TO: All Interested Parties

FROM: Jessica Schultz, Deputy Director, National Weather Service (NWS) Radar Operations Center

SUBJECT: Lowering the Minimum Scan Angle of the KCRP Weather Surveillance Radar - Model 1988 Doppler (WSR-88D) serving the Corpus Christi, TX, area

DATE: February 23, 2022

In accordance with provisions of the National Environmental Policy Act of 1969, the National Weather Service (NWS) prepared a Draft Environmental Assessment (EA) analyzing the potential environmental effects of lowering the minimum scan angle of the KCRP WSR-88D serving the Corpus Christi, TX, area. The Draft Environmental Assessment is available for public review and comment. The Draft EA may be obtained at:

https://www.roc.noaa.gov/WSR88D/SafetyandEnv/EAReports.aspx

The KCRP WSR-88D is an existing radar facility located at Corpus Christi International Airport in Corpus Christi, Nueces County, TX. The radar is in located about 7.2 miles west-northwest of downtown Corpus Christi. The KCRP WSR-88D, commissioned in September 1996, is one of 159 WSR-88Ds in the nationwide network. The KCRP WSR-88D antenna transmits a narrow focused main beam with a width of 1 degree. In normal operation, the radar antenna rotates horizontally to cover all directions (i.e., azimuths). The radar antenna also varies the scan angle at which it points with respect to the horizon. Currently, the WSR-88D operates at a minimum of scan angle of +0.5 degrees (deg) above the horizon. NWS proposes to reduce the minimum scan angle of the KCRP WSR-88D from the current minimum of +0.5 deg to +0.3 deg (i.e., 0.2 deg lower than existing) to provide enhanced coverage of the lower portions of the atmosphere. No construction activities or physical modification of the KCRP WSR-88D would be required to implement the proposed action; the only change would be to the radar's operating software.

NWS will accept written comments on the Draft EA until April 1, 2022. Please submit comments via either email or regular mail to:

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Comments sent by regular mail must be postmarked April 1, 2022. After the end of the Draft EA review period, NWS will prepare a Final EA containing responses to all comments. NWS will not make any decision on implementing the proposed action until completion of the environmental review. Thank you for your interest in this important project.

SENSOR ENVIRONMENTAL LLC
www.sensorenvirollc.com

Draft Environmental Assessment Report • February 2022

ENVIRONMENTAL ASSESSMENT (EA)

LOWERING THE MINIMUM SCAN ANGLE OF THE WEATHER SURVEILLANCE RADAR - MODEL 1988, DOPPLER (WSR-88D) SERVING THE CORPUS CHRISTI, TEXAS, AREA

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Executive Summary

The National Weather Service (NWS) owns and operates the existing Weather Surveillance Radar, Model 1988 Doppler (WSR-88D) serving the Corpus Christi, TX, area. The International Civil Aviation Organization designator for the radar is KCRP and the radar is located at Corpus Christi International Airport in the city of Corpus Christi, Nueces County, Texas, about 7.2 miles west-northwest of downtown Corpus Christi. The KCRP WSR-88D was commissioned in September 1996 and has been in continuous operation since 1996. It is one of 159 WSR-88Ds in the nationwide network.

The KCRP WSR-88D is an S-band Doppler, dual polarized weather radar, which NWS uses to collect meteorological data to support weather forecasts and severe weather warnings for southern and central Texas. The KCRP WSR-88D antenna transmits a narrow focused main beam with a width of 1 degree. In normal operation, the WSR-88D antenna rotates horizontally to cover all directions (i.e., azimuths). The radar antenna also varies the scan angle at which it points with respect to the horizon. The scan angle is measured along the axis of the main beam and can be changed in 0.1 deg increments. Currently, the KCRP WSR-88D operates at a minimum of scan angle of +0.5 degrees (deg) above the horizon. NWS proposes to reduce the minimum scan angle of the KCRP WSR-88D from the current minimum of +0.5 deg to +0.3 deg (the proposed action). Lowering the minimum scan angle would provide enhanced coverage of the lower portions of the atmosphere. No construction activities or physical modification of the KCRP WSR-88D would be required to implement the proposed action; the only change would be to the radar's operating software.

In April 1993, NWS prepared a National Environmental Policy Act (NEPA) document titled, *Supplemental Environmental Assessment (SEA) of the Effects of Electromagnetic Radiation from the WSR-88D Radar*. That document analyzed operating the WSR-88D at a minimum scan angle of +0.5 degree (deg). This Draft EA builds on that prior study by examining the possible effects of operating the KCRP WSR-88D at a minimum scan angle of +0.3 (i.e., 0.3 deg lower than the minimum scan angle examined in the April 1993 SEA). Operating this radar at a lower scan angle would increase the area of radar coverage, providing additional data on atmospheric conditions to NWS forecasters and other data users. The area covered at 2,000 ft above site level (ASL) would increase by 52.0%. The floor of radar coverage over the City of Laredo would be reduced from 6,900 feet above ground level to 5,800 feet. This radar coverage improvement would be very beneficial to NWS forecasters and others parties (e.g., public safety agencies and emergency responders) using the radar information.

The lower minimum scan angle would not result in the KCRP WSR-88D main beam impinging on the ground within 14,900 ft (2.8 miles) of the WSR-88D. The proposed action would slightly increase radiofrequency (RF) exposure levels in the vicinity of the KCRP WSR-88D. As shown in Table S-1, during normal operation of the radar with rotating antenna, RF exposure would comply with the safety standards developed by the Institute of Electrical and Electronic Engineers (IEEE) and the adopted by the American National Standards Institute (ANSI) for the

general public and workers. Federal Communications Commission (FCC) and Occupational safety and Health Administration (OSHA) safety levels would also be met at all locations.

Table S-1: RF Power Density within Main Beam of KCRP WSR-88D at Minimum Scan Angle of +0.3 deg Compared to ANSI/IEEE Safety Standards

Location / Distance from Radar	Time-Averaged Power Density (mW/cm^2)	ANSI/IEEE General Public RF Safety Standard		ANSI/IEEE Occupational RF Safety Standard	
		Safety Standard (mW/cm^2)	Factor Below Std	Safety Standard (mW/cm^2)	Factor Below Std
Surface of Radome	0.603	1.0	1.66	5.0	7.9
Closest Structure -- Airport Traffic Control Tower (8,900 ft)	0.00010	1.0	10,000	5.0	50,000
Closest Illuminated Ground (14,900 ft)	0.000037	1.0	27,000	5.0	135,000

During infrequent stationary antenna operation, RF exposure levels within the WSR-88D main beam would exceed ANSI/IEEE and FCC safety levels for exposure of the general public within 1,740 ft of the WSR-88D antenna. FCC and ANSI/IEEE occupational safety levels would be exceeded within 777 ft. The KCRP WSR-88D operating at +0.3 deg would not impinge on the ground surface or any occupied structures within those distance and risks to human health would not result.

Because the KCRP WSR-88D operates in a frequency band dedicated to government radiolocation services and the main beam would not impinge on the ground surface in the radar vicinity, the proposed action would not cause radio interference with television, radio, cellular telephone, personal communications devices (PCDs), electro-explosive devices, fuel handling, or active implantable medical devices.

WSR-88D RF emissions have the potential to cause electromagnetic interference (EMI) with sensitive equipment used at astronomical observatories. No astronomical observatories are located within 150 miles of the KCRP WSR-88D. A minimum scan angle of +0.3 deg would not result in the WSR-88D main beam impinging on any observatories.

Lowering the minimum scan angle of the KCRP WSR-88D would not require physical changes to the radar, vegetation removal, or ground disturbance. The proposed action would not result in significant effects in the following subject areas:

- Land Use and Coastal Zone Management
- Geology, Soils, and Seismic Hazards
- Drainage and Water Quality

- Transportation
- Air Quality
- Flood Hazards
- Wetlands
- Biological Resources / Protected Species
- Cultural and Historic Resources
- Environmental Justice Socioeconomic Impacts
- Farmlands
- Energy Consumption
- Visual Quality/ Light Emissions
- Solid and Hazardous Waste
- Wild and Scenic Rivers

NWS evaluated the benefits and potential impacts of lowering the minimum center of beam scan angle of the KCRP WSR-88D to each angle between +0.4 and +0.3 deg in 0.1 degree increments. Operating the KCRP WSR-88D at alternative minimum scan angle of +0.4 deg would result in similar environmental effects as the proposed action. Like the proposed action, significant environmental effects would not result. A minimum scan angle of +0.4 deg would increase the radar's coverage area, but by less than the proposed action (i.e., minimum scan angle of +0.3) deg. Minimum scan angles lower than +0.3 deg would not increase coverage area and would result in increased ground clutter returns. Thus, a minimum scan angle of +0.3 deg is the most beneficial among those considered by the NWS.

The no action alternative would result in continued operation of the KCRP WSR-88D at the existing minimum scan angle of +0.5 deg. The improvements in radar coverage resulting from the proposed project would not be achieved. The no-action alternative would not change RF exposure levels from existing. Under both the proposed action and the no action alternative, RF exposure during normal WSR-88D operations would conform to safety standards established by ANSI/IEEE, OSHA, and FCC. Similar to the proposed action, the no-action alternative would not cause significant effects to the natural or man-made environment.

The NWS will distribute the Draft EA to interested members of the public and government agencies for review and comment. Comments on the Draft EA will be accepted by NWS during a minimum 30-day comment period which will end on April 1, 2022. The NWS will provide official responses to all pertinent comments received during the Draft EA comment period in a Final EA report. The NWS will make a decision whether to implement the proposed lowering of the KCRP WSR-88D minimum scan angle after the Final EA report is completed.

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ABBREVIATIONS

ATCT	Airport Traffic Control Tower
AGL	above ground level
AAMI	Association for Advancement of Medical Instrumentation
ANSI	American National Standards Institute
ASL	above site level
deg	degree(s)
DoA	Department of Agriculture
EA	Environmental Assessment
E.O.	Executive Order
EED	electro-explosive device
EMI	electromagnetic interference
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FCC	Federal Communications Commission
FEMA	Federal Emergency Management Agency
FONSI	Finding of No Significant Impact
ft	foot, feet
HERO	Hazards of Electromagnetic Radiation to Ordnance
IEEE	Institute of Electrical and Electronics Engineers
JSPO	Joint System Program Office
KCRP	WSR-88D serving the Corpus Christi, TX, area
m	meter(s)
MBTA	Migratory Bird Treaty Act (of 1918)
MHz	megahertz
mi	mile(s)
MPE	maximum permissible exposure
MSL	mean sea level
mW/cm^2	milliwatts per square centimeter
NAO	NOAA Administrative Order
NEPA	National Environmental Policy Act
NEXRAD	Next Generation Weather Radar (also known as WSR-88D)
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NTIA	National Telecommunications and Information Agency
NWS	National Weather Service
PEIS	Programmatic Environmental Impact Statement
RF	radiofrequency
SEA	Supplemental Environmental Assessment
SHPO	State Historic Preservation Office

sq mi	square mile(s)
std	standard
TX	Texas
U.S.	United States
USAF	U.S. Air Force
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VcA	Victoria clay on slopes of 0 to 1%
WNW	west-northwest
WSR-88D	Weather Surveillance Radar – 1988, Doppler

1 BACKGROUND AND SCOPE OF REPORT

1.1 BACKGROUND

The National Weather Service (NWS) operates a nationwide network of weather radars that provide critical real-time information on atmospheric conditions to weather forecasters. Additional similar weather radars located in Alaska, Hawaii and Puerto Rico are operated by the Department of Transportation Federal Aviation Administration (FAA). The Department of Defense Air Weather Service also operates weather radars located at United States (U.S.) military installations in the U.S. and abroad. The weather radars operated by these three agencies are part of 159 WSR-88Ds in the nationwide network.

The network radars operated by NWS are named Weather Surveillance Radar-Model 1988 Doppler (WSR-88D) after the year they were first put into service and their capabilities to use Doppler shift measurements to determine wind velocities. They are also known as Next Generation Weather Radars (NEXRADs) or Weather Service Radars. Like all active radars, the WSR-88D transmits a radio signal, which reflects off targets and returns to the radar. The radar measures the strength of the return signal, its direction of return, and the time between transmission and return, which allows determination of the target characteristics. Because the WSR-88D has the potential to cause electromagnetic effects on the environment, NWS carefully considered these effects and strives to prevent effects, or when effects cannot be avoided, mitigate the significance of those effects. To that end, the NEXRAD Joint System Program Office (JSPO) prepared environmental reports evaluating potential electromagnetic effects of the WSR-88D during planning and implementation of the WSR-88D network. In 1984, the JSPO issued the first environmental document which considered electromagnetic effects (among other effects). That report is titled: *Next Generation Weather Radar Programmatic Environmental Impact Statement (PEIS), Report R400-PE201* [NWS, 1984]. In 1993, JSPO issued a supplemental report updating the analysis contained in the 1984 PEIS to account for changes since 1984 in electromagnetic standards and guidelines and developments in radar design and operational modes. The supplemental report is titled *Final Supplemental Environmental Assessment (SEA) of the Effects of Electromagnetic Radiation from the WSR-88D Radar* [NEXRAD JSPO, 1993]. The 1993 SEA analyzed the potential electromagnetic effects of operating the WSR-88D at a minimum scan angle of +0.5 degree (deg) above horizontal, measured at the center of the WSR-88D main beam. The minimum scan angle of +0.5 deg represented the lowest scan angle used operation of the WSR-88Ds at that time.

The National Weather Service (NWS) owns and operates the WSR-88D serving the Corpus Christi, TX, area. The radar identifier is KCRP and the radar is located at Corpus Christi International Airport, city of Corpus Christi, Nueces County, TX, about 7.2 miles west-northwest (WNW) of downtown Corpus Christi. The KCRP WSR-88D is part of the nationwide WSR-88D network. The NWS proposes to operate the KCRP WSR-88D at a minimum scan angle of +0.3

deg, which is lower than the current minimum scan angle of +0.5 deg above the horizon. Operating the KCRP WSR-88D at this lower scan angle was not analyzed in the 1993 SEA.

The National Oceanic and Atmospheric Administration (NOAA), the parent agency of NWS, require analysis of the potential environmental consequences of proposed actions to comply with the National Environmental Policy Act (NEPA). Procedures to be followed are set forth in NOAA Administrative Order (NAO) 216-6A (NOAA, 2016). Because NWS's proposed action of operating the KCRP WSR-88D at a minimum scan angle below +0.5 deg has the potential to cause environmental effects, there is a need to analyze potential environmental consequences, determine their significance, and develop measures to mitigate adverse impacts if necessary.

1.2 SCOPE OF REPORT

This Draft EA report analyzes the potential effects on persons and activities in the vicinity that could result from implementing the proposed action (i.e., lowering the KCRP WSR-88D minimum scan angle to +0.3 deg). Potential environmental effects of alternative minimum scan angles and the no-action alternative (i.e., continued operation of the KCRP WSR-88D at the current minimum scan angle of +0.5 deg) are also considered for comparison purposes. As part of that analysis, the findings of the 1993 SEA have been updated to account for changes in safety standards and guidelines that have been occurred since 1993 and site -specific conditions at the KCRP WSR-88D site and vicinity. The scope of this EA is limited to analyzing potential effects from lowering the minimum scan angle of the KCRP WSR-88D. Because the types of electromagnetic effects that may result and their significance depends on local conditions, including uses and topography of the local area, the analysis and findings in this EA are specific to the KCRP WSR-88D, and do not apply to other WSR-88Ds or the WSR-88D network as a whole.

2 PURPOSE AND NEED

The NWS is the nation's premiere meteorological forecasting organization. The agency's official mission is as follows:

> "The National Weather Service (NWS) provides weather, hydrologic, and climate forecasts and warnings for the United States, its territories, adjacent waters and ocean areas, for the protection of life and property and the enhancement of the national economy. NWS data and products form a national information database and infrastructure which can be used by other governmental agencies, the private sector, the public, and the global community [NWS, 2009]".

The nationwide network of 159 WSR-88Ds plays a crucial role in meeting the NWS mission. Data from the WSR-88Ds is used by the NWS to improve the accuracy of forecasts, watches, and warnings. As an example, the WSR-88D generates precipitation estimates allowing prediction of river flooding in hydrological basins of the area. The NWS then disseminates advance flood warnings to local and state public safety, emergency managers, and the public, allowing them to take appropriate actions to minimize hazards to life and property. Because the meteorological phenomena of greatest interest occur with a few thousand feet (ft) of the ground surface, radar coverage of lower portions of the atmosphere is of great value to forecasters.

However, the elevation above the ground at which the WSR-88D can collect atmospheric data rises with distance from the radar due to earth curvature and the upward tilt of the radar beam, which is currently +0.5 deg or greater. The proposed action of lowering the KCRP WSR-88D minimum scan angle to +0.3 deg would expand the geographic area with radar coverage below 10,000 ft AGL, a substantial benefit to forecasters and other users of WSR-88D data. This EA report describes the improvements in radar coverage that would result if the NWS operates the KCRP WSR-88D serving the Corpus Christi, TX, area at a minimum scan angle of +0.3 deg and the environmental effects that may result.

The National Oceanic and Atmospheric Administration (NOAA) is the parent agency of the NWS. NOAA requirements for complying with the National Environmental Policy Act (NEPA) are contained in NOAA Administrative Order (NAO) 216-6A, *Compliance with the National Environmental Policy Act, Executive Orders 12114, Environmental Effects Abroad of Major Federal Actions; 11988 and 13690, Floodplain Management; and 11990 Protection of Wetlands* (NOAA, 2016)], and the Companion Manual for NOAA Administrative Order 216-6A; Policies and Procedures for Compliance with the National Environmental Policy Act and Related Authorities (NOAA, 2017). NWS is subject to those requirements. Appendix E of the NOAA Companion Manual specifies the proper level of NEPA review for actions proposed by NOAA components and lists types of actions that are categorically excluded from the need to prepare a NEPA analysis document (e.g., an EA or environmental impact statement [EIS]). Categorical Exclusion G6, which addresses NEXRAD Radar Coverage, states that "Actions that change the NEXRAD radar coverage patterns that do not lower the lowest scan angle and do not result in

direct scanning of previously non-scanned terrain by the NEXRAD main beam" are categorically excluded from NEPA (NOAA, 2017). The proposed action would not meet these specifications and does not qualify for categorical exclusion treatment. Therefore, NEPA analysis is required for the proposed lowering of the KCRP WSR-88D minimum scan angle to +0.3 deg; this EA report satisfies that requirement.

3 DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

3.1 PROPOSED ACTION

3.1.1 DESCRIPTION OF KCRP WSR-88D

The NWS of the Department of Commerce, Air Force of the Department of Defense, and FAA of the Department of Transportation operate a nationwide network of Doppler meteorological radars, known as NEXRAD or WSR-88D. The WSR-88D collects data on weather conditions and provides critical inputs to forecasters. The network is composed of 159 radars, most of which were installed in the late 1980s and 1990s. Each radar includes a roughly 28-ft diameter dish antenna mounted on a steel lattice tower of varying height (depending on local conditions), and shelters housing electronic equipment, a standby power generator and fuel tank, and a transitional power maintenance system. The dish antenna rotates 360 deg and is covered by a fiberglass radome to protect it from the elements.

Figure 1 is a photograph of the KCRP WSR-88D, which was commissioned on September 4, 1996 and has been in continuous operations since being commissioned. The KCRP WSR-88D serves the Corpus Christi, TX, area and is operated and maintained by the NWS. The Corpus Christi, TX, Weather Forecast Office (WFO) is the primary recipient of data from the KCRP WSR-88D and serves southern Texas. The KCRP WSR-88D is located is located at Corpus Christi International Airport, city of Corpus Christi, Nueces County, TX, and is about 7.2 miles west of downtown Corpus Christi. (see Figure 2). The radar antenna, radome, and steel-lattice tower are standard. Table 1 provides information on the KCRP WSR-88D.

Table 1: Information on KCRP WSR-88D serving the Corpus Christi, TX, area

Elevation, ground surface at tower base (mean sea level, MSL)	45 ft
Elevation, center of antenna (MSL)	143 ft
Tower Height (m)	25 m (82 ft)
Latitude (WGS84)	27°47’03” N
Longitude (WGS84)	97˚30’40” W
Operating Frequency	2,810 megaHertz (MHz)
Spot Blanking or Sector Blanking used	No

Figure 1: Photograph of KCRP WSR-88D serving Corpus Christi, TX, area

Figure 2: Location of KCRP WSR-88D

3.1.2 Proposed Change in Minimum Scan Angle

The WSR-88D is designed to detect and track weather phenomena within a roughly 230 mi distance of the radar. It accomplishes this task by emitting a narrow main beam from a rotating dish antenna. The antenna rotates continuously around a vertical axis to cover the surrounding area. The main beam scan angle is the number of degrees above or below horizontal at the center of the main beam. The upward tilt of the antenna (and therefore the scan angle of the main beam) can be changed, allowing the radar to scan the sky at angles up to + 60.0 deg and down to -1.0 deg; however, in current operation, the maximum scan angle is +19.5 deg and the minimum scan angle is +0.5 deg.

The WSR-88D main beam has a total width of 1 deg in the horizontal and vertical directions (i.e., beam edge is ½ deg from the center of the beam), as shown in Figure 3. The power density of the WSR-88D is greatest at the center of the beam and decreases towards the edge of the beam. At the edge of the main beam, the power density is one half of the center of beam power density. In current operation, the minimum scan angle of the main beam is +0.5 deg (i.e., 0.5 deg above horizontal at the center of the main beam) and the lower edge of the main beam (i.e., lower half-power point) is at 0.0 deg or horizontal. NWS proposes to reduce the minimum center of beam scan angle to +0.3 deg, which is 0.2 deg lower than the current minimum scan angle.

