TO: All Interested Parties *SS*

FROM: Jessica Schultz, Deputy Director, Weather Surveillance Radar - Model 1988 Doppler (WSR-88D) Radar Operations Center (ROC)

SUBJECT: Lowering the Minimum Scan Angle of the KBMX WSR-88D serving the Birmingham, AL, area

DATE: September 18, 2023

In accordance with provisions of the National Environmental Policy Act of 1969, the WSR-88D ROC prepared a Draft Environmental Assessment (EA) analyzing the potential environmental effects of lowering the minimum scan angle of the KBMX WSR-88D serving the Birmingham, AL, 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 KBMXWSR-88D is an existing radar facility located at an Alabama Power maintenance facility in Calera, Al, 24 miles south of downtown Birmingham, AL. The BMX WSR-88D, commissioned in 1994, is one of 159 WSR-88Ds in the nationwide network. The 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. The ROC proposes to reduce the minimum scan angle of the KMOB WSR-88D from the current minimum of +0.5 deg to +0.4 deg (i.e., 0.1 deg lower than existing) to provide enhanced coverage of the lower portions of the atmosphere. No construction activities or physical modification of the KBMX WSR-88D would be required to implement the proposed action; the only change would be to the radar's operating software.

The ROC will accept written comments on the Draft EA until October 23, 2023. Please submit comments via either email or regular mail to:

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296 West Arbor Avenue
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Comments sent by regular mail must be postmarked October 23, 2023. After the end of the Draft EA review period, the ROC will prepare a Final EA containing responses to all comments. The government 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 • September 2023

ENVIRONMENTAL ASSESSMENT (EA)

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

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Executive Summary

The Weather Surveillance Radar, Model 1988 Doppler (WSR-88D) Radar Operations Center (ROC) is composed of representatives from the National Weather Service (NWS) of the Department of Commerce, the Air Force Weather Agency (AFWA) of the Department of Defense, and the Federal Aviation Administration (FAA) of the Department of Transportation. The ROC operates the existing WSR-88D serving the Birmingham, AL, area. The International Civil Aviation Organization designator for the radar is KBMX and the radar is located in Shelby county at an Alabama Power maintenance facility about 24 miles south of downtown Birmingham, AL. The KBMX WSR-88D was commissioned in September 1994 and has been in continuous operation since 1994. It is one of 159 WSR-88Ds in the nationwide network.

The KBMX WSR-88D is an S-band Doppler, dual polarized weather radar, which ROC uses to collect meteorological data to support weather forecasts and severe weather warnings for the Birmingham, AL, area. The KBMX 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 KBMX WSR-88D operates at a minimum of scan angle of +0.5 degrees (deg) above the horizon. ROC proposes to reduce the minimum scan angle of the KBMX WSR-88D from the current minimum of +0.5 deg to +0.4 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 KBMX WSR-88D would be required to implement the proposed action; the only change would be to the radar's operating software.

In April 1993, ROC 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 KBMX WSR-88D at a minimum scan angle of +0.4 (i.e., 0.1 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 ROC forecasters and other data users. The area covered at 2,000 ft above site level (ASL) would increase by 23.4%. This radar coverage improvement would be very beneficial to weather forecasters and others parties (e.g., public safety agencies and emergency responders) using the radar information.

A minimum scan angle of +0.4 deg would not result in the radiofrequency emissions exceeding safety levels for human exposure, implantable medical devices, electro-explosive devises (EEDs), or fuel handling, except at the upper portion of a nearby cell phone tower, where adverse impacts are unlikely. observatories. 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 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 KBMX WSR-88D at Minimum Scan Angle of +0.2 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	8.3
Closest Structure: Cell Phone Tower,1,400 ft SE	0.0042	1.0	238	5.0	1,190
Closest Terrain: 15,840 ft (3 miles) N	0.000032	1.0	31,200	5.0	156,000

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 only structure or terrain within 1,740 ft illuminated by KBMX WSR-88D main beam at +0.4 deg within those distances is a cellular telephone tower located 1,400 ft SE. RF exposure levels at that tower would exceed general public safety levels but would comply with occupational safety levels. Since the general public would not be expected at the upper portions of a cell phone tower risks to human health would not result. However, the cell phone tower is within safe setback distances for electro-explosive devices and ROC should not operate the KBMX WSR-88D with a stationary antenna pointed towards the cell phone tower to the SE.

