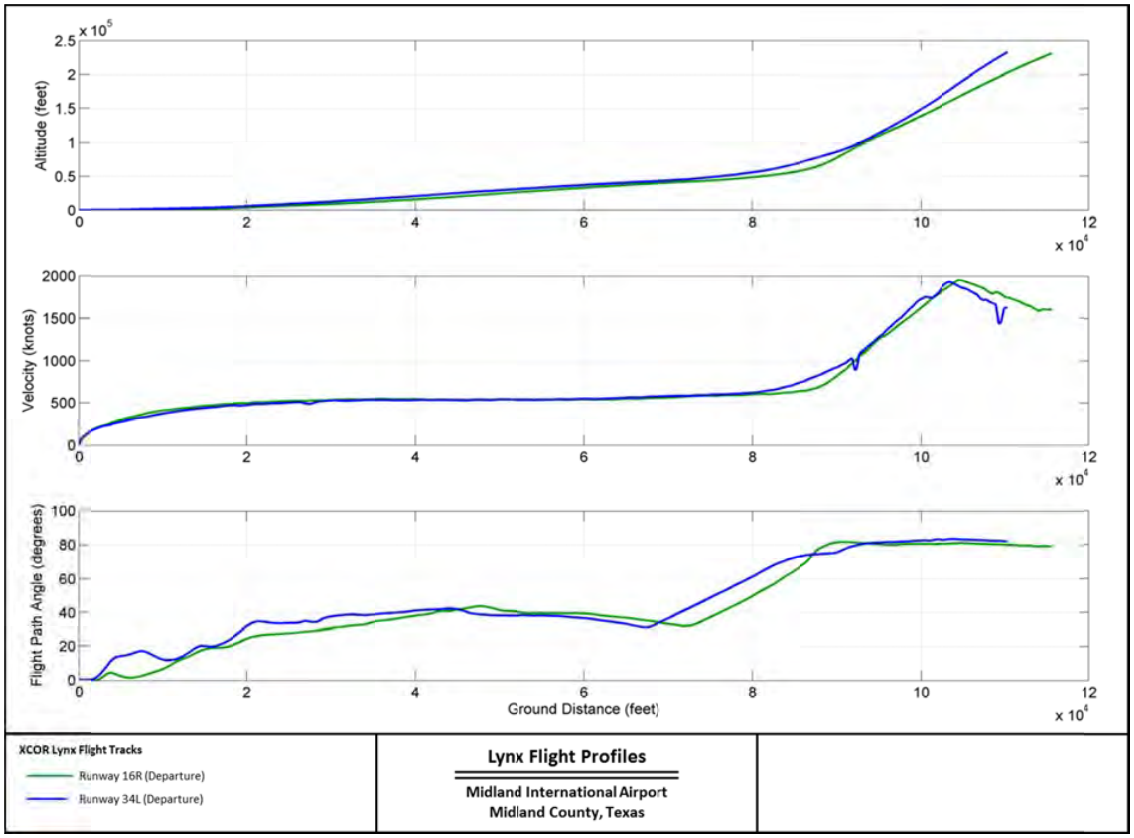

Figure 12. Lynx RLV flight profile parameters

Proposed launch operations would begin in 2014 and continue through 2018. The frequency of launch operations would initially be one launch per week, eventually increasing to two launches per day, five days a week. Fifty-two annual launch operations are proposed in 2014. The total number of annual launch operations would increase each year until 2018 when 520 annual launch operations are proposed. The Proposed Action also includes 100 hot-fire engine tests per year. A description of the Lynx RLV operations is provided in Table 9. Pre-flight run-up operations are modeled as a single engine running for two seconds at full thrust, repeating for all four engines. Engine hot-fire tests are modeled as a single engine running for eight seconds at full thrust.

Table 9. Lynx RLV proposed operations

Lynx Operation Type	Avg. Yearly Operations	Runway/ Static Pad	Runway Utilization	Acoustic Day	Acoustic Night
Flight event	520	16R	75%	95%	5%
		34L	25%	95%	5%
Pre-flight run-up	520	16R	75%	95%	5%
		34L	25%	95%	5%
Engine hot-fire test	100	Test Site	100%	100%	0%

5 Results

The following sections present the results of the acoustic models described in Section 3, with the purpose of supporting the MAF EA for Proposed Future Actions concerning XCOR Lynx space tourism operations at MAF in Midland County, Texas. The modeled noise impact is represented by DNL, presented in the form of contour maps in Section 5.1. Supplemental metrics including A-weighted OASPL ($L_{A,max}$) and unweighted OASPL are shown in Section 0. The results of the sonic boom analysis are presented in Section 5.3 to provide a complete assessment of the noise impact.

5.1 DNL Contour Maps

The DNL is a cumulative noise metric that accounts for the SEL of all noise events in a 24-hour period. The baseline DNL contours, shown in Figure 13, form the no-action alternative and correspond to the projected 2018 baseline operations of military and commercial aircraft. The Proposed Action of the Lynx RLV includes operations, projected to 2018, on two representative flight tracks broken down by north flow and south flow traffic, pre-flight run-ups, and engine hot-fire tests. The combination of the existing aircraft and proposed Lynx RLV operations result in the DNL contours shown in Figure 14.

The proposed Lynx RLV additional operations result in slightly larger DNL contours when compared to the baseline DNL, as seen in Figure 15. The most significant differences appear to follow the Lynx flight departure tracks, producing extended lobes outside the MAF boundary. The contour lobe following the Lynx RLV departure track from runway 16R extends further than that on runway 34L due to the slower climb rate of the flight profile from runway 16R, shown in Figure 16, as well as the larger number of operations attributed to this track.

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.” Three structures were identified as located outside of the baseline 65 dBA DNL contour, but within the baseline plus Proposed Action 65 dBA DNL contour, shown in Figure 17. The structures are located in the neighborhood east of the intersection of West County Road 116 and South County Road 1255, according to the Google Earth Aerial Imagery (June 16th 2011) used in Figure 13 through Figure 15. Specific point analysis at these three locations showed a change in level of approximately 0.3 dBA DNL (Table 10) as a result of the Proposed Action, less than the 1.5 dBA DNL significance criteria defined by FAA guidelines. Note, the structures were identified using Google Earth Imagery and their current occupied status has not been confirmed. Therefore, the noise impact, in relation to DNL, will not produce a significant impact to the existing population.

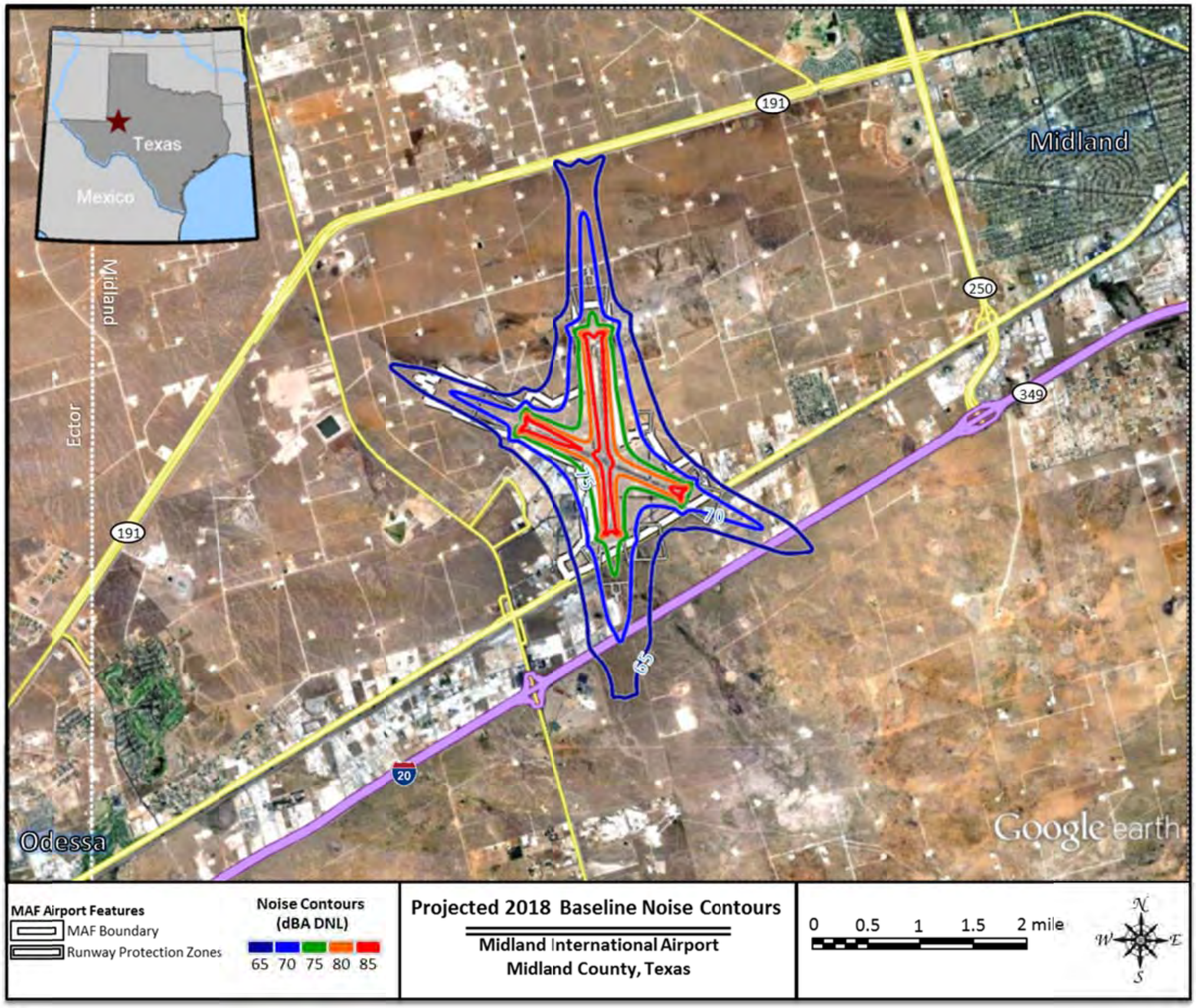

Figure 13. Baseline DNL contours, excluding the proposed XCOR Lynx operations

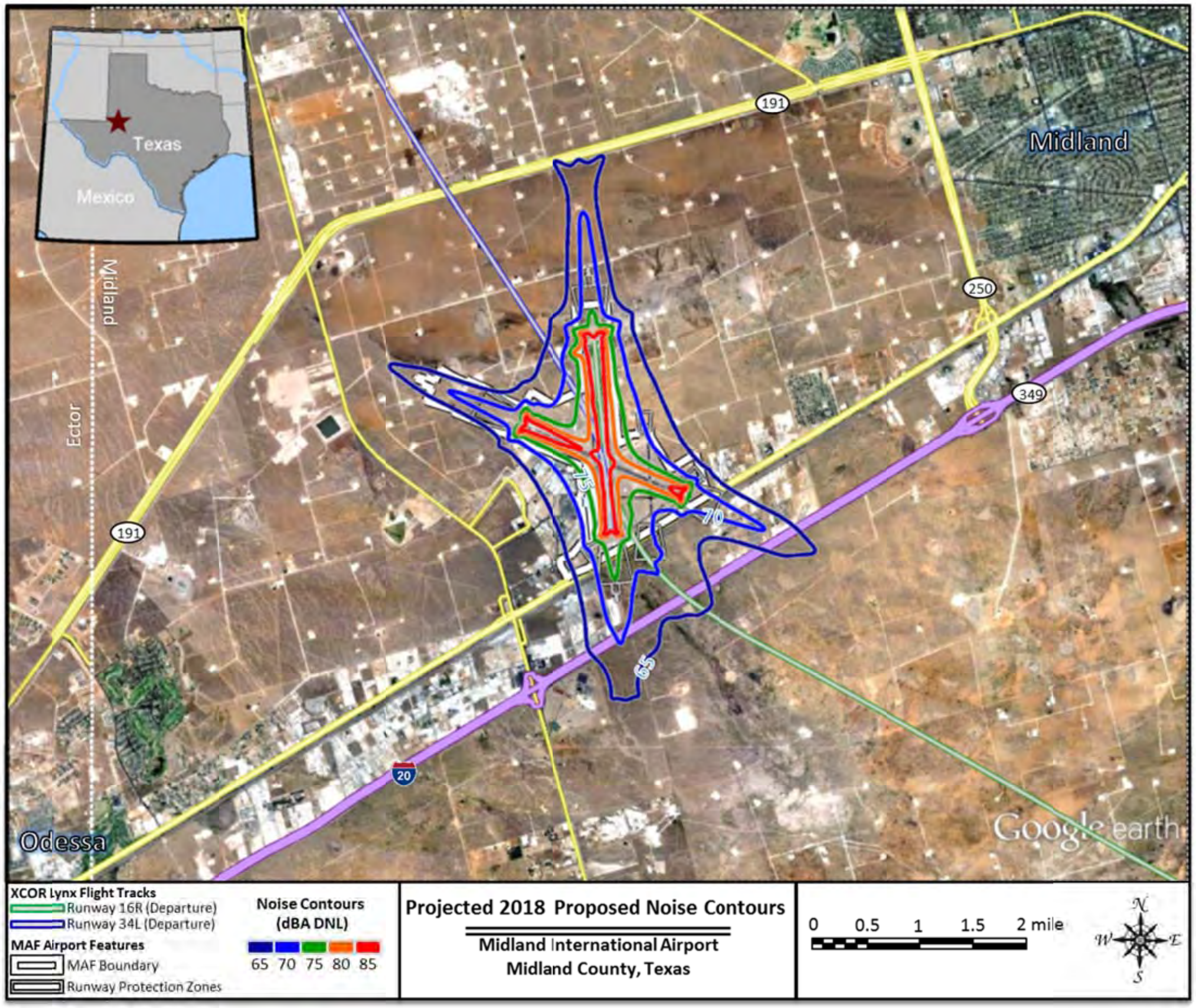

Figure 14. Proposed DNL contours, including the proposed XCOR Lynx operations

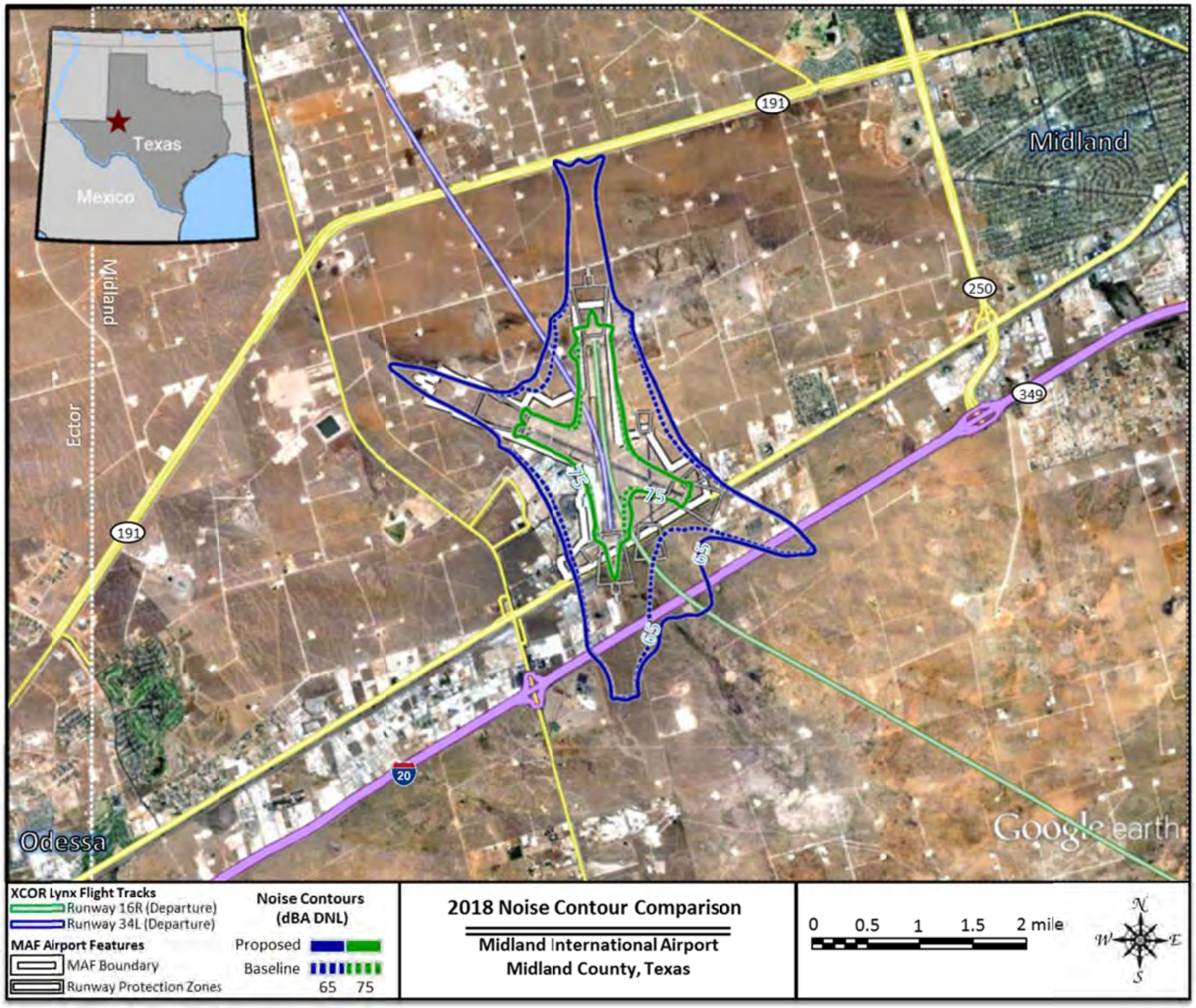

Figure 15. Comparison of the baseline (dashed) and proposed (solid) DNL contours

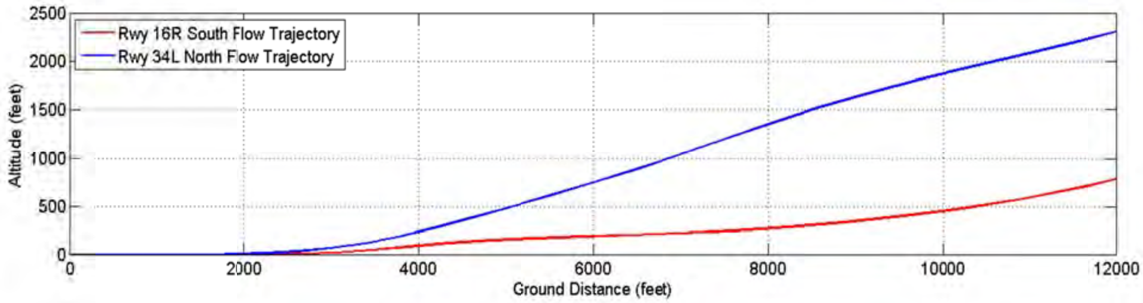

Figure 16. Comparison of trajectory altitude profiles along the first 12,000 feet of ground track.

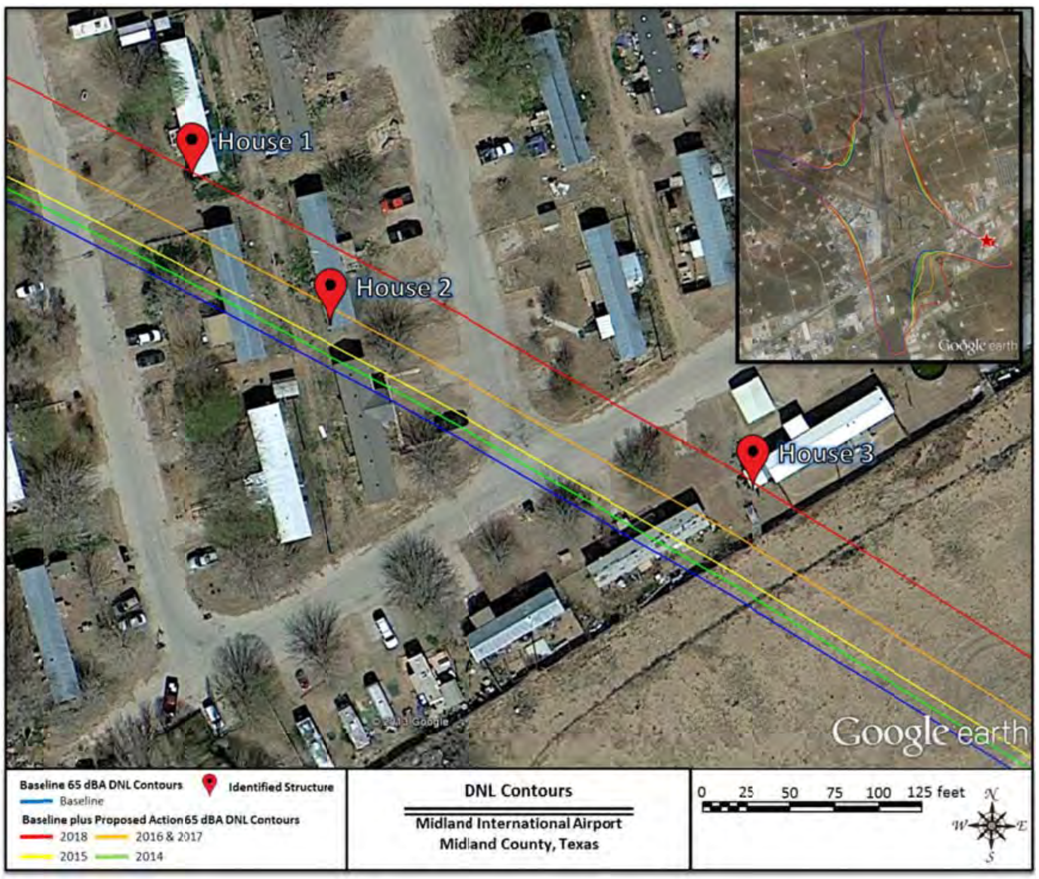

Figure 17. Aerial image of the three structures identified as located outside of the Baseline 65 dBA DNL contour, but within the Baseline plus Proposed Action 65 dBA DNL contour.

Table 10. Location and DNL comparison of the three identified households.

Structure	Latitude	Longitude	Baseline DNL	Proposed DNL	Difference
1	31.935651°	-102.176552°	64.7 dBA	65.0 dBA	0.3 dBA
2	31.935422°	-102.176299°	64.9 dBA	65.2 dBA	0.3 dBA
3	31.935167°	-102.175529°	64.7 dBA	65.0 dBA	0.3 dBA

5.2 Supplemental Metrics

5.2.1 Maximum A-weighted OASPL Contour Map

The OASPL provides a measure of the sound level at any given time, while the maximum OASPL ($L_{A,ax}$) indicates the maximum OASPL achieved over the duration of the event. OSHA has set an upper limit noise level of 115 dBA as a guideline to protect human hearing from long-term continuous daily exposures to high noise levels and aid in the prevention of noise-induced hearing loss. To identify potential locations affected by noise levels greater than 115 dBA, the $L_{A,max}$ was predicted for each Lynx RLV event. Figure 18 displays the composite 115 dBA contour, which encompasses the area affected by any of the Lynx RLV single events. The 115 dBA contour is dominated by the launch events and follows the Lynx RLV departure tracks from runways 16R and 34L. The 115 dBA contour extends further along the track departing from 16R due to the slower climb rate of the flight profile corresponding to this track, as shown in Figure 16. Although this lobe extends outside the MAF boundary, it is important to note that the 115 dBA contour appears to contain no existing developments or population, as shown in the Figure 18 image (Google Earth Aerial Imagery June 16th 2011).

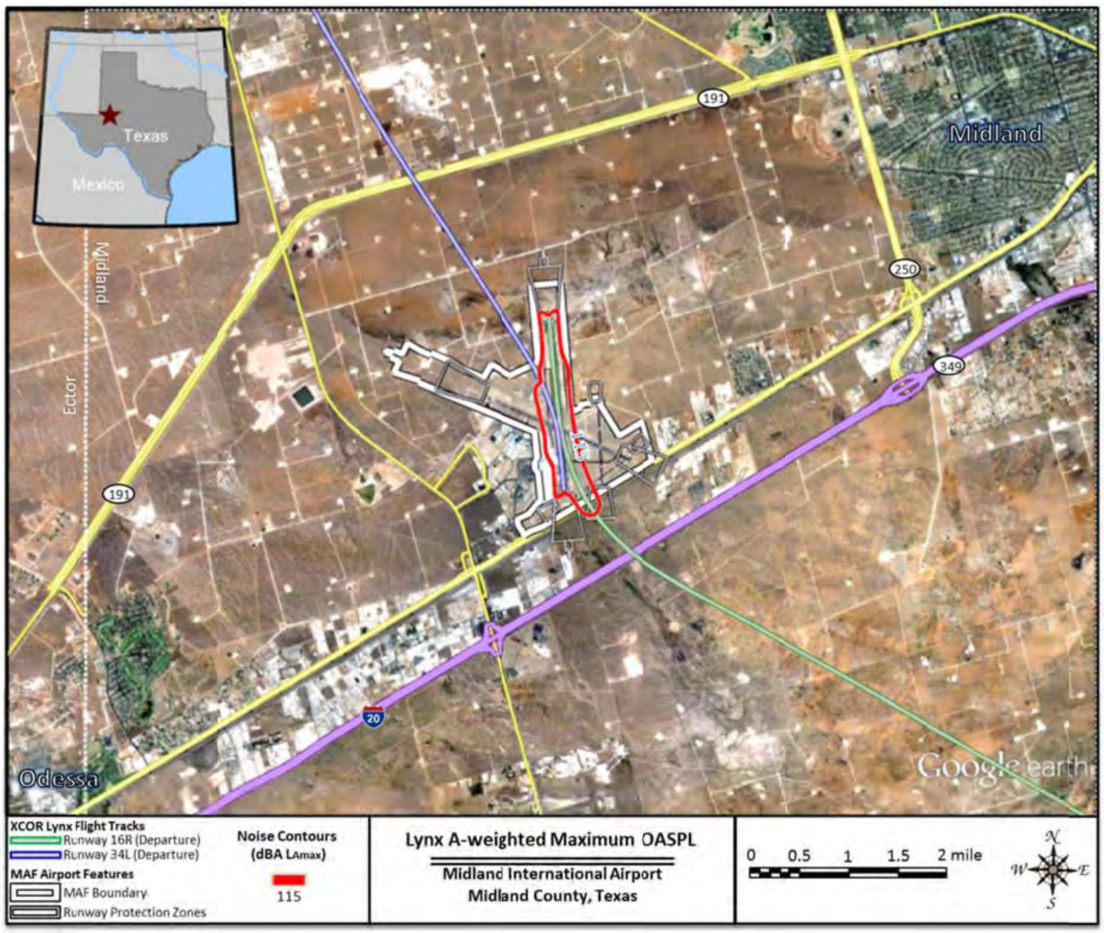

Figure 18. Composite 115 dBA maximum A-weighted OASPL contour

5.2.2 Maximum Unweighted OASPL Contour Map

The OASPL provides a measure of the sound level at any given time, while the maximum OASPL (L_{max}) indicates the maximum OASPL achieved over the duration of the event. A NASA technical memo written by Guest and Sloan [10] found a relationship between structural damage claims and overall sound pressure level from rocket firings. The study estimated that one damage claim in 1,000 households exposed is expected at an average continuous level of 111 dB, and one in 100 households at 120 dB. In order to assess the potential risk to structural damage claims. Figure 19 displays the composite 111 dB and 120 dB contours, which encompass the area affected by any of the Lynx RLV single events. The 111 dB and 120 dB contours are dominated by the launch events and follow the Lynx RLV departure tracks from runways 16R and 34L. Similar to the previous metrics presented, the 111 dB and 120 dB contours extend further along the track departing from 16R due to the slower climb rate of the flight profile corresponding to this track, as shown in Figure 16. Although the 111 dB contour extends slightly beyond the MAF boundary in certain directions, it is important to note that the affected areas appear to contain no existing developments or households, as shown in the Figure 19 image (Google Earth Aerial Imagery June 16th 2011)