Figure 4 is a schematic drawing showing the change in coverage that would result from lowering the KCRP WSR-88D minimum scan angle. The floor of coverage would decrease slightly, but at a scan angle of +0.3 deg would not impinge on the ground surface within 2.8 miles of the radar. Because the lowered radar main beam would not be significantly obstructed by nearby terrain, buildings, or trees, the radar would cover portions of the atmosphere which are currently not covered. Table 2 shows the improvement in radar coverage that would be achieved, which ranges from 52.0% increase in coverage area at 2,000 ft above site level (ASL) to 22.9% increase at 10,000 ft ASL. The floor of radar coverage over the City of Laredo would be reduced from 6,900 feet above ground level (AGL) to 5,800 feet. Figures 5, 6, and 7 show the improvement in radar coverage that would be achieved at 2,000 ft, 5,000 ft, and 10,000 ft ASL, respectively. The improvement in WSR-88D coverage would be beneficial to NWS forecasters and other users of radar data (e.g., emergency response mangers, water managers, farmers, transportation officials).

Table 2: Existing and Proposed Radar Coverage Areas for KCRP WSR-88D

Minimum Center of Beam Scan Angle (deg)	Coverage Floor (deg)	Area Covered (sq. mi.)		
		2,000 ft ASL	5,000 ft ASL	10,000 ft ASL
+0.5 (existing)	0.0	11,087	25,583	57,756
+0.3 (proposed)	-0.2	16,847 (+52.0%)	37,685 (47.3%)	70,956 (+22.9%)

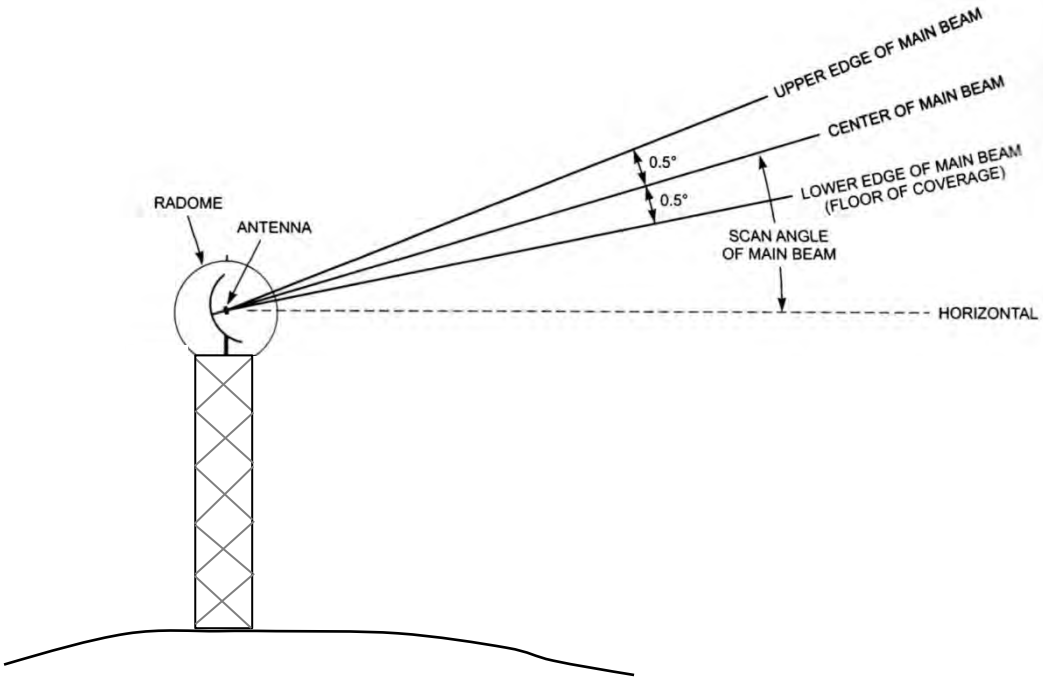

Figure 3: Schematic of WSR-88D Main beam

(Not to scale, width of main beam exaggerated)

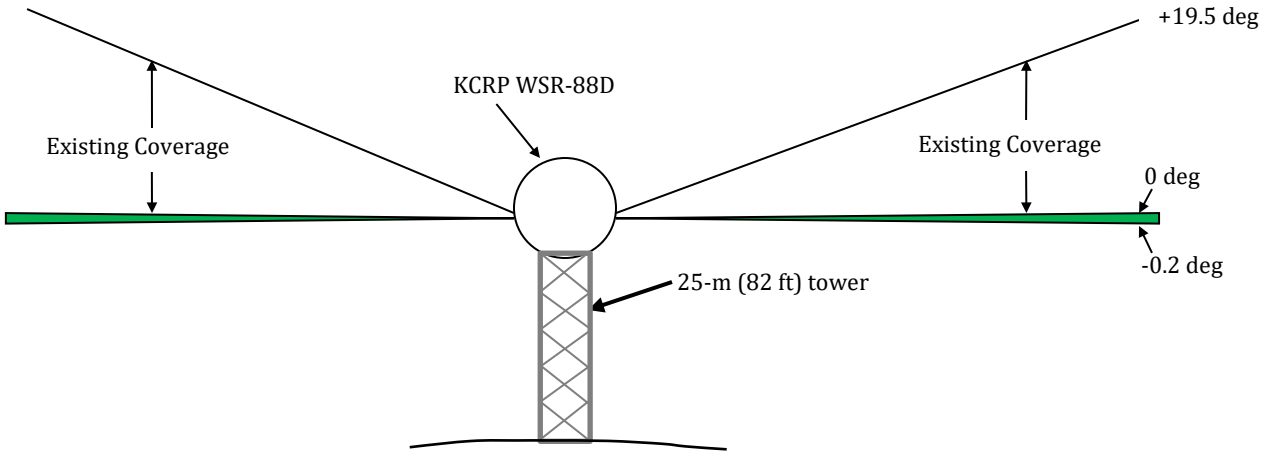

Figure 4: Drawing of Proposed Additional Radar Coverage

Figure 5: Existing and Proposed KCRP WSR-88D Coverage at 2,000 ft ASL

Figure 6: Existing and Proposed KCRP WSR-88D Coverage at 5,000 ft ASL

Figure 7: Existing and Proposed KCRP WSR-88D Coverage at 10,000 ft ASL

The existing WSR-88D transmitter and antenna are physically equipped to operate at the proposed minimum scan angle. The only change required to implement the proposed change would be modifications to the software that controls radar operations and processes data collected by the radar. No construction activities or ground disturbance would be required to implement the proposed action. The transmit power of the radar would also be unchanged.

3.2 ALTERNATIVES

NAO 216-6A requires analysis of the no-action alternative in EAs. For purposes of this EA report, the no-action alternative is defined as continuing to operate the KCRP WSR-88D serving the Corpus Christi, TX, area with the current minimum center of main beam scan angle of +0.5 deg. This is the same minimum scan angle used by most other WSR-88Ds in the nationwide network. The no-action alternative and alternative minimum scan angles between +0.4 and -0.2 deg are analyzed in Section 5 of this EA.

4 ENVIRONMENTAL SETTING, CONSEQUENCES, AND MITIGATION

4.1 EXPOSURE OF PERSONS TO RADIOFREQUENCY RADIATION

4.1.1 SAFETY STANDARDS

The electromagnetic environment at a specific location and time is composed of the all the electromagnetic fields from various sources (natural and manmade) that arrive there. The electromagnetic spectrum in an area is a continuously usable resource whose dimensions are amplitude, time, frequency, and space. In areas large enough to permit adequate spatial separation of users, the electromagnetic spectrum can simultaneously accommodate many users if they are sufficiently separated in frequency. The electromagnetic environment at any point can change nearly instantaneously and will vary spatially, even at locations in close proximity; therefore, it is convenient to measure and characterize electromagnetic phenomena using averages over time and space.

Manmade contributions to the electromagnetic environment are both intentional and unintentional. Radio and television broadcasts, cellular telephone transmissions, and radar signals are examples of intentional contributions. Electromagnetic noise generated by power lines, fluorescent lights, and motors of all sorts are examples of unintentional human contributions. The KCRP WSR-88D transmits a radio signal at a frequency of 2,810 MHz, which is within the radiofrequency (RF) or microwave portion of the electromagnetic spectrum. Although microwaves can add heat to objects, they do not contain enough energy to remove electrons from biological tissue, and are a form of non-ionizing radiation. In this regard, microwaves are fundamentally different from ionizing radiations (e.g., X-rays, ultraviolet rays) which occur at higher frequency portions of the electromagnetic spectrum. Ionizing radiation occurs only at frequencies greater than 10^9 MHz. RF or microwave fields are non-ionizing radiation. Due to the fundamental differences between ionizing and non-ionizing radiation, safety standards and guidelines vary greatly for the two types of electromagnetic radiation. In this section only standards for non-ionizing radiation are addressed because KCRP WSR-88D RF emissions are non-ionizing.

The Institute of Electrical and Electronics Engineers (IEEE) developed safety guidelines for human exposure to RFR, and those standards have been adopted by the American National Standards Institute (ANSI) [ANSI/IEEE, 2019 and 2020]. The ANSI/IEEE safety standard is designed to protect all persons (including infants, elderly persons, and pregnant women) from adverse health effects from exposure to radiofrequency (RF), even if exposure should last over an entire lifetime. These guidelines set safety levels for maximum permissible exposure (MPE) to RF signals, which include a 10- to 50-fold safety margin and are intended to protect all members of the population.

MPEs are specified in power density of the radio signal in milliwatts per square centimeter (mW/cm^2) and vary with operating frequency. Separate MPEs have been established for exposure of the general public and workers and for time-averaged exposure and peak exposure.

Occupational safety standards are higher than those for the general public because workers are trained in RF safety practices and have greater ability to use that knowledge to protect themselves from potentially harmful RF exposure. The KCRP WSR-88D operating frequency is 2,810 MHz. The IEEE/ANSI safety standards for those frequencies are 1.0 mW/cm^2 for the general public (averaged over 30 minutes) and 5.0 mW/cm^2 for workers (averaged over 6 minutes). Federal Communications Commission (FCC) RF exposure standards for RF exposure of the general public and occupational exposure are the same as the ANSI/IEEE safety standards. The Occupational Health and Safety Administration (OSHA) regulates occupational exposure to RF emissions; the OSHA safety standard is 10.0 mW/cm^2 (averaged over 6 minutes) (OSHA, 2021).

4.1.2 RF Exposure Levels

The KCRP WSR-88D is mounted on a 25 m tall steel-lattice tower. Ground elevation is 45 ft MSL. The center of the antenna is at 143 ft MSL and the lower edge of the antenna is at 129 ft MSL or 84 ft above ground level (AGL). When operating at the current minimum scan angle of +0.5 deg, the lower edge of the beam is at 0.0 deg (i.e., horizontal) and the radar's main beam does not impinge on the ground surface or any occupied structures close to the radar (see Appendix C). Operating at the proposed minimum scan angle of +0.3 deg would not change that situation; the main beam would not impinge on the ground surface within 14,900 feet (2.8 miles) of the WSR-88D. The closest structure within the main bean is the Airport Traffic Control Tower; RF power density levels at the ATCT distance are shown in Table 3.

Compared to the existing minimum scan angle of +0.5 deg, lowering the minimum scan angle to +0.3 deg would result in a slight increase in RF exposure levels at air space in the vicinity of the radar. Appendix A includes calculations of the existing time-averaged RF exposure levels in the vicinity of the KCRP WSR-88D, and the RF exposure that would result if NWS lowers the minimum scan angle to +0.3 deg. Table 3 summarizes the results from Appendix A.

Table 3: RF Power Densities of KCRP WSR-88D Main Beam Compared to Safety Levels

Location / Distance from KCRP WSR-88D	Time-Averaged Power Density (mW/cm^2)	ANSI/IEEE General Public RF Safety Standard		ANSI/IEEE and FCC Occupational RF Safety Standard	
		Safety Standard (mW/cm^2)	Factor Below Std	Safety Standard (mW/cm^2)	Factor Below Std
Surface of Radome	0.603	1.0	1.66	5.0	7.9
Closest Structure: ATCT 8,900 feet south	0.00010	1.0	10,000	5.0	50,000
Closest Terrain: 14,900 ft north	0.000037	1.0	27,000	5.0	135,000

During normal operation of the WSR-88D with a rotating antenna, RF exposure levels at all locations would comply with safety standards for exposure of both workers (i.e., occupational exposure) and the general public.

During infrequent stationary antenna operation, RF exposure levels within the WSR-88D main beam would exceed ANSI/IEEE and FCC safety levels for exposure of the general public within 1,740 ft of the WSR-88D antenna. FCC occupational safety levels would be exceeded within 777 ft. No structures or terrain are within those distances and no RF safety hazards would result.

4.1.3 RF ELECTRO-STIMULATION

The ANSI/IEEE safety guidelines also cover possible induction of currents within the bodies of persons and the potential for electro-stimulation of persons who make contact with conductive objects in the RFR field. The result is potentially harmful sensation of shock and/or burn. These effects only occur for RF fields at frequencies below 110 MHz (ANSI/IEEE, 2006). The KCRP WSR-88D would continue to operate at 2,810 MHz, outside the frequency range where induced currents or electro-simulation occur, and would not cause these effects.

4.1.4 CUMULATIVE RF EXPOSURE

As shown in Table 3, the power density of RF transmissions decreases exponentially with distance from the antenna. At all locations in the vicinity, RF emitted by the WSR-88D during normal operation would be at substantially below the safety standard for RF exposure of the general public. It is improbable that radio emissions from an external source would add to the WSR-88D RF emissions during normal operation to cause cumulative RF exposure levels exceeding safety standards.

4.2 RF EXPOSURE OF EQUIPMENT AND ACTIVITIES

4.2.1 TELEVISION, RADIO, CELLULAR TELEPHONE, AND PERSONAL COMMUNICATIONS DEVICES (PCDS)

High-power radar, such as the WSR-88D, can interfere with operation of radio, television, cellular telephone, and PCDs in close vicinity to the radar antenna. However, these devices operate at different frequencies from the WSR-88D, reducing the potential for radio interference. NTIA regulations reserve the 2,700 to 3,000 MHz band for government radiolocation users (e.g., meteorological and aircraft surveillance radars) [NTIA, 2009]. The WSR-88D operates outside the frequencies used by television and radio broadcasts, cellular telephones, and personal communication devices. Lowering the minimum scan angle to +0.3 deg would not result in the main beam impinging on the ground surface within 2.8 miles of the radar and the potential for radio interference would be low. No mitigation is necessary.

4.2.2 ELECTRO-EXPLOSIVE DEVICES (EEDS)

Electro-explosive devices are used to detonate explosives, separate missiles from aircraft, and propel ejection seats from aircraft. Under extreme circumstances, electromagnetic radiation can cause unintended firing of EEDs. Calculations based on a U.S. Air Force (USAF) standard

indicate that using electric blasting caps at distances beyond approximately 900 ft from the WSR-88D is a safe practice, even in the main beam of the radar, where the power density of the WSR-88D radio signal is greatest [USAF, 1982]. The U.S. Navy Hazards of Electromagnetic Radiation to Ordnance (HERO) regulations classify ordnance as safe, susceptible, or unsafe and unreliable, based on compliance with MIL-STD 664 (series). HERO safe ordnance is considered safe in all RFR environments. HERO susceptible ordnance may be detonated by RF energy under certain circumstances. HERO unsafe or unreliable ordnance has not been evaluated for compliance with MILSTD 664 or is being assembled, dissembled, or subject to unauthorized conditions, which can increase its sensitivity to RF emissions. Safe separation distances vary for susceptible and unsafe or unreliable ordnance [Naval Sea Systems Command, 2008]. For HERO susceptible ordnance, the safe separation distance (D) in ft is calculated as follows:

$$D = (781)\ (f)^{-1}(\text{average power x antenna gain})^{½}$$

Where f is operating frequency in MHz and average power = maximum transmitted power × duty cycle. Inserting these values gives:

$$D = (781)\ (2{,}810)^{-1}\ (475{,}000\ \text{W} \times 0.0021 \times 35{,}500)^{½}\ \text{ft}$$
$$D = 1{,}653\ \text{ft}$$

For HERO unsafe or unreliable ordnance, the safe separation distance (D) in ft is calculated as follows:

$$D = (2{,}873)\ (f)^{-1}(\text{average power x antenna gain})^{½}$$
$$D = (2{,}873)\ (2{,}810)^{-1}\ (475{,}000\ \text{W} \times 0.0021 \times 35{,}500)^{½}\ \text{ft}$$
$$D = 6{,}084\ \text{ft}$$

HERO concerns are only applicable in locations illuminated by the main beam of the radar. When operating at a minimum scan angle of +0.3 deg, the KCRP WSR-88D main beam would not illuminate the ground or structures within the safe setback distance for HERO safe and unsafe ordnance.

4.2.4 Fuel Handling

Electromagnetic fields can induce currents in conductive materials and those currents can generate sparks when contacts between conductive materials are made or broken. Sparks can ignite liquid fuels, such as gasoline. This phenomenon is rare, but can result in hazards to human health and property. This potential hazard arises during the transfer of fuel from container to another (e.g., fueling an automobile, boat, or airplane). The U.S. Navy developed a Technical Manual identifying the circumstances where this hazard may occur and providing direction on how to prevent it. The Technical Manual identifies a safe standoff distance based on radar operating characteristics [Naval Sea Systems Command, 2003]. Using formula contained in the Technical Manual, the distance from the WSR-88D at which RFR hazards to fuel may occur is 537 ft. This hazard only exists in areas directly illuminated by the main beam. The WSR-88D main beam operating at a minimum center of antenna scan angle of +0.3 deg would not

illuminate the ground or any occupied structures within 537 ft of the radar. The existing fuel tank for the standby generator at the base of the WSR-88D tower would not be illuminated by the WSR-88D main beam and hazards to fuel handling activities would not result. No mitigation is required.

4.2.5 Active Implantable Medical Devices

ANSI and the Association for Advancement of Medical Instrumentation (AAMI) developed the PC69:2007 standard to prevent external electromagnetic sources from causing electromagnetic interference with active implantable medical devices, including cardiac pacemakers and implantable cardiac defibrillators [ANSI/AAMI, 2007]. This standard specifies that cardiac pacemakers and ICDs must be tested by exposing them to a specified magnetic field and that the device must operate without malfunction or harm to the device. The specified field strength varies with frequency. For the WSR-88D operating frequency of 2,810 MHz, the field strength is 3 A/m. This is converted to power density (S) in units of W/m^2 by assuming free air impedance of 377 ohms:

$$S = 377\ |3|^2\ \ W/m^2$$
$$S = 3{,}393\ W/m^2$$

To convert to mW/cm^2, we multiply the numerator by 1,000 mW/W and the divisor by 10,000 $cm^2/\ m^2$ which gives a value of 339.3 mW/cm^2. The peak pulse power of the WSR-88D is given by the following formula (see Appendix A):

$$U_1 = 1.44\ X\ 10^9/R^2\ mW/cm^2$$

Inserting R = 2,060 ft gives a value of 339.3 mW/cm^2, which equals the threshold established by PC69:2007 standard. At distances of 2,060 ft or greater, the main beam of the WSR-88D would not adversely affect implantable medical devices. There would also be no hazards to implantable medical devices at locations outside the main beam. Operating at the minimum potential center of beam scan angle of +0.3 deg, the main beam of the KCRP WSR-88D would not illuminate the ground or structures within 2,060 ft of the radar.

Theoretically, persons in aircraft flying within 2,060 ft of the radar could be exposed to RF levels above the device susceptibility threshold set by ANSI/AAMI, but the likelihood of significant harm is extremely low. For persons in aircraft, the airframe would attenuate the RF level and the duration of exposure would be far less than the averaging time (6 to 30 minutes) specified in the RF safety standards, reducing the amount of RF exposure. Additionally, device susceptibility threshold in the PC69:2007 standard is based on coupling of the RFR directly into the device leads (which is the test protocol); the WSR-88D signal would be incident upon the surface of the body and would decrease considerably in strength at the location of the device leads within the body. Third, even in the unlikely event that the WSR-88D RFR couples into the device at levels above the susceptibility threshold, the device would revert to safe mode of operation that would prevent significant harm to the wearer or damage to the device [ANSI/AAMI, 2007].

FCC regulations at 47 CFR Part 95.1221 require that MedRadio medical implant devices and medical body-worn transmitters be able to withstand exposure to RF at the MPEs specified in FCC regulations at 47 CFR 1.1310 (FCC, 2017). As described in Section 4.1 above, RF exposure levels in the vicinity of the KCRP WSR-88D would comply with the FCC safety standards. Exposure of persons wearing implantable medical devices to the KCRP WSR-88D radio emissions would not result in adverse effects.

4.2.6 Astronomical Observatories

The WSR-88D can cause harmful electromagnetic interference (EMI) with charge-couple devices (CCDs) which electronically record data collected by astronomical telescopes (NEXRAD JSPO 1993). The potential for harmful EMI would arise if the WSR-88D's main beam would directly impinge on an astronomical observatory during low angle scanning. No astronomical observatories are located within 150 miles of the KCRP WSR-88D and adverse effects on astronomical observatories would not result.

4.2.7 Summary of RF Exposure Effects

Table 5 summarizes impacts to potentially RF-sensitive equipment and activities. The potential for the proposed action to cause radio interference with other radio users would be very low.

Table 4: Potential Effects of KCRP WSR-88D on Equipment and Activities

Equipment / Activity	Applicable Standard	Setback Distance	Would Main Beam Impinge Within Setback Distance?	Potential for Significant Effects
TV, Radio, Cellular Telephone, and Personal Communications Devices (PCDs)	NTIA Frequency Allocations	n/a	n/a	Very Low
EEDs	U.S. Navy HERO Safe/Unsafe	1,653 ft / 6,084 ft	No	Very Low
Fuel Handling	U.S. Navy Hazards to Personnel, Fuel, and Other Flammable Material	537 ft	No	Very Low
Active Implantable Medical Devices	AAMI PC69:2007, FCC 47 CFR Part 95.1221	2,060 ft	No	Very Low
Astronomical Observatories	Direct Exposure to WSR-88D Main Beam	n/a	n/a	None

4.3 LAND USE AND COASTAL ZONE MANAGEMENT

Texas is a coastal state and has a Coastal Zone Management Program administered by the Texas Coastal Management Program of the Texas General Land Office.(NOAA, 2022). Corpus Christi International Airport, including the WSXR-88D site is within the coastal management zone.