Because the KBMX 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.

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. Six astronomical observatories are within 150 miles. Five of the six observatories would not be affected by a lower scan angle. The University of Montevallo's James Wylie Sheperd Observatory would be illuminated by the WSR-88D main beam at +0.3 deg scan angle, but not at proposed minimum scan angle of +0.4 deg (see Appendix C).

Lowering the minimum scan angle of the KBMX 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

ROC evaluated the benefits and potential impacts of lowering the minimum center of beam scan angle of the KBMX WSR-88D to each angle between +0.4 and +0.0 deg in 0.1 degree increments. Operating the KBMX WSR-88D at alternative minimum scan angle of +0.3 deg or +0.2 deg would result in additional improvements in radar coverage, but could result in adverse effects to the University of Montevallo James Wylie Sheperd Observatory, located about 8 miles southwest and would also result in increased ground clutter returns. A minimum scan angle of +0.1 or 0.0 deg would produce no additional radar coverage benefits and could also impact the James Wylie Sheperd Observatory. Due to these concerns, the ROC rejected scan angles of +0.3 deg or lower and selected +0.4 deg as the minimum scan angle for the KBMX WSR-88D.

The no action alternative would result in continued operation of the KBMX 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 ROC 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 ROC during a minimum 30-day comment period which will end on October 23, 2023. The ROC will provide official responses to all pertinent comments received during the Draft EA comment period in a Final EA report. The ROC will make a decision whether to implement the proposed lowering of the KBMX WSR-88D minimum scan angle after the Final EA report is completed.

CONTENTS

FIGURES

TABLES

ABBREVIATIONS

AAMI	Association for Advancement of Medical Instrumentation
AFB	Air Force Base
AFWA	Air Force Weather Agency
AGL	above ground level
AL	Alabama
ANSI	American National Standards Institute
ASL	above site level
ATCT	Airport Traffic control Tower
Deg	degree(s)
CMP	Coastal Management Program
DoA	Department of Agriculture
E	east
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
KBMX	WSR-88D serving the Birmingham, AL, area
m	meter(s)
MBTA	Migratory Bird Treaty Act (of 1918)
MHz	megahertz
mi	mile(s)
MPE	maximum permissible exposure
MSL	mean sea level
MuE	Minvale-Fullerton-Urban land complex on 6 to 25% slope
mW/cm^2	milliwatts per square centimeter
NAO	NOAA Administrative Order
N	north
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
NE	northeast
NW	northwest
NWS	National Weather Service
PEIS	Programmatic Environmental Impact Statement

RF	radiofrequency
ROC	Radar Operations center
S	south
SE	southeast
SW	southwest
SEA	Supplemental Environmental Assessment
SHPO	State Historic Preservation Office
sq mi	square mile(s)
std	standard
U.S.	United States
USAF	U.S. Air Force
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
W	west
WSR-88D	Weather Surveillance Radar – 1988, Doppler

1 BACKGROUND AND SCOPE OF REPORT

1.1 BACKGROUND

The Weather Surveillance Radar, Model 1988 Doppler (WSR-88D) Radar Operations Center (ROC) is composed of representatives from the National Weather Service (NWS) of the National Oceanic and Atmospheric Administration within the Department of Commerce, the Air Force Weather Agency (AFWA) of the Department of Defense, and the Federal Aviation Administration (FAA) of the Department of Transportation. The ROC operates a nationwide network of 159 weather radars that provide critical real-time information on atmospheric conditions to weather forecasters.