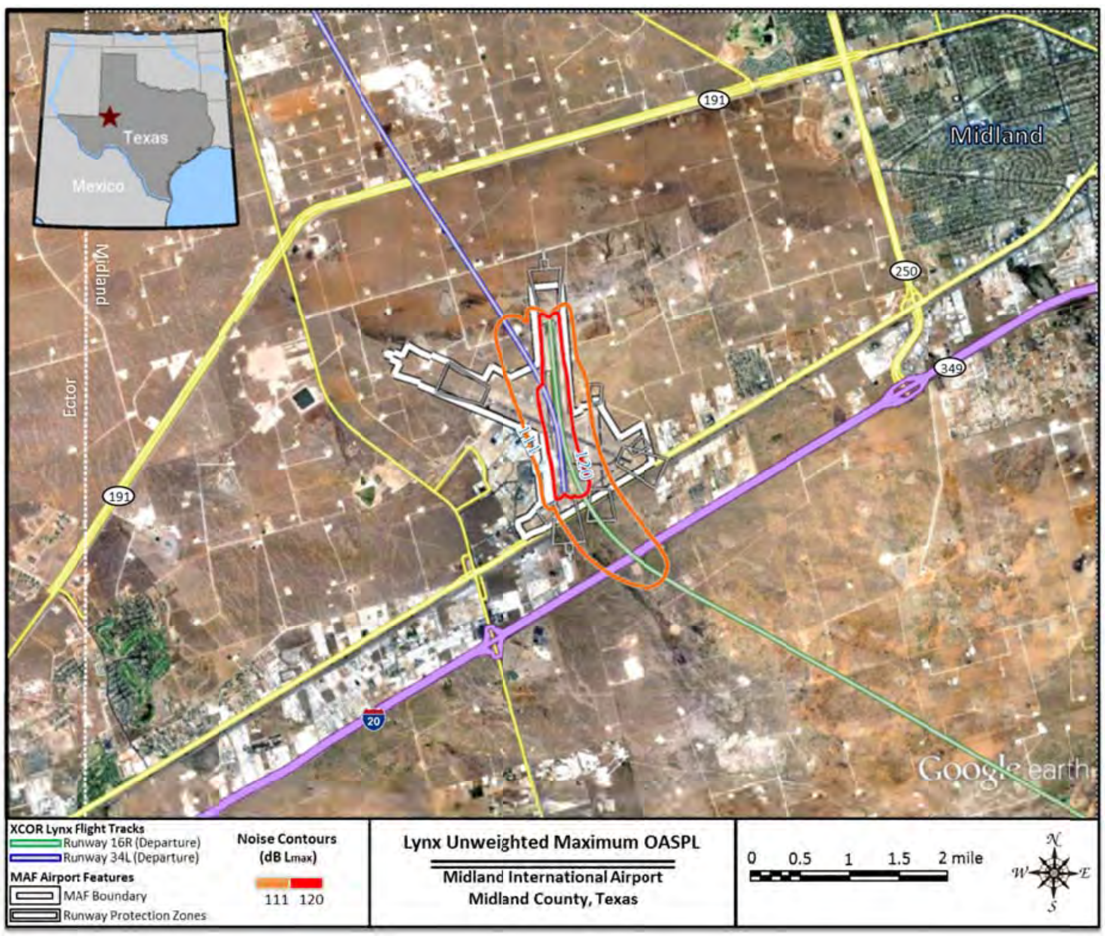

Figure 19. Composite 111 dB and 120 dB maximum unweighted OASPL contours

5.3 Sonic Boom Noise Analysis

A sonic boom is the sound associated with the shock waves created by the launch vehicle traveling through the air faster than the speed of sound. The duration of a sonic boom is less than a second, and the intensity is greatest directly under the flight path and weakens as distance from the flight track increases. The sonic boom resulting from the supersonic portion of the departure will not reach the ground due to the steep ascending flight path angle, as the boom propagates along an angle that is unlikely to intercept the ground with any substantial impact. Sonic boom analysis was completed for the supersonic re-entry portion of the two nominal Lynx RLV launch events arriving to runways 16R and 34L, highlighted in red in Figure 11. Figure 20 displays the contours encompassing the area where the sonic booms, resulting from the two nominal flight tracks, may be heard. The asymmetry of the contour "wings" is due to slight variations in the trajectories. Note that the contours correspond to the nominal flight tracks and atmospheric profile. Slight changes in these parameters may shift the contours. Although the extent of the sonic boom footprint, defined as the nominal area where a sonic boom "may" be heard, is expansive spanning approximately 19,000 square miles, the sonic boom overpressure is predicted at levels of less than 1 psf. Therefore, the potential for damage or significant impact is negligible [32]. Note, over the majority of this area the sonic boom levels are more likely to be closer to 0.1 psf. The area with levels near 1 psf will be in a more concentrated area of approximately 2.5 square mile. The maximum noise exposure of the proposed operational tempo along with maximum of 1 psf sonic boom is predicted to be a C-weighted DNL of 54 dBC, which translates to an equivalent A-weighted DNL of 63 dBA, according to ANSI 12.9 Part 4 Annex B [33]. The noise impacts from potential sonic booms would not be significant since the maximum predicted levels are less than the 65 dBA DNL noise exposure criteria.

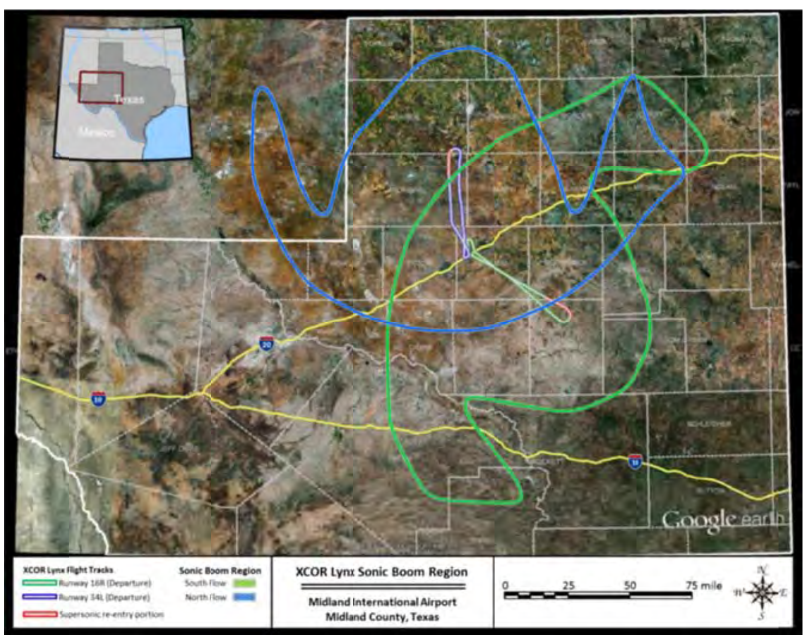

Figure 20. XCOR Lynx sonic boom footprint resulting from the south flow (Runway 16R, green) and north flow (Runway 34L, blue) flight profile re-entry

6 Summary

This noise analysis supports the City of Midland's application to the FAA AST for a launch site operator license for the operation of the Lynx RLV horizontal take-off and horizontal landing and other associated activities (e.g., engine testing). The issuance of a launch site operator license is considered a major Federal action subject to environmental review under the NEPA of 1969 as amended (42 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 dBA or more at or above DNL 65 dBA noise exposure when compared to the no action alternative for the same timeframe." The DNL is a cumulative noise metric that accounts for the SEL of all noise events in a 24-hour period. The combination of the existing aircraft and proposed Lynx RLV operations result in slightly larger DNL contours when compared to the no-action alternative. However, for existing populated areas, the increase in DNL is predicted to be less than 1.5 dBA, indicating no significant impacts. Areas that will experience more than a DNL 1.5 dBA increase due to the proposed future actions do not appear to contain any existing developments or households.

Two additional supplemental metrics, A-weighted $L_{A,max}$ and unweighted L_{max}, were analyzed to present a complete study of the noise impacts due to the proposed Lynx RLV operations. The L_{max} indicates the maximum OASPL achieved over the duration of the event. To identify potential locations affected by noise levels greater than 115 dBA, the upper limit noise level set by OSHA, the 115 dBA A-weighted L_{max} was predicted for each Lynx RLV event. In order to assess the potential risk to structural damage claims, the 111 dB and 120 dB unweighted L_{max} was predicted for each Lynx RLV event. Although the 115 dBA, 111 dB and 120 dB extend beyond the MAF airport boundary, the affected areas do not appear to contain any existing developments or households. Although, the 115 dBA guideline may be a conservative limit when considering the relatively short-term increase to this level, it is recommended that MAF personnel wear sufficient hearing protection and/or stay indoors to reduce noise levels below the 115 dBA limit during a launch.

Sonic boom analysis was completed for the supersonic re-entry portion of the two nominal Lynx RLV launch events arriving to runways 16R and 34L. A sonic boom is the sound associated with the shock waves created by the launch vehicle traveling through the air faster than the speed of sound. In general, for well-maintained structures, the threshold for damage from sonic booms is 2 psf, below which damage is unlikely and generally limited to bric-a-brac or structural elements that are in ill-repair.

Although the extent of the sonic boom footprint is expansive, spanning approximately 25,000 square miles, the sonic boom overpressure is predicted at levels of less than 1 psf. Therefore, the potential for damage or significant impact is negligible [32]. The noise impacts, in relation to DNL, from potential sonic booms would not be significant since the maximum predicted levels are less than the 65 dBA noise exposure criteria. Note, the sonic boom resulting from the supersonic portion of the departure will not reach the ground due to the steep ascending flight path angle.

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Appendix B
Air Quality Calculations and Assumptions

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Tab A. XCOR Launch Operational Emissions - MAF

$Kerosene_{density}$ = 0.795 g/m^3 or 6.6339294 lb/gal

[1]Total mass of Kerosene consumed from launch = 2,050.56 lb

Total gallons = 309.10

[1]Mass flow of Kerosene per engine = 2.67 lb/s or 0.402476398 gal/s

Table 1. Launch Emissions - Greenhouse Gases

Launch Vehicle	Max # launches/yr	Kerosene Use gal/launch	Kerosene MMBtu/gal	[2]CO2 kg/MMBtu	[3]CH4 kg/MMBtu	[3]N2O kg/MMBtu	CO2 kg	CH4 kg	N2O kg	CO2e MT/yr
XCOR Lynx	520	309.10	0.135	75.2	0.003	0.0006	1631761.154	65.0968546	13.019371	1,637
									Total CO2e	1,637

Table 2. Static Fire Test Emissions - Greenhouse Gases

Launch Vehicle	Max # tests/yr	Duration of Test in s	Kerosene Use gal/s/engine	Total fuel per test (gal)	Kerosene MMBtu/gal	[2]CO2 kg/MMBtu	[3]CH4 kg/MMBtu	[3]N2O kg/MMBtu	CO2 kg	CH4 kg	N2O kg	CO2e MT/yr
XCOR Lynx	100	32	0.402	12.879	0.135	75.2	0.003	0.0006	13,075.01	0.5216094	0.1043219	13
											Total CO2e	13

Table 3. Launch Emissions - Criteria Pollutants

Launch Vehicle	Max # launches/yr	[4]Emission Indices in Pounds Emitted per Pound of Propellant					Emissions in Pounds				
		CO	NOx	PM	SOx	VOCs	CO	NOx	PM	SOx	VOCs
XCOR Lynx	520	0.20	0.00	0.00	0.00	0.00	213,258.24	0.00	0.00	0.00	0.00
						Total Tons per Year	106.63	0.00	0.00	0.00	0.00

Table 4. Static Fire Tests - Criteria Pollutants

Launch Vehicle	Max # tests/yr	Propellant per Test (lb)	[4]Emission Indices in Pounds Emitted per Pound of Propellant					Emissions in Pounds				
			CO	NOx	PM	SOx	VOCs	CO	NOx	PM	SOx	VOCs
XCOR Lynx	100	85.44	0.20	0.00	0.00	0.00	0.00	1,708.80	0.00	0.00	0.00	0.00
							Total Tons per Year	0.85	0.00	0.00	0.00	0.00

Table 5. Commuter Emissions

# vehicles	# days	[1]mi/day	[5]VOCs lb/mi	[5]CO lb/mi	[5]NOx lb/mi	[5]SO_2 lb/mi	[5]PM_{10} lb/mi	[5]$PM_{2.5}$ lb/mi	[5]CO_2 g/mi	[6]CH_4 g/mi	[6]N_2O g/mi	VOCs lb	CO lb	NOx lb	SO_2 lb	PM_{10} lb	$PM_{2.5}$ lb	CO_2 lb	CH_4 lb	N_2O lb
200	245	24	0.00119	0.03467	0.00486	0.00001	0.00020	0.00018	182.00	0.02	0.02	1,393.76	40,776.62	5,719.21	15.34	231.52	213.38	471,862	41	41
											Tons per Year	0.70	20.39	2.86	0.01	0.12	0.11			
											Metric Tons per Year							214	0.02	0.02
																	CO2e in metric tons/year	220		

Table 6. 2018 Annual Operational Emissions Summary

VOCs T/yr	CO T/yr	Nox T/yr	SO2 T/yr	PM10 T/yr	PM2.5 T/yr	CO2e MT/yr
0.70	127.87	2.86	0.01	0.12	0.11	1,871

NOTES:

[1]Information provided via email from Stephen Matier, April 23, 2013

[2]CO_2 emission index from Federal Greenhouse Gas Accounting and Reporting Guidance: Technical Support Document (CEQ. 2010), Table D-1

[3]CH_4 and N_2O emission indices from Federal Greenhouse Gas Accounting and Reporting Guidance: Technical Support Document (CEQ. 2010), Table D-2

[4]Emission Indices from Table D-7 of Final Programmatic Environmental Impact Statement for Streamlining the Processing of Experimental Permit Applications, FAA, September 2009

[5]VOC, CO, NOx, SO_2, PM and CO_2 emission indices from MOVES, EPA 2010.

[6]CH_4 and N_2O emission indices from Federal Greenhouse Gas Accounting and Reporting Guidance: Technical Support Document (CEQ. 2010), Table D-12

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Appendix C
Agency Coordination

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Summary of TPWD Letter Recommendations Followed by FAA Responses C-71

U.S. Department of Transportation
Federal Aviation Administration

Office of the Associate Administrator for Commercial Space Transportation

800 Independence Ave., SW
Washington, DC 20591

RECEIVED
AUG 09 2013
TEXAS HISTORICAL COMMISSION

AUG 8 2013

NO HISTORIC PROPERTIES AFFECTED
PROJECT MAY PROCEED
by [signature]
for Mark Wolfe
State Historic Preservation Officer
Date 6 September 2013

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

SUBJECT: Environmental Assessment for the Midland International Air and Space Port, City of Midland, Midland County, 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 City of Midland's proposal to operate a commercial space launch site at the Midland International Airport (MAF) in Midland County, Texas and offer the site to XCOR Aerospace, Inc. (XCOR) for the operation of the Lynx horizontal take-off and horizontal landing reusable launch vehicle (RLV) and engine testing (see Enclosure 1).

The Lynx RLV is a two-seat piloted, transport vehicle that would carry humans and payloads on a half-hour suborbital flight to 330,000 feet and then land on the take-off runway. Like an aircraft, Lynx is a horizontal take-off and horizontal landing vehicle, but instead of a jet or piston engine, Lynx uses a rocket propulsion system to depart a runway and makes a non-powered glide return and landing with the rocket engines off.

Proposed launch operations would begin in 2014 and continue through 2018. The frequency of launch operations would initially be one launch per week, eventually increasing to two launches per day, five days a week. Fifty-two annual launch operations are proposed in 2014. The total number of annual launch operations would increase each year until 2018 when 520 annual launch operations are proposed.

Existing infrastructure, including a hangar and runways, would be used to support launch operations at MAF. Testing of rocket engines would be performed from a designated engine test pad within airport boundaries. Construction of this concrete pad (18 feet by 60 feet) would occur between the existing World War II-era bunkers (see Enclosure 2). In addition, several new aboveground permanent storage tanks would be needed to store propellant that would support the Lynx RLV (see Enclosure 2).

To operate a commercial space launch site, the City of Midland must obtain a commercial space launch site license from the FAA. Under the Proposed Action addressed in the EA, the FAA would: (1) issue a

launch site operator license to the City of Midland for the operation of a commercial space launch site at MAF, (2) issue experimental permits and/or launch licenses to XCOR that would allow XCOR to conduct launches of the Lynx RLV from MAF, and (3) provide unconditional approval to modify the existing Airport Layout Plan to reflect the designation of a launch site boundary, installation of aboveground propellant storage tanks, and construction of a concrete pad for engine testing.

The issuance of a launch site operator license, launch licenses, experimental permits, and the unconditional approval to modify an existing Airport Layout Plan is considered an 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 during noise studies for the EA (Enclosure 3). This area would encompass all potential direct and indirect effects on archaeological and architectural resources. For archaeological resources, potential effects would be limited to the area within the APE where ground disturbance would occur from installation of the concrete pad and aboveground storage tanks. 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 no previously inventoried or NRHP-listed archaeological or architectural resources within the APE.

There are no known Traditional Cultural Properties (TCPs) within the APE; however, two tribes with interests in Midland County 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.

A historical marker erected by the THC for the Midland Army Flying School is located within the APE. The marker was erected in 1968. The historical marker has not been formally evaluated for the NRHP, but is considered to be not eligible because it does not meet Criteria Consideration G for exceptional significance for properties less than 50 years of age.

The airport has been modernized and the majority of the remaining World War II-era buildings and structures have been demolished or heavily renovated. Two World War II-era igloo ammunition storage magazines are located on airport property. The igloos were associated with the military uses of this property during World War II and are located approximately 900 feet northeast of the northwest end of Runway 10/28 (see Enclosure 3). The FAA has determined the two igloo ammunition magazines at MAF to be not eligible for the NRHP. A context for igloo ammunition magazines and the NRHP evaluation of

these resources is included in Enclosure 4. The FAA requests your concurrence on this determination of eligibility.

Assessment of Effect

There are no known NRHP-listed or eligible archaeological resources within the APE; therefore, under the proposed undertaking, there would be no effects from ground disturbance to archaeological resources.

Under the proposed undertaking, existing infrastructure including hangars and runways would be used to support launch and landing operations at the facility. To support engine testing and provide propellant for testing and launches, a concrete pad and aboveground storage tanks would be installed. Proposed new construction is limited and is in keeping with current facilities. Minimal construction at a site that has been previously developed and functions as an airport would have no direct effect on cultural resources. Therefore, there would be no direct effects to architectural resources within the APE. The only structures remaining from the World War II era are two igloo ammunition magazines located to the north of Runway 10/28. Due to loss of integrity, the FAA concluded these magazines are not eligible for the NRHP, and there would be no effect to them.

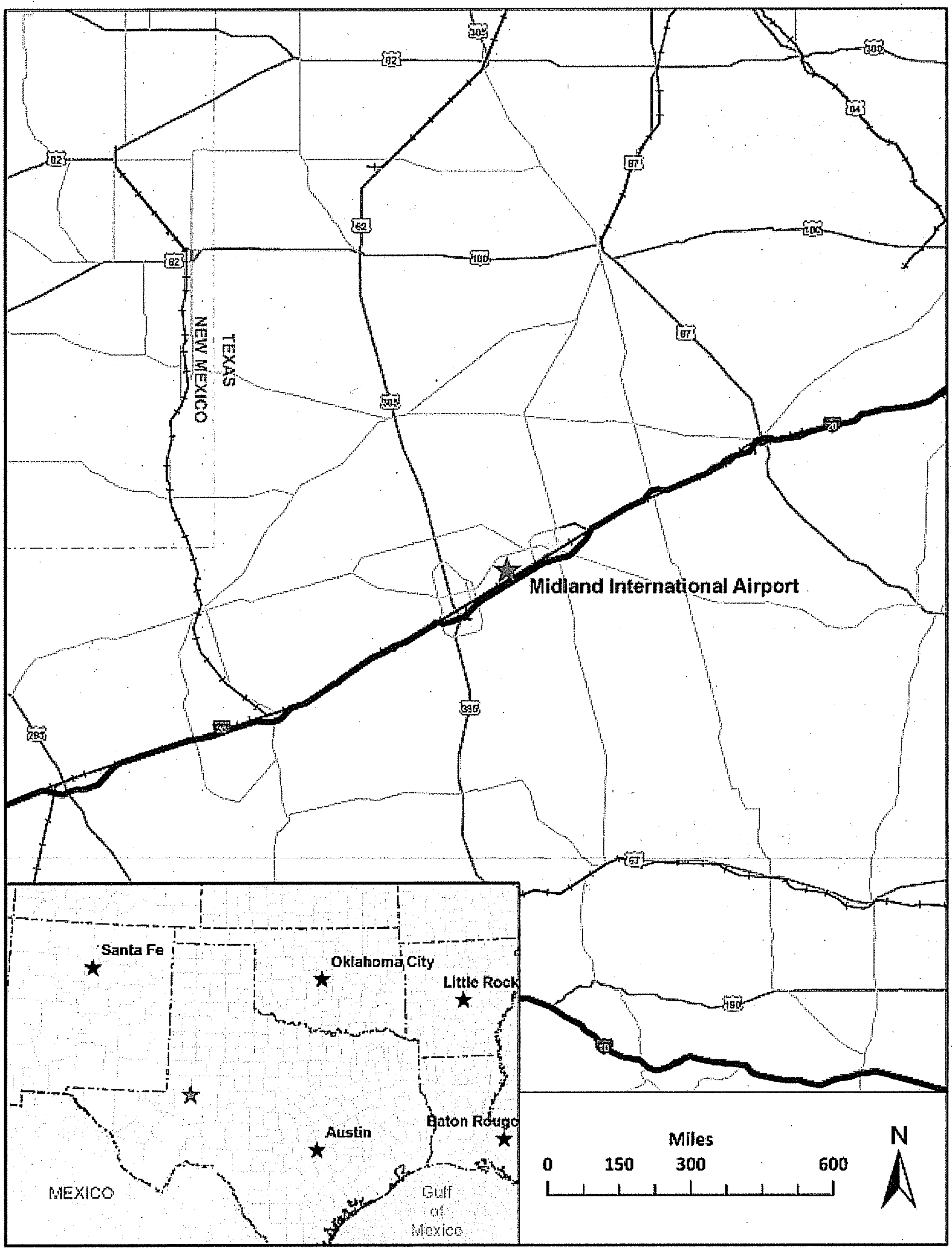
Increase in noise at the airport would be minimal, and there are no architectural resources eligible for the NRHP that would be adversely affected by changes to the setting due to noise from the proposed airfield operations under the proposed undertaking. The FAA requests your concurrence with the finding 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
Acting Manager, Space Transportation Development Division

Enclosures:
1. Regional Map of Proposed Launch Site
2. Existing and Proposed Facilities at MAF
3. APE for Cultural Resources at MAF
4. Determination of Eligibility of Two World War II-era Ammunition Storage Bunkers at MAF, April 2013



Enclosure 1. Regional Map of Proposed Launch Site

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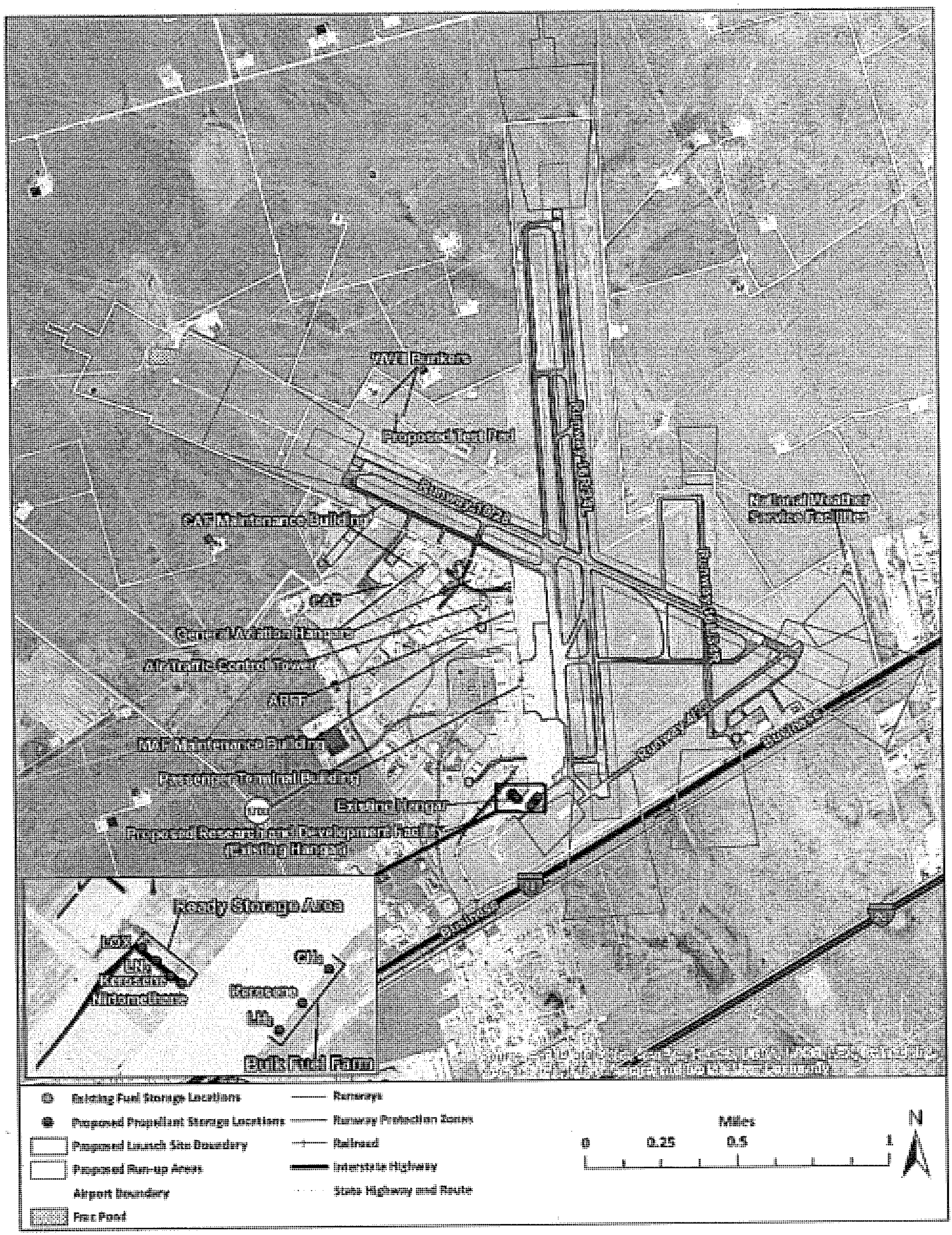
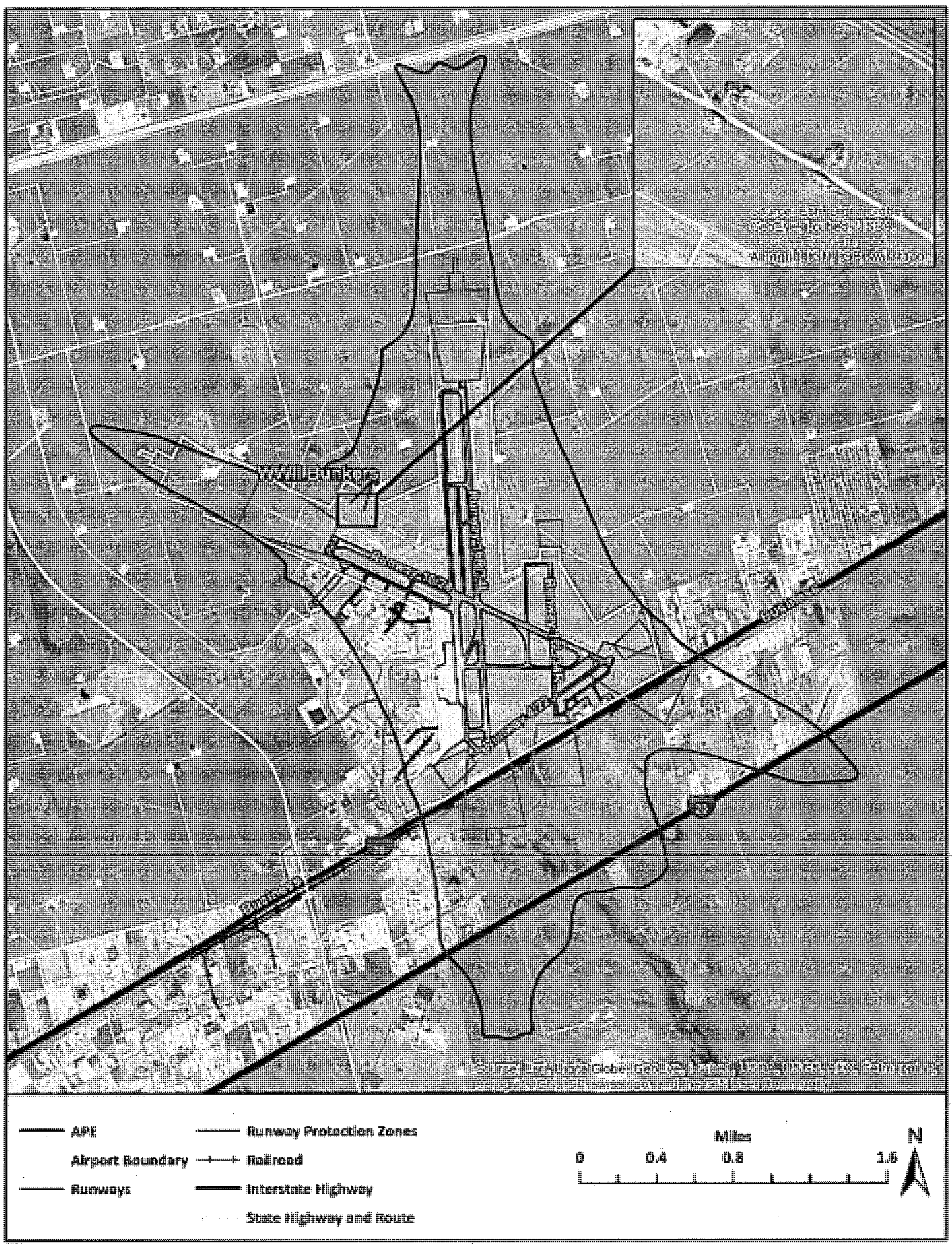


Enclosure 2. Existing and Proposed Facilities at MAF



Enclosure 3. APE for Cultural Resources at MAF

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Enclosure 4: Determination of Eligibility of Two WWII era Ammunition Storage Bunkers at MAF, April 2013

The Midland International Airport (MAF) was originally constructed as the Midland Army Airfield (AAF), a training center for bombardier cadets during World War II. Construction of the army airfield at and adjacent to Sloan Field, the city's municipal airport, began in July 1941 and was largely completed within six months. Midland AAF included two 6,500-foot-long asphalt runways, four hangars, aircraft maintenance shops, barracks, and other facilities (Ainsworth et al. 2008, B-66).