Operating the KCRP WSR-88D at a lower scan angle would not generate air or water emissions and would be in conformance with safety standards for RF exposure. No visual, transportation, or acoustic noise impacts would result. The KCRP WSR-88D is located at Corpus Christi International Airport and nearby land uses are aviation and commercial. The airport, including the WSR-88D site, are in a heavy industrial (IH) zoning district (City of Corpus Christi, 2022b). The proposed action would not change land uses at the KCRP WSR-88D site or vicinity and would not adversely affect nearby land uses. The proposed action would not adversely affect the coastal management zone.

4.4 GEOLOGY, SOILS, AND SEISMIC HAZARDS

Corpus Christi is within the Sand Plains geophysical province. Bedrock consists of shale and sandstone sedimentary deposits of Quaternary age (last 3 million years). Subsurface salt domes have formed and risen within these sedimentary layers (American Association of Petroleum Geologists, 1986) . Soil is Victoria Clay (VcA) on 0 to 1% slope. VcA soil forms from clayey fluviomarine deposits and is well drained. The depth to the water table is more than 80 inches and this soil is not hydric. VcA soil is considered prime farmland. The frequency or flooding or ponding is “none” (Natural Resources Conservation Service, 2021).

U.S. Geological Survey (USGS) considers the Corpus Christi area to have a low risk of seismic hazards (USGS, 2021). The proposed action would not affect the WSR-88D tower structure or change its seismic risk level.

Lowering the minimum scan angle of the KCRP WSR-88D would not require physical changes to the radar or result in ground disturbance. The proposed action would have no effect on geology, soils, or seismicity. No mitigation measures are required.

4.5 DRAINAGE AND WATER QUALITY

The KCRP WSR-88D site drains via overland flow to artificial channels that flow southward and eastward into Oso Creek. Oso creek flows southeastward to Oso Bay, which connects to Corpus Christi Bay south of downtown Corpus Christi. (USGS, 1984, 2019a, and 2019b). Lowering the minimum scan angle of the KCRP WSR-88D would not result in ground disturbance. The proposed action would not affect the amount of impervious surface area at the radar site, the rate of storm runoff flowing from the site during or after precipitation events, or generate water pollutants. The proposed action would have no effect on drainage or water quality. No mitigation measures are required.

4.6 TRANSPORTATION

The KCRP WSR-88D and WFO are located at Corpus Christi International Airport and nearby land uses are aviation and commercial. The WSR-88D is located about ½ mile northwest of the WFO and is accessible by Pinson Drive, a two-lane paved public road with low traffic volumes. The proposed action requires modification of the WSR-88D software to be able to scan at angles below +0.5 deg. To implement the change in scan angle, NWS technicians and engineers would

travel to the KCRP WSR-88D site to perform initial testing and ensure that the modified software is operating properly. Travel to the site would be minimal and would not result in significant congestion on local roads. Transportation effects would not be significant. No mitigation measures are required.

4.7 AIR QUALITY

The KCRP WSR-88D is equipped with a standby generator that is used if primary power is interrupted and also periodically for testing. The proposed action would not change the power consumption of the WSR-88D or affect the hours of operation of the standby generator, and no change in air emissions would result. A Clean Air Act Federal Conformity Determination is not required. No mitigation measures are required.

4.8 FLOOD HAZARDS

Executive Order (E.O.) 11988, *Floodplain Management*, requires the Federal Government to avoid adverse impacts to the 100-year or base floodplain (that is, the area subject to a 1 percent annual chance of flooding), unless there is no practicable alternative [President, 1977a]. The KCRP WSR-88D site is within Zone C, an area of minimal flooding and is not within a special flood hazard or other flood hazard area (FEMA, 1985). The proposed action of lowering the minimum would not affect floodplains or flood hazards. No mitigation measures are required.

4.9 WETLANDS

E.O. 11990, *Protection of Wetlands*, requires the Federal Government avoid funding or implementing projects which would adversely impact wetlands unless there is no practicable alternative [President, 1977b]. Based on National Wetland Inventory maps prepared by the U.S. Fish and Wildlife Service (USFWS), the WSR-88D site does not contain federal jurisdictional wetlands. The nearest wetlands area is a 2.58-acre riverine perennial unconsolidated bottom semi-permanently flooded, excavated wetland (R5UBFx) about 500 feet north of and across State Highway 44 State from the KCRP WSR-88D. Within the airport, a 1.83-acre R5UBFx wetland is located about 1,500 feet southeast of the WSR-88D (USFWS, 2021). The proposed action would not result in ground disturbance or changes to drainage and would not affect federal jurisdictional wetlands; no mitigation is required.

4.10 BIOLOGICAL RESOURCES / PROTECTED SPECIES

The USFWS administers the Endangered Species Act (ESA) and Migratory Bird Treaty Act. The KCRP WSR-88D is located within the area served by the USFWS Fish and Wildlife Service Texas Coastal Ecological Services Field Office in Corpus Christi, TX. The EA preparers obtained a protected species list from that office (see Appendix B). Fourteen species listed as threatened or endangered and one candidate species for listing potentially occur in the local area. These species and their status are shown in Table 5. The KCRP WSR-88D is not located within designated critical habitat for any listed species.

Table 5: Federal Endangered, Threatened, and Candidate Species of Nueces County, TX

Species Name (Scientific name)	Status	Critical Habitat Designated?	Is KCRP within critical habitat?
Mammals			
Gulf Coast Jaguarundi (*Herpailurus yagouaroundi cacomitli*)	Endangered	No	n/a
West Indian Manatee (*Trichechus manatus*)	Threatened	Yes	No
Birds			
Eastern black rail (*Laterallus jamaicensis ssp. jamaicensis*)	Threatened	No	n/a
Northern Aplomado Falcon (*Falco femoralis septentrionalis*)	Endangered	No	n/a
Piping plover (*Charadrius melodus*)	Threatened	Yes	No
Red Knot (*Calidris canutus rufa)*	Threatened	Proposed	No
Whooping crane (*Grus americana*)	Endangered	Yes	No
Reptiles			
Green Sea Turtle (*Chelonia mydas*)	Threatened	Yes	No
Hawksbill Sea turtle (*Eretmochelys imbricata*)	Endangered	Yes	No
Kemp's Ridley Sea Turtle (*Lepidochelys kempii*)	Endangered	Proposed	No
Leatherback Sea Turtle (*Dermochelys coriacea*)	Endangered	Yes	No
Loggerhead Sea Turtle (*Caretta caretta*)	Threatened	Yes	No
Insects			
Monarch Butterfly *(Danaus plexippus*)	Candidate	No	n/a
Flowering Plants			
Slender Rush-pea (*Hoffmannseggia tenella*)	Endangered	No	n/a
South Texas Ambrosia (*Ambrosia cheiranthifolia*)	Endangered	No	n/a

The Gulf Coast Jaguarundi is a small endangered feline that resembles an otter or weasel. Its range includes areas along the Rio Grande in South Texas where it inhabits thorny shrublands, and bunchgrass pastures. Known threats include habitat destruction due to urbanization and agriculture and motor vehicle collisions (USFWS, 2022a). The proposed action would not affect the Gulf Coast jaquaraundi or its habitat.

West Indian manatees are aquatic mammals. The six species of listed sea turtles are ocean-dwelling reptiles that use the shoreline to lay eggs. The proposed action would not include construction activities and would not result in ground disturbance, vegetation removal, or changes to water runoff rates or water quality. No impacts would result to the ocean, Corpus Christi Bay or other water bodies. The proposed action would not affect aquatic habitat or shoreline and would not result in impacts to manatees or sea turtles.

Five bird species listed as threatened or endangered may occur in Nueces county. Eastern black rail is a small threatened marsh bird that inhabits salt, brackish, and freshwater wetlands in the Eastern U.S. (USFWS, 2022b). There is no suitable habitat at or near the WSR-88D site or vicinity.

Northern Aplomado falcon is an endangered raptor that inhabits desert grasslands and coastal prairies of Texas, New Mexico, and Arizona. They feed on small birds and insects. Their population has declined due to pesticide use. (USFWS022c). The proposed action does not include construction or vegetation removal and would not affect the Northern aplomada falcon or its habitat.

The threatened piping plover is a small migratory shorebird. It nests and raises young on sparsely vegetated sandbars, reservoir shorelines, and alkali lake shorelines. They feed on aquatic invertebrates and crab eggs found in substrate of shorelines and gravel bars (USFWS 2021d). The WSR-88D site and vicinity do not contain water bodies or shoreline and lacks suitable nesting or foraging habitat for piping plovers.

The threatened red knot is a medium-sized migratory shorebird. It migrates between breeding grounds in the Canadian Arctic and wintering locations in Southeastern U.S., Gulf of Mexico, and South America. They feed on aquatic invertebrates, especially, small clams, mussels, snails, crustaceans, marine worms, and horseshoe crab eggs (USFWS 2021e). The WSR-88D site and vicinity do not contain water bodies or shoreline and lacks suitable nesting or foraging habitat for red knots.

The endangered whooping crane is a tallest North American bird, reaching 1.5 meters (about 5 ft) in height. They nest in Canada and winter along the Gulf Coast of Texas. Stopover locations during migration include marshes, lakes, ponds, wet meadows and agricultural fields. Salt Plains NWR is a stopover location. Whooping cranes are omnivorous, probing soil with their bills and eating frogs, rodents, crabs, crayfish, insects, small fish, small birds, seeds, and berries. They forage at water bodies, marshes, salt flats, and agricultural fields (especially when they contain fresh water) (USFWS, 2021f). The WSR-88D site and vicinity area does not contain water

bodies, shoreline, or agricultural fields and lacks suitable nesting or foraging habitat for whooping cranes.

One species which is a candidate for listing – monarch butterfly (*Danaus plexippus*) – could occur in Nueces County. Monarch butterflies are brightly colored and lay eggs on milkweed host plants, and larvae emerge in two to five days and feed on milkweed. Adults live two to five weeks, except when overwintering when they enter suspended reproduction and may live up to nine months. In temperate climates, monarchs seasonally migrate up to 1,800 miles (USFWS, 2021g). The KCRP WSR-88D site and vicinity do not contain suitable habitat for monarch butterflies.

Slender rush-pea is an endangered plant that occurs in shortgrass prairies of Nueces and Kleberg counties, TX. Habitat loss due to urbanization and agriculture and displacement by invasive non-native grasses has contributed to its decline (USFWS, 2022h). South Texas ambrosia is an endangered flowering herbaceous perennial plant that grows in grasslands and mesquite-dominated shrublands. This plant spreads by rhizomes. South Texas ambrosia has been observed growing in In a field at Nueces County Park in nearby Robstown, TX (USFWS, 2022i). The proposed action does not include vegetation removal or ground clearing; no impacts to plant species would result.

The proposed action would not directly affect federal listed or candidate species or disturb suitable habitat for those species. The Texas Parks and Wildlife Department maintains a list of rare species occurring in each county in Texas. The list for Nueces County is included in Appendix B and contains many of the same species listed by the USFWS and also Texas rare species. The proposed action does not include vegetation removal or ground clearing and would not be expected to adversely affect any of the rare species on the state list.

Lowering the minimum scan angle to +0.3 deg from the current +0.5 deg would result in a thin sliver of the atmosphere, which is currently below the main beam overage area, being exposed to the main beam of the WSR-88D (see Figure 4). The portion of this atmosphere above the newly exposed sliver of atmosphere is currently within the main beam and RF exposure levels would not change. The sliver of the atmosphere where new main beam coverage would result in increased RF exposure levels would be very small in close proximity to the WSR-88D - 5 ft thick at a distance of 900 ft from the WSR-88D and increasing in thickness with distance from the radar. At 1 mile it would be 28 ft thick and at five miles it would be 138 ft thick. Birds, bats, or insects flying within the newly covered sliver of the atmosphere would be exposed to RF emissions from the WSR-88D. The RF levels in the sliver of airspace would be no greater than in RF levels in the existing covered airspace, which occurs just above the newly exposed air space. At distances of several miles or greater where the volume of newly covered airspace would be substantial, RF levels would be very low. At a distance of 900 ft, RF exposure levels would be 100 times less than safety standards for human exposure. Based on the extremely low RF levels at distance from the WSR-88D, RF exposure of birds or insects flying within the newly covered airspace would not be harmful.

Increased RF exposure could result if birds or insects fly in a path that keeps it within the WSR-88D main beam for extended periods of time. However, during normal operation the WSR-88D main beam is continuously moving. At a distance of 1,000 ft the WSR-88D main beam is moving at an effective speed of about 89 miles per hour and it is very unlikely that a bird or insect could fly within the WSR-88D main beam for any length of time.

The proposed action would not result in significant impacts to protected species, critical habitat, or migratory birds. No mitigation measures are required.

4.11 CULTURAL AND HISTORIC RESOURCES

Section 106 of the National Historic Preservation Act of 1966 (as amended) requires that federal agencies consider the effects of their actions on historic places and, if effects may result, provide the State Historic Preservation Officer (SHPO) with an opportunity to comment on their actions. Section 106 regulations are set forth in 36 CFR Part 800, *Protection of Historic Properties* (Advisory Council on Historic Preservation, 2010).

Because the proposed action would not involve ground disturbance, no impacts to archaeological or paleontological resources would result. The proposed action's area of potential effect (APE) is defined as area within 1,740 ft of the KCRP WSR-88Ds where RF exposure of persons within the WSR-88D main beam could potentially exceed safety levels (see Appendix A). The Texas Historic Sites Atlas and the City of Corpus Christi Landmark Commission Web Viewer were searched for places listed on the National Register of Historic Places, National Historic Landmarks, Historic Markers, Recorded Texas Historical Markers, State Antiquities Landmarks, and properties with multiple listings. No listings occur within the APE (Texas Historical Commission, 2022, City of Corpus Christi, 2022a).

Under Section 106 Regulations 36 CFR Section 800.2 (a)(1), *Protection of Historic Properties*, if the proposed action doesn't have the potential to affect historic properties, NWS "has no further obligations under section 106" and consultation with the Texas SHPO regarding possible impacts on historic properties is not required [Advisory Council on Historic Preservation, 2010].

4.12 ENVIRONMENTAL JUSTICE AND SOCIOECONOMIC IMPACTS

E.O. 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations*, requires federal agencies to identify and address, as appropriate, disproportionately high and adverse environmental or human health effects on minority populations and low income populations (President, 1994).

The KCRP WSR-88D is located at Corpus Christi International Airport in the city of Corpus Christi, Nueces County, TX. Nearby lands are used for aviation, commercial, and government purposes. The nearest residences are located about 1.5 mile west of the radar. The proposed action would not generate air or water pollutants or hazardous waste. The project would modify the operation of the KCRP WSR-88D by reducing the minimum scan angle from +0.5 deg to +0.3 deg. The lowered WSR-88D main beam would not impinge on the ground in proximity to

the radar and would comply with safety standards for human exposure to RF energy and setbacks for activities (e.g., fuel handling and EED use) that are potentially sensitive to RF exposure. No disproportionately high and adverse effects would result to any persons, including minority or low income populations. No mitigation is required.

4.13 FARMLANDS

The Farmland Protection Policy Act sets forth federal policies to prevent the unnecessary conversion of agricultural land to non-agricultural use. NRCS regulations at 7 CFR Part 658, *Farmland Protection Policy Act*, are designed to implement those policies. Completion of Form AD-1006 and submission to the U.S. Department of Agriculture (DoA) is required if a federal agency proposes to convert land designated as prime farmland, farmland of statewide importance, or unique farmland to non-agricultural use. Soil at the KCRP WSR-88D site is classified as prime farmland (NRCS, 2021). However, the WSR-88D site and adjoining properties are committed to non-agricultural aviation, commercial, and industrial uses. The proposed action would not convert farmland to non-farm use. No mitigation is necessary.

4.14 ENERGY CONSUMPTION

The proposed action would not change electric use by the WSR-88D and would have no effect on energy consumption. No mitigation is necessary.

4.15 VISUAL QUALITY/ LIGHT EMISSIONS

The proposed action would not change the appearance of the KCRP WSR-88D or result in new emissions of visible light. The proposed action would have no effect on visual quality. No mitigation is necessary.

4.16 SOLID AND HAZARDOUS WASTE

The proposed action would result in no changes to solid or hazardous waste generation. No mitigation is necessary.

4.17 WILD AND SCENIC RIVERS

The Wild and Scenic Rivers Act of 1968 protects free-flowing rivers of the U.S. These rivers are protected under the Act by prohibiting water resource projects from adversely impacting values of the river: protecting outstanding scenic, geologic, fish and wildlife, historic, cultural, or recreational values; maintaining water quality; and implementing river management plans for these specific rivers. The wild and scenic rivers closest to the KCRP WSR-88D is the Rio Grande Wild and Scenic River in Big Bend National Park, about 275 miles west-northwest of the WSR-88D. (National Park Service, 2022). The proposed action would not affect that wild and scenic river. No mitigation is necessary.

5 ALTERNATIVES TO THE PROPOSED ACTION

5.1 MINIMUM SCAN ANGLES BETWEEN +0.4 AND -0.2 DEG

NWS evaluated the benefits and potential impacts of lowering the minimum center of beam scan angle of the KCRP WSR-88D to each angle between +0.4 and -0.2 deg in 0.1 degree increments (see Appendix C). That analysis found that the proposed action of lowering the minimum scan angle to +0.3 deg would result in the significant improvement in radar coverage.

A minimum scan angle of +0.4 deg would increase the radar's coverage area, but by less than the proposed action (i.e., minimum scan angle of +0.3) deg. A minimum scan angle lower than +0.3 deg would not increase coverage area and would have the drawback of increasing ground clutter returns.

Because a minimum scan angle of +0.3 deg would result in significant improvement in radar coverage area while avoiding significant environmental impacts, NWS selected +0.3 deg as the proposed minimum scan angle for the KCRP WSR-88D.

5.2 NO ACTION

The no action alternative consists of continued operation of the KCRP WSR-88D at the existing minimum scan angle of +0.5 deg. The improvements in radar coverage summarized in Section 3 would not be achieved and the project objectives would not be met.

The proposed action would result in increased RF exposure compared to existing WSR-88D operations as described in section 4.1; the no-action alternative would not change RF exposure levels from existing. Under both the proposed action and the no action alternative, RF exposure during normal WSR-88D operations would conform to safety standards established by ANSI/IEEE, OSHA, and FCC.

Similar to the proposed action, the no-action alternative would not result in adverse effects in the following topic areas:

- Land Use and Coastal Zone Management
- Geology, Soils, and Seismic Hazards
- Drainage and Water Quality
- Transportation
- Air Quality
- Flood Hazards
- Wetlands
- Biological Resources / Protected Species
- Cultural and Historic Resources
- Environmental Justice and Socioeconomic Impacts
- Farmlands

- Energy Consumption
- Visual Quality/ Light Emissions
- Solid and Hazardous Waste
- Wild and Scenic Rivers

6 FINDING

The proposed action of lowering the scan angle of the KCRP WSR-88D from the current minimum of +0.5 deg to +0.3 deg would not result in significant changes in the quality of the human environment. Lowering the minimum scan angle would also not add to the environmental effects of past, present, and reasonably foreseeable future actions to cause cumulatively significant effects

The proposed action would improve the quality of meteorological radar data available to NWS forecasters and others users of the data. This may indirectly benefit the residents and businesses of the Corpus Christi WFO service area (southern Texas) by improving the accuracy of forecast and severe weather alerts, which could result in environmental benefits if weather dependent economic activities (e.g., agriculture, construction, outdoor recreation, transportation, water management) become more efficient or safer as a result of improved weather services. The resulting environmental benefits are difficult to quantify, but are unlikely to be significant.

Implementation of the proposed action would not have the potential to cause significant changes in the environmental. A Finding of No Significant Impact is warranted for the proposed action.

7 DOCUMENT PREPARERS

This Draft EA was prepared by Sensor Environmental LLC under contract to Centuria Corporation. Centuria Corporation provides support to the NWS Radar Operations Center (ROC) in Norman, OK.

Mr. James Manitakos, CEO, served as Sensor's Project Manager. Alion Science and Technology Corporation prepared radar coverage maps and calculated coverage areas under subcontract to Sensor. Mr. Andre Tarpinian, Radio Frequency Engineer, served as Alion's Project Manager. Ms. Jessica Schultz, Deputy Director of the NWS Radar Operations Center, and Mr. William Deringer, Acting Program Manager, from the ROC assisted in preparation of this EA. Mr. John Metz, Meteorologist-in-Charge, and staff from the Corpus Christi, TX, WFO, also assisted in preparation of this EA.

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Environmental Assessment Report

ENVIRONMENTAL ASSESSMENT (EA)

LOWERING THE MINIMUM SCAN ANGLE OF THE WEATHER SURVEILLANCE RADAR - MODEL 1988, DOPPLER (WSR-88D) SERVING THE CORPUS CHRISTI, TEXAS, AREA

APPENDICES

APPENDIX A

RADIOFREQUENCY RADIATION POWER DENSITY CALCULATIONS

1. OBJECTIVE

This appendix quantifies the power densities of the radiofrequency radiation (RFR) emitted by the Weather Surveillance Radar, Model 1988 Doppler (WSR-88D) during operations that include minimum scan angles lower than +0.5 degrees (deg). The calculated power densities will be used to analyze the potential for effects to result from exposure of humans, equipment, and activities to the WSR-88D radio signal, and the significance of any identified potential effects.