The network radars operated by ROC 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). 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, ROC 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* [ROC, 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 by WSR-88Ds at that time.

The ROC operates the WSR-88D serving the Birmingham, AL, area. The radar identifier is KBMX and the radar is located at Birmingham Regional Airport about 12 miles west (W) of downtown Birmingham, AL. The KBMX WSR-88D is part of the nationwide WSR-88D network. The ROC proposes to operate the KBMX WSR-88D at a minimum scan angle of +0.4 deg above the horizon which is lower than the current minimum scan angle of +0.5 deg above the horizon. Operating the KBMX WSR-88D at this lower scan angle was not analyzed in the 1993 SEA.

The ROC follows procedures established by National Oceanic and Atmospheric Administration (NOAA), the parent agency of NWS, for evaluation of the potential environmental consequences 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 ROC's proposed action of operating the KBMX 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 KBMX WSR-88D minimum scan angle to +0.4 deg). Potential environmental effects of alternative minimum scan angles and the no-action alternative (i.e., continued operation of the KBMX 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 KBMX WSR-88D site and vicinity. The scope of this EA is limited to analyzing potential effects from lowering the minimum scan angle of the KBMX WSR-88D. Because the types of electromagnetic effects that may result and their significance depends on local conditions, uses and topography, the analysis and findings in this EA are specific to the KBMX WSR-88D, and do not apply to other WSR-88Ds or the WSR-88D network as a whole.

2 PURPOSE AND NEED

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 ROC supports NWS mission by operating a nationwide network of 159 WSR-88Ds. Data from the WSR-88Ds is used to improve the accuracy of meteorological forecasts, watches, and warnings. As an example, the WSR-88D generates precipitation estimates allowing prediction of river flooding in hydrological basins of the area. NWS 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.

The elevation above the ground at which the WSR-88D can collect atmospheric data increases 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. Lowering the KBMX WSR-88D minimum scan angle to +0.4 deg (the proposed action) 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 ROC operates the KBMX WSR-88D serving the Birmingham, AL, area at a minimum scan angle of +0.4 deg and the environmental effects that may result.

The National Oceanic and Atmospheric Administration (NOAA) is the parent agency of the NWS and the ROC follows 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). ROC 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 KBMX WSR-88D minimum scan angle to +0.2 deg; this EA report satisfies that requirement.

3 DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

3.1 PROPOSED ACTION

3.1.1 DESCRIPTION OF KBMX WSR-88D

The WSR-88D network 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 KBMX WSR-88D, which was commissioned in September 1994 and has been in continuous operations since being commissioned. The KBMX WSR-88D serves the Birmingham, AL, area and is operated by the ROC. The KBMX WSR-88D is located at an Alabama Power Maintenance Facility near Shelby County Airport, 24 miles south (S) of Birmingham, AL (see Figure 2). The radar antenna, radome, and steel-lattice tower are standard. Table 1 provides information on the KBMX WSR-88D.

Table 1: Information on KBMX WSR-88D serving the Birmingham, AL, area

Elevation, ground surface at tower base (mean sea level, MSL)	645 ft
Elevation, center of antenna (MSL)	758 ft
Tower Height (m)	30 m (98 ft)
Latitude (WGS84)	33° 10’ 20” N
Longitude (WGS84)	86˚ 46’ 11’ W
Operating Frequency	2,740 megaHertz (MHz)
Spot Blanking or Sector Blanking used	No

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.