Initially Midland AAF was a bombardier school and instructor bombardier school for pilots and crews with little to no experience. After September 1942, however, Midland AAF provided advanced bombardier instruction to trained bombardier aircrews and became the largest bombardier training facility in the U.S. (Midland Reporter-Telegram 2011). In 1943, it was designated the headquarters for three other bombardier schools in Texas. The trainees received one month of school instruction followed by extensive flight training to practice delivery of bombs to combat targets on a number of bombing ranges within an eight-county region surrounding Midland. Midland AAF was instrumental in the instruction of the secret Norden bombsight, development of photographic and sonic methods of scoring bombing hits, and the analyzing of bombing skills (Colwell 2013). A historical marker, issued by THC in 1968, commemorates the Midland Army Flying School.

The historical marker has not been formally evaluated for the NRHP, but is considered to be not eligible because it does not meet Criteria Consideration G for exceptional significance for properties less than 50 years of age.

Two World War II-era igloo ammunition storage magazines are located on airport property. No formal evaluation of these structures has been completed. The igloos were associated with the military uses of this property during World War II and are located approximately 900 feet northeast of the northwest end of Runway 10/28 (Enclosure 2). A narrow, unpaved lane from the airfield's perimeter road leads to the structures, which are spaced approximately 375 feet apart. Each igloo consists of a low, earthen bermed, barrel-arched structure faced with a 10-inch thick, polygonal, reinforced concrete complete headwall at the southern end (Photo 1). The structures measure approximately 100 feet in length by 85 feet in width. A thick steel blast door at the center of the retaining wall provides access to the interior of the igloo. Ventilators pierce the roof of the arched structure. The location of a third, former igloo is visible on aerial mapping approximately 400 feet to the east of the existing structures (Google Earth 2013).

Prior to World War II, few ammunition and explosives storage facilities were in existence. Magazines utilized during or before World War I were mainly aboveground, masonry or wood construction, or casemates, which were fortified masonry vaults used at coastal artillery installations. By the end of the war, Army ammunition storage facilities had been constructed at the proving grounds at Aberdeen, Maryland; Savanna, Illinois; and Erie, Ohio (Murphey et al. 2000).

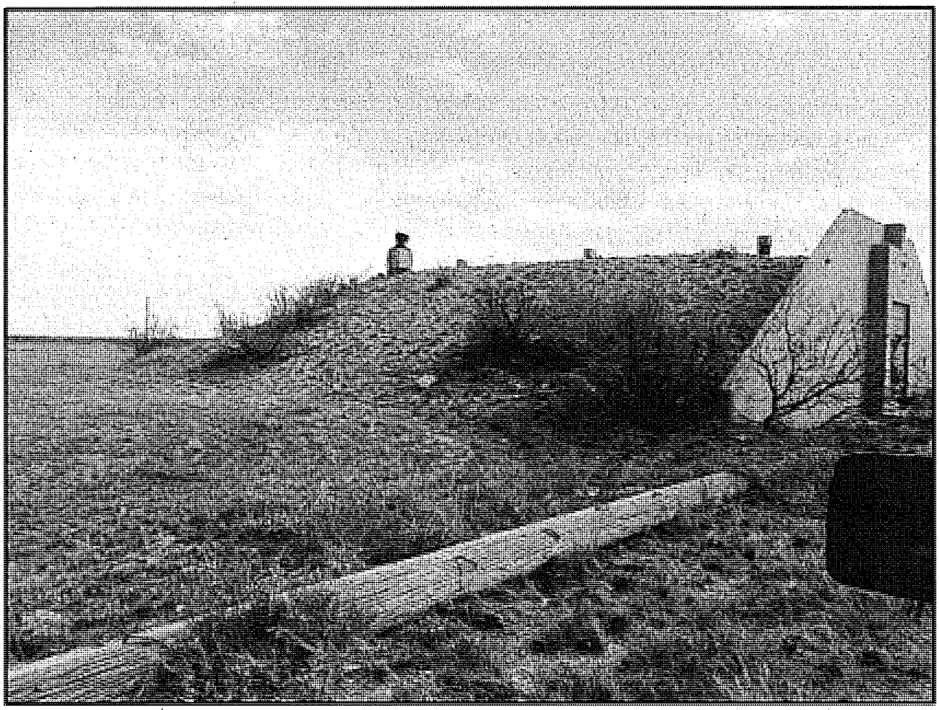

Photo 1. View of igloo ammunition magazine at MAF

Most ammunition storage facilities and structures were constructed in response to the mobilization efforts of the Army during the World War II era, with the construction of 16 new storage depots and over ten thousand individual ammunition storage magazines (Murphey et al. 2000).

Igloo ammunition structures were first utilized in the late 1920s, in response to an accident at the Lake Denmark Naval Ammunition Depot in Morris County, New Jersey (Murphey et al. 2000). In July 1926, a suspected lightning strike on Temporary Magazine Number 8, an aboveground ammunition storage building, caused the explosion of munitions left over from World War I (Beitler 2008; Murphey et al. 2000). The resulting massive explosion left a large crater and threw burning materials and shells over a mile distant, in the process igniting Magazine Number 9 and Shell House Number 22. Over 50 people, including civilians, were injured and 19 were killed in the explosions and the estimated damages were reported at over $40,000,000 (Murphey et al. 2000).

The ensuing public outcry and military inquiries led to recommendations on the safe storage of ammunition and the creation of the joint Army-Navy Ammunition Storage Board, known today as the Defense Ammunition Safety Board. These regulations provide for the oversight of explosive and chemical materials on military facilities (Murphey et al. 2000). Changes included the separation of depth charges, mines, and TNT bombs, the establishment of distances between magazines, the construction of magazines from nonflammable materials, the grounding of metallic parts of magazines, and other restrictive regulations designed to ensure that accidents like Lake Denmark would not occur again (Murphey et al. 2000; Prior and Freeman 2008).

1928 Army Standard regulations indicated the type of structure required for the storage of each class of explosive materials. Igloo magazines, so called because they resembled an Eskimo dwelling, were semi-subterranean, barrel-arched, steel-reinforced concrete structures that were partially covered with earth (Figure 1). The barrel-arch design allowed for the expulsion of an explosion at a 90-degree angle, allowing the force to exit straight up and not ignite adjacent storage structures (Murphey et al. 2000; Prior and Freeman 2008; USACE 1997). The presence of earth on three sides helped to dampen the force of an explosion, while the insulation created by the soil helped to eliminate high temperatures within the structure. In addition, a space of 400 feet was required between igloo magazines, also helping to limit the possibility of ignition of adjacent structures (Murphey et al. 2000). An earthen covering also assisted in the camouflage of these structures from the air.

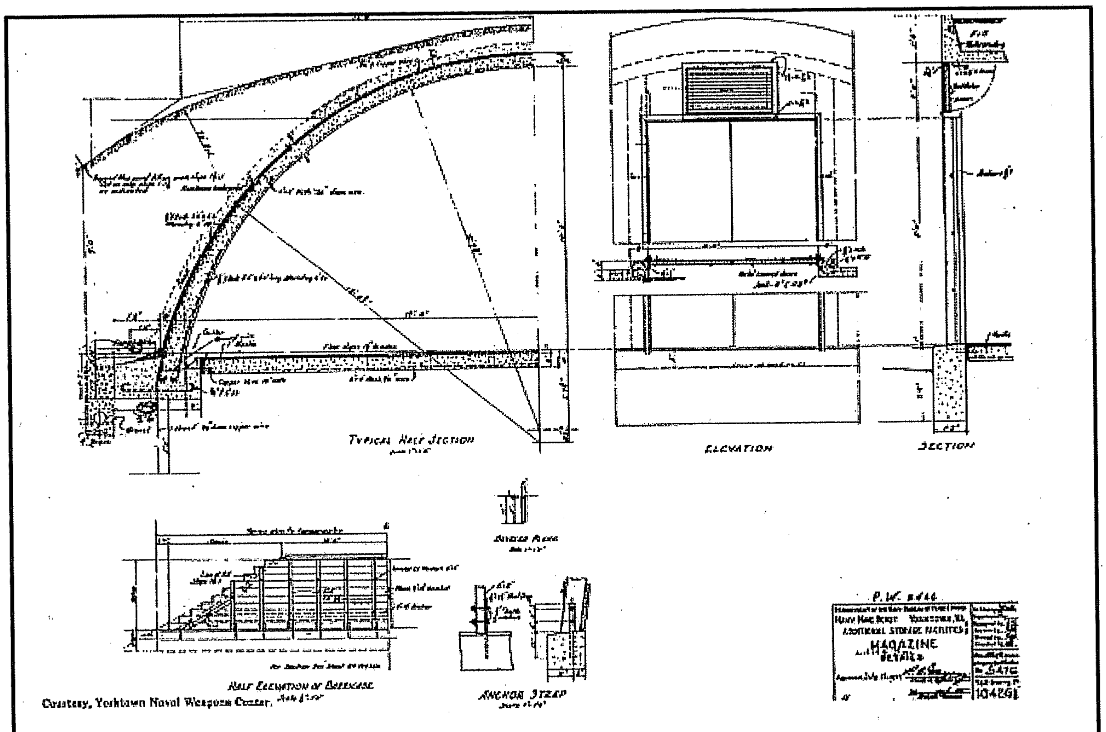

Figure 1. Magazine details for Drawing 104261 (adapted from Murphey et al. 2000)

The Navy began testing of igloo magazines in 1928 and construction of these structures at the Yorktown Naval Depot in Virginia. In 1931, the Navy constructed a modern ammunition depot at Hawthorne, Nevada (later transferred to the Army), where a total of 1,751 magazines would be erected by the end of World War II, nearly two-thirds of which were igloo structures. The Army also constructed igloo magazines at the Savanna, Illinois Depot in 1929 (Murphey et al. 2000). Testing and actual incidents, such as the explosion of Igloo 1014 at Umatilla Army Depot in March 1944, proved that the design of the igloo prevented sympathetic ignition of neighboring ammo structures (Hightower 1984).

The igloo design would soon become the Army's primary storage type for ammunition and explosives in the US. By 1941, the Army Ordnance Department required that all new ammunition storage facilities

include the igloo design magazines. Four main variations of the igloo bunker design are the Old Savanna (or Type 42), the Old Line, the Old Depot, and the Army Standard Igloo (or Type 49) (Murphey et al. 2000). An Army Materiel Command facilities survey conducted in 1991 indicated that at that time, 34 facilities in 28 states managed 18,642 igloo bunkers (two facilities did not reply to the survey). In Texas, Lone Star Army Ammunition Plant and Red River Army Depot in Texarkana contained 902 of the igloo magazines (Palazzo et al. 1991). Available sources do not indicate the number of igloo magazines that were originally built for Midland AAF.

Following the end of the war, Midland AAF was decommissioned and then returned to the City of Midland in 1947 (Colwell 2013). The airport has been modernized and the majority of the remaining World War II-era buildings and structures have been demolished or heavily renovated. In 2002, one of the last-remaining buildings from that period, a hangar, partially collapsed and was subsequently demolished. A letter from the THC concurred that the hangar did not retain enough integrity to be eligible for the NRHP and that demolition could proceed (THC 2012).

The igloo magazines at MAF are not known to have been associated with any significant person (Criterion B), and would not yield any information important to history because extensive documentation of the history and construction of these structures is available (Criterion D). In addition, although the igloo magazines at MAF are associated with the World War II Midland AAF (Criterion A) and embody the distinctive characteristics of a standard Army igloo magazine for World War II (Criterion C), the two magazines do not retain sufficient integrity to convey these associations.

Demolition of the majority of the original associated buildings, structures, and infrastructure of Midland AAF and the extensive modifications for the current MAF have compromised the overall integrity of the property, resulting in the loss of setting, location, feeling, and association of the defining features present for the period of significance of the Midland AAF and the igloo ammunition magazines. The Army Standard igloo magazine was meant to function as part of a larger complex, which included the design features of a prescribed distance between each igloo while remaining part of a cluster of identical structures. To be considered eligible for the NRHP, most often these igloo clusters would be recommended as a historic district or designed landscape as opposed to being considered individually eligible (Murphey et al. 2000). Because there are only two igloo magazine structures remaining while the rest of the structures have been demolished over time, they do not convey the setting, feeling, design, and association of their original purpose. In addition, thousands of these igloo ammunition structures are still in existence throughout the United States and in Texas. Red River Army Depot in Bowie County, Texas, which in 1991 contained 702 Igloos, still retains several hundred Igloo ammunition magazines in their original setting and configurations (Google Earth 2013; Palazzo et al. 1991). For these reasons, therefore, the two igloo ammunition magazines at MAF are recommended not eligible for the NRHP.

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U.S. Department
of Transportation
Federal Aviation Administration

Office of the Associate Administrator for
Commercial Space Transportation

800 Independence Ave., SW
Washington, DC 20591

AUG 8 2013

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

SUBJECT: **Environmental Assessment for the Midland International Air and Space Port, City of Midland, Midland County, Texas - Section 106 Consultation**

The Honorable Mr. Jonny Wauqua:

This letter initiates government-to-government consultation with the Comanche Nation of Oklahoma regarding the City of Midland's proposal to operate a commercial space launch site at the Midland International Airport (MAF) in Midland County, Texas and offer the site to XCOR Aerospace, Inc. (XCOR) for the operation of the Lynx horizontal take-off and horizontal landing reusable launch vehicle (RLV) and engine testing (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 Lynx RLV is a two-seat piloted, transport vehicle that would carry humans and payloads on a half-hour suborbital flight to 330,000 feet and then land on the take-off runway. Like an aircraft, Lynx is a horizontal take-off and horizontal landing vehicle, but instead of a jet or piston engine, Lynx uses a rocket propulsion system to depart a runway and makes a non-powered glide return and landing with the rocket engines off.

Proposed launch operations would begin in 2014 and continue through 2018. The frequency of launch operations would initially be one launch per week, eventually increasing to two launches per day, five days a week. Fifty-two annual launch operations are proposed in 2014. The total number of annual launch operations would increase each year until 2018 when 520 annual launch operations are proposed.

Existing infrastructure, including a hangar and runways, would be used to support launch operations at MAF. Testing of rocket engines would be performed from a designated engine test pad within airport boundaries. Construction of this concrete pad (18 feet by 60 feet) would occur between the existing World War II-era bunkers (see Enclosure 2). In addition, several new aboveground permanent storage tanks would be needed to store propellant that would support the Lynx RLV (see Enclosure 2).

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 noise studies for the EA (Enclosure 3). This area would encompass all potential direct and indirect effects on archaeological and architectural resources.

For archaeological resources, potential effects would be limited to the area within the APE where ground disturbance would occur from installation of a concrete pad and aboveground storage tanks. For architectural resources, potential effects would extend to the boundary of the APE. Ground-disturbing activities would be minimal and limited to areas previously disturbed by activities at the airport.

There are no known archaeological sites within the APE. Increase in noise at the airport would be minimal, and there are no architectural resources eligible for the NRHP that would be adversely affected by changes to the setting due to noise from the proposed airfield operations under the Proposed Action.

To operate a commercial space launch site, the City of Midland must obtain a commercial space launch site license from the FAA. Under the Proposed Action addressed in the EA, the FAA would: (1) issue a launch site operator license to the City of Midland for the operation of a commercial space launch site at MAF, (2) issue experimental permits and/or launch licenses to XCOR that would allow XCOR to conduct launches of the Lynx RLV from MAF, and (3) provide unconditional approval to modify the existing Airport Layout Plan to reflect the designation of a launch site boundary, installation of aboveground propellant storage tanks, and construction of a concrete pad for engine testing.

The issuance of a launch site operator license, launch licenses, experimental permits, and the unconditional approval to modify an existing Airport Layout Plan is considered an 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 MAF.

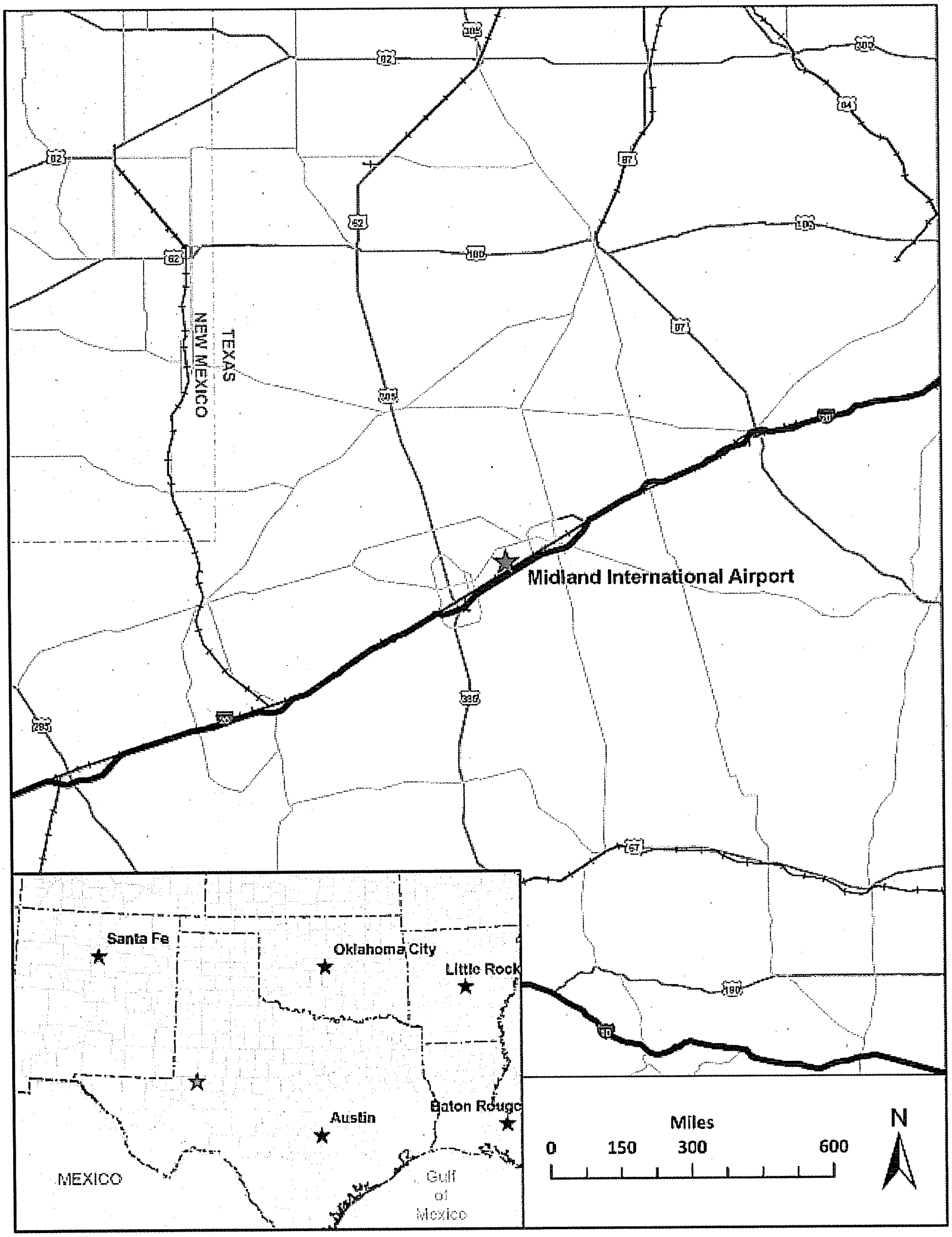
The FAA is interested in determining any concerns that you may have regarding cultural resources issues related to the proposed undertaking, including the presence of archaeological sites, traditional cultural properties, sacred sites, graves, tribal resources, or any other important cultural issues that may be affected by the proposed launch operations. Although no historic properties were identified within the project APE, 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.

Because the FAA did not identify any historic properties within the APE, we request that you provide any comments you have regarding the APE determination or the proposed undertaking 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
Acting Manager, Space Transportation Development Division

Enclosures: 1. Regional Map of Proposed Launch Site
2. Existing and Proposed Facilities at MAF
3. APE for Cultural Resources at MAF



Enclosure 1. Regional Map of Proposed Launch Site

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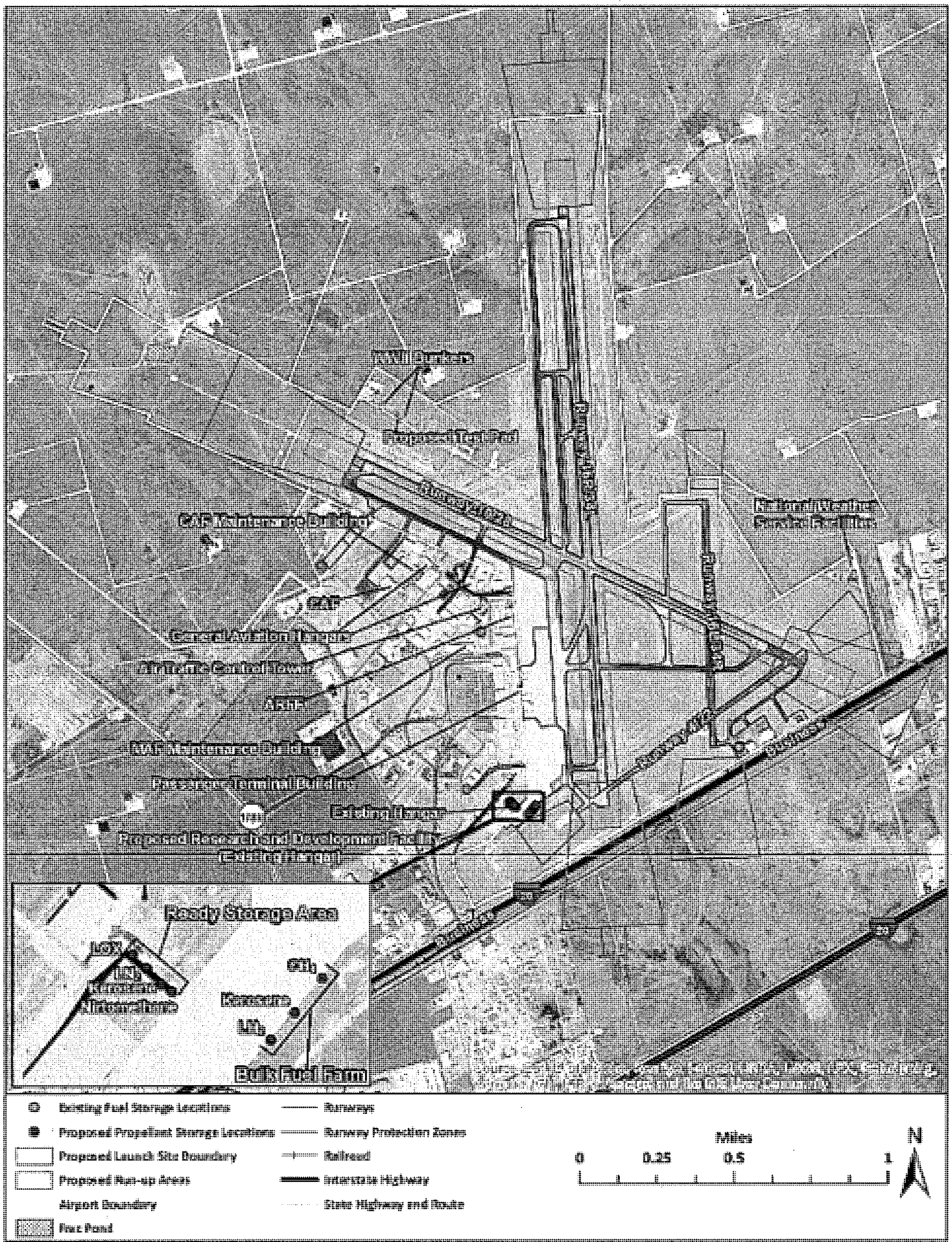
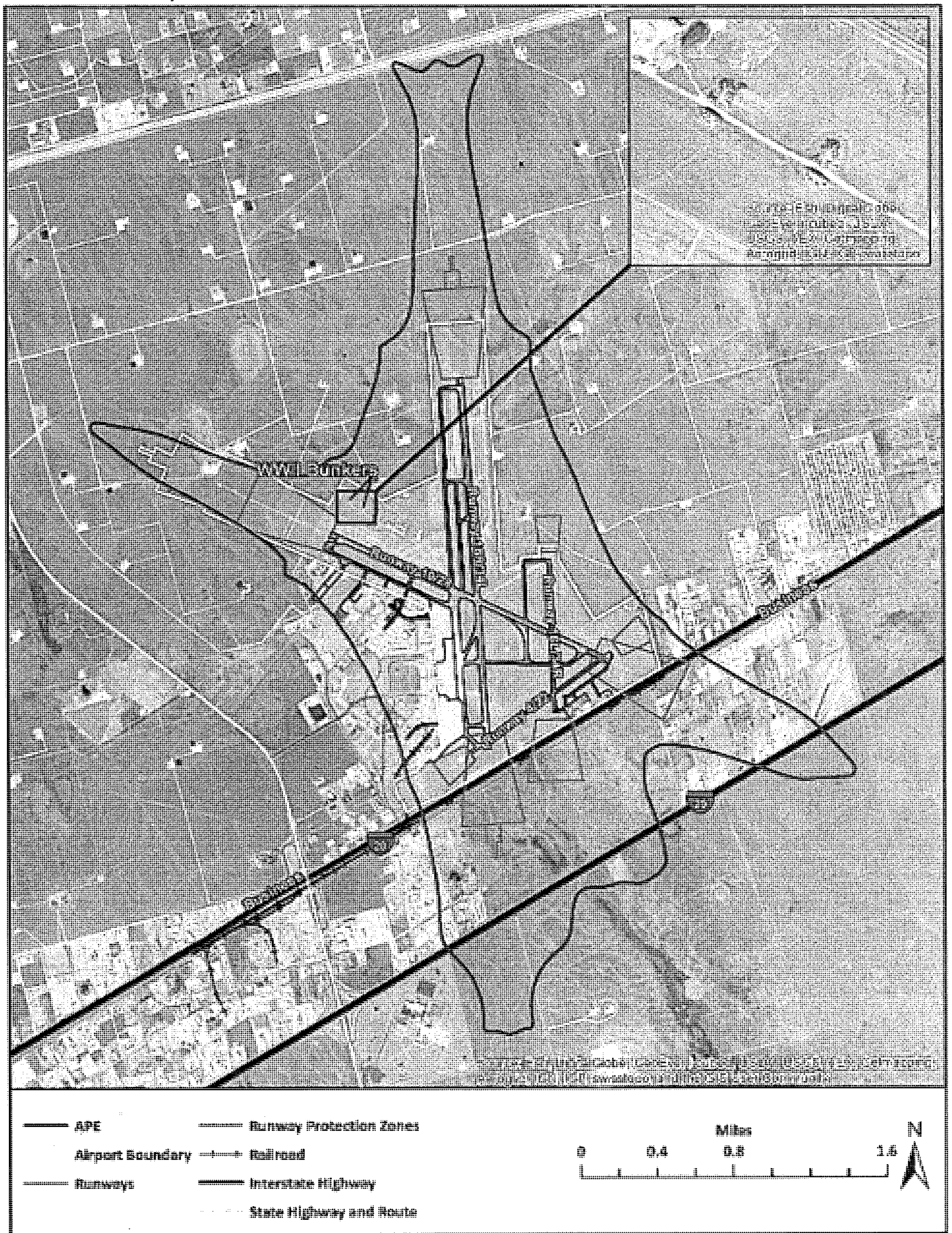


Enclosure 2. Existing and Proposed Facilities at MAF



Enclosure 3. APE for Cultural Resources at MAF

5 of 5

Johnson, Jaclyn M.