2. METHODOLOGY

This memorandum builds upon the analysis included in the 1993 *Supplemental Environmental Assessment (SEA) of the Effects of Electromagnetic Radiation from the WSR-88D Radar* [NEXRAD Joint System program Office, 1993]. The 1993 analysis analyzed the potential electromagnetic effects of the WSR-88D signal when the radar operates at a minimum center of beam scan angle of +0.5 deg. This memorandum builds on that analysis by considering operation at a lower minimum scan angle of -0.2 deg. The parameters of the WSR-88D are shown in Table A-1 and are not changed from the 1993 analysis:

TABLE A-1: Operating Characteristics of WSR-88D Serving the Corpus Christi, TX Area (KCRP)

Parameter	**Value**
Operating Frequency	2,810 megahertz (MHz)
Wavelength at center frequency (2,850 MHz)	0.331 ft, 10.1 cm
Maximum pulse power	475 kiloWatts (kW)
Maximum duty cycle	0.21%
Antenna diameter	28 ft, 853 cm
Antenna gain	35,500:1, 45.5 dB
Beam width to half-power points	1.0 deg
First sidelobe relative power density, maximum	0.00325, -25 dB
Other sidelobe maximum power density, relative to main beam	0.0004, -34 dB

The NWS proposes to modify the minimum center of beam scan angle used during operation of the KCRP WSR-88D below the +0.5 angle currently used. This would not require changes to the antenna, other hardware which composes the WSR-88D, or the radiated pulse power of the WSR-88D. However, incorporating scans at angles below +0.5 deg could affect the amount of RFR exposure experienced by persons, equipment, and activities at or near ground level in the vicinity of the radar. This memorandum quantifies that change.

3. MODIFIED VOLUME SCAN PATTERN 31

The WSR-88D uses a number of complex volume scan patterns to maximize the quality and usefulness of the meteorological data it collects. The 1993 report analyzed volume scan pattern 31, which results in the highest levels of ground-level RFR exposure. Volume Scan Pattern

(VCP) 31 consists of eight 360 deg rotations of the antenna at various scan angles. NWS proposed to add two additional antenna rotations at a scan angle between +0.5 and 0.0 deg to this scan pattern to increase the range at which the radar can detect and track meteorological phenomena, especially at low elevations within the atmosphere. This memorandum assumes that the two added scans would be at +0.3 deg (i.e., lower half power point of -0.3 deg), the lowest scan angles under consideration by NWS. Adding two +0.3 degree scans would result in the greatest possible increase in ground level RFR exposure. The modified VCP 31 would be as follows:

- Two complete rotations at +0.3 deg
- Two complete rotations at +0.5 deg
- Two complete rotations at +1.5 deg
- Two complete rotations at +2.5 deg
- One complete rotation at +3.5 deg
- One complete rotation at +4.5 deg

The complete pattern would include 10 rotations of the antenna at a speed of 0.8 revolutions per minute (rpm), the pattern would take about 12 minutes and 22 seconds to complete [Turner, 2011].

4. CALCULATION OF RF POWER DENSITIES

Appendix A of the 1993 SEA includes detailed calculations of the RFR power density and exposure levels resulting from volume scan pattern 31. The proposed scan change would not affect the distance of the transition from the near field to the far field, calculated at 640 to 800 ft in section A.3 of the 1993 Appendix A.

4.1 Far Field

The values of U_1, U_2, and U_3 would be unchanged from the values derived in 1993 Appendix A. The maximum pulse power density within the main beam (U_1) is given by the formula:

$$U_1 = 1.44 \times 10^9/R^2 \text{ milliWatts per square centimeter } (mW/cm^2)$$

where R is the distance from the antenna in ft. The maximum pulse power density at locations greater than 6 deg off the main beam axis (i.e., outside the area illuminated by the main beam and first five sidelobes is U_2 (unchanged from 1993 Appendix A), given below:

$$U_2 = 5.76 \times 10^5/R^2 \ mW/cm^2$$

The RF human exposure standards are based on time-averaged RF exposure for six minutes (occupational exposure) or 30 minutes (general public exposure) [American National Standards Institute/Institute of Electrical and Electronic Engineers, 2005]. We use six minutes as the averaging time as a worst-case analysis. The time-averaged power density for the main beam rotating continuously at +0.5 deg, considering the contributions from both the main beam and the first five sidelobes is given by U_3 (unchanged from 1993 Appendix A), below:

$$U_3 = 1.35 \times 10^4/R^2 \ \ mW/cm^2$$

At this point the analysis must consider the proposed modifications to VCP 31. The modified VCP 31 would have two additional +0.3 deg scans. Within our six minute averaging time, these two added scans would replace the RFR contribution from one +1.5 deg and one +2.5 deg scan. As described in the 1993 appendix, U_4 sums the RFR contributions at center of antenna level from each of the scans performed during the six minute period of interest. The coefficients for the +0.3 deg scans are 2.4/6 reflecting the proportion of the 6 minutes and 1.0 because the center of beam will essentially be at antenna level (i.e., +0.2 deg which equates to 2.8 ft, or one-tenth of the beam width at the far field transition distance of 800 ft). The corresponding coefficients for the two +0.5 deg scans within the six minutes are 2.4/6 and 0.5, and for the one +1.5 deg scan within the six minutes are 1.2/6 and 0.012. The modified U_4 calculation is given below

$$U_4 = [(2.4/6)\ (1.0) + (2.4/6)\ (0.5) + (1.2/6)\ (0.012)]\ U_3$$

$$U_4 = (0.602)U_3$$

Inserting the U_3 value of $1.35 \times 10^4/R^2$ milliwatts/cm^2 (mw/ cm^2), yields:

$$U_4 = 8.13 \times 10^3/R^2 \quad mW/cm^2$$

U_4 is the 6-minute time-averaged power density at locations in the far field directly illuminated by the main beam and at the same elevation as the WSR-88D antenna, considering the RFR contributed from the main beam and the first five sidelobes. According to the WSR-88D specification, sidelobes of higher order than the first five will contain less than 5% of the eradiated energy. The 1993 SEA calculated the average power density of these higher order sidelobes at $4/R^2$ mW/cm^2. We add this to U_4 to obtain U_5, the total time-averaged power density at an elevation even with the center of antenna elevation and distances greater than 800 ft from the antenna:

$$U_5 = 8.13 \times 10^3/R^2 \ + 4/R^2 \ = 8.134 \times 10^3/R^2 \quad mW/cm^2$$

4.2 Near Field

Appendix A of the 1993 SEA calculates the height Y of the mathematical cylinder illuminated by all scans during the six-minute period using the formula Y = 28 + R Tan (2 deg) + 0.035R . Since the modified scan pattern of interest includes scans of +0.3. +0.5, and +1.5 degs, the angular range is 1.2 deg, and we recalculate Y as follows:

$$Y = 28 + R \times \text{Tan}\ (1.2\ \text{deg}) = 28 + 0.021R$$

The circumference of the illumination cylinder is $2\pi RY$ and the total area A is

$$A = 2\pi RY = 176R + 0.13R^2$$

The average power radiated is less than or equal to 1 kW, and the average power over the cylindrical surface cannot exceed this value divided by the area. At the mid-height of the cylinder, the local power density will exceed the average value by a factor of 2 (unchanged from the 1993 analysis). We introduce this factor, multiply by 10^6 to convert from kW to mW, and divide by 929 to convert from sq ft to square centimeters (sq cm):

$$U_6 = 2 * 10^6 / (929) (176R + 0.13R^2) = 16{,}556 / (R^2 + 1{,}353\ R)\ mW/cm^2$$

U_6 is the time-averaged RFR exposure within the area illuminated by the WSR-88D main beam up to distances of 640 ft where the beam begins to spread.

4.3 RF Exposure Levels near KCRP WSR-88D

Table A-2 shows the time-averaged RF power densities that would result at locations directly illuminated by the main beam of the KCRP WSR-88D when operating in modified VCP 31. The near field is within 640 ft of the radar and the U_6 formula is used to calculate these near field values. At greater distances, the far field formula for U_5 is used. For comparison purposes, corresponding values for the original VCP 31 are also shown. As can be seen from Table A-1, use of modified scan pattern 31 would lower the elevation at which the main beam occurs and would also slightly increase the time-averaged power densities in both the near and far fields.

Table A-2: Comparison of RF Power Densities within the WSR-88D Directly Illuminated Area Using VCP 31 and Modified VCP 31

Place	Distance (ft)	Original VCP 31 Lowest Elev (ft MSL)	Original VCP 31 Time-Avg Power Density (mW/cm2)	Modified VCP 31 Lowest Elev (ft MSL)	Modified VCP 31 Time-Avg Power Density (mW/cm^2)
Surface of Radome	20	127*	0.598	n/a	0.603
Closest Structure: Airport Traffic Control Tower	8,900	127	0.000073	96	0.00010
Closest Illuminated Ground	14,900	127**	0.000026	75	0.000037

*****Elevation of bottom edge of KCRP WSR-88D antenna

****** Not illuminated by +0.5 deg scan, illuminated by proposed +0.3 deg scan

NWS may infrequently operate the KCRP WSR-88D with a stationary antenna, resulting in the main beam being continuously pointed at the same location for a period of time. The RF exposure level within the main beam can be calculated using equation U_1 multiplied by the radar duty cycle

$U_7 = (1.44 \times 10^9/R^2)\ 0.0021 = 3.024 \times 10^6/R^2$ (mW/cm^2)

When operating in stationary antenna mode, the KAH WSR-88D would exceed the American National Standards Institute / Institute of Electrical and Electronic Engineers (ANSI/IEEE) safety levels within the following distances:

- ANSI/IEEE and FCC General Public Safety Level (1.0 mW/cm^2): 1,740 ft
- Federal communications commission (FCC) and ANSI Occupational Safety Level (5.0 mW/cm^2): 777 ft

5. REFERENCES

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APPENDIX B

PROTECTED SPECIES LIST

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Texas Coastal Ecological Services Field Office
4444 Corona Drive, Suite 215
Corpus Christi, TX 78411
Phone: (281) 286-8282 Fax: (281) 488-5882
http://www.fws.gov/southwest/es/TexasCoastal/
http://www.fws.gov/southwest/es/ES_Lists_Main2.html

In Reply Refer To: November 17, 2021
Consultation Code: 02ETTX00-2022-SLI-0616
Event Code: 02ETTX00-2022-E-01431
Project Name: KCRP WSR-88D Lower Scan Angle

Subject: List of threatened and endangered species that may occur in your proposed project location or may be affected by your proposed project

To Whom It May Concern:

The U.S. Fish and Wildlife Service (Service) field offices in Clear Lake, Tx, and Corpus Christi, Tx, have combined administratively to form the Texas Coastal Ecological Services Field Office. A map of the Texas Coastal Ecological Services Field Office area of responsibility can be found at: http://www.fws.gov/southwest/es/TexasCoastal/Map.html. All project related correspondence should be sent to the field office responsible for the area in which your project occurs. For projects located in southeast Texas please write to: Field Supervisor; U.S. Fish and Wildlife Service; 17629 El Camino Real Ste. 211; Houston, Texas 77058. For projects located in southern Texas please write to: Field Supervisor; U.S. Fish and Wildlife Service; P.O. Box 81468; Corpus Christi, Texas 78468-1468. For projects located in six counties in southern Texas (Cameron, Hidalgo, Starr, Webb, Willacy, and Zapata) please write: Santa Ana NWR, ATTN: Ecological Services Sub Office, 3325 Green Jay Road, Alamo, Texas 78516.

The enclosed species list identifies federally threatened, endangered, and proposed to be listed species; designated critical habitat; and candidate species that may occur within the boundary of your proposed project and/or may be affected by your proposed project.

New information from updated surveys, changes in the abundance and distribution of species, changes in habitat conditions, or other factors could change the list. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. The Service recommends that verification be completed by visiting the ECOS-IPaC website http://ecos.fws.gov/ipac/ at regular intervals during project planning and implementation for updates to species list and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

Candidate species have no protection under the Act but are included for consideration because they could be listed prior to the completion of your project. The other species information should help you determine if suitable habitat for these listed species exists in any of the proposed project areas or if project activities may affect species on-site, off-site, and/or result in "take" of a federally listed species.

"Take" is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. In addition to the direct take of an individual animal, habitat destruction or modification can be considered take, regardless of whether it has been formally designated as critical habitat, if the activity results in the death or injury of wildlife by removing essential habitat components or significantly alters essential behavior patterns, including breeding, feeding, or sheltering.

Section 7

Section 7 of the Act requires that all Federal agencies consult with the Service to ensure that actions authorized, funded or carried out by such agencies do not jeopardize the continued existence of any listed threatened or endangered species or adversely modify or destroy critical habitat of such species. It is the responsibility of the Federal action agency to determine if the proposed project may affect threatened or endangered species. If a "may affect" determination is made, the Federal agency shall initiate the section 7 consultation process by writing to the office that has responsibility for the area in which your project occurs.

Is not likely to adversely affect - the project may affect listed species and/or critical habitat; however, the effects are expected to be discountable, insignificant, or completely beneficial. Certain avoidance and minimization measures may need to be implemented in order to reach this level of effects. The Federal agency or the designated non-Federal representative should seek written concurrence from the Service that adverse effects have been eliminated. Be sure to include all of the information and documentation used to reach your decision with your request for concurrence. The Service must have this documentation before issuing a concurrence.

Is likely to adversely affect - adverse effects to listed species may occur as a direct or indirect result of the proposed action or its interrelated or interdependent actions, and the effect is not discountable, insignificant, or beneficial. If the overall effect of the proposed action is beneficial to the listed species but also is likely to cause some adverse effects to individuals of that species, then the proposed action "is likely to adversely affect" the listed species. An "is likely to adversely affect" determination requires the Federal action agency to initiate formal section 7 consultation with this office.

No effect - the proposed action will not affect federally listed species or critical habitat (i.e., suitable habitat for the species occurring in the project county is not present in or adjacent to the action area). No further coordination or contact with the Service is necessary. However, if the project changes or additional information on the distribution of listed or proposed species becomes available, the project should be reanalyzed for effects not previously considered.

Regardless of your determination, the Service recommends that you maintain a complete record of the evaluation, including steps leading to the determination of affect, the qualified personnel conducting the evaluation, habitat conditions, site photographs, and any other related articles.

Please be advised that while a Federal agency may designate a non-Federal representative to conduct informal consultations with the Service, assess project effects, or prepare a biological assessment, the Federal agency must notify the Service in writing of such a designation. The Federal agency shall also independently review and evaluate the scope and contents of a biological assessment prepared by their designated non-Federal representative before that document is submitted to the Service.

The Service's Consultation Handbook is available online to assist you with further information on definitions, process, and fulfilling Act requirements for your projects at: http://www.fws.gov/endangered/esa-library/pdf/esa_section7_handbook.pdf

Section 10

If there is no federal involvement and the proposed project is being funded or carried out by private interests and/or non-federal government agencies, and the project as proposed may affect listed species, a section 10(a)(1)(B) permit is recommended. The Habitat Conservation Planning Handbook is available at: http://www.fws.gov/endangered/esa-library/pdf/HCP_Handbook.pdf

Service Response

Please note that the Service strives to respond to requests for project review within 30 days of receipt, however, this time period is not mandated by regulation. Responses may be delayed due to workload and lack of staff. Failure to meet the 30-day timeframe does not constitute a concurrence from the Service that the proposed project will not have impacts to threatened and endangered species.

Proposed Species and/or Proposed Critical Habitat

While consultations are required when the proposed action may affect listed species, section 7(a)(4) was added to the ESA to provide a mechanism for identifying and resolving potential conflicts between a proposed action and proposed species or proposed critical habitat at an early planning stage. The action agency should seek conference from the Service to assist the action agency in determining effects and to advise the agency on ways to avoid or minimize adverse effect to proposed species or proposed critical habitat.

Candidate Species

Candidate species are species that are being considered for possible addition to the threatened and endangered species list. They currently have no legal protection under the ESA. If you find you have potential project impacts to these species the Service would like to provide technical assistance to help avoid or minimize adverse effects. Addressing potential impacts to these species at this stage could better provide for overall ecosystem healh in the local area and ay avert potential future listing.

Several species of freshwater mussels occur in Texas and four are candidates for listing under the ESA. The Service is also reviewing the status of six other species for potential listing under the ESA. One of the main contributors to mussel die offs is sedimentation, which smothers and suffocates mussels. To reduce sedimentation within rivers, streams, and tributaries crossed by a

project, the Service recommends that that you implement the best management practices found at: http://www.fws.gov/southwest/es/TexasCoastal/FreshwaterMussels.html.

Candidate Conservation Agreements (CCAs) or Candidate Conservation Agreements with Assurances (CCAAs) are voluntary agreements between the Service and public or private entities to implement conservation measures to address threats to candidate species. Implementing conservation efforts before species are listed increases the likelihood that simpler, flexible, and more cost-effective conservation options are available. A CCAA can provide participants with assurances that if they engage in conservation actions, they will not be required to implement additional conservation measures beyond those in the agreement. For additional information on CCAs/CCAAs please visit the Service's website at http://www.fws.gov/endangered/what-we-do/cca.html.

Migratory Birds

The Migratory Bird Treaty Act (MBTA) implements various treaties and conventions for the protection of migratory birds. Under the MBTA, taking, killing, or possessing migratory birds is unlawful. Many may nest in trees, brush areas or other suitable habitat. The Service recommends activities requiring vegetation removal or disturbance avoid the peak nesting period of March through August to avoid destruction of individuals or eggs. If project activities must be conducted during this time, we recommend surveying for active nests prior to commencing work. A list of migratory birds may be viewed at http://www.fws.gov/migratorybirds/regulationspolicies/mbta/mbtandx.html.

The bald eagle (*Haliaeetus leucocephalus*) was delisted under the Act on August 9, 2007. Both the bald eagle and the goden eagle (*Aquila chrysaetos*) are still protected under the MBTA and BGEPA. The BGEPA affords both eagles protection in addition to that provided by the MBTA, in particular, by making it unlawful to "disturb" eagles. Under the BGEPA, the Service may issue limited permits to incidentally "take" eagles (e.g., injury, interfering with normal breeding, feeding, or sheltering behavior nest abandonment). For more information on bald and golden eagle management guidlines, we recommend you review information provided at http://www.fws.gov/midwest/eagle/pdf/NationalBaldEagleManagementGuidelines.pdf.

The construction of overhead power lines creates threats of avian collision and electrocution. The Service recommends the installation of underground rather than overhead power lines whenever possible. For new overhead lines or retrofitting of old lines, we recommend that project developers implement, to the maximum extent practicable, the Avian Power Line Interaction Committee guidelines found at http://www.aplic.org/.

Meteorological and communication towers are estimated to kill millions of birds per year. We recommend following the guidance set forth in the Service Interim Guidelines for Recommendations on Communications Tower Siting, Constructions, Operation and Decommissioning, found online at: http://www.fws.gov/habitatconservation/communicationtowers.html, to minimize the threat of avian mortality at these towers. Monitoring at these towers would provide insight into the effectiveness of the minimization measures. We request the results of any wildlife mortality monitoring at towers associated with this project.

We request that you provide us with the final location and specifications of your proposed towers, as well as the recommendations implemented. A Tower Site Evaluation Form is also available via the above website; we recommend you complete this form and keep it in your files. If meteorological towers are to be constructed, please forward this completed form to our office.

More information concerning sections 7 and 10 of the Act, migratory birds, candidate species, and landowner tools can be found on our website at: http://www.fws.gov/southwest/es/TexasCoastal/ProjectReviews.html.

Wetlands and Wildlife Habitat

Wetlands and riparian zones provide valuable fish and wildlife habitat as well as contribute to flood control, water quality enhancement, and groundwater recharge. Wetland and riparian vegetation provides food and cover for wildlife, stabilizes banks and decreases soil erosion. These areas are inherently dynamic and very sensitive to changes caused by such activities as overgrazing, logging, major construction, or earth disturbance. Executive Order 11990 asserts that each agency shall provide leadership and take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial value of wetlands in carrying out the agency's responsibilities. Construction activities near riparian zones should be carefully designed to minimize impacts. If vegetation clearing is needed in these riparian areas, they should be re-vegetated with native wetland and riparian vegetation to prevent erosion or loss of habitat. We recommend minimizing the area of soil scarification and initiating incremental re-establishment of herbaceous vegetation at the proposed work sites. Denuded and/or disturbed areas should be re-vegetated with a mixture of native legumes and grasses. Species commonly used for soil stabilization are listed in the Texas Department of Agriculture's (TDA) Native Tree and Plant Directory, available from TDA at P.O. Box 12847, Austin, Texas 78711. The Service also urges taking precautions to ensure sediment loading does not occur to any receiving streams in the proposed project area. To prevent and/or minimize soil erosion and compaction associated with construction activities, avoid any unnecessary clearing of vegetation, and follow established rights-of-way whenever possible. All machinery and petroleum products should be stored outside the floodplain and/or wetland area during construction to prevent possible contamination of water and soils.

Wetlands and riparian areas are high priority fish and wildlife habitat, serving as important sources of food, cover, and shelter for numerous species of resident and migratory wildlife. Waterfowl and other migratory birds use wetlands and riparian corridors as stopover, feeding, and nesting areas. We strongly recommend that the selected project site not impact wetlands and riparian areas, and be located as far as practical from these areas. Migratory birds tend to concentrate in or near wetlands and riparian areas and use these areas as migratory flyways or corridors. After every effort has been made to avoid impacting wetlands, you anticipate unavoidable wetland impacts will occur; you should contact the appropriate U.S. Army Corps of Engineers office to determine if a permit is necessary prior to commencement of construction activities.

If your project will involve filling, dredging, or trenching of a wetland or riparian area it may require a Clean Water Act Section 404 permit from the U.S. Army Corps of Engineers (COE).

For permitting requirements please contact the U.S. Corps of Engineers, District Engineer, P.O. Box 1229, Galveston, Texas 77553-1229, (409) 766-3002.

Beneficial Landscaping

In accordance with Executive Order 13112 on Invasive Species and the Executive Memorandum on Beneficial Landscaping (42 C.F.R. 26961), where possible, any landscaping associated with project plans should be limited to seeding and replanting with native species. A mixture of grasses and forbs appropriate to address potential erosion problems and long-term cover should be planted when seed is reasonably available. Although Bermuda grass is listed in seed mixtures, this species and other introduced species should be avoided as much as possible. The Service also recommends the use of native trees, shrubs, and herbaceous species that are adaptable, drought tolerant and conserve water.

State Listed Species

The State of Texas protects certain species. Please contact the Texas Parks and Wildlife Department (Endangered Resources Branch), 4200 Smith School Road, Austin, Texas 78744 (telephone 512/389-8021) for information concerning fish, wildlife, and plants of State concern or visit their website at: http://www.tpwd.state.tx.us/huntwild/wild/wildlife_diversity/texas_rare_species/listed_species/.

If we can be of further assistance, or if you have any questions about these comments, please contact 281/286-8282 if your project is in southeast Texas, or 361/994-9005, ext. 246, if your project is in southern Texas. Please refer to the Service consultation number listed above in any future correspondence regarding this project.

Attachment(s):

- Official Species List

Official Species List

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

Texas Coastal Ecological Services Field Office
4444 Corona Drive, Suite 215
Corpus Christi, TX 78411
(281) 286-8282

Project Summary

Consultation Code: 02ETTX00-2022-SLI-0616
Event Code: Some(02ETTX00-2022-E-01431)
Project Name: KCRP WSR-88D Lower Scan Angle
Project Type: COMMUNICATIONS TOWER
Project Description: Lowering the minimum scan angle of the KCRP WSR-88D. No construction or ground disturbance would result.

Project Location:

Approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/@27.7839384,-97.5112320243401,14z

Counties: Nueces County, Texas

Endangered Species Act Species

There is a total of 15 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

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1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

Mammals

NAME	STATUS
Gulf Coast Jaguarundi *Herpailurus (=Felis) yagouaroundi cacomitli* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/3945	Endangered
West Indian Manatee *Trichechus manatus* There is **final** critical habitat for this species. The location of the critical habitat is not available. ***This species is also protected by the Marine Mammal Protection Act, and may have additional consultation requirements.*** Species profile: https://ecos.fws.gov/ecp/species/4469	Threatened

Birds

NAME	STATUS
Eastern Black Rail *Laterallus jamaicensis ssp. jamaicensis*	Threatened
No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/10477	
Northern Aplomado Falcon *Falco femoralis septentrionalis*	Endangered
Population: Wherever found, except where listed as an experimental population No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/1923	
Piping Plover *Charadrius melodus*	Threatened
Population: [Atlantic Coast and Northern Great Plains populations] - Wherever found, except those areas where listed as endangered. There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/6039	
Red Knot *Calidris canutus rufa*	Threatened
There is **proposed** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/1864	
Whooping Crane *Grus americana*	Endangered
Population: Wherever found, except where listed as an experimental population There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/758	

Reptiles

NAME	STATUS
Green Sea Turtle *Chelonia mydas*	Threatened
Population: North Atlantic DPS There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/6199	
Hawksbill Sea Turtle *Eretmochelys imbricata*	Endangered
There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/3656	
Kemp's Ridley Sea Turtle *Lepidochelys kempii*	Endangered
There is **proposed** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/5523	
Leatherback Sea Turtle *Dermochelys coriacea*	Endangered
There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/1493	
Loggerhead Sea Turtle *Caretta caretta*	Threatened
Population: Northwest Atlantic Ocean DPS There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/1110	

Insects

NAME	STATUS
Monarch Butterfly *Danaus plexippus* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/9743	Candidate

Flowering Plants

NAME	STATUS
Slender Rush-pea *Hoffmannseggia tenella* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/5298	Endangered
South Texas Ambrosia *Ambrosia cheiranthifolia* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/3331	Endangered

Critical habitats

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

Last Update: 10/1/2021

NUECES COUNTY

AMPHIBIANS

black-spotted newt *Notophthalmus meridionalis*

Terrestrial and aquatic: Terrestrial habitats used by adults are typically poorly drained clay soils that allow for the formation of ephemeral wetlands. A wide variety of vegetation associations are known to be used, such as thorn scrub and pasture. Aquatic habitats used for reprodution are a variety of ephemeral and permanent water bodies.

Federal Status:	State Status: T	SGCN: Y
Endemic: N	Global Rank: G3	State Rank: S3

sheep frog *Hypopachus variolosus*

Terrestrial and aquatic: Predominantly grassland and savanna; largely fossorial in areas with moist microclimates.

Federal Status:	State Status: T	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S4

South Texas siren (Large Form) *Siren sp. 1*

Aquatic: Mainly found in bodies of quiet water, permanent or temporary, with or without submergent vegetation. Wet or sometimes wet areas, such as arroyos, canals, ditches, or even shallow depressions; aestivates in the ground during dry periods, but does require some moisture to remain.

Federal Status:	State Status: T	SGCN: Y
Endemic: N	Global Rank: GNRQ	State Rank: S1

Strecker's chorus frog *Pseudacris streckeri*

Terrestrial and aquatic: Wooded floodplains and flats, prairies, cultivated fields and marshes. Likes sandy substrates.

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S3

BIRDS

bald eagle *Haliaeetus leucocephalus*

Found primarily near rivers and large lakes; nests in tall trees or on cliffs near water; communally roosts, especially in winter; hunts live prey, scavenges, and pirates food from other birds

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S3B,S3N

Black Rail *Laterallus jamaicensis*

Salt, brackish, and freshwater marshes, pond borders, wet meadows, and grassy swamps; nests in or along edge of marsh, sometimes on damp ground, but usually on mat of previous years dead grasses; nest usually hidden in marsh grass or at base of Salicornia

Federal Status: LT	State Status: T	SGCN: Y
Endemic: N	Global Rank: G3	State Rank: S2

Botteri's sparrow *Peucaea botterii*

Two allopatric subspecies occur in Texas. The arizonae subspecies found in the Trans Pecos is considered to be a vagrant because there is just one record from Presidio County in 1997. The other subspecies, texana, can be found regularly in sacahuista habitat (or cordgrass flats) in counties that along the lower coastline like Kenedy, Willacy, and Cameron counties, but also rarely in Kleberg and Brooks counties. This migratory species does not overwinter in Texas. Breeding birds return in spring and sit fairly visibly on (low) commanding perches like fence posts or mesquite limbs where males sing vigorously throughout summer.

Federal Status:	State Status: T	SGCN: Y
Endemic: N	Global Rank: G4	State Rank: S3B

Franklin's gull *Leucophaeus pipixcan*

This species is only a spring and fall migrant throughout Texas. It does not breed in or near Texas. Winter records are unusual consisting of one or a few individuals at a given site (especially along the Gulf coastline). During migration, these gulls fly during daylight hours but often come down to wetlands, lake shore, or islands to roost for the night.

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S2N

Lark Bunting *Calamospiza melanocorys*

Overall, it's a generalist in most short grassland settings including ones with some brushy component plus certain agricultural lands that include grain sorghum. Short grasses include sideoats and blue gramas, sand dropseed, prairie junegrass (Koeleria), buffalograss also with patches of bluestem and other mid-grass species. This bunting will frequent smaller patches of grasses or disturbed patches of grasses including rural yards. It also uses weedy fields surrounding playas. This species avoids urban areas and cotton fields.

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S4B

mountain plover *Charadrius montanus*

Breeding: nests on high plains or shortgrass prairie, on ground in shallow depression; nonbreeding: shortgrass plains and bare, dirt (plowed) fields; primarily insectivorous

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G3	State Rank: S2

northern aplomado falcon *Falco femoralis septentrionalis*

Open country, especially savanna and open woodland, and sometimes in very barren areas; grassy plains and valleys with scattered mesquite, yucca, and cactus; nests in old stick nests of other bird species

Federal Status: LE	State Status: E	SGCN: Y
Endemic: N	Global Rank: G4T2T3	State Rank: S1

piping plover *Charadrius melodus*

Beaches, sandflats, and dunes along Gulf Coast beaches and adjacent offshore islands. Also spoil islands in the Intracoastal Waterway. Based on the November 30, 1992 Section 6 Job No. 9.1, Piping Plover and Snowy Plover Winter Habitat Status Survey, algal flats appear to be the highest quality habitat. Some of the most important aspects of algal flats are their relative inaccessibility and their continuous availability throughout all tidal conditions. Sand flats often appear to be preferred over algal flats when both are available, but large portions of sand flats along the Texas coast are available only during low-very low tides and are often completely unavailable during extreme high tides or strong north winds. Beaches appear to serve as a secondary habitat to the flats associated with the primary bays, lagoons, and inter-island passes. Beaches are rarely used on the southern Texas coast, where bayside habitat is always available, and are abandoned as bayside habitats become available on the central and northern coast. However, beaches are probably a vital habitat along the central and northern coast (i.e. north of Padre Island) during periods of extreme high tides that cover the flats. Optimal site characteristics appear to be large in area, sparsely vegetated, continuously available or in close proximity to secondary habitat, and with limited human disturbance.

Federal Status: LT	State Status: T	SGCN: Y
Endemic: N	Global Rank: G3	State Rank: S2N

reddish egret *Egretta rufescens*

Resident of the Texas Gulf Coast; brackish marshes and shallow salt ponds and tidal flats; nests on ground or in trees or bushes, on dry coastal islands in brushy thickets of yucca and prickly pear

Federal Status:	State Status: T	SGCN: Y
Endemic: N	Global Rank: G4	State Rank: S2B

Rufa Red Knot *Calidris canutus rufa*

Habitat: Primarily seacoasts on tidal flats and beaches, herbaceous wetland, and Tidal flat/shore. Bolivar Flats in Galveston County, sandy beaches Mustang Island, few on outer coastal and barrier beaches, tidal mudflats and salt marshes

Federal Status: LT State Status: T SGCN: Y
Endemic: N Global Rank: G4T2 State Rank: S2N

sooty tern *Onychoprion fuscatus*

Primarily an offshore bird; does nest on sandy beaches and islands, breeding April-July.

Federal Status: State Status: T SGCN: Y
Endemic: N Global Rank: G5 State Rank: S1B

swallow-tailed kite *Elanoides forficatus*

Lowland forested regions, especially swampy areas, ranging into open woodland; marshes, along rivers, lakes, and ponds; nests high in tall tree in clearing or on forest woodland edge, usually in pine, cypress, or various deciduous trees

Federal Status: State Status: T SGCN: Y
Endemic: N Global Rank: G5 State Rank: S2B

tropical parula *Setophaga pitiayumi*

Semi-tropical evergreen woodland along rivers and resacas. Texas ebony, anacua and other trees with epiphytic plants hanging from them. Dense or open woods, undergrowth, brush, and trees along edges of rivers and resacas; breeding April to July.

Federal Status: State Status: T SGCN: Y
Endemic: N Global Rank: G5 State Rank: S3B

western burrowing owl *Athene cunicularia hypugaea*

Open grasslands, especially prairie, plains, and savanna, sometimes in open areas such as vacant lots near human habitation or airports; nests and roosts in abandoned burrows

Federal Status: State Status: SGCN: Y
Endemic: N Global Rank: G4T4 State Rank: S2

white-faced ibis *Plegadis chihi*

Prefers freshwater marshes, sloughs, and irrigated rice fields, but will attend brackish and saltwater habitats; currently confined to near-coastal rookeries in so-called hog-wallow prairies. Nests in marshes, in low trees, on the ground in bulrushes or reeds, or on floating mats.

Federal Status: State Status: T SGCN: Y
Endemic: N Global Rank: G5 State Rank: S4B

white-tailed hawk *Buteo albicaudatus*

Near coast on prairies, cordgrass flats, and scrub-live oak; further inland on prairies, mesquite and oak savannas, and mixed savanna-chaparral; breeding March-May

Federal Status: State Status: T SGCN: Y
Endemic: N Global Rank: G4G5 State Rank: S4B

whooping crane *Grus americana*

Small ponds, marshes, and flooded grain fields for both roosting and foraging. Potential migrant via plains throughout most of state to coast; winters in coastal marshes of Aransas, Calhoun, and Refugio counties.

Federal Status: LE State Status: E SGCN: Y
Endemic: N Global Rank: G1 State Rank: S1S2N

wood stork *Mycteria americana*

Prefers to nest in large tracts of baldcypress (Taxodium distichum) or red mangrove (Rhizophora mangle); forages in prairie ponds, flooded pastures or fields, ditches, and other shallow standing water, including salt-water; usually roosts communally in tall snags, sometimes in association with other wading birds (i.e. active heronries); breeds in Mexico and birds move into Gulf States in search of mud flats and other wetlands, even those associated with forested areas; formerly nested in Texas, but no breeding records since 1960

Federal Status:	State Status: T	SGCN: Y
Endemic: N	Global Rank: G4	State Rank: SHB,S2N

FISH

american eel *Anguilla rostrata*

Originally found in all river systems from the Red River to the Rio Grande. Aquatic habtiats include large rivers, streams, tributaries, coastal watersheds, estuaries, bays, and oceans. Spawns in Sargasso Sea, larva move to coastal waters, metamorphose, and begin upstream movements. Females tend to move further upstream than males (who are often found in brackish estuaries). American Eel are habitat generalists and may be found in a broad range of habitat conditions including slow- and fast-flowing waters over many substrate types. Extirpation in upstream drainages attributed to reservoirs that impede upstream migration.

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G4	State Rank: S4

fat snook *Centropomus parallelus*

Occupies freshwater, estuarine, and marine areas near mangroves, rocky overhangs or protected riverbanks, but is most commonly found inshore (freshwater). Spawning occurs from March-August in freshwater. After hatching, larvae disperse with the currents to estuarine areas (Gilmore et al. 1983, McMichael and Parsons 1989). Juveniles migrate from freshwater to estuarine areas based on flow and salinity regimes.

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S3?

Oceanic Whitetip Shark *Carcharhinus longimanus*

Habitat description is not available at this time.

Federal Status: LT	State Status: T	SGCN: Y
Endemic: N	Global Rank: GNR	State Rank: S2

opossum pipefish *Microphis brachyurus*

Adults are only found in low salinity waters of estuaries or freshwater tributaries within 30 miles of the coast (Gilmore 1992), where they also give birth. Young move or are carried into more saline waters off the coast after birth. Newly released larvae must have conditions near 18 ppt salinity for at least two weeks after birth to survive, indicating a physiology adapted for downstream transport to estuarine and marine environments (Frias-Torres 2002). Juvenile migration toward the ocean depends on water flow regimes, salinity, and vegetation for cover and capturing prey (Frias-Torres 2002). Seawalls, docks, and riprap construction destroy habitat and poor water quality and alteration of flow regimes may prevent migration (NMFS 2009).

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G4G5	State Rank: S3N

Shortfin Mako Shark *Isurus oxyrinchus*

Habitat description is not available at this time.

Federal Status:	State Status: T	SGCN: Y
Endemic: N	Global Rank: GNR	State Rank: S2

snook *Centropomus undecimalis*

Juvenile common snook are generally restricted to the protection of riverine, salt marshes, seagrass beds, and estuary environments. These environments offer shallow water and an overhanging vegetative shoreline. Juvenile common snook can survive in waters with lower oxygen levels than adults. Adult common snook inhabit many fresh, estuarine, and marine environments including mangrove forests, beaches, river mouths, nearshore reefs, salt marshes, sea grass meadows, and near structure (pilings, artificial reefs, etc.). Adult common snook appear to be

less sensitive to cold water temperatures than larvae or small juveniles. The lower lethal limit of water temperature is 48.2°-57.2° F (9°-14° C) for juveniles and 42.8°-53.6° F (6°-12° C) for adults (Hill 2005, Press 2010).

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S3?

southern flounder *Paralichthys lethostigma*

This is an estuarine-dependent species that inhabits riverine, estuarine and coastal waters, and prefers muddy, sandy, or silty substrates (Reagan and Wingo 1985). Individuals can tolerate wide temperature (~5-35°C) and salinity ranges (0-60 ppt). Southern Flounder spawn in offshore waters of the Gulf of Mexico from October to February (Reagan and Wingo 1985). The oceanic larval stage is pelagic and lasts 30–60 days. Metamorphosing individuals enter estuaries and migrate towards low-salinity headwaters, where settlement occurs (Burke et al. 1991, Walsh et al. 1999). The young fish enter the bays during late winter and early spring, occupying seagrass; some may move further into coastal rivers and bayous. Juveniles remain in estuaries until the onset of sexual maturation (approximately two years), at which time they migrate out of estuaries to join adults on the inner continental shelf. Adult southern flounder leave the bays during the fall for spawning in the Gulf of Mexico. They spawn for the first time when two years old at depths of 50 to 100 feet. Although most of the adults leave the bays and enter the Gulf for spawning during the winter, some remain behind and spend winter in the bays. Those in the Gulf will reenter the bays in the spring. The spring influx is gradual and does not occur with large concentrations that characterize the fall emigration.

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S5

INSECTS

American bumblebee *Bombus pensylvanicus*

Habitat description is not available at this time.

Federal Status:	State Status:	SGCN: Y
Endemic:	Global Rank: G3G4	State Rank: SNR

Comanche harvester ant *Pogonomyrmex comanche*

Habitat description is not available at this time.

Federal Status:	State Status:	SGCN: Y
Endemic: Y	Global Rank: G2G3	State Rank: S2

Gladiator short-winged katydid *Dichopetala gladiator*

Habitat description is not available at this time.

Federal Status:	State Status:	SGCN: Y
Endemic:	Global Rank: GNR	State Rank: SNR

Gulf Dune Grasshopper *Trimerotropis schaefferi*

Coastal dunes and areas behind the dunes.

Federal Status:	State Status:	SGCN: Y
Endemic: Y	Global Rank: G2G3	State Rank: S2?

Manfreda giant-skipper *Stallingsia maculosus*

Most skippers are small and stout-bodied; name derives from fast, erratic flight; at rest most skippers hold front and hind wings at different angles; skipper larvae are smooth, with the head and neck constricted; skipper larvae usually feed inside a leaf shelter and pupate in a cocoon made of leaves fastened together with silk

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G1	State Rank: S1

MAMMALS

barrier island Texas pocket gopher *Geomys personatus personatus*

Limited information available. Likely found in sandy soils.

Federal Status: State Status: SGCN: Y
Endemic: Y Global Rank: G4TNR State Rank: SNR

big free-tailed bat *Nyctinomops macrotis*

Habitat data sparse but records indicate that species prefers to roost in crevices and cracks in high canyon walls, but will use buildings, as well; reproduction data sparse, gives birth to single offspring late June-early July; females gather in nursery colonies; winter habits undetermined, but may hibernate in the Trans-Pecos; opportunistic insectivore

Federal Status: State Status: SGCN: Y
Endemic: N Global Rank: G5 State Rank: S3

blue whale *Balaenoptera musculus*

Inhabits tropical, subtropical, temperate, and subpolar waters worldwide, but are infrequently sighted in the Gulf of Mexico. They migrate seasonally between summer feeding grounds and winter breeeding grounds, but specifics vary. Commonly observed at the surface in open ocean.

Federal Status: LE State Status: E SGCN: Y
Endemic: N Global Rank: G3G4 State Rank: SH

cave myotis bat *Myotis velifer*

Colonial and cave-dwelling; also roosts in rock crevices, old buildings, carports, under bridges, and even in abandoned Cliff Swallow (Hirundo pyrrhonota) nests; roosts in clusters of up to thousands of individuals; hibernates in limestone caves of Edwards Plateau and gypsum cave of Panhandle during winter; opportunistic insectivore.

Federal Status: State Status: SGCN: Y
Endemic: N Global Rank: G4G5 State Rank: S2S3

eastern red bat *Lasiurus borealis*

Red bats are migratory bats that are common across Texas. They are most common in the eastern and central parts of the state, due to their requirement of forests for foliage roosting. West Texas specimens are associated with forested areas (cottonwoods). Also common along the coastline. These bats are highly mobile, seasonally migratory, and practice a type of "wandering migration". Associations with specific habitat is difficult unless specific migratory stopover sites or wintering grounds are found. Likely associated with any forested area in East, Central, and North Texas but can occur statewide.

Federal Status: State Status: SGCN: Y
Endemic: N Global Rank: G3G4 State Rank: S4

eastern spotted skunk *Spilogale putorius*

Generalist; open fields prairies, croplands, fence rows, farmyards, forest edges & woodlands. Prefer wooded, brushy areas & tallgrass prairies. S.p. ssp. interrupta found in wooded areas and tallgrass prairies, preferring rocky canyons and outcrops when such sites are available.

Federal Status: State Status: SGCN: Y
Endemic: N Global Rank: G4 State Rank: S1S3

Gulf of Mexico Bryde's Whale *Balaenoptera edeni*

Habitat description is not available at this time.

Federal Status: LE State Status: E SGCN: N
Endemic: N Global Rank: G4 State Rank: SNR

hoary bat *Lasiurus cinereus*

Hoary bats are highly migratory, high-flying bats that have been noted throughout the state. Females are known to migrate to Mexico in the winter, males tend to remain further north and may stay in Texas year-round. Commonly associated with forests (foliage roosting species) but are found in unforested parts of the state and lowland deserts. Tend to be captured over water and large, open flyways.

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G3G4	State Rank: S4

humpback whale *Megaptera novaeangliae*

Inhabits tropical, subtropical, temperate, and subpolar waters world wide. Migrate up to 5,000 miles between colder water (feeding grounds) and warmer water (calving grounds) each year. They will use both open ocean and coastal waters, sometimes including inshore areas such as bays, and are often found near the surface; however, this species is rare in the Gulf of Mexico. The northwest Atlantic/Gulf of Mexico distinct population segment is not considered at risk of extinction and is not listed as Endangered on the Endangered Species Act.

Federal Status: LE	State Status:	SGCN: Y
Endemic: N	Global Rank: G4	State Rank: SNR

long-tailed weasel *Mustela frenata*

Includes brushlands, fence rows, upland woods and bottomland hardwoods, forest edges & rocky desert scrub. Usually live close to water.

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S5

maritime pocket gopher *Geomys personatus maritimus*

Fossorial, in deep sandy soils; feeds mostly from within burrow on roots and other plant parts, especially grasses; ecologically important as prey species and in influencing soils, microtopography, habitat heterogeneity, and plant diversity

Federal Status:	State Status:	SGCN: Y
Endemic: Y	Global Rank: G4T2	State Rank: S2

mountain lion *Puma concolor*

Generalist; found in a wide range of habitats statewide. Found most frequently in rugged mountains & riparian zones.