From: Daniel.Czelusniak@faa.gov
Sent: Thursday, August 22, 2013 1:13 PM
To: Johnson, Jaclyn M.
Cc: Woods, Hova; Baker, Nicholas; Sullivan, Neil; Daniel.Murray@faa.gov; Stacey.Zee@faa.gov
Subject: Fw: Midland International Air and Space Port, City of Midland, Midland County, Texas

FYI.

Daniel Czelusniak
Commercial Space Transportation, AST-100
Federal Aviation Administration
(202)267-5924
----- Forwarded by Daniel Czelusniak/AWA/FAA on 08/22/2013 01:11 PM -----

From: Jimmy Arterberry <jimmya@comanchenation.com>
AST-100, Space Transportation Development Div
To: Daniel Czelusniak/AWA/FAA@FAA
Date: 08/22/2013 12:11 PM
Subject: Midland International Air and Space Port, City of Midland, Midland County, Texas

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In response to your request, the above referenced project has been reviewed by staff of this office. Based on the information provided and a search within the Comanche Nation Site Files, we have determined that there are ***no properties*** affected by the proposed undertaking.
If you require additional information or are in need of further assistance, please contact this office at (580) 595-9960 or 9618.
This review is performed in order to identify and preserve the Comanche Nation and State's cultural heritage, in conjunction with the State Historic Preservation Office.

Jimmy W. Arterberry, THPO
Comanche Nation
P.O. Box 908
Lawton, Oklahoma 73502
(580) 595-9960 or 9618
(580) 595-9733 FAX

U.S. Department of Transportation
Federal Aviation Administration

Office of the Associate Administrator for Commercial Space Transportation

800 Independence Ave., SW
Washington, DC 20591

AUG 8 2013

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

SUBJECT: Environmental Assessment for the Midland International Air and Space Port, City of Midland, Midland County, Texas - Section 106 Consultation

Dear Ms. Allen:

This letter initiates government-to-government consultation with the Tonkawa Tribe of Oklahoma regarding the City of Midland's proposal to operate a commercial space launch site at the Midland International Airport (MAF) in Midland County, Texas and offer the site to XCOR Aerospace, Inc. (XCOR) for the operation of the Lynx horizontal take-off and horizontal landing reusable launch vehicle (RLV) and engine testing (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 Lynx RLV is a two-seat piloted, transport vehicle that would carry humans and payloads on a half-hour suborbital flight to 330,000 feet and then land on the take-off runway. Like an aircraft, Lynx is a horizontal take-off and horizontal landing vehicle, but instead of a jet or piston engine, Lynx uses a rocket propulsion system to depart a runway and makes a non-powered glide return and landing with the rocket engines off.

Proposed launch operations would begin in 2014 and continue through 2018. The frequency of launch operations would initially be one launch per week, eventually increasing to two launches per day, five days a week. Fifty-two annual launch operations are proposed in 2014. The total number of annual launch operations would increase each year until 2018 when 520 annual launch operations are proposed.

Existing infrastructure, including a hangar and runways, would be used to support launch operations at MAF. Testing of rocket engines would be performed from a designated engine test pad within airport boundaries. Construction of this concrete pad (18 feet by 60 feet) would occur between the existing World War II-era bunkers (see Enclosure 2). In addition, several new aboveground permanent storage tanks would be needed to store propellant that would support the Lynx RLV (see Enclosure 2).

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 noise studies for the EA (Enclosure 3). This area

would encompass all potential direct and indirect effects on archaeological and architectural resources. For archaeological resources, potential effects would be limited to the area within the APE where ground disturbance would occur from installation of a concrete pad and aboveground storage tanks. For architectural resources, potential effects would extend to the boundary of the APE. Ground-disturbing activities would be minimal and limited to areas previously disturbed by activities at the airport.

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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 important cultural issues that may be affected by the proposed launch operations. Although no historic properties were identified within the project APE, 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.

Because the FAA did not identify any historic properties within the APE, we request that you provide any comments you have regarding the APE determination or the proposed undertaking 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
Acting Manager, Space Transportation Development Division

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2. Existing and Proposed Facilities at MAF
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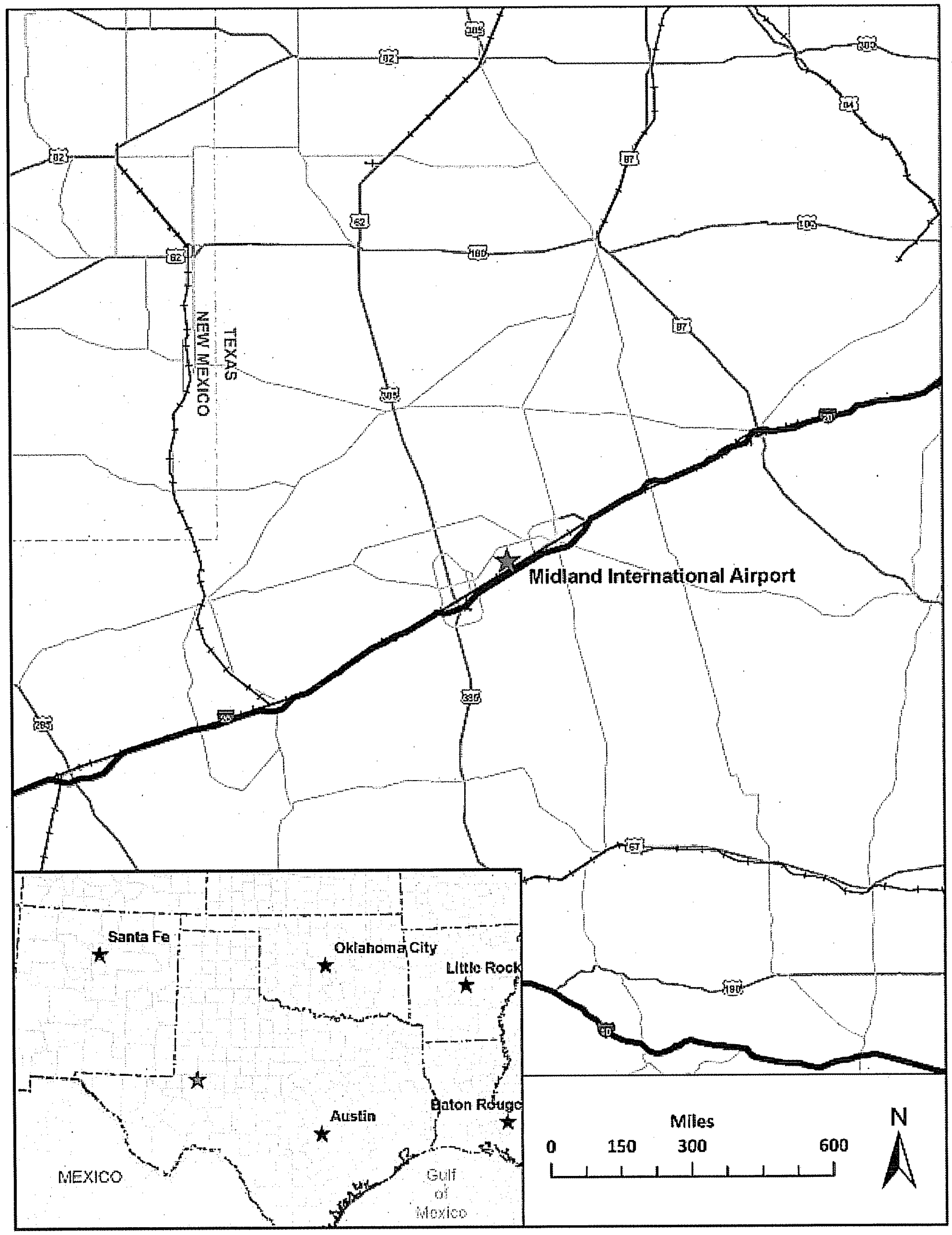

Enclosure 1. Regional Map of Proposed Launch Site

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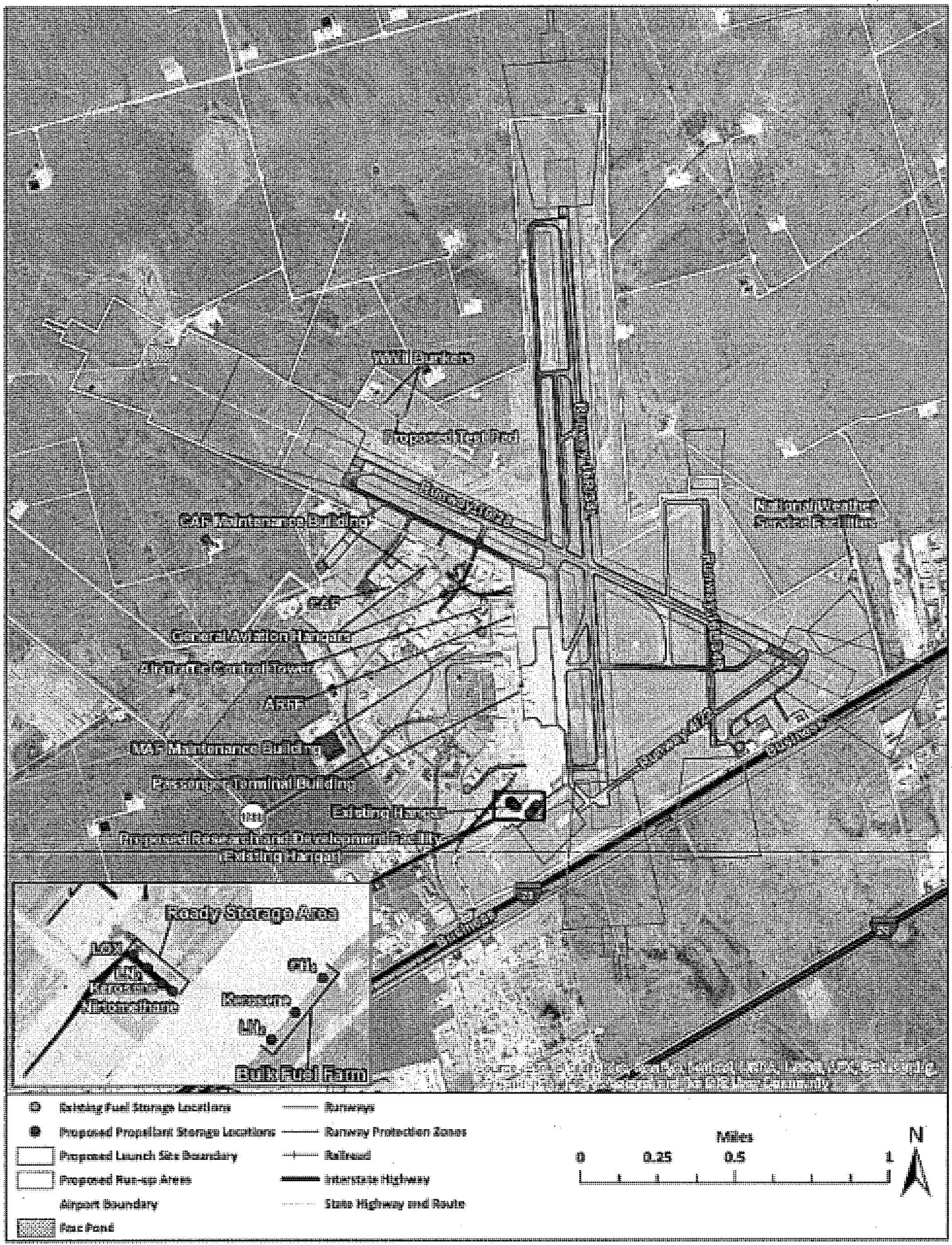
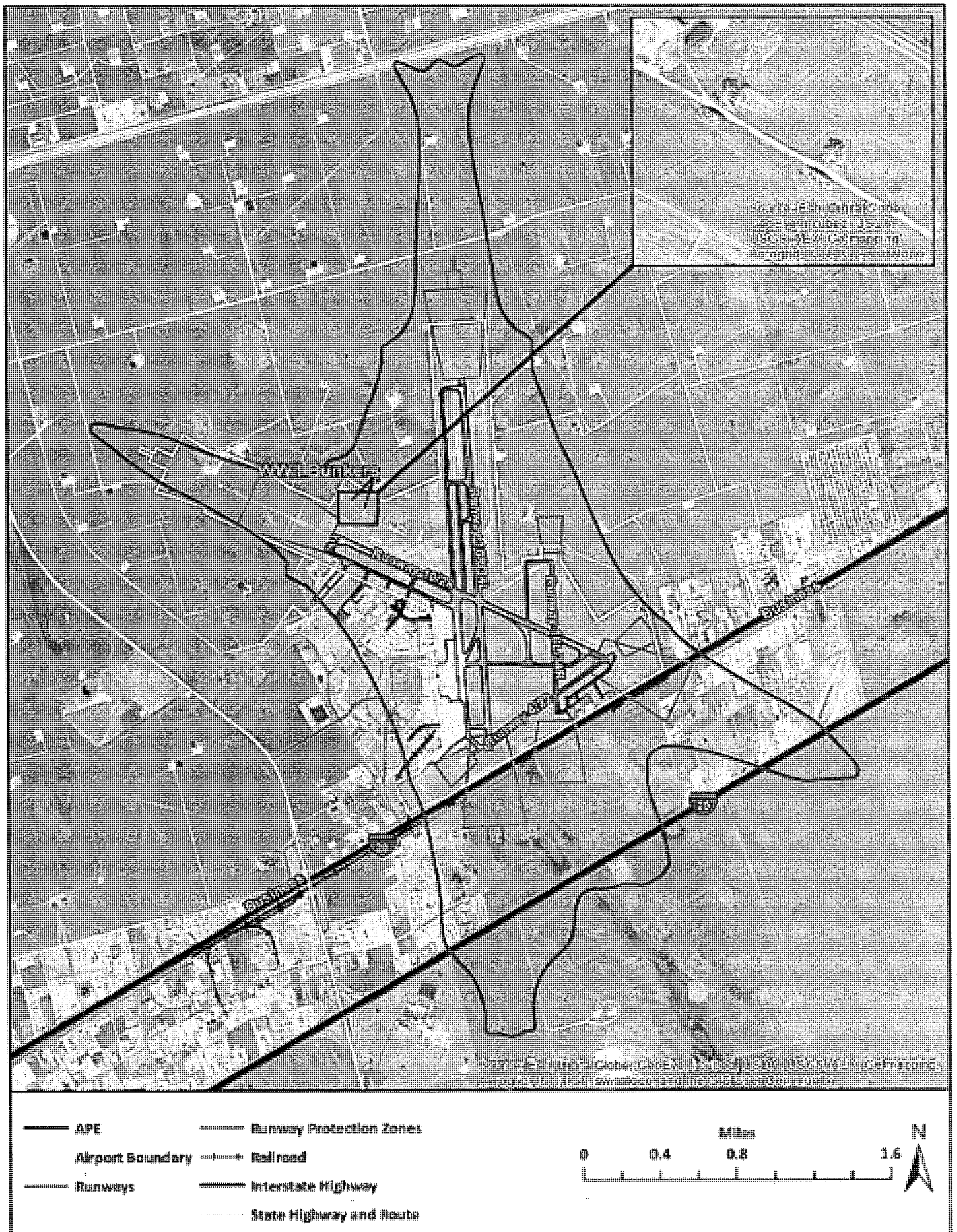


Enclosure 2. Existing and Proposed Facilities at MAF



Enclosure 3. APE for Cultural Resources at MAF

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TONKAWA TRIBE OF OKLAHOMA

NATIVE AMERICAN GRAVES PROTECTION AND REPATRIATION ACT

• 1 RUSH BUFFALO ROAD, TONKAWA, OKLAHOMA 74653 •
• PHONE (580) 628-2561 • FAX: (580) 628-9903 •
WEB SITE: www.tonkawatribe.com

Dear Sir or Madam,

Regarding your proposed projects, the Tonkawa Tribe of Indians of Oklahoma submits the following:

The Tonkawa Tribe has no specifically designated historical or cultural sites identified in the above listed project area. However if any human remains, funerary objects, or other evidence of historical or cultural significance is inadvertently discovered then the Tonkawa Tribe would certainly be interested in proper disposition thereof.

We appreciate notification by your office of the many projects on-going, and as always the Tonkawa Tribe is willing to work with your representatives in any manner to uphold the provisions of NAGPRA to the extent of our capability.

Respectfully,

Miranda "Nax'ce" Myer
NAGPRA Representative

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

Office of the Associate Administrator for
Commercial Space Transportation

800 Independence Ave., SW
Washington, DC 20591

AUG 8 2013

Tanya Sommer
Branch Chief
U.S. Fish and Wildlife Service
Austin Ecological Services Field Office
10711 Burnet Road, Suite 200
Austin, Texas 78758

SUBJECT: **Request for Concurrence on Effects Determination for Federally Listed Species from the Proposed Operation of the Midland International Air and Space Port, City of Midland, Midland County, Texas**

Dear Ms. Sommer:

In accordance with section 7 of the Endangered Species Act (ESA), the Federal Aviation Administration (FAA) is requesting concurrence from the U.S. Fish and Wildlife Service that the proposed operation of a commercial space launch site at the Midland International Airport (MAF) in Midland County, Texas, and associated launch operations and engine testing ***may affect, but is not likely to adversely affect*** the northern aplomado falcon (*Falco femoralis septentrionalis*), black-capped vireo (*Vireo atricapilla*), least tern (*Sterna antillarum*), and whooping crane (*Grus americana*).

Project Description

The City of Midland proposes to operate a commercial space launch site at MAF and offer the site to XCOR Aerospace, Inc. (XCOR) for the operation of the Lynx horizontal take-off and horizontal landing reusable launch vehicle (RLV) and engine testing (see Figure 1). To operate a commercial space launch site, the City of Midland must obtain a commercial space launch site license from the FAA. Under the Proposed Action, the FAA would: (1) issue a launch site operator license to the City of Midland for the operation of a commercial space launch site at MAF, (2) issue experimental permits and/or launch licenses to XCOR that would allow XCOR to conduct launches of the Lynx RLV from MAF, and (3) provide unconditional approval to modify the existing Airport Layout Plan to reflect the designation of a launch site boundary, installation of aboveground propellant storage tanks, and construction of a concrete pad for engine testing.

The Lynx RLV is a two-seat piloted, transport vehicle that would carry humans and payloads on a half-hour suborbital flight to 330,000 feet (ft) and then land on the take-off runway. Like an aircraft, Lynx is a horizontal take-off and horizontal landing vehicle, but instead of a jet or piston engine, Lynx uses a rocket propulsion system to depart a runway and makes a non-powered glide return and landing with the rocket engines off. Sonic booms would be generated during launch vehicle ascent and reentry.

Proposed launch operations would begin in 2014 and continue through 2018. The frequency of launch operations would initially be 1 per week or 52 per year in 2014 (Table 1). By 2018, proposed launch

operations would be 2 per day, 5 days a week, for a total of 520 per year. There would be a total of 1,196 launch operations for the proposed 5-year period of Lynx RLV operations at MAF.

Table 1. Proposed Launch Operations

Year	*Frequency*	*Launch Operations per Year**
2014	1 per week	52
2015	2 per week	104
2016	1 per day, 5 days a week	260
2017	1 per day, 5 days a week	260
2018	2 per day, 5 days a week	520
Total Number of Launch Operations from 2014 to 2018		**1,196**

Note: *One launch operation includes a takeoff and reentry.

Existing infrastructure, including a hangar and runways, would be used to support launch operations at MAF. Testing of rocket engines would be performed from a designated engine test pad within airport boundaries. Construction of an 18-ft by 60-ft concrete engine test pad would occur between the existing World War II-era bunkers (see Figure 2). In addition, several new aboveground permanent storage tanks would be needed to store propellant that would support the Lynx RLV (see Figure 2).

Action Area

The action area is defined as all areas to be affected directly or indirectly by the Federal action. Thus, the action area is MAF and the surrounding area that would experience potential impacts from implementation of the Proposed Action, including construction and operational activities. However, as no ESA-listed species occur within Midland County (http://www.fws.gov/southwest/; as of July 26, 2013), there would be no effects to ESA-listed species due to proposed construction and operational activities at MAF (i.e., construction of engine test pad, installation of aboveground propellant storage tanks, engine testing, and launch vehicle take-offs and landings). Noise generated from construction of the engine test pad, engine testing, installation of aboveground propellant storage tanks, and launch vehicle take-offs and landings would not be heard outside of Midland County. Operational noise generated by sonic booms represents the potential impact with the largest geographic extent. Therefore, the action area is defined by the sonic boom contours (see Figure 3).

Two sonic booms would be generated during a launch – one during ascent and another during vehicle reentry. The sonic boom generated during ascent would not be heard on the ground due to the steep ascending flight path angle of the Lynx RLV. Sonic booms generated by the launch vehicle during reentry could be heard in several counties around MAF, including Midland County (see Figure 3). Because the Lynx RLV has two proposed reentries/approaches onto Runway 16R/34L – from either a northern or southern trajectory – Figure 3 depicts two sonic boom contours. These contours overlie approximately 19,000 square miles of 28 counties in Texas and one county in New Mexico (Table 2).

Table 2. Counties within the Action Area

Texas				*New Mexico*
Andrews	Gaines	Midland	Terrell	Lea
Borden	Glasscock	Mitchell	Terry	
Crane	Howard	Nolan	Tom Green	
Crockett	Irion	Pecos	Upton	
Dawson	Loving	Reagan	Ward	
Ector	Lynn	Scurry	Winkler	
Fisher	Martin	Sterling	Yoakum	

Federally Listed Species that May be Affected by the Proposed Action

Pursuant to the ESA and the National Environmental Policy Act, the FAA has reviewed information regarding federally listed species and designated critical habitat that may be present in the action area. The FAA has determined the Proposed Action would have no effect on critical habitat, because (1) the only construction activity that would occur is related to the engine test pad and aboveground storage tanks, (2) these construction activities would occur at MAF, and (3) there is no designated critical habitat present at MAF. Therefore, critical habitat is not addressed further in this analysis.

The U.S. Fish and Wildlife Service Region 2 website (http://www.fws.gov/southwest/; as of July 26, 2013) was utilized to identify federally listed species that have the potential to occur within counties in the action area. Although the action area includes a total of 29 counties, not all counties have occurrences of ESA-listed species based on species listings by county provided on the Region 2 website. Four endangered bird species potentially occur within the action area (Table 3). Plants, snails, and fish are not considered in this analysis, because there are no species listed for Midland County where construction activities would occur, and because the only potential impact outside of Midland County would be from noise generated by sonic booms. The FAA has determined the Proposed Action would have no effect on federally listed plants, snails, and fish in the action area. Excluding those counties that with no species listed and those counties that only have candidate species, there are a total of 22 counties with species occurrences in the action area (see Table 3).

Although the golden-cheeked warbler (*Dendroica chrysoparia*) is listed as occurring within Tom Green County, based on species habitat requirements, it would not be found within the area of Tom Green County within the action area. Nesting and foraging habitat for golden-cheeked warblers is found in live oak-ash juniper woodlands consisting of tall, closed canopy, dense, mature stands of Ashe juniper mixed with trees such as oaks, Texas ash, cedar elm, hackberry, bigtooth maple, sycamore, little walnut, and escarpment cherry. This type of woodland generally grows in relatively moist areas such as steep-sided canyons, slopes, and adjacent uplands (USFWS 2013a). The habitat within the extreme northwestern portion of Tom Green County within the action area is mesquite-juniper shrub (Texas Parks and Wildlife Department [TPWD] 1984). The southeastern corner of Tom Green County is the only area within the county that contains suitable golden-cheeked warbler habitat (i.e., live oak-ash juniper parks and live oak-mesquite-ashe juniper parks; TPWD 1984) and this area is outside of the action area. Therefore, the FAA has determined that the Proposed Action would have no effect on the golden-cheeked warbler and the species is not addressed further.

Table 3. Federally Listed Species under the Jurisdiction of the USFWS and Potentially Occurring within the Action Area

Common name	*Status**	*County Occurrence†*
Northern aplomado falcon	E	Andrews, Ector, Loving, Pecos, Ward, Winkler
Black-capped vireo	E	Crockett, Glasscock, Howard, Irion, Mitchell, Nolan, Pecos, Reagan, Sterling, Terrell, Tom Green, Upton
Least tern	E	Tom Green
Whooping crane	E	Dawson, Lynn, Martin, Terry, Yoakum

Notes: *E = Endangered.
†County occurrence based on species listings by county provided at http://www.fws.gov/southwest/; as of July 26, 2013.

Northern Aplomado Falcon

Northern aplomado falcons require open grasslands or savannah with scattered trees or shrubs. It is at its northern limits in Texas. They do not make their own nests, but use those of other birds. They eat mostly birds and insects (TPWD 2013a). Although the aplomado falcon is listed on the USFWS Southwest Region website as potentially occurring within Lea County, New Mexico, based on current distribution and occurrences of the species in New Mexico, and the national USFWS Endangered Species Program website, the species is known to or believed to occur only in Texas; it is listed as an experimental, non-essential population in New Mexico (USFWS 2013b). The only occurrences of experimental, non-essential populations are within Colfax County, north of Lea County, and in southcentral New Mexico in Sierra, Soccoro, and Otero counties. Therefore, this assessment only addresses the occurrences of the species within Texas and the counties within the action area (Table 3).

Black-capped Vireo

This migrant inhabits mid-successional areas where the dominant species are oaks, sumacs, persimmon, and other broad-leafed shrubs, particularly oak-juniper woodlands with a distinctive patchy, two-layered aspect (a shrub and tree layer with open, grassy spaces). The vireo feeds on insects in deciduous and broad-leaved shrubs and trees (primarily oaks) (TPWD 2013a).

Least Tern

The least tern is listed as occurring in only Tom Green County within the action area. The tern nests along sand and gravel bars within braided streams and rivers and also on man-made structures (reservoirs, inland beaches, wastewater treatment plants, gravel mines, etc.). The only documented occurrence of least terns in Tom Green County is at the O.C. Fisher Reservoir, west of the town of San Angelo and over 60 miles east of the sonic boom contour that overlies the western portion of Tom Green County (Lockwood and Freeman 2004; Lott 2006).

Whooping Crane

A small, self-sustaining whooping crane population breeds and nests at Wood Buffalo National Park in Canada and over-winters at Aransas National Wildlife Refuge on the Texas gulf coast. They migrate through the Great Plains in spring and fall using rivers, lakes, and other water bodies for feeding and resting. They typically roost in riverine habitat on isolated sandbars and in large, palustrine wetlands (TPWD 2013a).