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S2S3

North Atlantic right whale *Eubalaena glacialis*

Inhabits subtropical and temperate waters in the northern Atlantic. Commonly found in coastal waters or clsoe to the continental shelf near the surface. They migrate from feeding grounds in cooler waters (Canada and New England) to warmer waters of the southeast US (South Carolina, Georgia, and Florida) to give birth in the fall/winter - both areas are identified as critical habitat by NOAA-NMFS. Nursery areas are in shallow, coastal waters. This species is very rare in the Gulf of Mexico and the few reported sightings are likely vagrants (Ward-Geiger etal 2011).

Federal Status: LE	State Status: E	SGCN: Y
Endemic: N	Global Rank: G1	State Rank: S1

Northern yellow bat *Lasiurus intermedius*

Occurs mainly along the Gulf Coast but inland specimens are not uncommon. Prefers roosting in spanish moss and in the hanging fronds of palm trees. Common where this vegtation occurs. Found near water and forages over grassy, open areas. Males usually roost solitarily, whereas females roost in groups of several individuals.

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S4

ocelot *Leopardus pardalis*

Restricted to mesquite-thorn scrub and live-oak mottes; avoids open areas. Dense mixed brush below four feet; thorny shrublands; dense chaparral thickets; breeds and raises young June-November.

Federal Status: LE	State Status: E	SGCN: Y
Endemic: N	Global Rank: G4	State Rank: S1

Padre Island kangaroo rat *Dipodomys compactus compactus*

Dunes and open sandy areas near the coast.

Federal Status:	State Status:	SGCN: Y
Endemic: Y	Global Rank: G4T3	State Rank: S3

Sei Whale *Balaenoptera borealis*

Habitat description is not available at this time.

Federal Status: LE	State Status: E	SGCN: N
Endemic: N	Global Rank: G3	State Rank: SNR

southern yellow bat *Lasiurus ega*

Relict palm grove is only known Texas habitat. Neotropical species roosting in palms, forages over water; insectivorous; breeding in late winter. Roosts in dead palm fronds in ornamental palms in urban areas.

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S3S4

sperm whale *Physeter macrocephalus*

Inhabits tropical, subtropical, and temperate waters world wide, avoiding icey waters. Distribution is highly dependent on their food source (squids, sharks, skates, and fish), breeding, and composition of the pod. In general, this species migrates from north to south in the winter and south to north in the summer; however, individuals in tropical and temperate waters don't seem to migrate at all. Routinely dive to catch their prey (2,000-10,000 feet) and generally occupies water at least 3,300 feet deep near ocean trenches.

Federal Status: LE	State Status: E	SGCN: Y
Endemic: N	Global Rank: G3G4	State Rank: S1

tricolored bat *Perimyotis subflavus*

Forest, woodland and riparian areas are important. Caves are very important to this species.

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G2G3	State Rank: S2

West Indian manatee *Trichechus manatus*

Large rivers, brackish water bays, coastal waters. Warm waters of the tropics, in rivers and brackish bays but may also survive in salt water habitats. Very sensitive to cold water temperatures. Rarely occurring as far north as Texas. Gulf and bay system; opportunistic, aquatic herbivore.

Federal Status: LT	State Status: T	SGCN: Y
Endemic: N	Global Rank: G2G3	State Rank: S1

western hog-nosed skunk *Conepatus leuconotus*

Habitats include woodlands, grasslands & deserts, to 7200 feet, most common in rugged, rocky canyon country; little is known about the habitat of the ssp. telmalestes

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G4	State Rank: S4

white-nosed coati *Nasua narica*

Woodlands, riparian corridors and canyons.Most individuals in Texas probably transients from Mexico; diurnal and crepuscular; very sociable; forages on ground and in trees; omnivorous; may be susceptible to hunting, trapping, and pet trade

Federal Status:	State Status: T	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S1

MOLLUSKS

No accepted common name *Millerelix gracilis*

Habitat description is not available at this time.

Federal Status:	State Status:	SGCN: Y
Endemic:	Global Rank: G2G3	State Rank: S2?

REPTILES

Atlantic hawksbill sea turtle *Eretmochelys imbricata*

Inhabit tropical and subtropical waters worldwide, in the Gulf of Mexico, especially Texas. Hatchling and juveniles are found in open, pelagic ocean and closely associated with floating lgae/seagrass mats. Juveniles then migrate to shallower, coastal areas, mainly coral reefs and rocky areas, but also in bays and estuaries near mangroves when reefs are absent; seldom in water lmore than 65 feet deep. They feed on sponges, jellyfish, sea urchins, molluscs, and crustaceans. Nesting occurs from April to November high up on the beach where there is vegetation for cover and little or no sand. Some migrate, but others stay close to foraging areas - females are philopatric.

Federal Status: LE	State Status: E	SGCN: Y
Endemic: N	Global Rank: G3	State Rank: S2

green sea turtle *Chelonia mydas*

Inhabits tropical, subtropical, and temperate waters worldwide, including the Gulf of Mexico. Adults and juveniles occupy inshore and nearshore areas, including bays and lagoons with reefs and seagrass. They migrate from feeding grounds (open ocean) to nesting grounds (beaches/barrier islands) and some nesting does occur in Texas (April to September). Adults are herbivorous feeding on sea grass and seaweed; juveniles are omnivorous feeding initially on marine invertebrates, then increasingly on sea grasses and seaweeds.

Federal Status: LT	State Status: T	SGCN: Y
Endemic: N	Global Rank: G3	State Rank: S3B, S3N

Kemp's Ridley sea turtle *Lepidochelys kempii*

Inhabits tropical, subtropical, and temperate waters of the northwestern Atlantic Ocean and Gulf of Mexico. Adults are found in coastal waters with muddy or sandy bottoms. Some males migrate between feeding grounds and breeeding grounds, but some don't. Females migrate between feeding and nesting areas, often returning to the same destinations. Nesting in Texas occurs on a smaller scale compared to other areas (i.e. Mexico). Hatchlings are quickly swept out to open water and are rarely found nearshore. Similarly, juveniles often congregate near floating algae/seagrass mats offshore, and move into nearshore, coastal, neritic areas after 1-2 years and remain until they reach maturity. They feed primarily on crabs, but also snails, clams, other crustaceans and plants, juveniles feed on sargassum and its associated fauna; nests April through August.

Federal Status: LE	State Status: E	SGCN: Y
Endemic: N	Global Rank: G1	State Rank: S3

leatherback sea turtle *Dermochelys coriacea*

Inhabit tropical, subtropical, and temperate waters worldwide, including the Gulf of Mexico. Nesting is not common in Texas (March to July). Most pelagic of the seaturtles with the longest migration (>10,000 miles) between nesting and foraging sites. Are able to dive to depths of 4,000 feet. They are omnivorous, showing a preference for jellyfish.

Federal Status: LE	State Status: E	SGCN: Y
Endemic: N	Global Rank: G2	State Rank: S1S2

loggerhead sea turtle *Caretta caretta*

Inhabits tropical, subtropical, and temperate waters worldwide, including the Gulf of Mexico. They migrate from feeding grounds to nesting beaches/barrier islands and some nesting does occur in Texas (April to September). Beaches that are narrow, steeply sloped, with coarse-grain

sand are preffered for nesting. Newly hatched individuals depend on floating alage/seaweed for protection and foraging, which eventually transport them offshore and into open ocean. Juveniles and young adults spend their lives in open ocean, offshore before migrating to coastal areas to breed and nest. Foraging areas for adults include shallow continental shelf waters.

Federal Status: LT	State Status: T	SGCN: Y
Endemic: N	Global Rank: G3	State Rank: S4

Mexican blackhead snake *Tantilla atriceps*

Terrestrial: Shrubland savanna.

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G4	State Rank: S1

slender glass lizard *Ophisaurus attenuatus*

Terrestrial: Habitats include open grassland, prairie, woodland edge, open woodland, oak savannas, longleaf pine flatwoods, scrubby areas, fallow fields, and areas near streams and ponds, often in habitats with sandy soil.

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S3

Tamaulipan spot-tailed earless lizard *Holbrookia subcaudalis*

Terrestrial: Habitats include moderately open prairie-brushland regions, particularly fairly flat areas free of vegetation or other obstructions (e.g., open meadows, old and new fields, graded roadways, cleared and disturbed areas, prairie savanna, and active agriculture including row crops); also, oak-juniper woodlands and mesquite-prickly pear associations (Axtell 1968, Bartlett and Bartlett 1999).

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: GNR	State Rank: S2

Texas diamondback terrapin *Malaclemys terrapin littoralis*

Coastal marshes, tidal flats, coves, estuaries, and lagoons behind barrier beaches; brackish and salt water; burrows into mud when inactive. Bay islands are important habitats. Nests on oyster shell beaches.

Federal Status:	State Status:	SGCN: Y
Endemic: Y	Global Rank: G4T3Q	State Rank: S2

Texas horned lizard *Phrynosoma cornutum*

Terrestrial: Open habitats with sparse vegetation, including grass, prairie, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky; burrows into soil, enters rodent burrows, or hides under rock when inactive. Occurs to 6000 feet, but largely limited below the pinyon-juniper zone on mountains in the Big Bend area.

Federal Status:	State Status: T	SGCN: Y
Endemic: N	Global Rank: G4G5	State Rank: S3

Texas indigo snake *Drymarchon melanurus erebennus*

Terrestrial: Thornbush-chaparral woodland of south Texas, in particular dense riparian corridors.Can do well in suburban and irrigated croplands. Requires moist microhabitats, such as rodent burrows, for shelter.

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5T4	State Rank: S4

Texas scarlet snake *Cemophora lineri*

Terrestrial: Prefers well drained soils with a variety of forest, grassland, and scrub habitats.

Federal Status:	State Status: T	SGCN: Y
Endemic: Y	Global Rank: G2	State Rank: S1S2

Texas tortoise *Gopherus berlandieri*

Terrestrial: Open scrub woods, arid brush, lomas, grass-cactus association; often in areas with sandy well-drained soils. When inactive occupies shallow depressions dug at base of bush or cactus; sometimes in underground burrow or under object. Eggs are laid in nests dug in soil near or under bushes.

Federal Status:	State Status: T	SGCN: Y
Endemic: N	Global Rank: G4	State Rank: S2

western box turtle *Terrapene ornata*

Terrestrial: Ornate or western box trutles inhabit prairie grassland, pasture, fields, sandhills, and open woodland. They are essentially terrestrial but sometimes enter slow, shallow streams and creek pools. For shelter, they burrow into soil (e.g., under plants such as yucca) (Converse et al. 2002) or enter burrows made by other species.

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S3

western hognose snake *Heterodon nasicus*

Terrestrial: Shortgrass or mixed grass prairie, with gravel or sandy soils. Often found associated with draws, floodplains, and more mesic habitats within the arid landscape. Frequently occurs in shrub encroached grasslands.

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G5	State Rank: S4

western massasauga *Sistrurus tergeminus*

Terrestrial: Shortgrass or mixed grass prairie, with gravel or sandy soils. Often found associated with draws, floodplains, and more mesic habitats within the arid landscape. Frequently occurs in shrub encroached grasslands.

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G3G4	State Rank: S3

PLANTS

black lace cactus *Echinocereus reichenbachii var. albertii*

Grasslands, thorn shrublands, mesquite woodlands on sandy, somewhat saline soils on coastal prairie, most frequently in naturally open areas sparsely covered with brush of a low stature not resulting from disturbance or along creeks in ecotonal areas between this upland type and lower areas dominated by halophytic grasses and forbs; flowering April-June

Federal Status: LE	State Status: E	SGCN: Y
Endemic: Y	Global Rank: G5T1Q	State Rank: S1

Buckley's spiderwort *Tradescantia buckleyi*

Occurs on sandy loam or clay soils in grasslands or shrublands underlain by the Beaumount Formation.

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G3	State Rank: S3

Cory's croton *Croton coryi*

Grasslands and woodland openings on barrier islands and coastal sands of South Texas, inland on South Texas Sand Sheet; Annual; Flowering July-Oct; Fruiting July-Nov

Federal Status:	State Status:	SGCN: Y
Endemic: Y	Global Rank: G3	State Rank: S3

crestless onion *Allium canadense var. ecristatum*

Occurs on poorly drained sites on sandy substrates within coastal prairies of the Coastal Bend area (Carr 2015).

Federal Status: State Status: SGCN: Y
Endemic: Y Global Rank: G5T3 State Rank: S3

Drummond's rushpea *Hoffmannseggia drummondii*

Open areas on sandy clay; Perennial

Federal Status: State Status: SGCN: Y
Endemic: N Global Rank: G3 State Rank: S3

Elmendorf's onion *Allium elmendorfii*

Grassland openings in oak woodlands on deep, loose, well-drained sands; in Coastal Bend, on Pleistocene barrier island ridges and Holocene Sand Sheet that support live oak woodlands; to the north it occurs in post oak-black hickory-live oak woodlands over Queen City and similar Eocene formations; one anomalous specimen found on Llano Uplift in wet pockets of granitic loam; Perennial; Flowering March-April, May

Federal Status: State Status: SGCN: Y
Endemic: Y Global Rank: G2 State Rank: S2

Greenman's bluet *Houstonia parviflora*

Grass pastures. Feb- Apr. (Correll and Johnston 1970).

Federal Status: State Status: SGCN: Y
Endemic: Y Global Rank: G3 State Rank: S3

Jones' nailwort *Paronychia jonesii*

Occurs in early successional open areas on deep well-drained sand; Biennial Annual; Flowering March-Nov; Fruiting April-Nov

Federal Status: State Status: SGCN: Y
Endemic: Y Global Rank: G3G4 State Rank: S3S4

Jones's rainlilly *Cooperia jonesii*

Hardpan swales and other seasonally moist low areas (Jones 1977). Flowering mid summer--early fall (Jul--Oct) (Flagg, Smith & Flory 2002).

Federal Status: State Status: SGCN: Y
Endemic: Y Global Rank: G3Q State Rank: S3

large selenia *Selenia grandis*

Occurs in seasonally wet clayey soils in open areas; Annual; Flowering Jan-April; Fruiting Feb-April

Federal Status: State Status: SGCN: Y
Endemic: Y Global Rank: G3 State Rank: S3

lila de los llanos *Echeandia chandleri*

Most commonly encountered among shrubs or in grassy openings in subtropical thorn shrublands on somewhat saline clays of lomas along Gulf Coast near mouth of Rio Grande; also observed in a few upland coastal prairie remnants on clay soils over the Beaumont Formation at inland sites well to the north and along railroad right-of-ways and cemeteries; flowering (May-) September-December, fruiting October-December

Federal Status: State Status: SGCN: Y
Endemic: N Global Rank: G2G3 State Rank: S2S3

Mexican mud-plantain *Heteranthera mexicana*

Wet clayey soils of resacas and ephemeral wetlands in South Texas and along margins of playas in the Panhandle; flowering June-December, only after sufficient rainfall

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G2G3	State Rank: S1

plains gumweed *Grindelia oolepis*

Coastal prairies on heavy clay (blackland) soils, often in depressional areas, sometimes persisting in areas where management (mowing) may maintain or mimic natural prairie disturbance regimes; crawfish lands; on nearly level Victoria clay, Edroy clay, claypan, possibly Greta within Orelia fine sandy loam over the Beaumont Formation, and Harlingen clay; roadsides, railroad rights-of-ways, vacant lots in urban areas, cemeteries; flowering April-December

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G2	State Rank: S2

sand Brazos mint *Brazoria arenaria*

Sandy areas in South Texas; Annual; Flowering/Fruiting March-April

Federal Status:	State Status:	SGCN: Y
Endemic: Y	Global Rank: G3	State Rank: S3

slender rush-pea *Hoffmannseggia tenella*

Coastal prairie grasslands on level uplands and on gentle slopes along drainages, usually in areas of shorter or sparse vegetation; soils often described as Blackland clay, but at some of these sites soils are coarser textured and lighter in color than the typical heavy clay of the coastal prairies; flowering April-November

Federal Status: LE	State Status: E	SGCN: Y
Endemic: Y	Global Rank: G1	State Rank: S1

South Texas ambrosia *Ambrosia cheiranthifolia*

Grasslands and mesquite-dominated shrublands on various soils ranging from heavy clays to lighter textured sandy loams, mostly over the Beaumont Formation on the Coastal Plain; in modified unplowed sites such as railroad and highway right-of-ways, cemeteries, mowed fields, erosional areas along small creeks; Perennial; Flowering July-November

Federal Status: LE	State Status: E	SGCN: Y
Endemic: N	Global Rank: G2	State Rank: S1

South Texas spikesedge *Eleocharis austrotexana*

Occurring in miscellaneous wetlands at scattered locations on the coastal plain; Perennial; Flowering/Fruiting Sept

Federal Status:	State Status:	SGCN: Y
Endemic: Y	Global Rank: G3	State Rank: S3

Texas peachbush *Prunus texana*

Occurs at scattered sites in various well drained sandy situations; deep sand, plains and sand hills, grasslands, oak woods, 0-200 m elevation; Perennial; Flowering Feb-Mar; Fruiting Apr-Jun

Federal Status:	State Status:	SGCN: Y
Endemic: Y	Global Rank: G3G4	State Rank: S3S4

Texas stonecrop *Lenophyllum texanum*

Found in shrublands on clay dunes (lomas) at the mouth of the Rio Grande and on xeric calcareous rock outcrops at scattered inland sites; Perennial; Flowering/Fruiting Nov-Feb

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G3	State Rank: S3

Texas windmill grass *Chloris texensis*

Sandy to sandy loam soils in relatively bare areas in coastal prairie grassland remnants, often on roadsides where regular mowing may mimic natural prairie fire regimes; flowering in fall

Federal Status:	State Status:	SGCN: Y
Endemic: Y	Global Rank: G2	State Rank: S2

Tharp's dropseed *Sporobolus tharpii*

Occurs on barrier islands, shores of lagoons and bays protected by the barrier islands, and on shores of a few near-coastal ponds. Plants occur at the bases of dunes, in interdune swales and sandflats, and on upper beaches. The substrate is of Holocene age.

Federal Status:	State Status:	SGCN: Y
Endemic: Y	Global Rank: G3	State Rank: S3

Tharp's rhododon *Rhododon angulatus*

Deep, loose sands in sparsely vegetated areas on stabilized dunes of Pleistocene barrier islands; flowering (May-) June-September, sometimes later with appropriate rainfall

Federal Status:	State Status:	SGCN: Y
Endemic: Y	Global Rank: G1Q	State Rank: S1

tree dodder *Cuscuta exaltata*

Parasitic on various Quercus, Juglans, Rhus, Vitis, Ulmus, and Diospyros species as well as Acacia berlandieri and other woody plants; Annual; Flowering May-Oct; Fruiting July-Oct

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G3	State Rank: S3

velvet spurge *Euphorbia innocua*

Open or brushy areas on coastal sands and the South Texas Sand Sheet; Perennial; Flowering Sept-April; Fruiting Nov-July

Federal Status:	State Status:	SGCN: Y
Endemic: Y	Global Rank: G3	State Rank: S3

Welder machaeranthera *Psilactis heterocarpa*

Grasslands , varying from midgrass coastal prairies, and open mesquite-huisache woodlands on nearly level, gray to dark gray clayey to silty soils; known locations mapped on Victoria clay, Edroy clay, Dacosta sandy clay loam over Beaumont and Lissie formations; flowering September-November

Federal Status:	State Status:	SGCN: Y
Endemic: Y	Global Rank: G2G3	State Rank: S2S3

Wright's trichocoronis *Trichocoronis wrightii var. wrightii*

Most records from Texas are historical, perhaps indicating a decline as a result of alteration of wetland habitats; Annual; Flowering Feb-Oct; Fruiting Feb-Sept

Federal Status:	State Status:	SGCN: Y
Endemic: N	Global Rank: G4T3	State Rank: S2

APPENDIX C

TECHNICAL MEMORANDUM AND TRIP REPORT

SENSOR ENVIRONMENTAL LLC
www.sensorenvirollc.com

TECHNICAL MEMORANDUM

TO: William Deringer, Program Manager, Centuria Corporation	**FROM:** James Manitakos, CEO, Sensor Environmental LLC
CC: Jessica Schultz, Deputy Director, National Weather Service Radar Operations center Andre Tarpinian, Senior RF Engineer, Alion Science and Technology Corp.	**SUBJECT:** Analysis of Lower Scan Angles For Weather Surveillance Radar, Model 1988 Doppler (WSR-88D) Serving Corpus Christi, TX, Area
DATE: January 28, 2022	

1. BACKGROUND AND NEED

The National Weather Service (NWS) proposes to reduce the minimum vertical scan angles used during normal operation of the WSR-88D serving Corpus Christi, TX, area. Information on this radar is shown in Table 1. This WSR-88D was commissioned on September 4, 1996 and has been in operation at its current location since then.

TABLE 1: Information on WSR-88D Serving the Corpus Christi, TX, Area	
Location	Corpus Christi International Airport, Corpus Christi, Nueces County, TX
Commissioning Date	September 4, 1996
International Civil Aviation Organization designator	KCRP
Elevation, ground surface at tower base (mean sea level, MSL)	45 feet (ft)
Elevation, center of antenna (MSL)	143 ft
Tower Height (m)	25 m (82 ft)
Latitude (WGS84)	27˚47’03” N
Longitude (WGS84)	97˚30’40” W
Weather Forecast Office (WFO)	426 Pinson Drive Corpus Christi, TX 78406
Meteorologist-in-Charge (MIC)	John Metz Email: john.metz@noaa.gov Tel. (361)232-8289
Operating Frequency	2,810 megaHertz (MHz)
Spot Blanking or Sector Blanking used	No

NWS currently operates the KCRP WSR-88D at a minimum center-of-beam scan angle of +0.5 degree (deg). The WSR-88D main beam has a width of 1 deg to the half power points. Half of the beam (i.e., 0.5 deg) is below the axis, resulting in an essentially horizontal floor for existing radar coverage. As a result, the WSR-88D cannot provide radar coverage of the atmosphere below the elevation of the WSR-88D antenna. At considerable distance from the radar, earth curvature increases the height above the ground surface of the uncovered area. To increase the amount of radar coverage provided by the KCRP WSR-88D, NWS proposes to operate the radar with a center-of-beam scan angle as low -0.2 deg, which would result in the lower half power point of the main beam at -0.7 deg.