Potential Effects to ESA-listed Species

Because there are no species listed for Midland County where minor construction activities would occur, the only component of the Proposed Action that has the potential to affect ESA-listed species is the transmission of sonic booms during reentry of the Lynx RLV. As stated above and summarized in Table 1, reentry operations by the Lynx RLV would generate 1,196 sonic boom events over the proposed 5-year operating period at MAF. Sonic boom events would only occur 1-2 times per week during the first 2 years of proposed operations (2014-2015); increasing to 1 per day, 5 days per week during 2016-2017; and then 2 per day, 5 days a week in 2018. However, because the Lynx RLV could reenter/approach Runway 16R/34L from either a northern or southern proposed trajectory (see Figure 3), it is assumed that 50% of the time reentry/approach would occur from a northern trajectory and 50% of the time reentry/approach would occur from a southern trajectory. As shown in Figure 3, some counties underlie only the sonic boom reentry contour for Runway 16R, while others underlie only the sonic boom contour for Runway 34L, and others underlie both contours. Of the 22 counties that have ESA-listed species, 12 would only be

subject to half of the total proposed sonic booms in a given year (Table 4). That is, counties such as Crockett, Irion, Pecos, and Tom Green would only be potentially exposed to a sonic boom, on average, once every 2 weeks in 2014. Based on the above assumption, the most they would experience would be 1 a day, 5 days a week, or 260 sonic booms in 2018.

Table 4. Potential Annual Sonic Boom Exposure by County – 2014-2018*

County†	*Launch Operations per Year*					*Total Operations*
	2014	2015	2016	2017	2018	*2014-2018*
UNDERLYING SONIC BOOM REENTRY CONTOURS 16R AND 34L (see Figure 3)						
Andrews, Dawson, Ector, Glasscock, Howard, Martin, Mitchell, Reagan, Sterling, Upton	52	104	260	260	520	1,196
UNDERLYING SONIC BOOM REENTRY CONTOUR 16R OR 34L (see Figure 3)						
Crockett, Irion, Loving, Lynn, Nolan, Pecos, Terrell, Terry, Tom Green, Ward, Winkler, Yoakum	26	52	130	130	260	598

Notes: *The numbers in this table assume that 50% of the time reentry/approach would occur from a northern trajectory and 50% of the time reentry/approach would occur from a southern trajectory.
†County based on occurrence of ESA-listed species as outlined in Table 3.

Characteristics of Sonic Booms

The Lynx RLV has the potential to create a sonic boom, an impulsive sound similar to thunder. A sonic boom is the sound associated with the shock waves created by a vehicle traveling through air faster than the speed of sound. Sonic boom analysis was completed for the supersonic reentry portion of the nominal Lynx RLV launch events landing on runways 16R or 34L. As stated previously, the sonic boom resulting from RLV departures would not reach the ground due to the steep ascending flight path angle of the RLV.

The duration of a sonic boom is brief, less than a second, and the intensity is greatest directly under the flight path and weakens as distance from the flight track increases. The change in air pressure associated with a sonic boom is only a few pounds per square foot (psf) greater than normal atmospheric pressure. This is about the same pressure change experienced by a change in elevation of 20-30 ft, or riding an elevator down two or three floors. This additional pressure above normal atmospheric pressure is called *overpressure*. It is the sudden onset of the pressure change that makes the sonic boom audible. Overpressures greater than 1.5 psf generally elicit public reaction (National Aeronautics and Space Administration [NASA] 2005).

Under the Proposed Action, a sonic boom may be heard up to 100 miles from MAF in areas as far as Terry County to the north, Terrell County to the south, Fisher County to the east, and Lea County, New Mexico to the west. Although the extent of the sonic boom footprint (see Figure 3), defined as the area where a sonic boom may be heard, is approximately 19,000 square miles, the sonic boom overpressure is predicted to be at levels of less than 1 psf (or approximately 128 decibels [dB], peak sound pressure level [L_{peak}]). The peak overpressure level generated from the Lynx RLV would be similar in nature to a clap of thunder, which typically registers at about 120 dB in close proximity to the ground (National Lightning Safety Institute 2013). Within the majority of the action area, the sonic boom levels would be approximately 0.1 psf or 108 dB L_{peak}, which is less than a typical thunder clap. The area with levels near 1 psf would be in a more concentrated area of approximately 2.5 square miles, in the vicinity of north Reagan County and north Glasscock County, for the modeled atmospheric conditions and nominal trajectory departing from Runway 16R and Runway 34L, respectively. However, the location of the nominal impact point is variable in nature due to changes in atmospheric conditions or the vehicle flight trajectory.

Effects of Sonic Booms on Wildlife

Animal species differ greatly in their responses to noise. Noise effects on domestic animals and wildlife are classified as primary, secondary, and tertiary. Primary effects are direct, physiological changes to the auditory system, and most likely include the masking of auditory signals. Masking is defined as the inability of an individual to hear important environmental signals that may arise from mates, predators, or prey. There is some potential that noise could disrupt a species' ability to communicate or could interfere with behavioral patterns (Manci et al. 1988). Although the effects are likely temporal, aircraft noise may cause masking of auditory signals within exposed faunal communities. Animals rely on hearing to avoid predators, obtain food, and communicate with, and attract, other members of their species. Aircraft noise may mask or interfere with these functions. Other primary effects, such as ear drum rupture or temporary and permanent hearing threshold shifts, are not as likely given the noise levels produced by aircraft overflights. Secondary effects may include non-auditory effects such as stress and hypertension; behavioral modifications; interference with mating or reproduction; and impaired ability to obtain adequate food, cover, or water. Tertiary effects are the direct result of primary and secondary effects, and include population decline and habitat loss. Most of the effects of noise are mild enough that they may never be detectable as variables of change in population size or population growth against the background of normal variation (Bowles 1995). Other environmental variables (e.g., predators, weather, changing prey base, ground-based disturbance) also influence secondary and tertiary effects, and confound the ability to identify the ultimate factor in limiting productivity of a certain nest, area, or region. Overall, the literature suggests that species differ in their response to various types, durations, and sources of noise (Manci et al. 1988; Bowles 1995).

Many scientific studies have investigated the effects of aircraft noise and sonic booms on wildlife, and some have focused on wildlife "flight" due to noise. Natural factors which affect reaction include season, group size, age and sex composition, on-going activity, motivational state, reproductive condition, terrain, weather, and temperament (Bowles 1995). Individual animal response to a given noise event or series of events also can vary widely due to a variety of factors, including time of day, physical condition of the animal, physical environment, the experience of the individual animal with noises, and whether or not other physical stressors (e.g., drought) are present (Manci et al. 1988). Consequently, it is difficult to generalize animal responses to noise disturbances across species.

One result of the Manci et al. (1988) literature review was the conclusion that, while behavioral observation studies were relatively limited, a general behavioral reaction in animals from exposure to aircraft noise is the startle response. The intensity and duration of the startle response appears to be dependent on which species is exposed, whether there is a group or an individual, and whether there have been some previous exposures. Responses range from flight, trampling, stampeding, jumping, or running, to movement of the head in the apparent direction of the noise source. Manci et al. (1988) reported that the literature indicated that avian species may be more sensitive to aircraft noise than mammals.

The following discussion presents a summary of some of the more relevant studies addressing the potential impacts to wildlife from sonic booms.

Teer and Truett (1973) tested quail eggs subjected to sonic booms at 2, 4, and 5.5 psf and found no adverse effects. Heinemann and LeBrocq (1965) exposed chicken eggs to sonic booms at 3-18 psf and found no adverse effects. In a mathematical analysis of the response of avian eggs to sonic boom overpressures, Ting et al. (2002) determined that it would take a sonic boom of 250 psf to crack an egg. Bowles (1995) states that it is physically impossible for a sonic boom to crack an egg because one cannot generate sufficient sound pressure in air to crack eggs.

Teer and Truett (1973) examined reproductive success in mourning doves, mockingbirds, northern cardinals, and lark sparrows when exposed to sonic booms of 1 psf or greater and found no adverse effects. Awbrey and Bowles (1990) in a review of the literature on the effects of aircraft noise and sonic booms on raptors found that the available evidence shows very marginal effects on reproductive success. Ellis et al. (1991) examined the effects of sonic booms (actual and simulated) on nesting peregrine falcons (*Falco peregrinus*), prairie falcons (*Falco mexicanus*), and six other raptor species. While some individuals did respond by leaving the nest, the response was temporary and overall there were no adverse effects on nesting. Lynch and Speake (1978) studied the effects of both real and simulated sonic booms on the nesting and brooding of eastern wild turkey (*Meleagris gallopavo silvestris*) in Alabama. Hens at four nest sites were subjected to between 8 and 11 combined real and simulated sonic booms. All tests elicited similar responses, including quick lifting of the head and apparent alertness for between 10 and 20 seconds. No apparent nest failure occurred as a result of the sonic booms.

Animal species exhibit a wide variety of responses to noise. It is therefore difficult to generalize animal responses to noise disturbances or to draw inferences across species, as reactions to jet aircraft noise and sonic booms appear to be species-specific. Consequently, some animal species may be more sensitive than other species and/or may exhibit different forms or intensities of behavioral responses.

The literature does suggest that common responses include the "startle" or "fright" response and, ultimately, habituation. It has been reported that the intensities and durations of the startle response decrease with the numbers and frequencies of exposures, suggesting no long-term adverse effects. The majority of the literature suggests that domestic animal species (cows, horses, chickens) and wildlife species exhibit adaptation, acclimation, and habituation after repeated exposure to jet aircraft noise and sonic booms.

Conclusion

Potential Proposed Action-related noise such as sonic booms are temporal, not sustained, and not fixed in location. The four ESA-listed avian species addressed in this analysis would experience an estimated maximum of 26-52 sonic booms in 2014 and up to 260-520 sonic booms in 2018. These events are expected to produce infrequent startle effects. Within the majority of the action area, the sonic boom levels would be approximately 0.1 psf, which is less than a typical thunder clap. As previous studies have found no adverse effects to avian species when exposed to sonic booms greater than 1 psf, and given the number of proposed sonic boom events spread over a large area, the FAA concludes that the Proposed Action ***may effect, but is not likely to adversely affect*** the northern aplomado falcon, black-capped vireo, least tern, and whooping crane within the action area (Table 5).

Table 5. Effects Determinations for Federally Listed Species under the Jurisdiction of the USFWS and Potentially Occurring within the Action Area

Species	*Status**	*Effects Determination*
Northern aplomado falcon	E	may affect, but is not likely to adversely affect
Black-capped vireo	E	may affect, but is not likely to adversely affect
Least tern	E	may affect, but is not likely to adversely affect
Whooping crane	E	may affect, but is not likely to adversely affect

Note: *E = endangered.

The FAA appreciates your review of the proposed project and requests your concurrence with the effects determinations in this letter. If you have any questions, please contact Mr. Daniel Czelusniak, of my staff, at 202-267-5924 or at Daniel.Czelusniak@faa.gov.

Sincerely,

Daniel Murray
Acting Manager, Space Transportation Development Division

Attachments: Figure 1. Regional Map of Proposed Launch Site
Figure 2. Existing and Proposed Facilities at MAF
Figure 3. Sonic Boom Footprint

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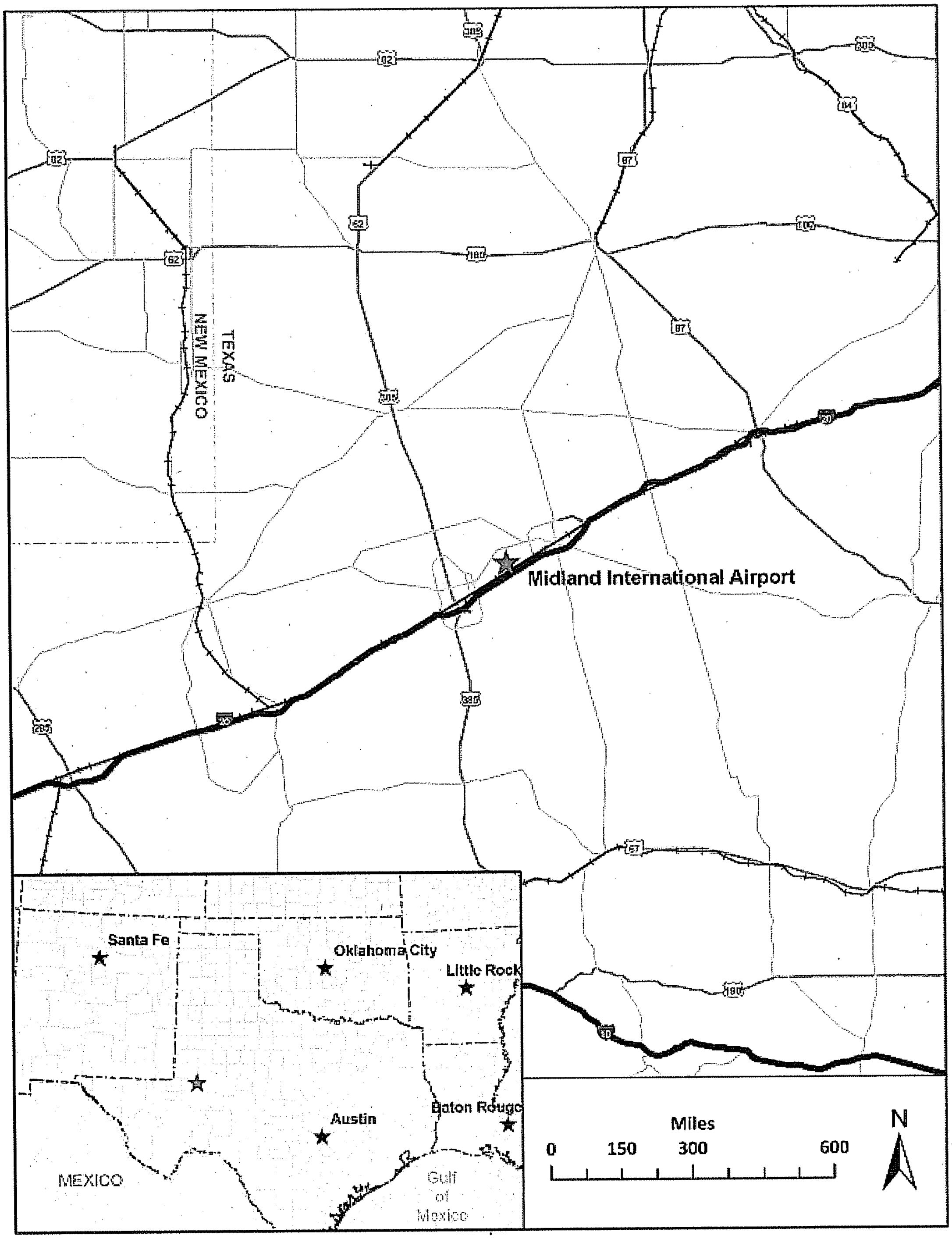

Figure 1. Regional Map of Proposed Launch Site

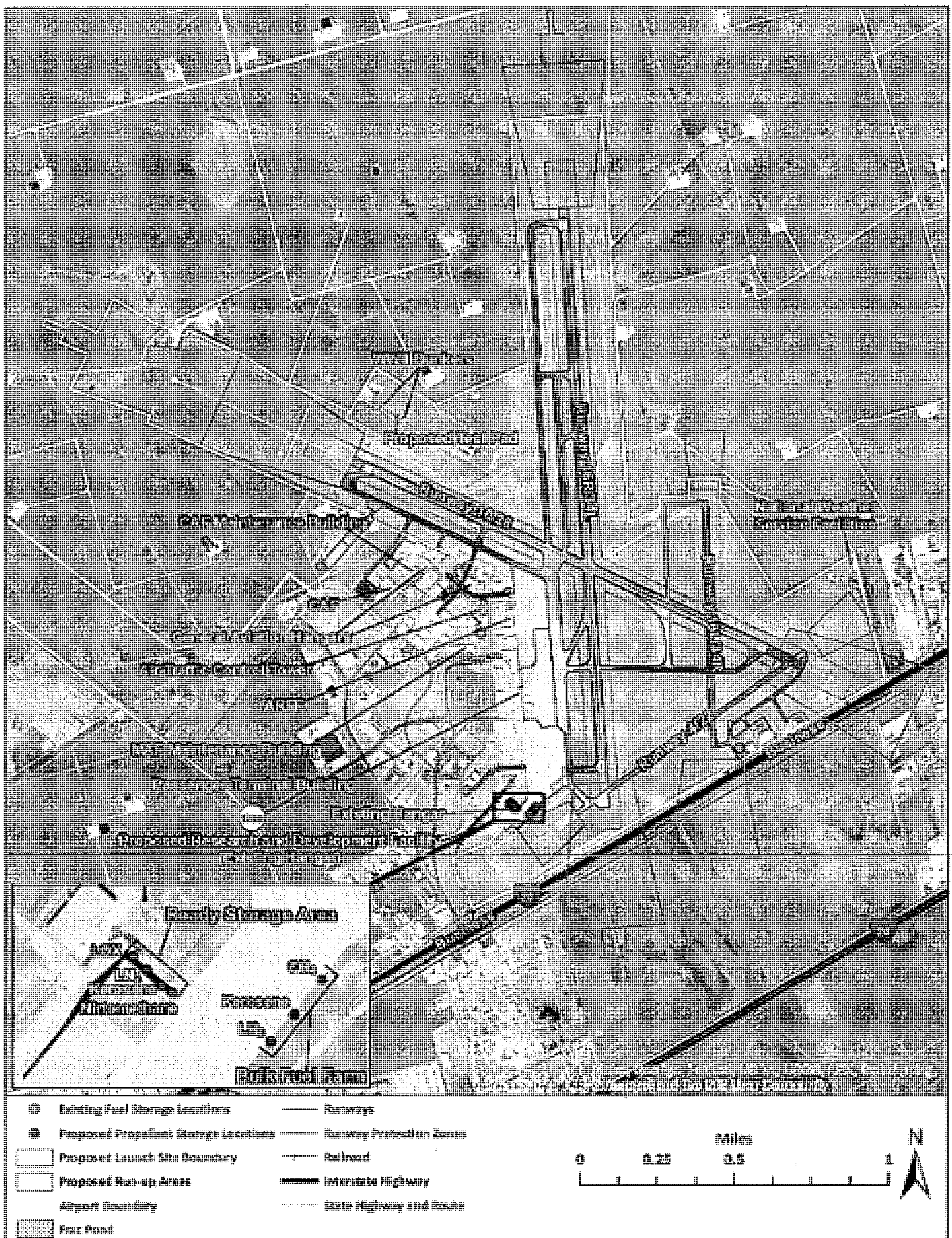

Figure 2. Existing and Proposed Facilities at MAF

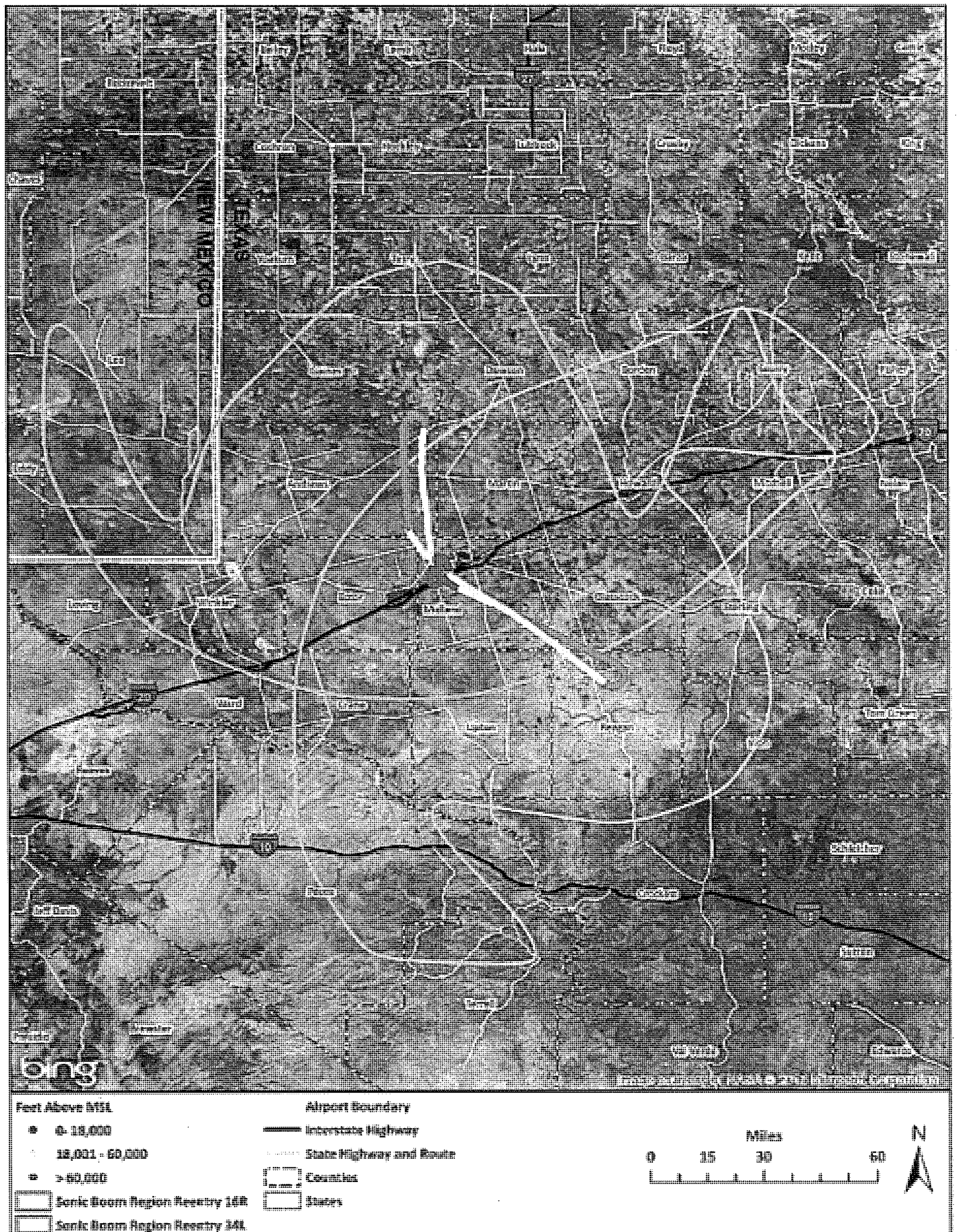

Figure 3. Sonic Boom Footprint

United States Department of the Interior

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NOV 19 2013

Mr. Daniel Murray
Space Transportation Development Division
U.S. Department of Transportation
Federal Aviation Administration
800 Idependence Ave., SW
Washington, DC 20591

Consultation Number 02ETAU00-2013-I-0250

Dear Mr. Murray

Thank you for your letter of August 8, 2013, requesting informal consultation for the proposed Operation of the Midland International Air (MAF) and Space Port, in Midland, Midland County, Texas. The Federal Aviation Administration has submitted documentation to the U.S. Fish and Wildlife Service (Service) requesting concurrence that the proposed project "may affect, but is not likely to adversely affect" the northern aplomado falcon (Falco femoralis septentrionalis), black-capped vireo (Vireo atricapilla), least tern (Sterna atillarum), and whooping crane (Grus Americana), species listed pursuant to the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

Section 7 of the Act requires that all Federal agencies consult with the Service to ensure that the actions authorized, funded, or carried out by such agencies do not jeopardize the continued existence of any threatened or endangered species or adversely modify or destroy designated critical habitat of such species.

The proposed project involves the construction and operation of a commercial space launch site at the Midland International Airport (MAF). The site will be used by XCOR Aerospace, Inc. (XCOR) for the operation of the Lynx horizontal take-off and horizontal landing of reusable launch vehicle (RLV) and engine testing. The Lynx RLV is a transport vehicle that will carry humans and payloads on a half-hour suborbital flight to 330,000 feet. The operational noise generated by sonic booms during RLV reentry may be heard 100 miles from the MAF for duration of less than one second.

Based on the information provided, review of Service files, and additional correspondence with Service biologists, we concur with the FAA's conclusion that the proposed project "may affect, but is not likely to adversely affect" the northern aplomado falcon (Falco femoralis septentrionalis), black-capped vireo (Vireo atricapilla), least tern (Sterna atillarum), and whooping crane (Grus Americana). Therefore, no further endangered species consultation will be required for this project unless: 1) the identified action is subsequently modified in a manner that causes an effect on listed species or designated critical habitat; 2) new information reveals the identified action may affect federally protected species or designated critical habitat in a

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manner or to an extent not previously considered; or 3) a new species is listed or critical habitat is designated under the Act that may be affected by the identified action.

We appreciate the opportunity to comment on this project. If you have any questions or comments, please contact Moni Belton at 281-286-8282, ext. 233.

Sincerely,

Adam Zerrenner
Supervisor

U.S. Department
of Transportation
Federal Aviation Administration

Office of Commercial Space Transportation

800 Independence Ave., SW.
Washington, DC 20591

MAY 12 2014

Tanya Sommer
Branch Chief
U.S. Fish and Wildlife Service
Austin Ecological Services Field Office
10711 Burnet Road, Suite 200
Austin, Texas 78758

SUBJECT: Request for Concurrence on Effects Determination for the Lesser Prairie-Chicken from the Proposed Operation of the Midland International Air and Space Port, City of Midland, Midland County, Texas

Dear Ms. Sommer:

In accordance with section 7 of the Endangered Species Act (ESA), the Federal Aviation Administration (FAA) is requesting concurrence from the U.S. Fish and Wildlife Service (USFWS) that the proposed operation of a commercial space launch site at the Midland International Airport (MAF) in Midland County, Texas, and associated launch operations and engine testing ***may affect, but is not likely to adversely affect*** the lesser prairie-chicken (*Tympanuchus pallidicinctus*). We previously conducted informal consultation with your office regarding this project and its potential effect on the northern aplomado falcon (*Falco femoralis septentrionalis*), black-capped vireo (*Vireo atricapilla*), least tern (*Sterna atillarum*), and whooping crane (*Grus Americana*) (Consultation Number 02ETAU00-2013-I-0250). The USFWS concurred with the FAA's conclusion that the proposed project "may affect, but is not likely to adversely affect" the northern aplomado falcon, black-capped vireo, least tern, and whooping crane. Since the conclusion of the previous consultation, the USFWS listed the lesser prairie-chicken as a threatened species. Construction or operations associated with the proposed project has not started.

Project Description

The City of Midland proposes to operate a commercial space launch site at MAF and offer the site to XCOR Aerospace, Inc. (XCOR) for the operation of the Lynx horizontal take-off and horizontal landing reusable launch vehicle (RLV) and engine testing (see Figure 1). To operate a commercial space launch site, the City of Midland must obtain a commercial space launch site license from the FAA. Under the Proposed Action, the FAA would: (1) issue a launch site operator license to the City of Midland for the operation of a commercial space launch site at MAF, (2) issue experimental permits and/or launch licenses to XCOR that would allow XCOR to conduct launches of the Lynx RLV from MAF, and (3) provide unconditional approval to modify the existing Airport Layout Plan to reflect the designation of a launch site boundary, installation of aboveground propellant storage tanks, and construction of a concrete pad for engine testing.

The Lynx RLV is a two-seat piloted, transport vehicle that would carry humans and payloads on a half-hour suborbital flight to 330,000 feet (ft) and then land on the take-off runway. Like an aircraft, Lynx is a

horizontal take-off and horizontal landing vehicle, but instead of a jet or piston engine, Lynx uses a rocket propulsion system to depart a runway and makes a non-powered glide return and landing with the rocket engines off. Sonic booms would be generated during launch vehicle ascent and reentry.

Proposed launch operations would begin in 2014 and continue through 2018. The frequency of launch operations would initially be 1 per week or 52 per year in 2014 (Table 1). By 2018, proposed launch operations would be 2 per day, 5 days a week, for a total of 520 per year. There would be a total of 1,196 launch operations for the proposed 5-year period of Lynx RLV operations at MAF.

Table 1. Proposed Launch Operations

Year	*Frequency*	*Launch Operations per Year**
2014	1 per week	52
2015	2 per week	104
2016	1 per day, 5 days a week	260
2017	1 per day, 5 days a week	260
2018	2 per day, 5 days a week	520
Total Number of Launch Operations from 2014 to 2018		**1,196**

Note: *One launch operation includes a takeoff and reentry.