2. INVESTIGATIONS PERFORMED

To analyze the benefits and potential impacts of lowering the minimum scan angle of the KCRP WSR-88D, Sensor Environmental LLC and our subcontractor Alion Science and Technology Corporation performed the following tasks:

1. We visited the KCRP WSR-88D with NWS staff from the Corpus Christi, TX Weather Forecast Office (WFO) to ascertain site conditions and activities in the vicinity (see Attachment A, Trip Report).
2. We obtained 360-degree calibrated panoramic photograph taken at 25-m level of the KCRP WSR-88D tower, which is about 30 ft lower than the center of antenna height.
3. We prepared maps showing the extent of WSR-88D coverage at 2,000 ft above site level for each (center of beam) scan angle from the current minimum of +0.5 degree to -0.2 degree (See Attachment B).
4. We identified areas of terrain and activities that are potentially sensitive to radiofrequency (RF) radiation exposure in proximity to the WSR-88D that would be directly illuminated by the main beam at each lower scan angle under consideration (see Attachment C).

3. WSR-88D COVERAGE

The Project team used Alion Integrated Target Acquisition System (ITAS) terrain-based computer model with GIS-based interface to project the terrain-dependent radar coverage for the KCRP WSR-88D at 2,000 ft above site level (ASL). The radar coverages shown in Attachment B are based on Digital Terrain Elevation Data (DTED) Level 2 topographic data and 4/3 earth radius to account for atmospheric refraction of the WSR-88D main beam. The lower half-power point of the unobstructed WSR-88D main beam is considered the minimum elevation (i.e., floor) of WSR-88D coverage. Table 2 shows KCRP WSR-88D coverage areas at 2,000 ft above site level (ASL) for the range of minimum scan angles under consideration by NWS.

TABLE 2: KCRP WSR-88D Radar Coverage Areas for Minimum Scan Angles				
Coverage Altitude (ft ASL)	**Minimum Center of Beam Scan Angle (deg)**	**Lower Half-power Point (deg)**	**Area in Lambert Projection (sq mi)**	**Change from Existing Minimum Scan Angle**
2,000	+0.5 (existing)	0.0	11,183	n/a
2,000	+0.4	-0.1	14,827	+32.6%
2,000	+0.3, +0.2, +0.2, 0.0, -0.1, -0.2	-0.2	16,193	+44.8%

KCRP WSR-88D is located on nearly level ground at Corpus Christi International Airport in Corpus Christi, Nueces County, TX. When operating at the current minimum center of beam minimum scan angle of +0.5 deg, the KCRP WSR-88D is not subject to terrain blockage (see Attachment B). At a minimum scan angle of +0.4 deg, radar coverage would improve in all directions, although minor terrain blockage would occur to the west (W) and north (N). At a minimum scan angle of +0.3 deg, additional improvements in radar coverage would occur to the N, northeast (NE), east (E), southeast (SE), south (S), and southwest (SW). No additional improvement would result at minimum scan angles below +0.3 deg.

The city of Laredo, Webb County, TX is an area of interest to the NWS. Laredo is about 120 miles west-southwest of the KCRP WSR-88D at elevation 420 ft MSL. At the current minimum scan angle of +0.5 deg, the minimum altitude or floor of radar coverage over Laredo is about 6,900 ft above ground level (AGL). Lowering the minimum scan angle of the KCRP WSR-88D to +0.4 deg or lower would reduce the floor of radar coverage over Laredo to about 5,800 ft AGL.

4. HUMAN EXPOSURE AND POTENTIALLY RF-SENSITIVE ACTIVITIES

Exposure to radiofrequency (RF) radiation can potentially be harmful to humans and RF-sensitive activities. Table 3 presents the safe setback distances from the WSR-88D for human exposure, implantable medical devices, fuel handling, and EEDs (Sensor Environmental LLC, 2011). Safety standards for implantable medical devices, fuel handling, and EEDs are based on instantaneous exposure. Safety standards for human exposure are based on time-averaged exposure; therefore, exposure during both rotating antenna and stationary antenna operations are considered.

TABLE 3: Safe Setback Distances For Human Exposure And Potentially RF-Sensitive Activities Directly Illuminated By The WSR-88D Main Beam			
Activity	**Safe Setback Distance (ft)**		**Source**
Human Exposure	Rotating Antenna	20	American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE)
	Stationary Antenna	1,740	
Implantable Medical devices	2,060		ANSI/Association for the Advancement of Medical Instrumentation (AAMI)
EEDs (Safe/Unsafe)	1,654 / 6,084		Naval Sea Systems Command
Fuel Handling	537		Naval Sea Systems Command

5. DIRECTLY ILLUMINATED TERRAIN AND STRUCTURES

The safe setback distances from the WSR-88D for human exposure, implantable medical devices, fuel handling, and electro-explosive devices (EEDs), are given in section 4 of this memorandum. The greatest safe setback distance for human exposure or any of these activities for exposure of EEDs, which include blasting caps, some types of ordnance, and equipment used in aviation systems (e.g., ejection seats and separation systems for air-launched missiles). Hazard of Radiation to Ordnance (HERO) regulations characterize EEDs as either unsafe or safe with differing setback distances. HERO unsafe or unreliable EEDs have not been evaluated for compliance with MILSTD 664 or are being assembled, dissembled, or subject to unauthorized conditions, which can increase its sensitivity to RF emissions. HERO safe EEDs have been evaluated for compliance with MILSTD 664 and are not being assembled or dissembled (Naval Sea Systems command, 2008). Based on the U.S. Navy HERO regulations, the safety setback distances for HERO unsafe and safe EED, respectively are 6,084 ft and 1,654 ft respectively. U.S. Air Force safety regulations consider a 900 ft setback distance from radars such as the WSR-88D safe for all types of blasting caps (U.S. Air Force, 1982).

Attachment C contains maps showing terrain directly illuminated by the KCRP WSR-88D main beam at minimum center of beam scan angles of +0.5 seg (current operation) through -0.2 deg. At the current minimum scan angle of +0.5 deg or a minimum scan angle of +0.4 deg, the main beam does not impinge on the ground within 3 miles. At a minimum scan angle of +0.3 deg, higher terrain about 14,900 ft (2.8 miles) to the north would be illuminated. At a minimum scan angle of +0.2 deg, the main beam would illuminate elevated terrain about 14,300 ft (2.7 miles) to the NE, E, SW, W and northwest (NW). At a minimum scan angle of +0.1 deg, terrain in all directions would be illuminated at a distance of about 11,200 ft (2.1 miles). At scan angles of

0.0 deg and lower, terrain in all direction would be illuminated at progressively closer distances. A scan angle of -0.2 deg would illuminate ground 6,800 ft (1.3 miles) from the radar. The directly illuminated terrain at all minimum scan angles under consideration would be outside the safe setback distance for human exposure, implantable medical devices, HERO unsafe and safe EEDs, and fuel handling.

Photographs 2A through 2D in Attachment A Trip Report are panoramic photographs taken from the 20-m level of the KCRP WSR-88D tower and show a 360 deg view of the horizon. As shown in Photograph 3A equipment at Citgo and Valero refineries rise above the radar horizon. Those refineries are located 2.2 miles NNE and 2.8 miles NE from the WSR-88D. As shown in Photograph 3D, two additional refineries have equipment rising above the radar horizon –the LyondellBasell and Flint Hills refineries at distances of 3.5 miles WNW and 3.2 miles NNW, respectively. Also, in the distant background of Photographs 3A and 3D is a wind farm composed of several dozen wind turbines rising above the radar horizon to the NW through NE at distances of 8.2 to 12.5 miles from the WSR-88D. The Airport Traffic Control Tower (ATCT), located 8,900 ft (1.7 miles) SSE of the WSR-88D, has an elevation of 184 ft MSL and rises above the radar horizon (Federal Aviation Administration, 2022). The ATCT is behind the WSR-88D stairway and not visible in the panoramic photos. All of these structures are further from the KCRP WSR-88D than all safe setback distances for human exposure and potentially RF-sensitive activities. No hazards to humans or potentially RF-sensitive activities would result from lowering the minimum scan angle of the KCRP WSR-88D.

6. ASTRONOMICAL OBSERVATORIES

The WSR-88D can potentially cause adverse electromagnetic interference (EMI) with charge-couple devices (CCDs) which electronically record data collected by astronomical telescopes (NEXRAD JSPO), 1993). Due to the sensitivity of astronomical equipment which is designed to detect very faint signals from space, this equipment is vulnerable to EMI. The potential for harmful EMI would arise if the WSR-88D main beam would directly impinge on an astronomical observatory during low angle scanning. The area of potential impact to observatories is within 150 miles of the WSR-88D. Portions of Texas and the Mexican States of Coahuila, Nuevo Leon, and Tamaulipas are within 150 miles of the KCRP WSR-88D. There are no astronomical observatories located in these states within 150 miles of the KCRP WSR-88D. The closest astronomical observatory is the Eagle Eye observatory in Burnet, TX, about 180 miles NE. Lowering the minimum scan angle of the KCRP WSr-88D would not affect astronomical observatories.

7. RECOMMENDATION

Lowering the minimum scan angle of the KCRP WSR-88D serving the Corpus Christi, TX, area to +0.3 deg would increase coverage area at 2,000 ft above site level by 44.8% and would not result in adverse effects to person or activities or astronomical observatories. The coverage floor

over Laredo, TX, would decrease from the current 6,900 ft AGL to about 5,800 ft AGL. A minimum scan angle lower than +0.3 deg would provide no additional increase in radar coverage and would increase ground clutter returns. Therefore, a minimum center of beam scan angle of +0.3 deg is recommended for the KCRP WSR-88D.

8. MEMORANDUM AUTHORS

This memorandum was prepared by Sensor Environmental LLC under contract to Centuria Corporation, which is a support contractor to the National Weather Radar Operations Center. Mr. James Manitakos, CEO, served as Sensor's Project Manager. Alion Science and Technology Corporation prepared radar coverage maps and calculated coverage areas under subcontract to Sensor. Mr. Andre Tarpinian, Radio Frequency Engineer, served as Alion's Project Manager.

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NTIA. *Manual of Regulations and Procedures for Federal Radio Frequency Management.* May 2014.

U.S. Air Force. *Explosive Safety Standards*. U.S. Air Force Regulation 127-100(c1). July 27, 1982.

ATTACHMENT A

TRIP REPORT, KCRP WSR-88D

TRIP REPORT

Traveler: James Manitakos, Sensor Environmental LLC

Destination: Weather Forecast Office (WFO) and KCRP Weather Surveillance Radar, Model 1988 Doppler (WSR-88D) serving the Corpus Christi, TX, area

Dates: January 20, 2022

Purpose: Field Inspection of radar and vicinity and obtaining 360-degree panoramic photographs from of KCRP WSR-88D tower.

Summary: January 20: Mr. Manitakos flew from San Jose, CA, to San Antonio, TX and drove to Corpus Christi, TX.

January 21: Weather: 38° F, overcast. Mr. Manitakos took pictures of the KCRP WSR-88D and investigated land uses in the vicinity of the radar. He met at the Corpus Christi WFO with WZFO staff. The WFO staff and Mr. Manitakos went over the radar coverage plots for KCRP WSR-88D. Mr. Manitakos took a photograph of the KCRP WFO Sign (Photograph 1), WSR-88D (Photograph 2) and panoramic photographs (Photograph 3) from the 20-m level of the KCRP WSR-88D, which is about 30 ft below the center of the WSR-88D antenna.

January 22: Mr. Manitakos flew to San Jose, CA.

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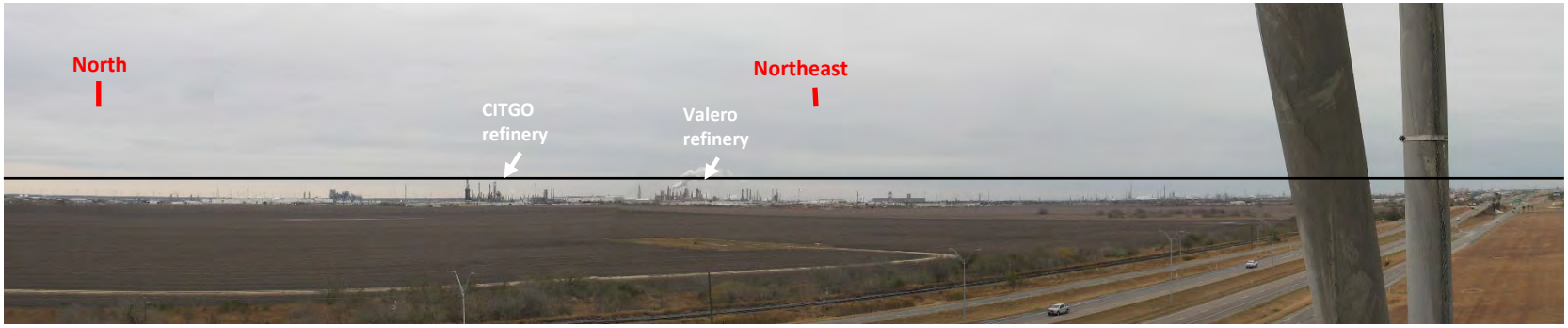
Photograph 1: KCRP WFO Sign

Photograph 1: KCRP WSR-88D serving Corpus Christi, area viewed from southwest.



Photograph 3A: Panoramic photograph from KCRP WSR-88D tower [— 0 deg]

Photograph 3B: Panoramic photograph from KCRP WSR-88D tower [— 0 deg]

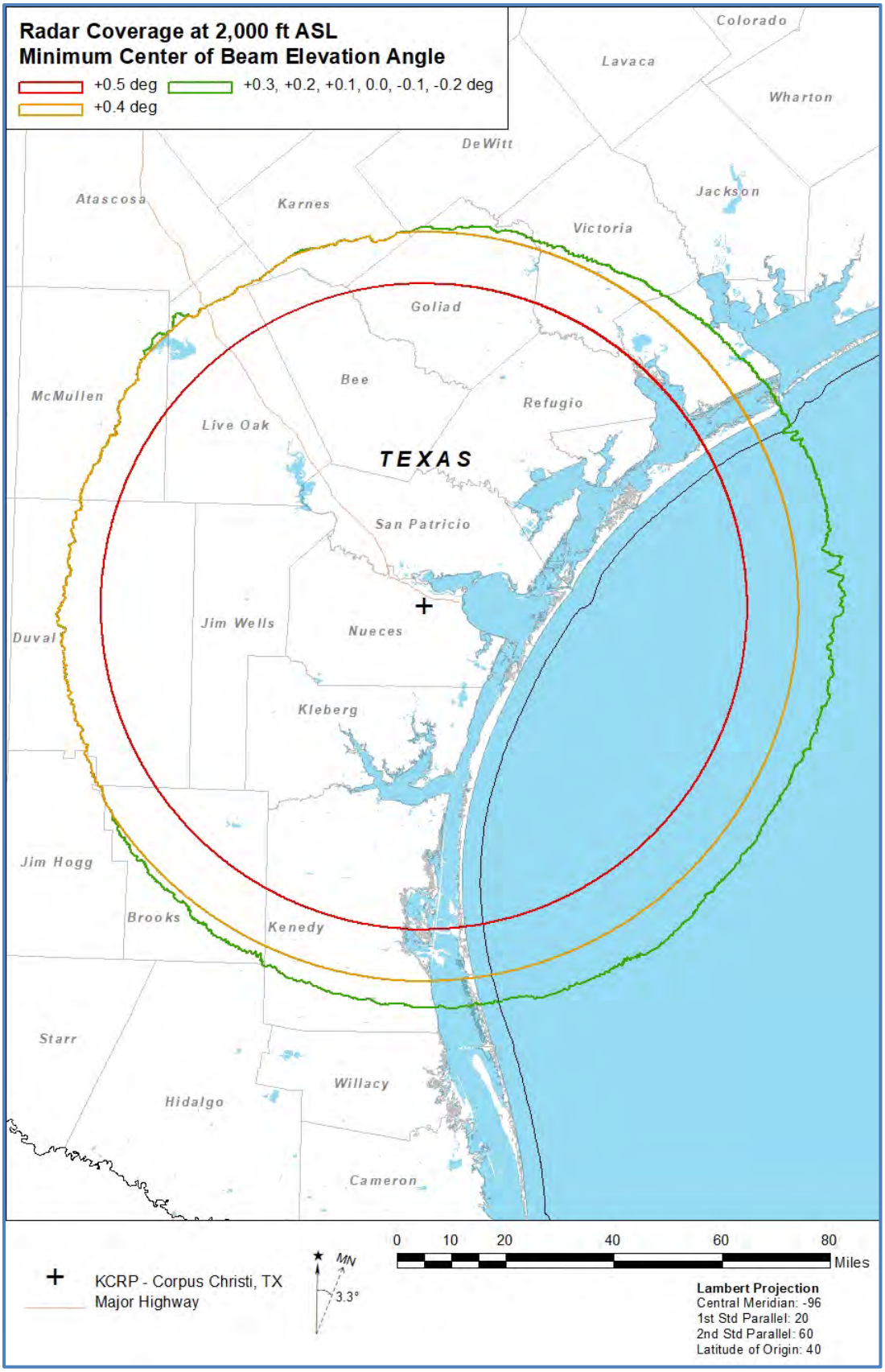
Photograph 3C: Panoramic photograph from KCRP WSR-88D tower [— 0 deg]

Photograph 3D: Panoramic photograph from KCRP WSR-88D tower [— 0 deg]

ATTACHMENT B

KCRP WSR-88D COVERAGE MAP

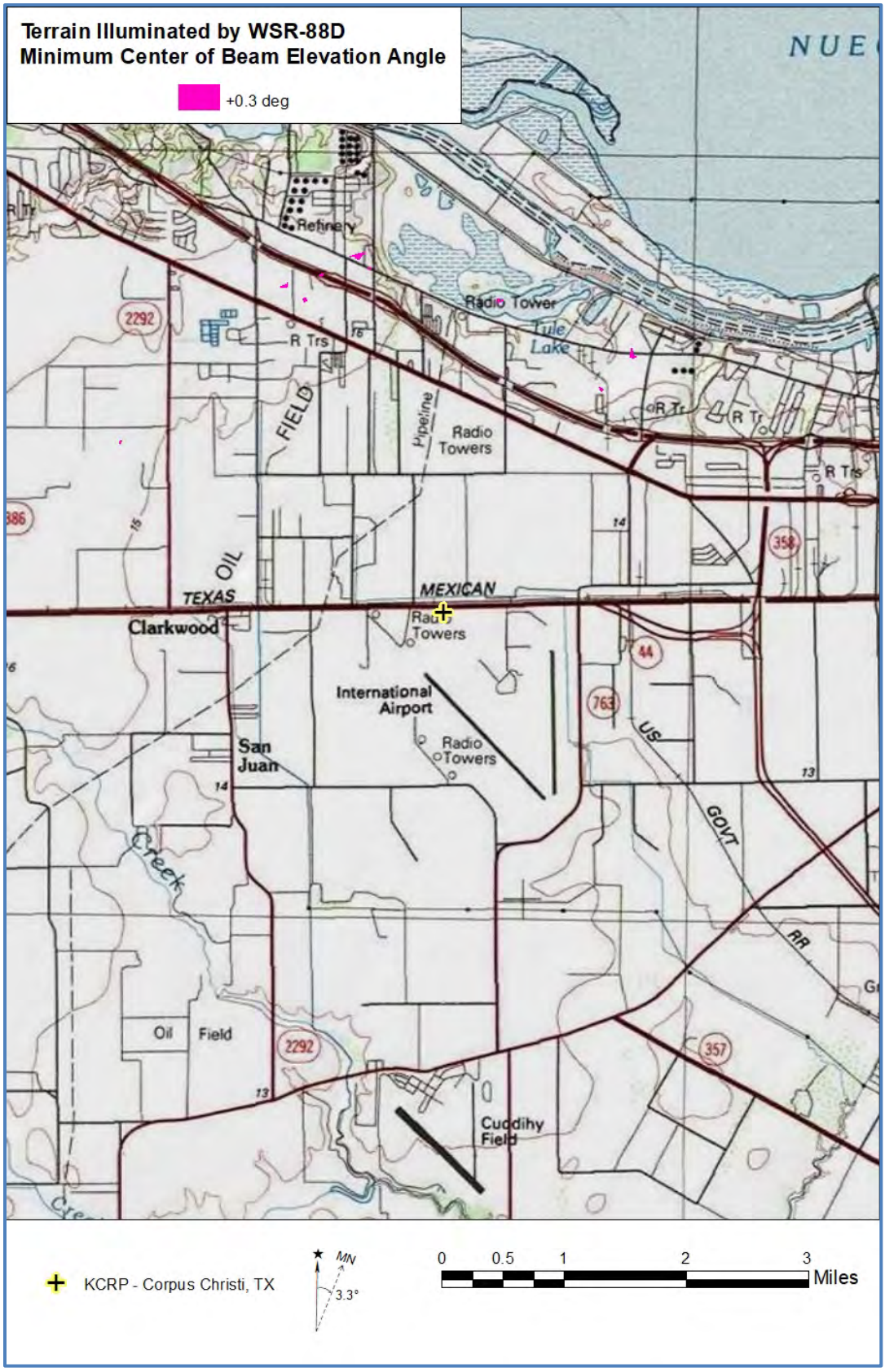
MINIMUM SCAN ANGLES +0.5 deg to -0.2 deg