Existing infrastructure, including a hangar and runways, would be used to support launch operations at MAF. Testing of rocket engines would be performed from a designated engine test pad within airport boundaries. Construction of an 18-ft by 60-ft concrete engine test pad would occur between the existing World War II-era bunkers (see Figure 2). In addition, several new aboveground permanent storage tanks would be needed to store propellant that would support the Lynx RLV (see Figure 2).

Action Area

The action area is defined as all areas to be affected directly or indirectly by the Federal action. Thus, the action area is MAF and the surrounding area that would experience potential impacts from implementation of the Proposed Action, including construction and operational activities. However, because the lesser prairie-chicken is not listed or known to occur within Midland County, there would be no effects to the lesser prairie-chicken from proposed construction and operational activities at MAF (i.e., construction of engine test pad, installation of aboveground propellant storage tanks, engine testing, and launch vehicle take-offs and landings). Noise generated from construction of the engine test pad, engine testing, installation of aboveground propellant storage tanks, and launch vehicle take-offs and landings would not be heard outside of Midland County. Operational noise generated by sonic booms represents the potential impact with the largest geographic extent. Therefore, the action area is defined by the sonic boom contours (see Figure 3).

Two sonic booms would be generated during a launch – one during ascent and another during vehicle reentry. The sonic boom generated during ascent would not be heard on the ground due to the steep ascending flight path angle of the Lynx RLV. Sonic booms generated by the launch vehicle during reentry could be heard in several counties around MAF, including Midland County (see Figure 3). Because the Lynx RLV has two proposed reentries/approaches onto Runway 16R/34L – from either a northern or southern trajectory – Figure 3 depicts two sonic boom contours. These contours overlie approximately 19,000 square miles of 28 counties in Texas and one county in New Mexico (Table 2).

Table 2. Counties within the Action Area

Texas				*New Mexico*
Andrews	Gaines	Midland	Terrell	Lea
Borden	Glasscock	Mitchell	Terry	
Crane	Howard	Nolan	Tom Green	
Crockett	Irion	Pecos	Upton	
Dawson	Loving	Reagan	Ward	
Ector	Lynn	Scurry	Winkler	
Fisher	Martin	Sterling	Yoakum	

Federally Listed Species that May be Affected by the Proposed Action

Pursuant to the ESA and the National Environmental Policy Act, the FAA has reviewed information regarding federally listed species and designated critical habitat that may be present in the action area. The FAA has determined the Proposed Action would have no effect on critical habitat, because (1) the only construction activity that would occur is related to the engine test pad and aboveground storage tanks, (2) these construction activities would occur at MAF, and (3) there is no designated critical habitat present at MAF. Therefore, critical habitat is not addressed further in this analysis.

Based on the USFWS species profile for the lesser prairie-chicken, the species is known or believed to occur in the following action area counties: Andrews, Gaines, Terry, and Yoakum Counties, Texas; and Lea County, New Mexico.

Lesser Prairie-Chicken

The lesser prairie-chicken was listed by the USFWS as a threatened species under the ESA in April 2014 (USFWS 2014a). Lesser prairie-chickens inhabit mixed grass-dwarf shrub communities that occur on sandy soils. These communities are principally found in the sand sagebrush (*Artemisia filifoilia*)-bluestem (*Andropogon* spp.) association in Colorado, Kansas, and Oklahoma, and to a lesser extant, Texas and New Mexico; and the shinnery oak (*Quercus havardii*)-bluestem association in Oklahoma, Texas, and New Mexico. Leks typically occur on knolls or ridges with relatively short and/or sparse vegetation, but may also be on human-created open areas and recently burned areas (Palis et al. 2010).

While the species is known or believed to occur within the Texas counties of Andrews, Gaines, Terry, and Yoakum, and Lea County, New Mexico, the closest known occurrences of lesser prairie-chickens are approximately 50 miles north/northwest of MAF in northern Andrews County and southern Gaines County, Texas, and 70 miles west in Lea County, New Mexico (USFWS 2014b).

Potential Effects to ESA-listed Species

Because the lesser prairie-chicken is not known or believed to occur within Midland County where minor construction activities would occur, the only component of the Proposed Action that has the potential to affect the species is the transmission of sonic booms during reentry of the Lynx RLV. As stated above and summarized in Table 1, reentry operations by the Lynx RLV would generate 1,196 sonic boom events over the proposed 5-year operating period at MAF. Sonic boom events would only occur 1–2 times per week during the first 2 years of proposed operations (2014–2015); increasing to 1 per day, 5 days per week during 2016–2017; and then 2 per day, 5 days a week in 2018. However, because the Lynx RLV could reenter/approach Runway 16R/34L from either a northern or southern proposed trajectory (see Figure 3), it is assumed that 50% of the time reentry/approach would occur from a northern trajectory and 50% of the time reentry/approach would occur from a southern trajectory. As shown in Figure 3, some

counties underlie only the sonic boom reentry contour for Runway 16R, while others underlie only the sonic boom contour for Runway 34L, and others underlie both contours. Of the five counties where the lesser prairie-chicken is known or believed to occur, four would only be subject to half of the total proposed sonic booms in a given year (Table 4). That is, Gaines, Terry, and Yoakum Counties, Texas, and Lea County, New Mexico would only be potentially exposed to a sonic boom, on average, once every 2 weeks in 2014. Based on the above assumption, the most they would experience would be 1 a day, 5 days a week, or 260 sonic booms in 2018.

Table 4. Potential Annual Sonic Boom Exposure by County, 2014–2018*

County	*Launch Operations per Year*					*Total Operations*
	2014	*2015*	*2016*	*2017*	*2018*	*2014–2018*
UNDERLYING SONIC BOOM REENTRY CONTOURS 16R AND 34L (see Figure 3)						
Andrews	52	104	260	260	520	1,196
UNDERLYING SONIC BOOM REENTRY CONTOUR 16R OR 34L (see Figure 3)						
Gaines, Terry, Yoakum, Lea	26	52	130	130	260	598

Notes: *The numbers in this table assume that 50% of the time reentry/approach would occur from a northern trajectory and 50% of the time reentry/approach would occur from a southern trajectory.

Characteristics of Sonic Booms

The Lynx RLV has the potential to create a sonic boom, an impulsive sound similar to thunder. A sonic boom is the sound associated with the shock waves created by a vehicle traveling through air faster than the speed of sound. Sonic boom analysis was completed for the supersonic reentry portion of the nominal Lynx RLV launch events landing on runways 16R or 34L. As stated previously, the sonic boom resulting from RLV departures would not reach the ground due to the steep ascending flight path angle of the RLV.

The duration of a sonic boom is brief, less than a second, and the intensity is greatest directly under the flight path and weakens as distance from the flight track increases. The change in air pressure associated with a sonic boom is only a few pounds per square foot (psf) greater than normal atmospheric pressure. This is about the same pressure change experienced by a change in elevation of 20-30 ft, or riding an elevator down two or three floors. This additional pressure above normal atmospheric pressure is called *overpressure*. It is the sudden onset of the pressure change that makes the sonic boom audible. Overpressures greater than 1.5 psf generally elicit public reaction (National Aeronautics and Space Administration [NASA] 2005).

Under the Proposed Action, a sonic boom may be heard up to 100 miles from MAF in areas as far as Terry County to the north, Terrell County to the south, Fisher County to the east, and Lea County, New Mexico to the west. Although the extent of the sonic boom footprint (see Figure 3), defined as the area where a sonic boom may be heard, is approximately 19,000 square miles, the sonic boom overpressure is predicted to be at levels of less than 1 psf (or approximately 128 decibels [dB], peak sound pressure level [L_{peak}]). The peak overpressure level generated from the Lynx RLV would be similar in nature to a clap of thunder, which typically registers at about 120 dB in close proximity to the ground (National Lightning Safety Institute 2013). Within the majority of the action area, the sonic boom levels would be approximately 0.1 psf or 108 dB L_{peak}, which is less than a typical thunder clap. The area with levels near 1 psf would be in a more concentrated area of approximately 2.5 square miles, in the vicinity of north Reagan County and north Glasscock County, for the modeled atmospheric conditions and nominal trajectory departing from Runway 16R and Runway 34L, respectively. However, the location of the nominal impact point is variable in nature due to changes in atmospheric conditions or the vehicle flight trajectory.

Effects of Sonic Booms on Wildlife

Animal species differ greatly in their responses to noise. Noise effects on domestic animals and wildlife are classified as primary, secondary, and tertiary. Primary effects are direct, physiological changes to the auditory system, and most likely include the masking of auditory signals. Masking is defined as the inability of an individual to hear important environmental signals that may arise from mates, predators, or prey. There is some potential that noise could disrupt a species' ability to communicate or could interfere with behavioral patterns (Manci et al. 1988). Although the effects are likely temporal, aircraft noise may cause masking of auditory signals within exposed faunal communities. Animals rely on hearing to avoid predators, obtain food, and communicate with, and attract, other members of their species. Aircraft noise may mask or interfere with these functions. Other primary effects, such as ear drum rupture or temporary and permanent hearing threshold shifts, are not as likely given the noise levels produced by aircraft overflights. Secondary effects may include non-auditory effects such as stress and hypertension; behavioral modifications; interference with mating or reproduction; and impaired ability to obtain adequate food, cover, or water. Tertiary effects are the direct result of primary and secondary effects, and include population decline and habitat loss. Most of the effects of noise are mild enough that they may never be detectable as variables of change in population size or population growth against the background of normal variation (Bowles 1995). Other environmental variables (e.g., predators, weather, changing prey base, ground-based disturbance) also influence secondary and tertiary effects, and confound the ability to identify the ultimate factor in limiting productivity of a certain nest, area, or region. Overall, the literature suggests that species differ in their response to various types, durations, and sources of noise (Manci et al. 1988; Bowles 1995).

Many scientific studies have investigated the effects of aircraft noise and sonic booms on wildlife, and some have focused on wildlife "flight" due to noise. Natural factors which affect reaction include season, group size, age and sex composition, on-going activity, motivational state, reproductive condition, terrain, weather, and temperament (Bowles 1995). Individual animal response to a given noise event or series of events also can vary widely due to a variety of factors, including time of day, physical condition of the animal, physical environment, the experience of the individual animal with noises, and whether or not other physical stressors (e.g., drought) are present (Manci et al. 1988). Consequently, it is difficult to generalize animal responses to noise disturbances across species.

One result of the Manci et al. (1988) literature review was the conclusion that, while behavioral observation studies were relatively limited, a general behavioral reaction in animals from exposure to aircraft noise is the startle response. The intensity and duration of the startle response appears to be dependent on which species is exposed, whether there is a group or an individual, and whether there have been some previous exposures. Responses range from flight, trampling, stampeding, jumping, or running, to movement of the head in the apparent direction of the noise source. Manci et al. (1988) reported that the literature indicated that avian species may be more sensitive to aircraft noise than mammals.

The following discussion presents a summary of some of the more relevant studies addressing the potential impacts to wildlife from sonic booms.

Teer and Truett (1973) tested quail eggs subjected to sonic booms at 2, 4, and 5.5 psf and found no adverse effects. Heinemann and LeBrocq (1965) exposed chicken eggs to sonic booms at 3-18 psf and found no adverse effects. In a mathematical analysis of the response of avian eggs to sonic boom overpressures, Ting et al. (2002) determined that it would take a sonic boom of 250 psf to crack an egg. Bowles (1995) states that it is physically impossible for a sonic boom to crack an egg because one cannot generate sufficient sound pressure in air to crack eggs.

Teer and Truett (1973) examined reproductive success in mourning doves, mockingbirds, northern cardinals, and lark sparrows when exposed to sonic booms of 1 psf or greater and found no adverse effects. Awbrey and Bowles (1990) in a review of the literature on the effects of aircraft noise and sonic booms on raptors found that the available evidence shows very marginal effects on reproductive success. Ellis et al. (1991) examined the effects of sonic booms (actual and simulated) on nesting peregrine falcons (*Falco peregrinus*), prairie falcons (*Falco mexicanus*), and six other raptor species. While some individuals did respond by leaving the nest, the response was temporary and overall there were no adverse effects on nesting. Lynch and Speake (1978) studied the effects of both real and simulated sonic booms on the nesting and brooding of eastern wild turkey (*Meleagris gallopavo silvestris*) in Alabama. Hens at four nest sites were subjected to between 8 and 11 combined real and simulated sonic booms. All tests elicited similar responses, including quick lifting of the head and apparent alertness for between 10 and 20 seconds. No apparent nest failure occurred as a result of the sonic booms.

Animal species exhibit a wide variety of responses to noise. It is therefore difficult to generalize animal responses to noise disturbances or to draw inferences across species, as reactions to jet aircraft noise and sonic booms appear to be species-specific. Consequently, some animal species may be more sensitive than other species and/or may exhibit different forms or intensities of behavioral responses.

The literature does suggest that common responses include the "startle" or "fright" response and, ultimately, habituation. It has been reported that the intensities and durations of the startle response decrease with the numbers and frequencies of exposures, suggesting no long-term adverse effects. The majority of the literature suggests that domestic animal species (cows, horses, chickens) and wildlife species exhibit adaptation, acclimation, and habituation after repeated exposure to jet aircraft noise and sonic booms.

Conclusion

Potential Proposed Action-related noise such as sonic booms are random, not sustained, and not fixed in location. The lesser prairie-chicken would experience an estimated maximum of 26–52 sonic booms in 2014 and up to 260–520 sonic booms in 2018. These events are expected to produce infrequent startle effects. Within the majority of the action area, the sonic boom levels would be approximately 0.1 psf, which is less than a typical thunder clap. As previous studies have found no adverse effects to avian species when exposed to sonic booms greater than 1 psf, and given the number of proposed sonic boom events spread over a large area, the FAA concludes that the Proposed Action ***may effect, but is not likely to adversely affect*** the lesser prairie-chicken within the action area.

The FAA appreciates your review of the proposed project and requests your concurrence with the effects determinations in this letter. If you have any questions, please contact Mr. Daniel Czelusniak, of my staff, at 202-267-5924 or at Daniel.Czelusniak@faa.gov.

Sincerely,

Daniel Murray
Manager, Space Transportation Development Division

Attachments: Figure 1. Regional Map of Proposed Launch Site
Figure 2. Existing and Proposed Facilities at MAF
Figure 3. Sonic Boom Footprint

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Figure 1. Regional Map of Proposed Launch Site

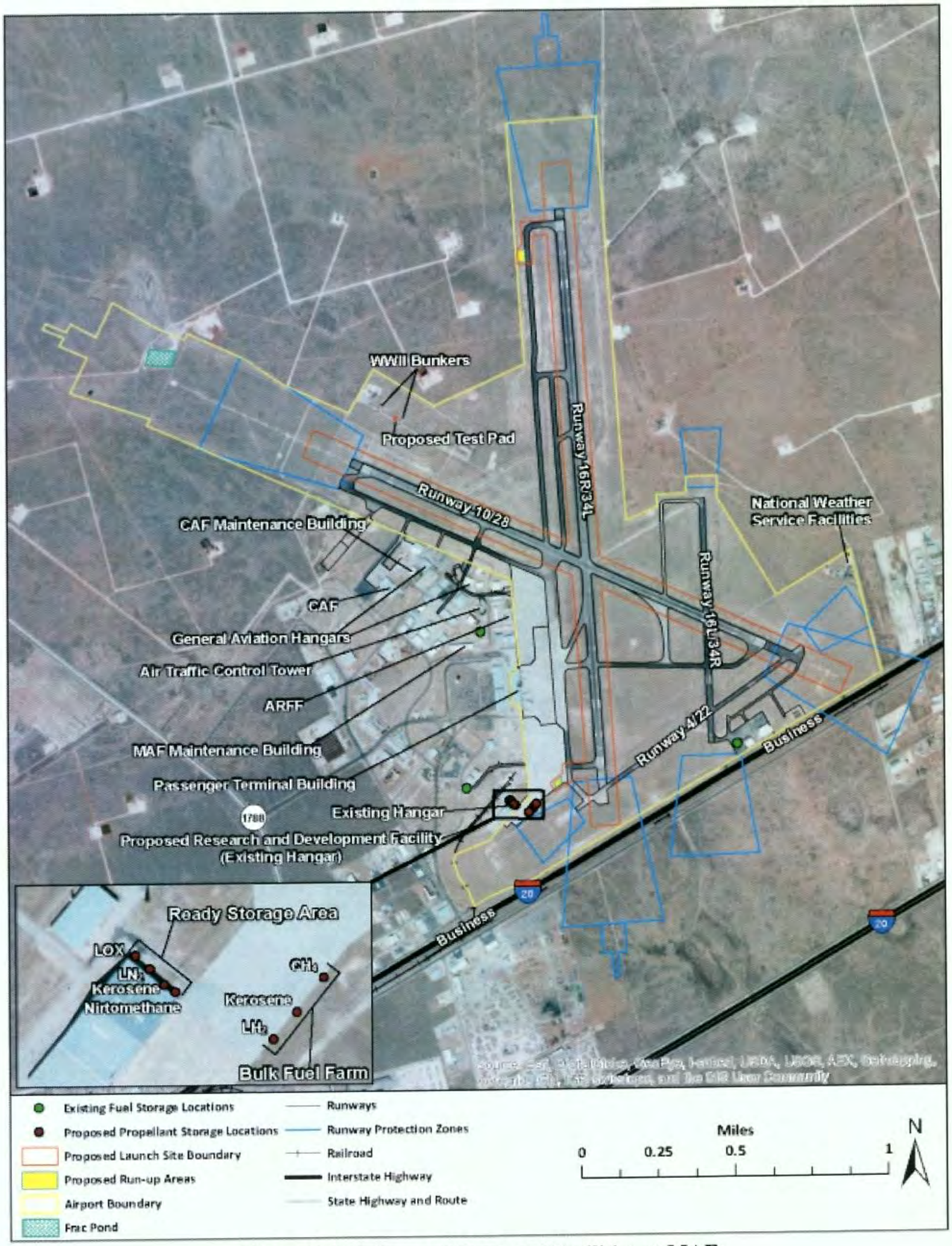

Figure 2. Existing and Proposed Facilities at MAF

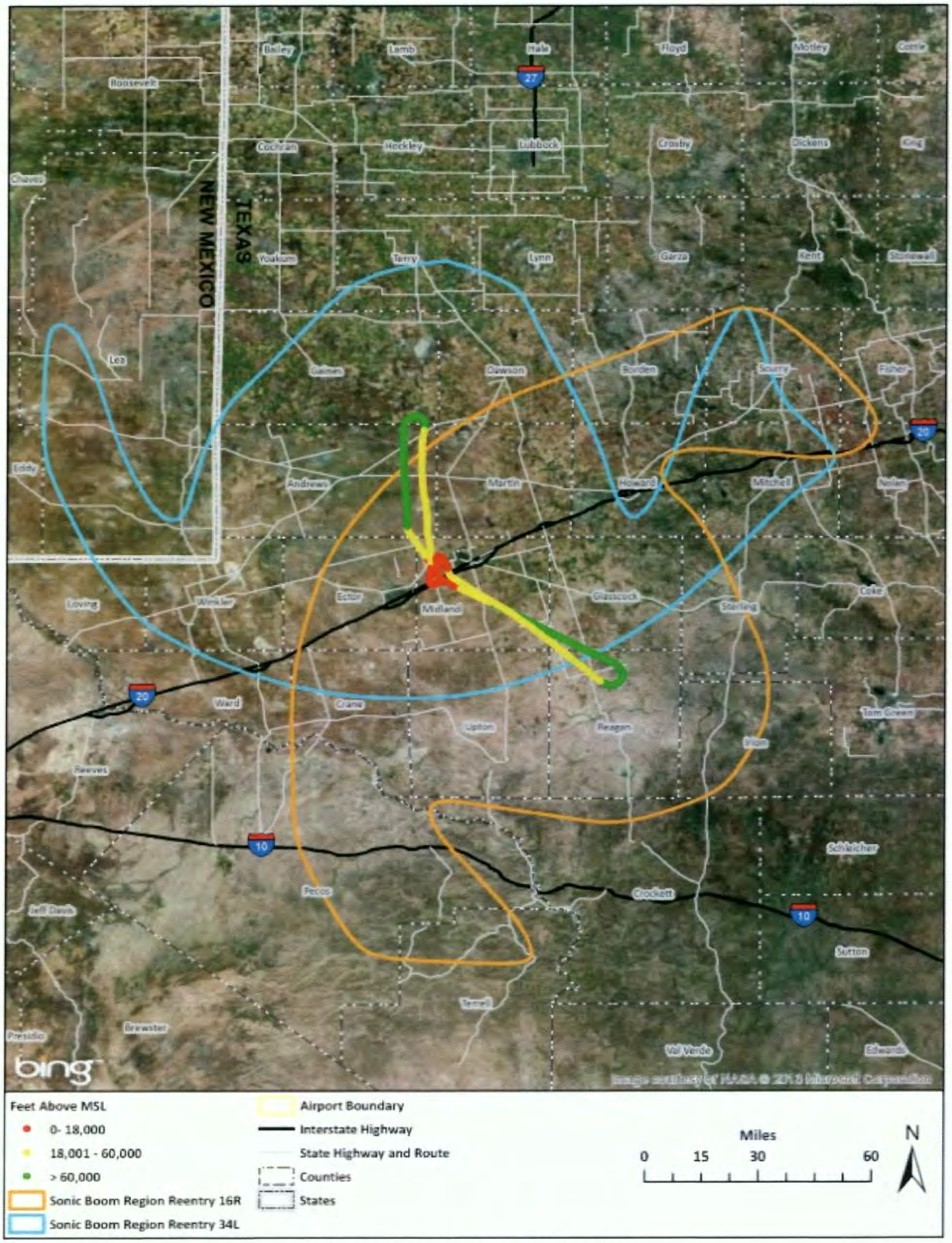

Figure 3. Sonic Boom Footprint

United States Department of the Interior

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JUL 14 2014

Mr. Daniel Murray
Space Transportation Development Division
U.S. Department of Transportation
Federal Aviation Administration
800 Independence Ave., SW
Washington, DC 20591

Consultation Number 02ETAU00-2014-I-0237

Dear Mr. Murray

Thank you for your letter dated May 12, 2014, requesting informal consultation for the proposed Operation of the Midland International Air (MAF) and Space Port, in Midland, Midland County, Texas. The Federal Aviation Administration (FAA) has submitted documentation to the U.S. Fish and Wildlife Service (Service) requesting concurrence that the proposed project "may affect, but is not likely to adversely affect" the lesser prairie-chicken *Tympanuchus pallidicinctus* (LEPC), a species listed as threatened pursuant to the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq*.).

Section 7 of the Act requires that all Federal agencies consult with the Service to ensure that the actions authorized, funded, or carried out by such agencies do not jeopardize the continued existence of any threatened or endangered species or adversely modify or destroy designated critical habitat of such species.

The proposed project involves the construction and operation of a commercial space launch site at the Midland International Airport (MAF). The site will be used by XCOR Aerospace, Inc. (XCOR) for the operation of the Lynx horizontal take-off and horizontal landing of reusable launch vehicle (RLV) and engine testing. The Lynx RLV is a transport vehicle that will carry humans and payloads on a half-hour suborbital flight to 330,000 feet. The operational noise generated by sonic booms during RLV reentry may be heard 100 miles from the MAF for duration of less than one second.

Based on the information provided in your informal request letter, review of Service files, correspondence with a Service biologist, and additional information received from the FAA and MAF via e-mail exchanges, we concur with the FAA's conclusion that the proposed project "may affect, but is not likely to adversely affect lesser prairie-chicken. Therefore, no further endangered species consultation will be required for this project unless: 1) the identified action is subsequently modified in a manner that causes an effect on listed species or designated Critical Habitat; 2) new information reveals the identified action may affect federally protected species or designated Critical Habitat in a manner or to an extent not previously considered; or 3) a new species is listed or Critical Habitat is designated under the Act that may be affected by the identified action.

Based on an e-mail dated June 7, 2014, to the Service from the FAA, MAF has agreed to monitor LEPC lekking areas once space port launches start. The Service will continue to work with the FAA and MAF to identify LEPC lekking sites and develop an appropriate survey protocol that will adequately evaluate sonic boom disturbance and the effects, if any, to the LEPC. We greatly appreciate the FAA and MAF working with the Service to conduct surveys on the LEPC.

We appreciate the opportunity to comment on this project. If you have any questions or comments, please contact Moni Belton at 281-286-8282, ext. 233.

Sincerely,

Adam Zerrenner
Field Supervisor

U.S. Department of Transportation
Federal Aviation Administration

Office of the Associate Administrator for Commercial Space Transportation

800 Independence Ave., SW
Washington, DC 20591

AUG 8 2013

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 the Midland International Air and Space Port, City of Midland, Midland County, 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 City of Midland's proposal to operate a commercial space launch site at the Midland International Airport (MAF) in Midland County, Texas and offer the site to XCOR Aerospace, Inc. (XCOR) for the operation of the Lynx horizontal take-off and horizontal landing reusable launch vehicle (RLV) and engine testing (see Figure 1). To operate a commercial space launch site, the City of Midland must obtain a commercial space launch site license from the FAA. Under the Proposed Action addressed in the EA, the FAA would: (1) issue a launch site operator license to the City of Midland for the operation of a commercial space launch site at MAF, (2) issue experimental permits and/or launch licenses to XCOR that would allow XCOR to conduct launches of the Lynx RLV from MAF, and (3) provide unconditional approval to modify the existing Airport Layout Plan to reflect the designation of a launch site boundary, installation of aboveground propellant storage tanks, and construction of a concrete pad for engine testing.

The Lynx RLV is a two-seat piloted, transport vehicle that would carry humans and payloads on a half-hour suborbital flight to 330,000 feet and then land on the take-off runway. Like an aircraft, Lynx is a horizontal take-off and horizontal landing vehicle, but instead of a jet or piston engine, Lynx uses a rocket propulsion system to depart a runway and makes a non-powered glide return and landing with the rocket off.

Proposed launch operations would begin in 2014 and continue through 2018. The frequency of launch operations would initially be one launch per week, eventually increasing to two launches per day, five days a week. Fifty-two annual launch operations are proposed in 2014. The total

number of annual launch operations would increase each year until 2018 when 520 annual launch operations are proposed.

Existing infrastructure, including a hangar and runways, would be used to support launch operations at MAF. Testing of rocket engines would be performed from a designated engine test pad within airport boundaries. Construction of this concrete engine test pad (18 feet by 60 feet) would occur between the existing World War II-era bunkers (see Figure 2). In addition, several new aboveground permanent storage tanks would be needed to store propellant that would support the Lynx RLV (see Figure 2).

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 includes MAF and the surrounding area in Midland County that would experience potential impacts (i.e., noise) from engine testing, launch vehicle take-offs and landings, and sonic booms. Noise generated from engine testing and Lynx RLV take-offs and landings is not expected to extend outside the general airport area, similar to the current aircraft that operate at MAF. Sonic booms would be generated during launch vehicle ascent and reentry. The sonic boom generated during ascent would not be heard on the ground due to the steep ascending flight path angle of the Lynx RLV. Sonic booms generated during reentry would be heard on the ground in areas around Midland County (see Figure 3), but are not expected to result in any adverse effects to biological resources. Figure 3 depicts two sonic boom contours, because the Lynx RLV has two proposed reentries onto Runway 16R/34L from either a northern or southern trajectory.

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's) most current threatened and endangered species list for Midland County (http://www.tpwd.state.tx.us/; last revised May 25, 2013 and accessed on July 1, 2013). A project-specific review request was submitted to the TPWD Texas Natural Diversity Database. The database contained no known records of any of the identified state-listed species potentially occurring within Midland County. If there is any further site-specific information which can be provided beyond the contents of the TPWD web-page or the Natural Diversity Database, we would appreciate your assistance in this matter.

Table 1. State-Listed Species for Midland County, Texas

Common Name (Scientific Name)	*Texas Status**
REPTILES	
Texas horned lizard (*Phrynosoma cornutum*)	T
BIRDS	
American peregrine falcon *(Falco peregrinus anatum)*	T
Bald eagle *(Haliaeetus leucocephalus)*	T
Whooping crane *(Grus americana)*	E

Notes: *E = Endangered, T = Threatened.

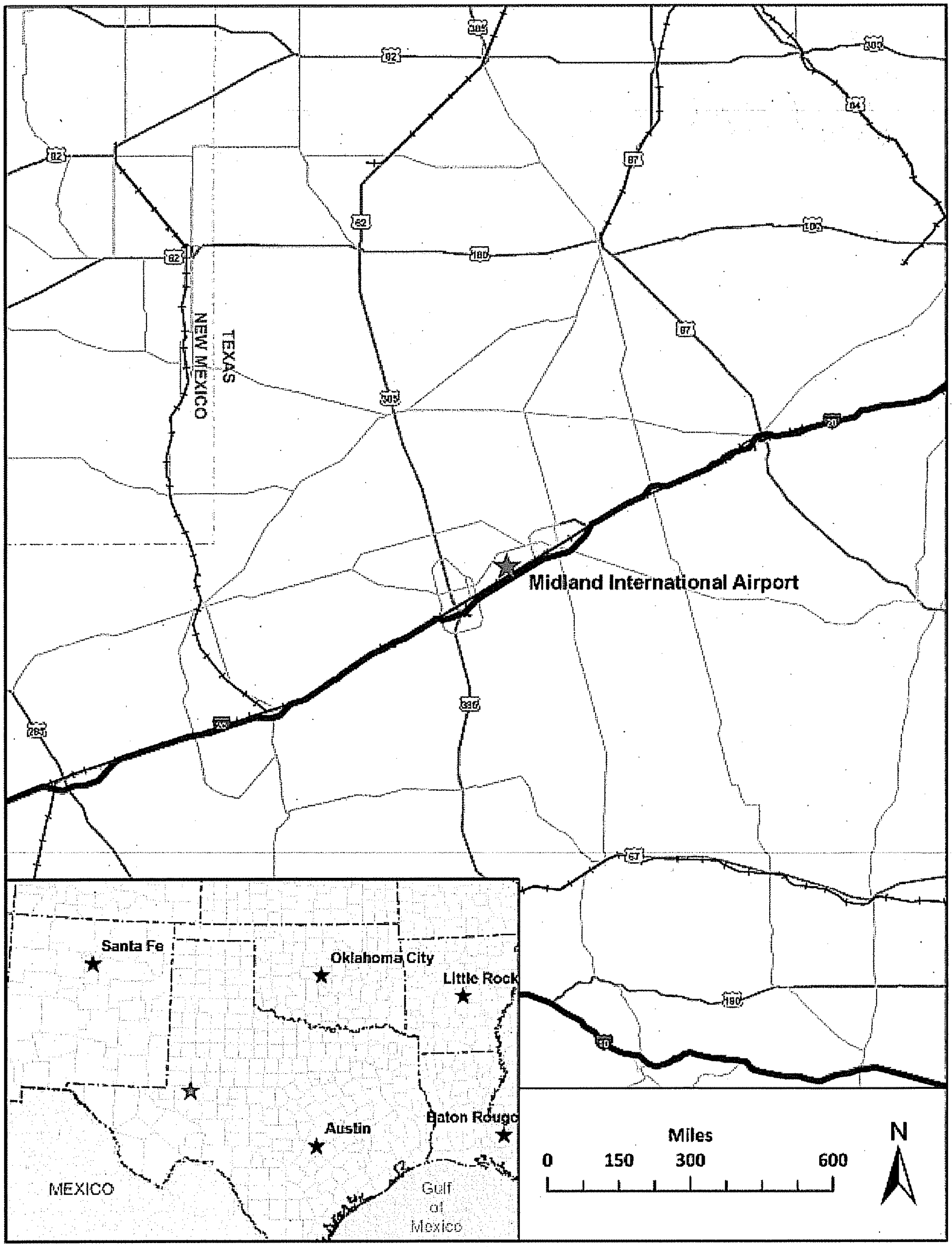
Please identify concerns, if any, you may have regarding this proposed project or list of species presented in Table 1. If you have any questions or need further information on the project, please

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 important project.

Sincerely,

Daniel Murray
Acting Manager, Space Transportation Development Division

Attachments: Figure 1. Regional Map of Proposed Launch Site
Figure 2. Existing and Proposed Facilities at MAF
Figure 3. Sonic Boom Footprint



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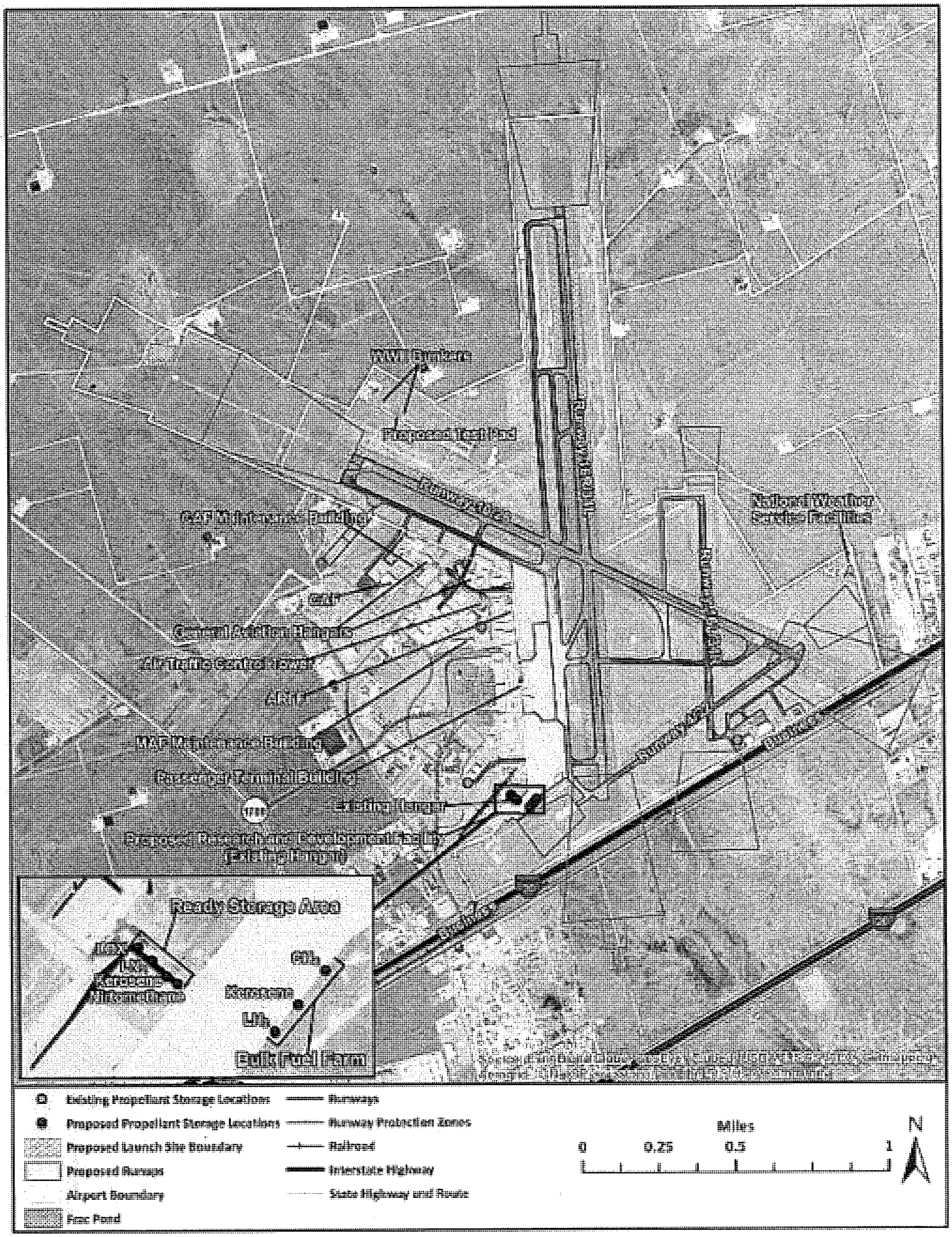

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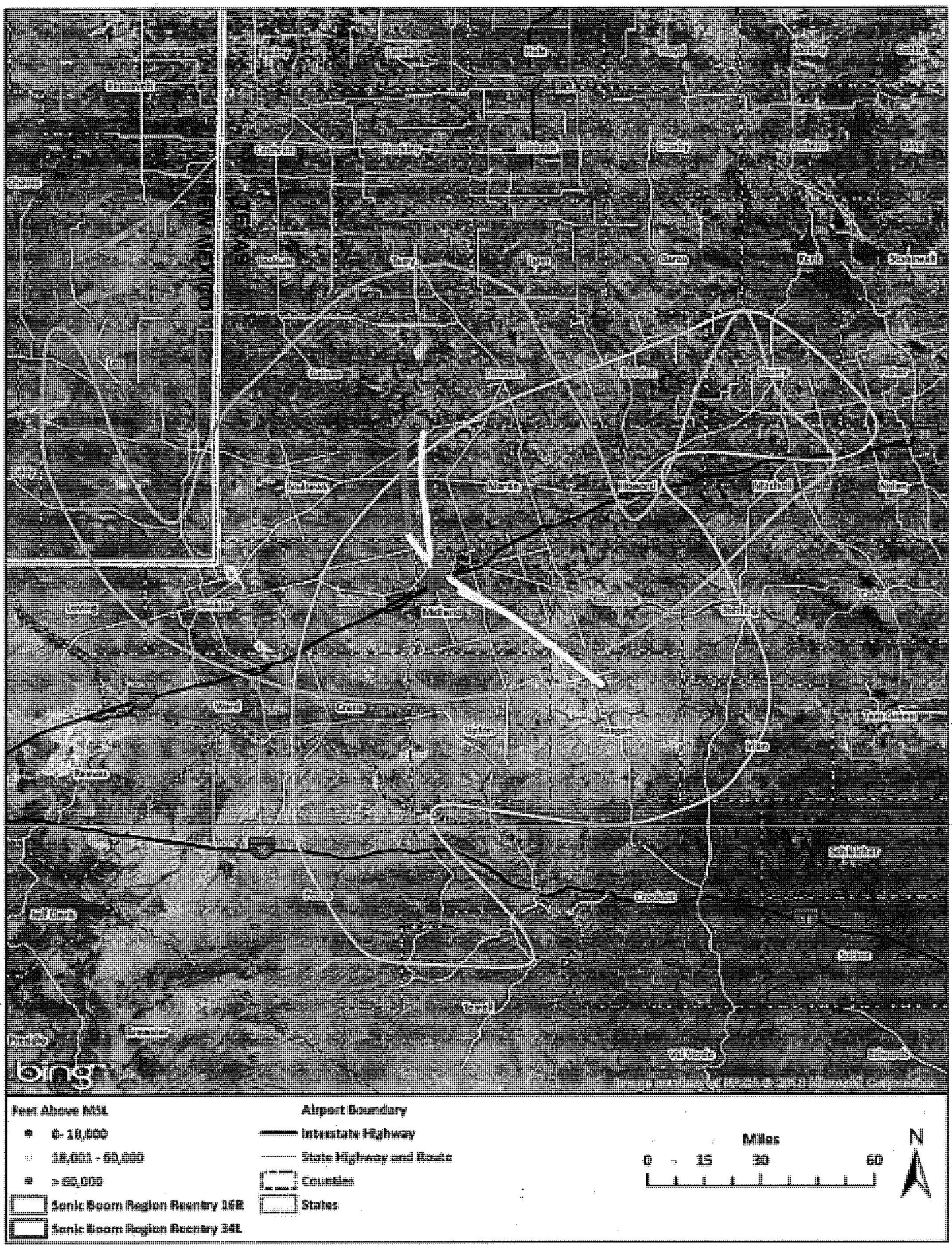

Figure 3. Sonic Boom Footprint

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October 28, 2013

Mr. Daniel A. Czelusniak
Federal Aviation Administration
Space Transportation Development Division
800 Independence Ave., SW
Washington DC 20591

RE: Preliminary Information Request, Environmental Assessment for the Midland International Air and Space Port, Midland County, Texas

Dear Mr. Czelusniak:

Texas Parks and Wildlife Department (TPWD) received the request for preliminary information to be considered during preparation of an Environmental Assessments (EA) for the above-referenced project. TPWD provides the following information and recommendations for consideration when preparing the EA.

Project Description

The Federal Aviation Administration (FAA) is preparing an EA to assess the potential environmental impacts of the City of Midland (City) proposal to operate a commercial space launch site at the Midland International Airport. The City would offer the site to XCOR Aerospace, Inc. for the operation of Lynx horizontal take-off and horizontal landing reusable launch vehicle (RLV) and engine testing. The Lynx RLV would use a rocket propulsion system to depart the runway, conduct a half-hour suborbital flight to 330,000 feet, and then make a non-powered glide return and land on the take-off runway with the rocket off. The frequency of launch operations would initially be one launch per week (52 launches per year) in 2014, eventually increasing to two launches per day, five days per week (520 launches per year) in 2018. Existing infrastructure would be used to support launch operations at the airport, and all construction associated with this project would be located within the existing airport boundaries. However, surrounding areas would experience potential noise impacts from sonic booms generated upon re-entry. Two sonic boom contours are expected to occur because the Lynx RLV has two proposed re-entries onto Runway 16R/34L from either a northern or southern trajectory. Under the proposed action the FAA would issue the City an operator license, experimental permits, and unconditional approval to modify the existing airport layout plan to accommodate the proposed project.

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> **Comment:** Because construction activities associated with this project would be located within previously-disturbed portions of the existing airport, adverse impacts to fish and wildlife resources from the footprint of the proposed project are expected to be minimal. The following comments and recommendations pertain to potential noise impacts within the surrounding area.
>
> **Recommendation:** A portion of one of the sonic boom contours is located in southeastern New Mexico. Please note that TPWD does not maintain detailed information about natural resources or managed areas outside of Texas. Therefore, this letter addresses only the portion of the proposed project located in Texas. TPWD recommends the City and the FAA contact the New Mexico Department of Game and Fish regarding potential impacts in New Mexico.

<u>Federal Laws</u>

Endangered Species Act

Federally-listed animal species and their habitat are protected from "take" on any property by the Endangered Species Act (ESA). Take of a federally-listed species can be allowed if it is "incidental" to an otherwise lawful activity and must be permitted in accordance with Section 7 or 10 of the ESA. Federally-listed plants are not protected from take except on lands under federal/state jurisdiction or for which a federal/state nexus (i.e., permits or funding) exists. Any take of a federally-listed species or its habitat without the required take permit (or allowance) from the U.S. Fish and Wildlife Service (USFWS) is a violation of the ESA.

Whooping Crane (*Grus americana*) – Federal and State Listed Endangered

The proposed project is not located within the approximately 200-mile-wide corridor in which 95 percent of sightings of the Whooping Crane have been documented during migration. However, this species has been documented migrating with flocks of Sandhill Cranes (*G. canadensis*) outside of that corridor and, as shown on the attached map, was reported north of the project area in Martin County in 1993.

> **Recommendation:** TPWD recommends the City monitor the project site and the immediate surrounding area (i.e., adjacent grain fields and playa

lakes) for Whooping Cranes during their northern migration (approximately late March through early June) and southern migration (approximately mid-September through late December). If Whooping Cranes are observed in or near the project area during migration, TPWD recommends the City avoid disturbing this species. If adverse impacts to the Whooping Crane are unavoidable, TPWD recommends the City contact Wade Harrell of the USFWS (Wade_Harrell@fws.gov) for further guidance.

Lesser Prairie-Chicken (*Tympanuchus pallidicinctus*) – Proposed Threatened

On December 11, 2012, the USFWS issued a proposed rule to list the Lesser Prairie-Chicken (LPC or LEPC) as threatened under the ESA. The USFWS will publish a final determination concerning the proposed listing by March 30, 2014.

The LPC Interstate Working Group, which includes a representative from TPWD, recently developed the LPC Range-Wide Conservation Plan (RWP) and submitted the RWP to the USFWS for consideration during deliberations on the proposed listing of this species. The RWP describes a locally-controlled and innovative approach for maintaining state authority to conserve the LPC and, if implemented in a timely manner, to influence a final decision to preclude the need to list the LPC under the ESA. Should the LPC be listed as threatened under the ESA, any RWP authorization granted by the USFWS would provide assurances to participants who voluntarily enroll and fully implement their conservation commitments under the RWP. This voluntary RWP is to be administered by the Western Association of Fish and Wildlife Agencies (WAFWA) and the Foundation for Western Fish and Wildlife. Participants will be required to document their commitment by signing a WAFWA Certificate of Participation (WCP) and entering into the accompanying WAFWA Conservation Agreement or signing onto other permitting mechanisms held by WAFWA through the RWP. Additional information including a link to the RWP can be found at http://www.wafwa.org/html/rangewide_lpc_conservation_plan.shtml.

The Covered Area of the RWP includes public and private property that currently provides or could potentially provide suitable habitat for the LPC within the current estimated occupied range of the LPC and 10 miles around that range (EOR+10). The Covered Area is represented in the Southern Great Plains Crucial Habitat Assessment Tool (CHAT, available at

Mr. Daniel A. Czelusniak
Page 4
October 28, 2013

http://www.kars.ku.edu/maps/sgpchat/). As shown on the attached map, the sonic boom footprints overlap areas mapped as CHAT Category 3 (Modeled Habitat) and Category 4 (Modeled Non-habitat) in Texas and New Mexico.

Measures to minimize disturbance of breeding, nesting, and brooding activity listed in the RWP include noise abatement for new equipment or infrastructure located within 1.25 miles of a lek recorded as active within the previous five years. The plan states that noise from new facilities should not exceed 75 decibels when measured at the permit holder's property line or any point greater than 30 feet from the facility boundary.

> **Recommendation:** Enrollment is recommended for sites that are within the EOR+10 or where impacts may occur. TPWD recommends the FAA and the City evaluate the project to determine whether noise impacts in areas mapped as CHAT Category 3 would exceed 75 decibels. If noise impacts that occur as a result of the proposed project may interfere with breeding, nesting, or brood-rearing activities of the LEPC, TPWD recommends the City enroll in the RWP and participate in the mitigation framework. TPWD recommends the City monitor the listing status of the LPC during planning and operation of this project.

Dune sagebrush lizard (*Sceloporus arenicolus*) - formerly Proposed for ESA Listing:

The Dune sagebrush lizard (DSL, also known as Sand dune lizard) is found in active and semi-stable shinnery oak sand dunes in New Mexico and a small area of West Texas. In December 2010, the DSL was proposed for federal listing under the ESA. Since that time, the USFWS has received new information regarding suitable and occupied habitat for this species, and voluntary conservation measures (discussed below) have been established. Based on these efforts, on June 13, 2012, the USFWS determined the DSL is no longer in danger of extinction. However, the USFWS will closely monitor the conservation measures to ensure they are being implemented and effectively address identified threats. The USFWS can then reevaluate whether the DSL requires protection under the ESA.

A voluntary conservation program has been created to protect suitable habitat for the DSL and minimize adverse impacts from development. In February 2012, the USFWS approved the *Texas Conservation Plan for the Dunes Sagebrush Lizard*, which was developed in consultation with the USFWS, the

Texas Comptroller of Public Accounts, TPWD, and several other agencies. This plan can be found at http://texasahead.org/texasfirst/resources/task_force/priority/pdf/DSL_Plan_021312.pdf. The goal of the Texas Conservation Plan is to facilitate continued economic activity in this region and to promote conservation of the DSL in compliance with the ESA for covered activities.

As shown on the attached map, the sonic boom footprints overlap the final permit area as mapped in the DSL Texas Conservation Plan. Based on the 1988 publication *Effects of Aircraft Noise and Sonic Booms on Domestic Animals and Wildlife: A Literature Synthesis*, some desert reptiles experience loss of hearing sensitivity when exposed to certain sounds. Because critical environmental sounds (movement of insect prey and predators such as owls) are low intensity, sensitive hearing acuity is essential to the survival of some reptiles.

> **Recommendation:** TPWD recommends the City review the above-referenced publication and any other available literature regarding the potential impacts of sonic booms to the DSL. If adverse impacts have the potential to occur, TPWD recommends the City review the Texas Conservation Plan and enroll in the Candidate Conservation Agreement with Assurances program. Please contact the Texas Conservation Plan Administrator, Jason Brooks, at (432) 813-5809 regarding enrollment in the plan and specific mitigation requirements.

State Parks

As shown on the attached map, Monahans Sandhills State Park and Lake Colorado City State Park are located in the sonic boom footprint of re-entries on Runway 16R, and Big Spring State Park is located within the sonic boom footprint of re-entries on Runway 34L.

> **Recommendation:** TPWD recommends the FAA include an analysis of potential impacts to state parks in the EA. The analysis should include potential impacts to wildlife that inhabit the parks, visitation/revenue, and historic structures such as the pavilion at Big Spring State Park constructed in the 1930s by the Civilian Conservation Corps. Respective park managers should be notified of any public hearings on these projects. Contact information for park managers is available at http://www.tpwd.state.tx.us/state-parks/.

I appreciate the opportunity to review and comment on this project. Please call me at (512) 389-4579 if we may be of further assistance.

Sincerely,

Julie C. Wicker
Wildlife Habitat Assessment Program
Wildlife Division

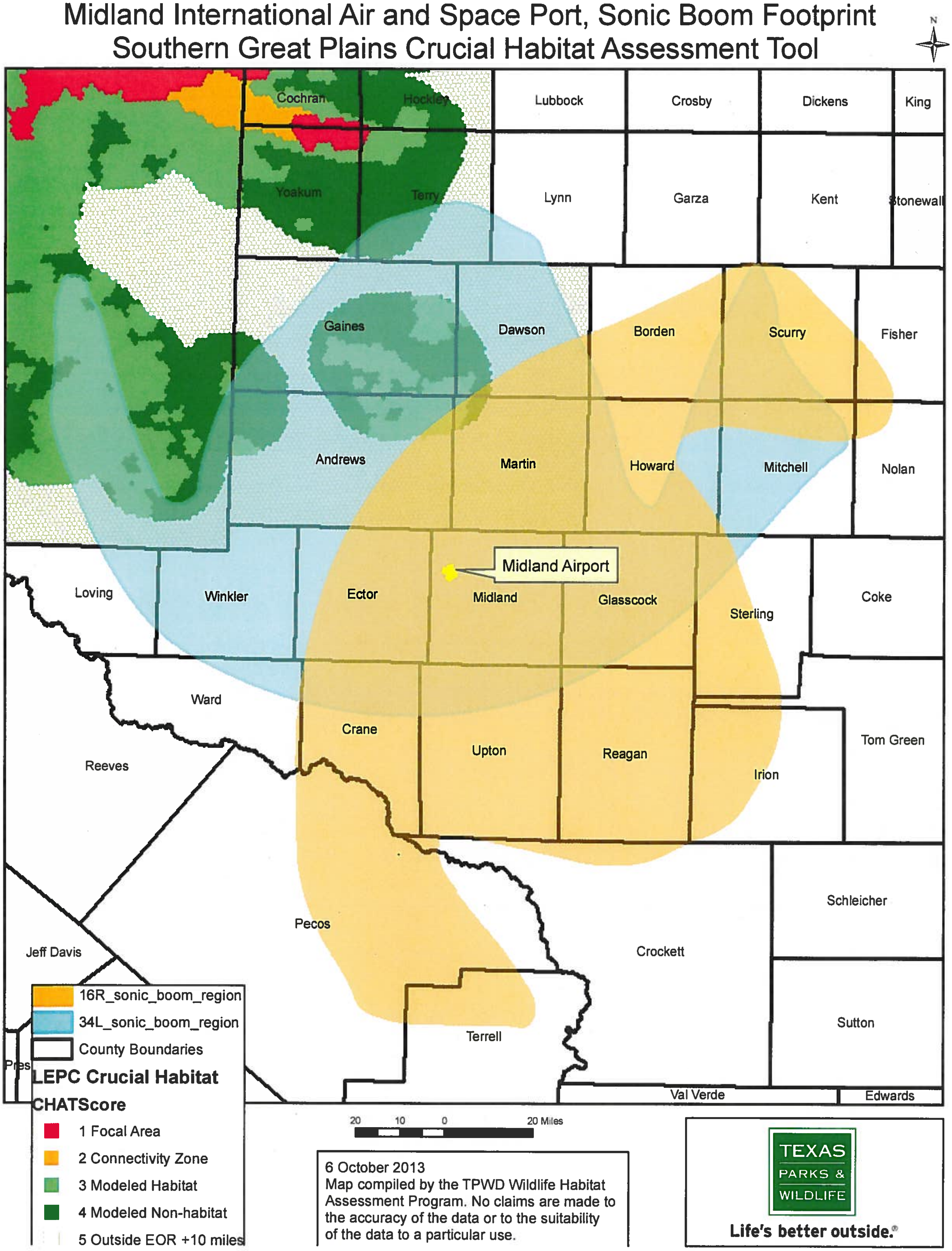
JCW: gg.ERCS-7397

Attachments (4)

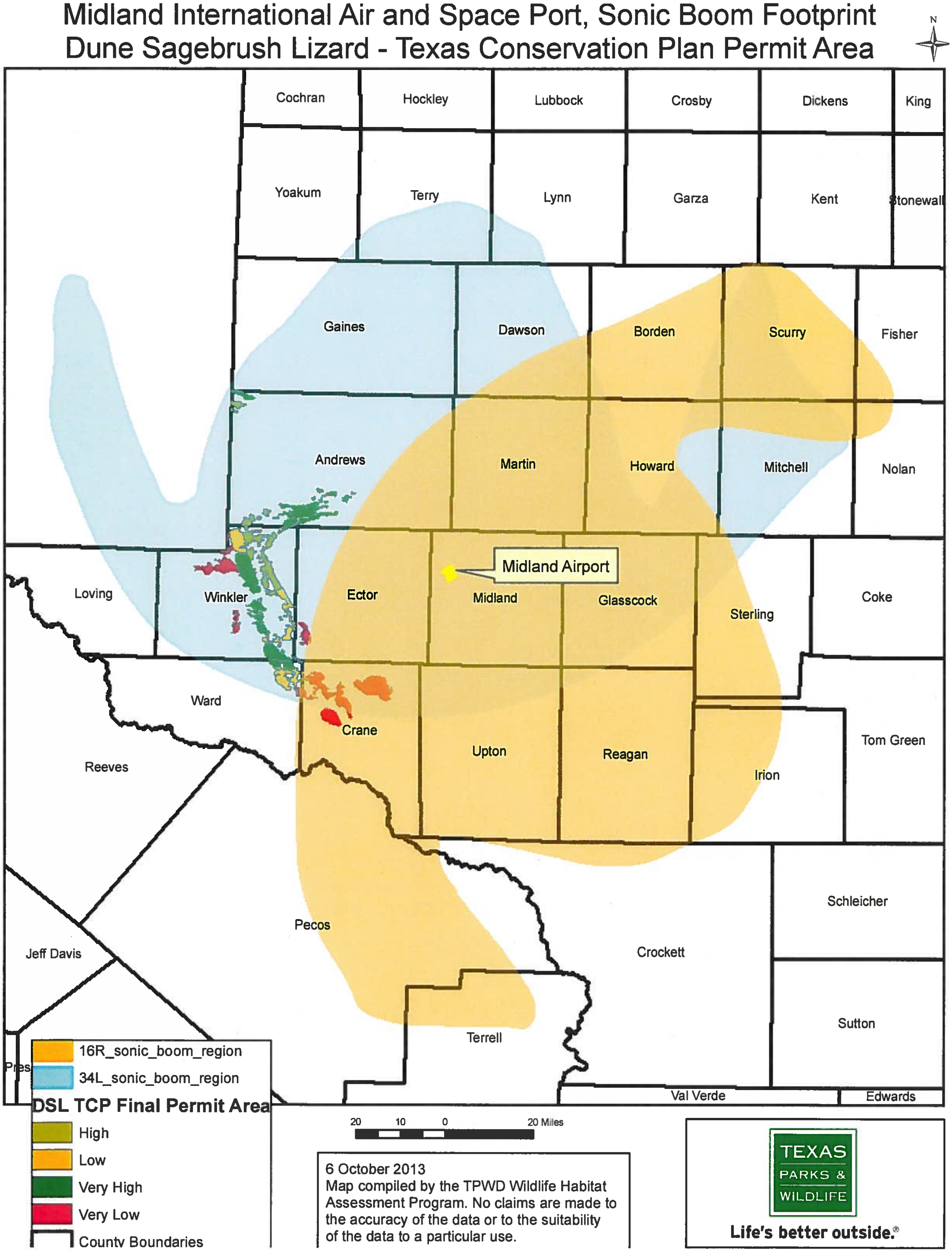
References:

Manci, K.M., D.N. Gladwin, R. Villella, and M.G. Cavendish. 1988. Effects of aircraft noise and sonic booms on domestic animals and wildlife: a literature synthesis. U.S. Fish and Wildl. Serv. National Ecology Research Center, Ft. Collins, CO. NERC-88/29. 88 pp.