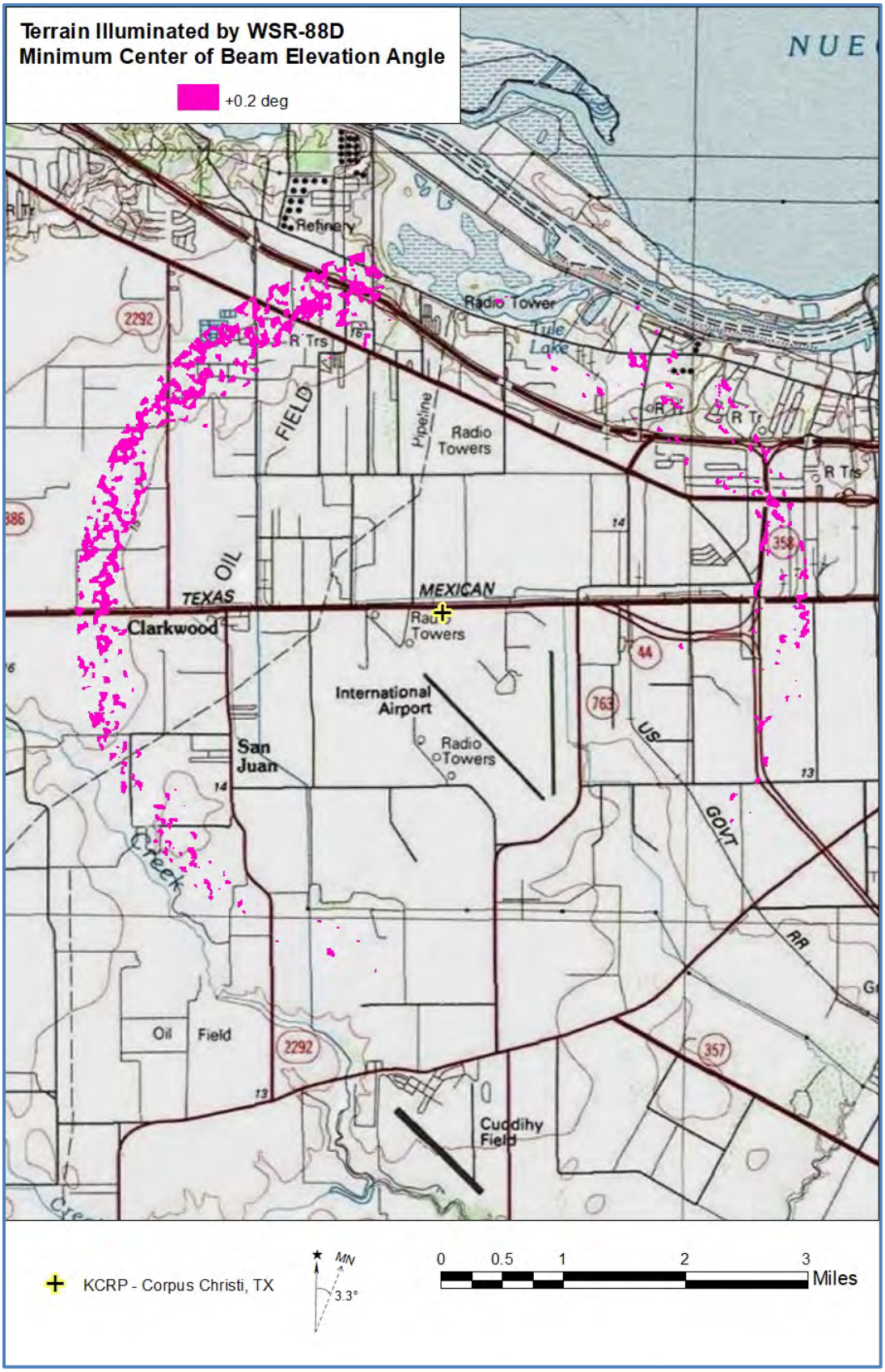

Radar Coverage at 2,000 ft ASL
Minimum Center of Beam Elevation Angle
+0.5 deg
+0.4 deg
+0.3, +0.2, +0.1, 0.0, -0.1, -0.2 deg
Colorado
Lavaca
Wharton
DeWitt
Jackson
Victoria
Atascosa
Karnes
Goliad
Bee
McMullen
Live Oak
Refugio
TEXAS
San Patricio
Jim Wells
Nueces
Duval
Kleberg
Jim Hogg
Brooks
Kenedy
Starr
Willacy
Hidalgo
Cameron
KCRP - Corpus Christi, TX
Major Highway
MN
3.3°
0 10 20 40 60 80
Miles
Lambert Projection
Central Meridian: -96
1st Std Parallel: 20
2nd Std Parallel: 60
Latitude of Origin: 40

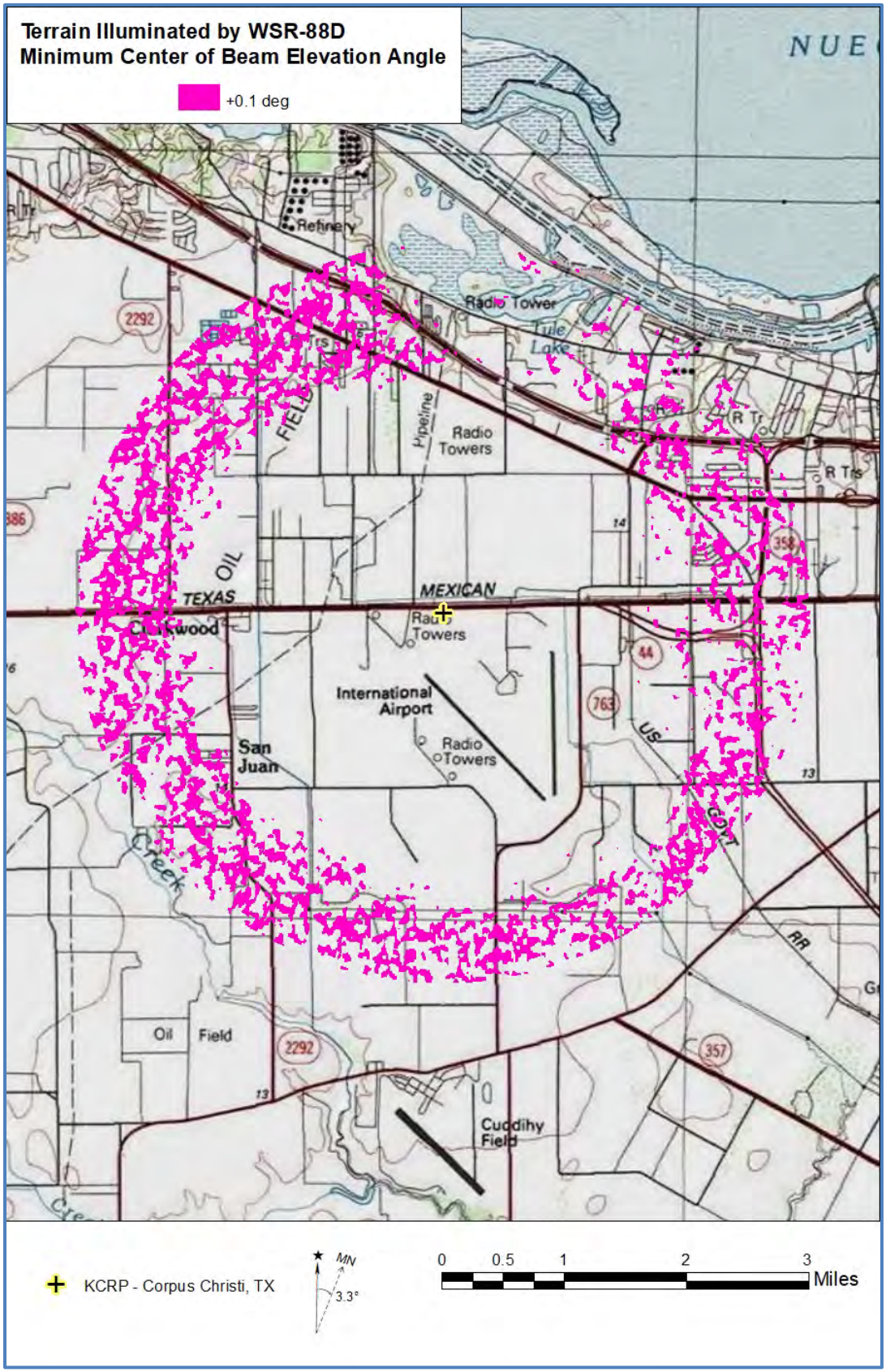
ATTACHMENT C

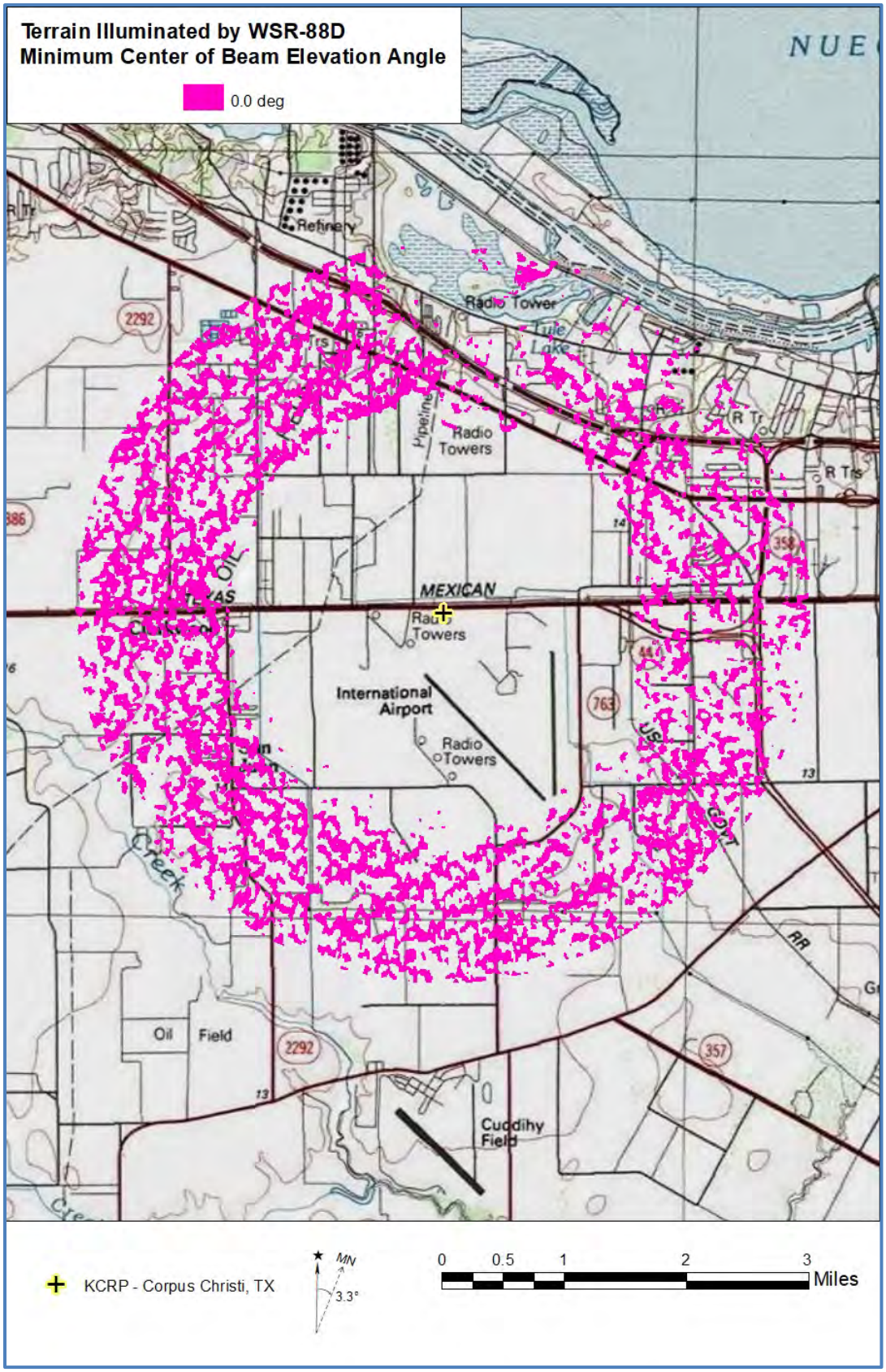
KCRP WSR-88D NEARBY DIRECTLY ILLUMINATED TERRAIN

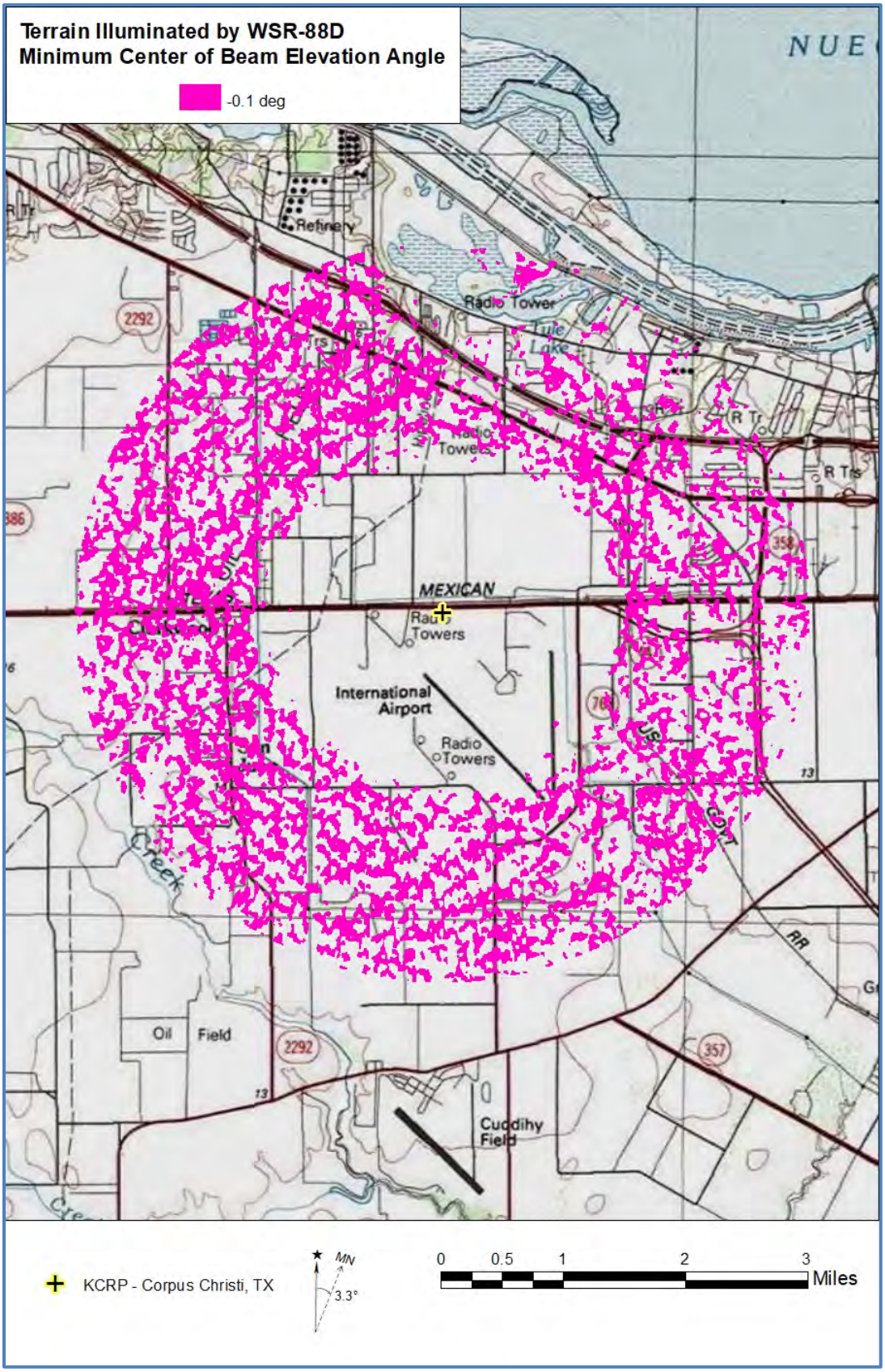
AT SCAN ANGLES OF +0.5 to -0.2 deg

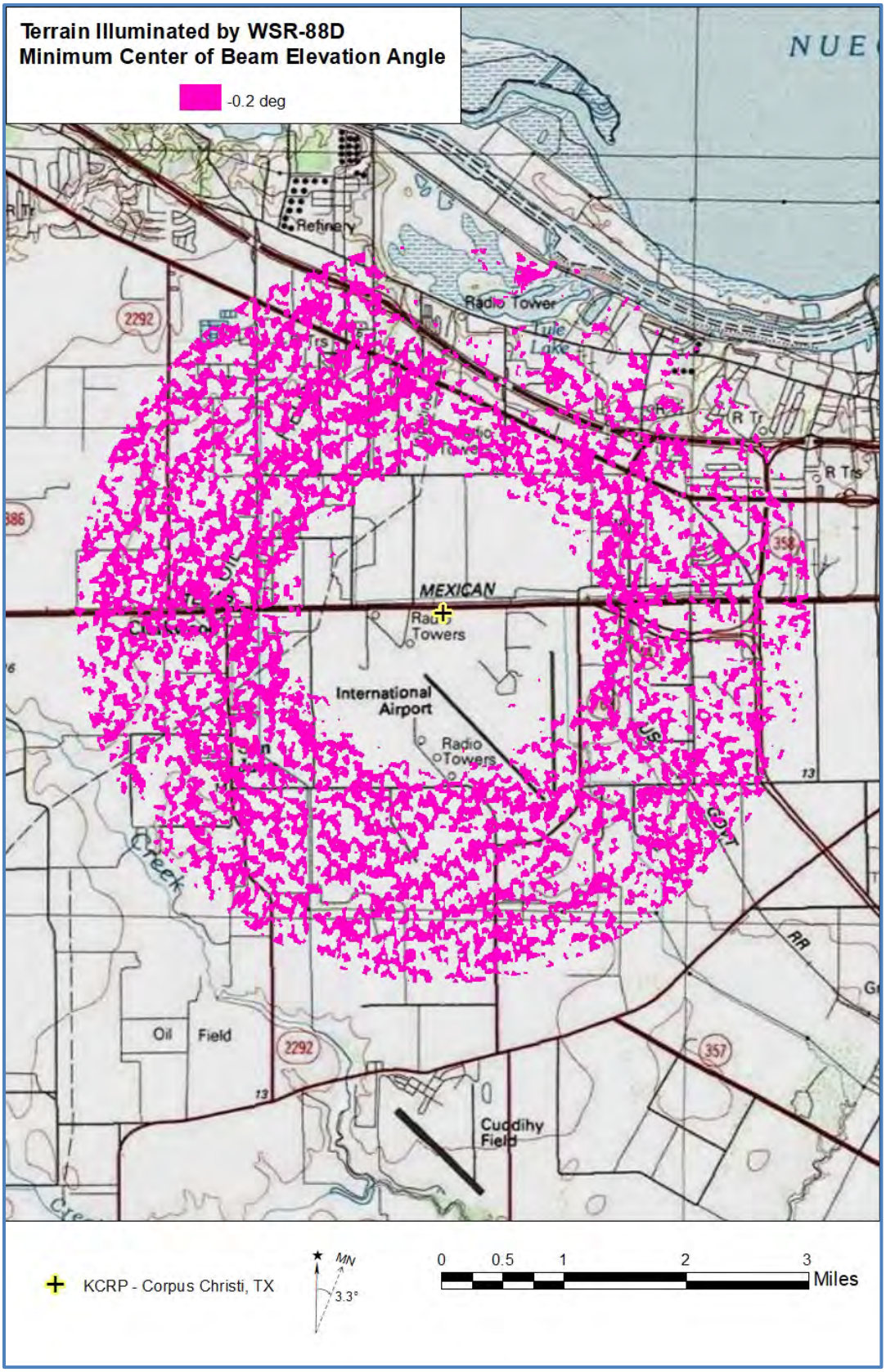

Terrain Illuminated by WSR-88D
Minimum Center of Beam Elevation Angle
+0.3 deg
Refinery
Radio Tower
Tule Lake
Pipeline
Radio Towers
FIELD
OIL
TEXAS
MEXICAN
Clarkwood
International Airport
San Juan
Creek
Oil Field
Cuddihy Field
GOVT
RR
KCRP - Corpus Christi, TX
MN
3.3°
0 0.5 1 2 3
Miles


Terrain Illuminated by WSR-88D
Minimum Center of Beam Elevation Angle
+0.2 deg
NUE
Refinery
Radio Tower
Tule Lake
2292
R Trs
FIELD
Pipeline
Radio Towers
OIL
TEXAS
MEXICAN
Clarkwood
Radio Towers
International Airport
San Juan
Radio Towers
763
US
GOVT
RR
Creek
Oil Field
2292
357
Cuddihy Field
KCRP - Corpus Christi, TX
MN
3.3°
0 0.5 1 2 3
Miles


Terrain Illuminated by WSR-88D
Minimum Center of Beam Elevation Angle
+0.1 deg
Refinery
Radio Tower
Tule Lake
Pipeline
Radio Towers
OIL FIELD
TEXAS
MEXICAN
Rad Towers
Corkwood
International Airport
Radio Towers
San Juan
Creek
Oil Field
Cuddihy Field
2292
763
44
357
359
386
KCRP - Corpus Christi, TX
MN
3.3°
0 0.5 1 2 3
Miles


Terrain Illuminated by WSR-88D
Minimum Center of Beam Elevation Angle
0.0 deg
Refinery
Radio Tower
Radio Towers
MEXICAN
International Airport
Radio Towers
Oil Field
Cuddihy Field
KCRP - Corpus Christi, TX
MN
3.3°
0 0.5 1 2 3
Miles


Terrain Illuminated by WSR-88D
Minimum Center of Beam Elevation Angle
-0.1 deg
Refinery
Radio Tower
2292
MEXICAN
Radio Towers
International Airport
Radio Towers
Oil Field
2292
Cuddihy Field
357
KCRP - Corpus Christi, TX
MN
3.3°
0 0.5 1 2 3
Miles


Terrain Illuminated by WSR-88D
Minimum Center of Beam Elevation Angle
-0.2 deg
Refinery
Radio Tower
Tule Lake
2292
MEXICAN
Radio Towers
International Airport
Radio Towers
Oil Field
2292
Cuddihy Field
KCRP - Corpus Christi, TX
MN
3.3°
0 0.5 1 2 3
Miles