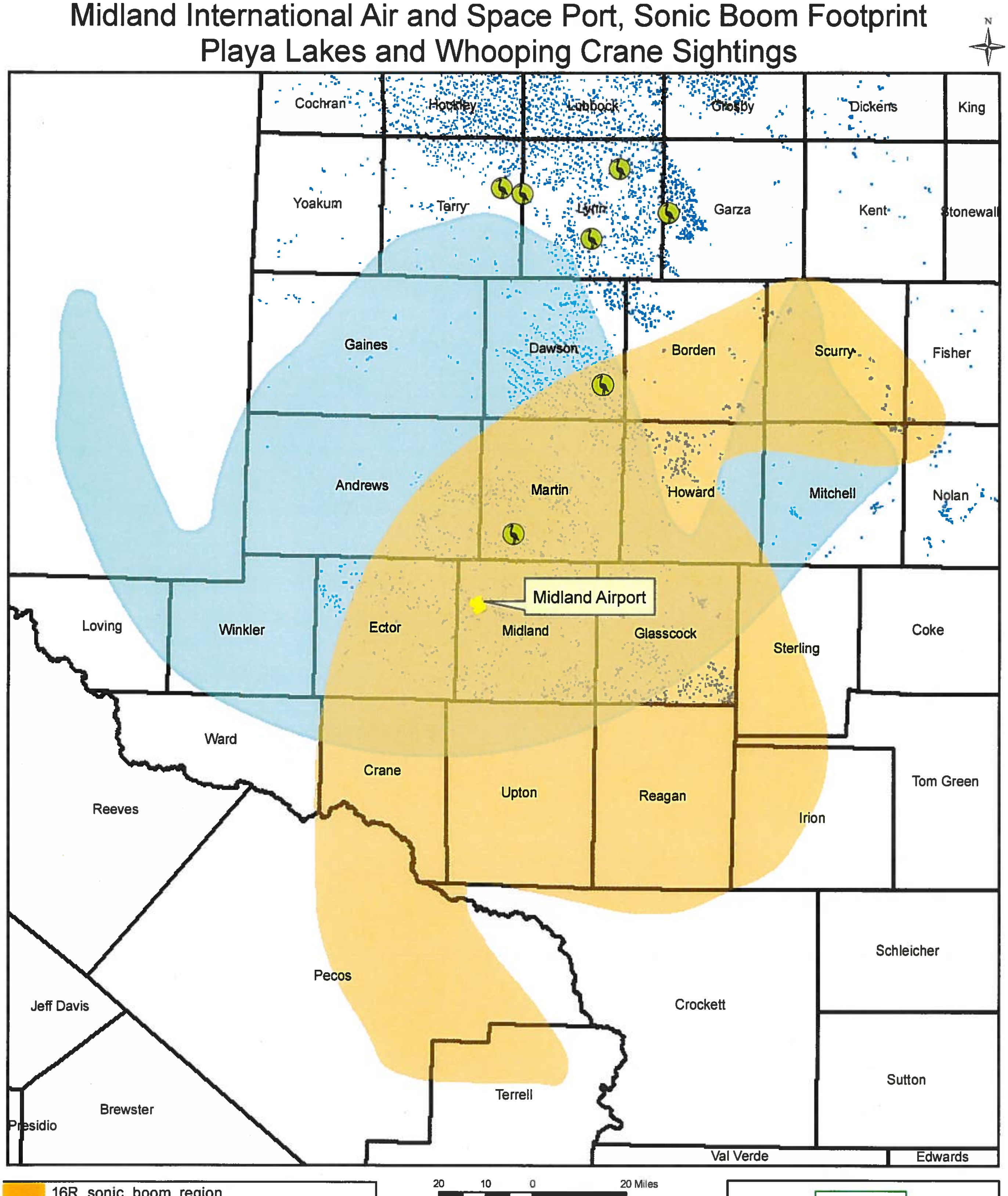
Midland International Air and Space Port, Sonic Boom Footprint
Southern Great Plains Crucial Habitat Assessment Tool



Midland International Air and Space Port, Sonic Boom Footprint
Dune Sagebrush Lizard - Texas Conservation Plan Permit Area



Midland International Air and Space Port, Sonic Boom Footprint
Playa Lakes and Whooping Crane Sightings



16R_sonic_boom_region
34L_sonic_boom_region
Playa Lakes Digital Database
County Boundaries
Whooping Crane_TX_sightings_thru_Fall_2007

6 October 2013
Map compiled by the TPWD Wildlife Habitat Assessment Program. No claims are made to the accuracy of the data or to the suitability of the data to a particular use.

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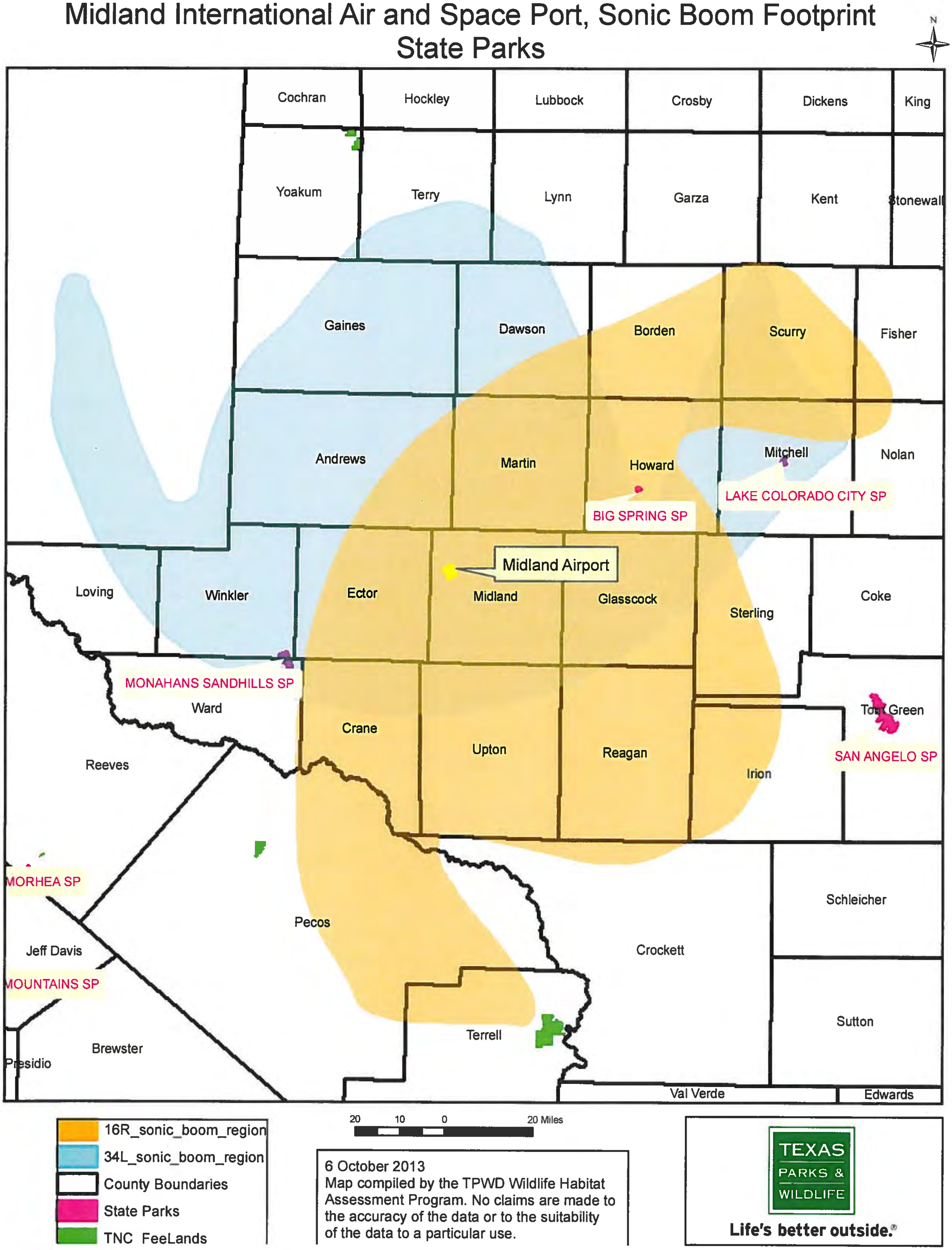
Midland International Air and Space Port, Sonic Boom Footprint
State Parks



Summary of TPWD letter (October 28, 2013) recommendations followed by FAA responses:

1) New Mexico: The New Mexico Department of Fish and Game should be contacted regarding the sonic boom.
Response: The Environmental Assessment (EA) impact analysis determined the project would not result in significant impacts to wildlife, including special-status species, and the United States Fish and Wildlife Service (USFWS) concurred with the FAA's determination that the sonic boom may affect but would not likely adversely affect species listed pursuant to the Endangered Species Act. Therefore, it can be assumed these findings would also apply to New Mexico species and coordination already undertaken should be sufficient.

2) Whooping Crane: The City of Midland should monitor the project site and the immediately surrounding area for Whooping Crane during migration (March - June and September - December)
Response: Midland International Airport (MAF) has a Wildlife Management Program and monitors the presence of birds. MAF personnel use a wildlife activity log to report wildlife observations or management activities carried out. USFWS concurred that the project may affect but would not likely adversely affect whooping crane, and no conservation measures where proposed by USFWS.

3) Lesser prairie-chicken: Evaluate project noise impacts within Southern Great Plains Crucial Habitat Assessment Tool (CHAT) Category 3 (modeled habitat) for the proposed threatened lesser prairie-chicken. If modeled habitat would exceed 75 dB, which could impact breeding, nesting, and brood-rearing, the City of Midland should enroll the project site in the Range-wide Conservation Plan and participate in mitigation. The City should monitor the listing status of the lesser prairie-chicken.
Response: Lesser prairie-chicken modeled habitat does occur within the sonic boom footprint and under the flight path of Runway 34L. However, the suggested 75 dB criteria is not applicable to the noise associated with the temporary and very short term (less than 1 second) sonic boom single event peak levels of 108 to 128 dB. The 75 dB criterion is used for construction noise and other ground-based activities and is not directly applicable to the sonic boom footprint. The peak overpressure level generated from the Lynx RLV would be similar in nature to a clap of thunder, which typically registers at about 120 dB in proximity to the ground strike. Previous studies have found no adverse effects to wildlife when exposed to sonic booms greater than 1 pound per square foot (psf), and given the number of proposed sonic boom events spread over a large area, the FAA concluded that the Proposed Action would not result in significant impacts to wildlife, including special-status species. Due to the very temporary nature of the sonic boom, the nature of the sound (i.e., similar to clap of thunder), and previous findings regarding effects of sonic booms on birds, sonic booms from the proposed action are not likely to impact the lesser prairie-chicken modeled habitat and would not need mitigation.

4) Dune sagebrush lizard: TPWD recommended that the City consult the 1988 publication *Effects of Aircraft Noise and Sonic Booms on Domestic Animals and Wildlife* about loss of hearing

sensitivity when exposed to certain sounds. If potential impact could occur, TPWD recommends the City enroll in the Candidate Conservation Agreement with Assurances program and contact the administrator.

Response: The cited publication refers to close, loud, and land-based noises, specifically from off-road vehicles. The very short duration of a sonic boom would not impair any species ability to detect prey or avoid predators. Lizards living near roads experience higher ambient noise levels that are almost continuous. The sonic boom sound would be a very brief noise event (less than 1 second) similar to clap of thunder. The source would also be well removed from the receptor, and most animals react to a noise that is associated with the visual or physical presence of the noise source not just the noise). A sonic boom would not cause any species, including the dune sagebrush lizard to lose hearing sensitivity.

5) State Parks: Analyze impacts to wildlife, visitation, and historic structures at three State Parks TWPD listed within sonic boom footprint. Notify park managers about the public hearing.
Response: The sonic boom would occur only up to 2 times per day, 5 days per week, and the maximum noise exposure of the proposed Lynx RLV operations is predicted to translate to an equivalent day-night average sound level of 63 dBA. The noise would not substantially limit the use or diminish the quality of refuges and parks in the City of Midland and surrounding area such that their value is impaired. Although the extent of the sonic boom footprint, defined as the area where a sonic boom may be heard, is approximately 19,000 square miles, the sonic boom overpressure is predicted to be at levels of less than 1 psf (or approximately 128 dB, peak sound pressure level), similar to a clap of thunder. Therefore, the potential for damage or significant impact is negligible.

Appendix D
Airfields and Airspace

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D.1 Airfields and Airspace

The FAA ensures the National Airspace System (NAS) is safe, efficient, and environmentally responsible and meets the needs of the traveling public. Through the Airport Safety Program, the FAA addresses general aviation airport safety, runway safety, airport certification under 14 CFR Part 139, and safety management systems. Additionally, the FAA defines airports by service certifications found in 14 CFR Part 139; MAF is defined as a Class I Airport and is certified to serve scheduled operations of large air carrier aircraft, unscheduled passenger operations of large air carrier aircraft, and/or scheduled operations of small air carrier aircraft. MAF averages 199 aircraft operations per day (AirNav 2013).

The FAA designs and manages the airspace above MAF pursuant to regulations at 14 CFR Part 71, which defines the airspace classes and designations and the classification of air traffic service and jet routes. Airspace management is defined as the direction, control, and handling of flight operations in the "navigable airspace" that overlies the geopolitical borders of the U.S. and its territories. Navigable airspace is defined as airspace above the minimum altitudes of flight prescribed by regulations under 49 U.S.C. 40102, and includes airspace needed to ensure safety in the take-off and landing of aircraft. Under 49 U.S.C. 40101 et seq., the U.S. Government has exclusive sovereignty over the nation's airspace. The FAA is responsible for developing plans and policies for the use of navigable airspace. The FAA assigns use of airspace necessary to ensure its efficient use, as well as the safety of aircraft (49 U.S.C. 40103(b); FAA Order JO 7400.8U).

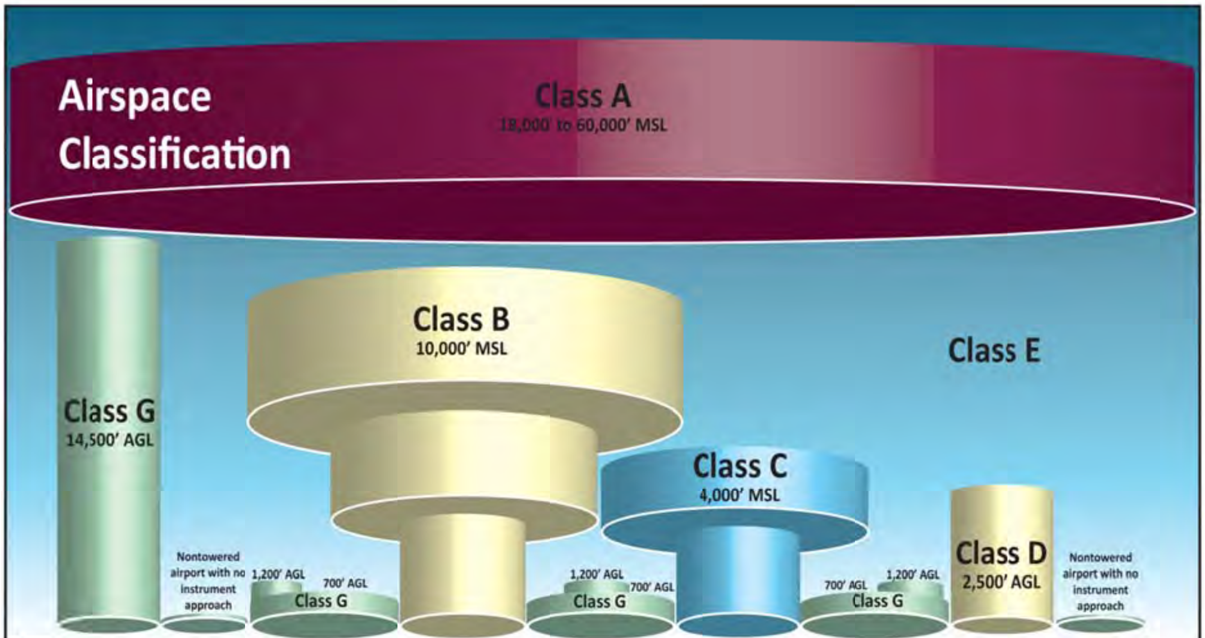
There are two categories of airspace or airspace areas: regulatory and non-regulatory. Within these two categories, there are four types of airspace: Controlled, Special Use, Other, and Uncontrolled airspace. *Controlled airspace* is airspace of defined dimensions within which air traffic control service is provided to Instrument Flight Rule flights and to Visual Flight Rule flights in accordance with the airspace classification (FAA 2008). Controlled airspace is categorized into five separate classes: Classes A through E (Exhibit D.1-1). These classes identify airspace that is controlled, airspace supporting airport operations, and designated airways affording *en route* transit from place-to-place. The classes also dictate pilot qualification requirements, rules of flight that must be followed, and the type of equipment necessary to operate within that airspace. *Uncontrolled airspace* is designated Class G airspace.

Special Use Airspace (SUA) is airspace of defined dimensions wherein activities must be confined because of their nature, or wherein limitations may be imposed upon aircraft operations that are not a part of those activities. The types of SUA are Prohibited Areas, Restricted Areas, Military Operations Areas (MOAs), Warning Areas, Alert Areas, and Controlled Firing Areas.

The airspace surrounding MAF is Class C controlled airspace. Class C airspace is used around airports with a moderate traffic level and protects the approach and departure paths from aircraft not under air traffic control. All aircraft inside Class C airspace are subject to air traffic control. Traffic operating under visual flight rules must be in communication with a controller before entering the airspace.

D.1.1 Airfields

The MAF property contains four runways and associated taxiways. The runways are identified as 4/22, 10/28, 16L/34R, and 16R/34L and span 4,605 ft, 8,302 ft, 4,247 ft, and 9,501 ft, respectively (refer to Exhibit 2-1).



Notes:
1. Class A - Spanning from 18,000 to 60,000 feet MSL, Class A airspace mostly supports long-distance commercial and military aircraft. All flight operations must be under Air Traffic Control (ATC) radar coverage and have a clearance prior to entry.
2. Class B - Airspace surrounding the busiest airports in the U.S. (e.g., Phoenix, Los Angeles, Atlanta, etc.) normally beginning at the surface in the immediate airport area and extending higher as the distance from the airport increases, up to an upper limit of 10,000 feet MSL
3. Class C - Similar to Class B, but around moderately busy airports (e.g., Chicago Midway, Boise, Jacksonville, etc.) with a vertical limit of 4,000 feet above the airport.
4. Class D- This class extends from the surface to 2,500 feet AGL around airports with a control tower and not otherwise within Class B or Class C airspace.
5. Class E - Usually Class E airspace begins at 1,200 AGL and extends up to but not including 18,000 feet MSL. No ATC clearance or radio communication is required for flights under Visual Flight Rules.
6. Class F - There is no Class F airspace in the U.S.
7. Class G - Includes all airspace not otherwise classified below 60,000 feet MSL. Class G airspace is typically the airspace very near the ground; 700 or 1,200 feet AGL near airports adjacent to Class B, C or D airspace, and below 14,500 beneath Class E airspace away from airports.
Source: Derived from FAA 2008

Exhibit D.1-1 Controlled Airspace Categories

D.1.2 Airspace

The ROI for airspace encompasses the airspace above the immediate vicinity of MAF, the airspace surrounding the north and south vehicle trajectories (Exhibit D.1-1), and the airspace associated with any FAA approved hazard areas. The counties within the ROI include Midland, Ector, Andrews, Gaines, Glasscock, and Reagan.

The Class C airspace above the MAF airfield is controlled by Midland Tower (i.e., “Midland Approach”), and by the Fort Worth ARTCC outside the Class C airspace. The Fort Worth ARTCC encompasses the northern portion of Texas, a small sliver of southeastern New Mexico, southern Oklahoma, the

southwestern portion of Arkansas, and northwestern Louisiana. The north trajectory (Exhibit D.1-2) would be from runway 34L and would be over portions of Ector and Andrews counties. The south trajectory (Exhibit D.1-2) would include take-off from runway 16R into portions of Glasscock and Reagan counties and would be covered by the Fort Worth ARTCC. For each mission, MAF would establish hazard areas to ensure public safety according to regulations in 14 CFR Part 431 or 437. 14 CFR Part 420 regulations require the launch operator to establish agreements with air traffic control facilities with jurisdiction over the airspace to be used. As part of the licensing process, the FAA would require MAF to establish agreements with the Fort Worth ARTCC and Midland Approach to coordinate the use of the required airspace.

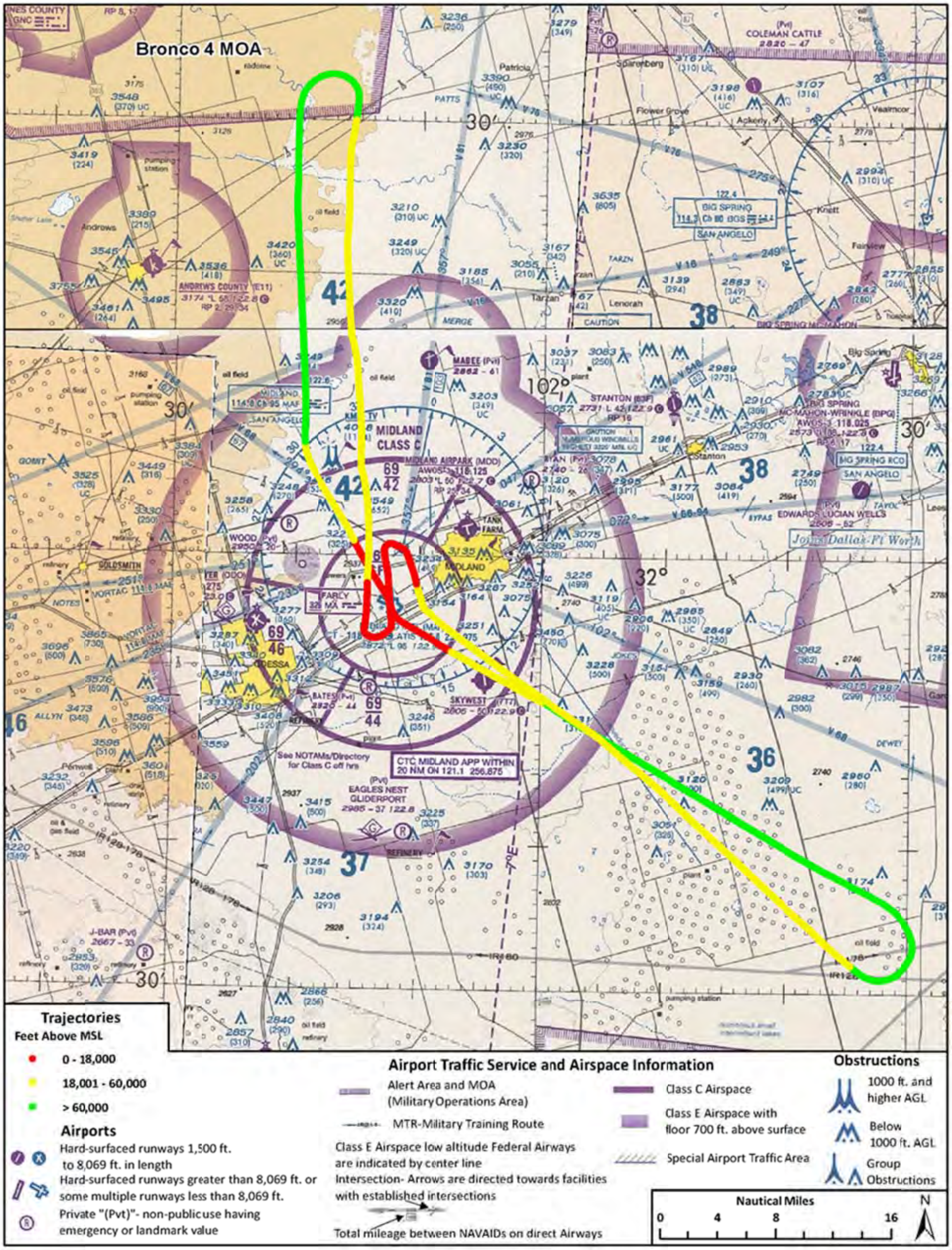


Exhibit D.1-2 Airspace in the Proposed Trajectories for Lynx RLV

D.2 Airfields and Airspace

D.2.1 Proposed Action

Under the Proposed Action, the FAA would issue a launch site operator license to the City of Midland for the operation of a commercial space launch site at MAF. In addition, Midland would offer the site to XCOR for the operation of the Lynx RLV and other associated activities. The FAA proposes to issue experimental permits and/or launch licenses to XCOR to allow XCOR to conduct launches of the Lynx RLV from MAF. Airspace use would be coordinated by the FAA. MAF would be required to obtain Letters of Agreement from the Fort Worth ARTCC and Midland Approach to operate the Lynx RLV in the proposed airspace before any launches could commence.

Under the Proposed Action, advance notice via Notice to Airmen (NOTAMs) would assist general aviation pilots in scheduling around any temporary disruption of flight activity at MAF. The numerous runways at MAF should also limit interference in the daily flight timetable. Additionally, launches would be infrequent (less than 1 percent of the total operations occurring at MAF), of short duration, and scheduled well in advance to minimize interruption of airport operations.

Under the Proposed Action, the FAA would not alter the dimensions (shape and altitude) of the airspace. However, temporary closures of existing airspace may be necessary to ensure public safety during the proposed operations. The Letters of Agreement would include notification requirements, including requirements for the issuance of NOTAMs, which provide notice of unanticipated or temporary changes to components of, or hazards in, the NAS (FAA Order JO 7930.2M, *Air Traffic Organization Policy*). For the above reasons, environmental impacts from the temporary closure of airspace and the issuance of NOTAMs under the proposed action are not anticipated. Moreover, in accordance with FAA Order 1050.1E, Chapter 3 (Advisory and Emergency Actions and Categorical Exclusions), the issuance of NOTAMs is categorically excluded from NEPA review absent extraordinary circumstances.

Due to the accelerated rate of climb associated with the Lynx RLV, the vehicle would only be in Class C airspace for a minimal amount of time during each flight (see Section 2.1.1 of the EA for further information on a typical flight profile). The Lynx RLV would be above the 4,000 ft MSL designated Class C airspace within a 5-mile radius of the airport. In the case of the northern flight trajectory, the altitude of the Lynx RLV would be in the range of 61,000 ft MSL to 72,000 ft MSL while over the Bronco 4 MOA (see Exhibit D.1-2), which extends from 10,000 ft MSL up to but not including 18,000 ft MSL. Therefore, the operations of the Lynx RLV would not require any changes to the current lateral or vertical configuration of the MOA. Any use of the airspace associated with the MOA for the Lynx RLV operations would be coordinated through Letter of Agreement with the using agency, the U.S. Air Force 27th Special Operations Wing of Cannon Air Force Base.

Safety of air traffic in the region would be ensured through close coordination of scheduling with the Fort Worth ARTCC and Midland Approach and the use of temporary airspace closures, as necessary. Any effect on the performance and capability of the NAS from these closures would be addressed through

airspace management strategies that would be developed when XCOR obtains the Letter of Agreement with the Fort Worth ARTCC and Midland Approach that is required for its license and/or permit.

D.2.2 No Action Alternative

Under the No Action Alternative, the FAA would not issue a launch site operator license to the City of Midland and thus would also not issue experimental permits and/or launch licenses to XCOR for operation of the Lynx RLV at MAF. Also, there would be no need to update the ALP for MAF, and thus there would be no unconditional approval of a revised ALP. Therefore, the level of airspace use would not change and there would be no impacts to airspace.

References

AirNav. 2013. http://www.airnav.com/airport/KMAF. Accessed April 11, 2013.

FAA. 2008. Pilot's Handbook of Aeronautical Knowledge. FAA-H-8083-25A.

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