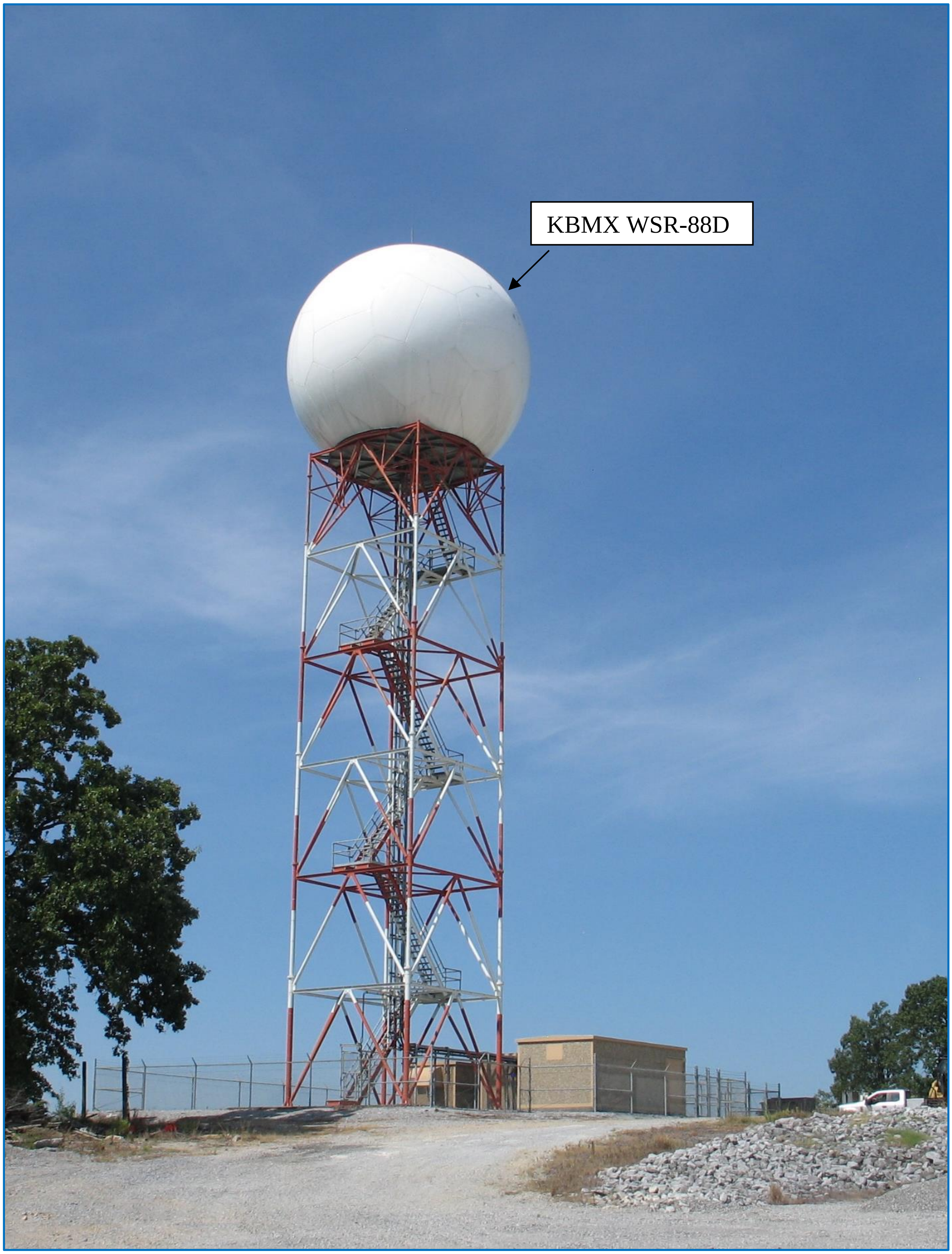

Figure 1: Photograph of KBMX WSR-88D serving Birmingham, AL, area

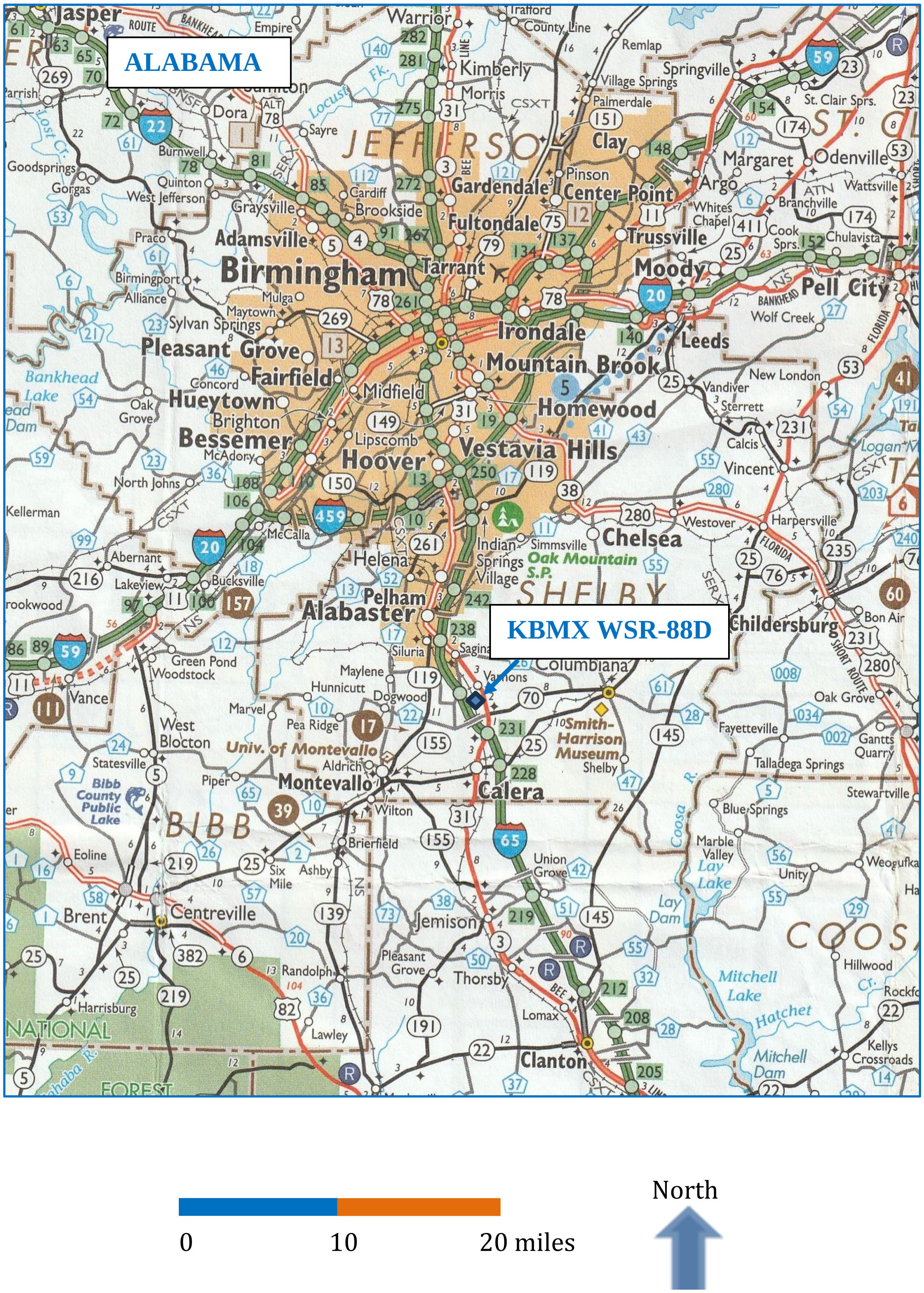

Figure 2: Location of KBMX WSR-88D

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. ROC proposes to reduce the minimum center of beam scan angle to +0.4 deg, which is 0.1 deg lower than the current minimum scan angle, placing the lower edge of the main beam at -0.1 deg.

Figure 4 is a schematic drawing showing the change in coverage that would result from lowering the KBMX WSR-88D minimum scan angle. The floor of coverage would decrease slightly. 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 23.4% increase in coverage area at 2,000 ft above site level (ASL) to 9.6% increase at 10,000 ft ASL. 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, FAA and AFWA 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 KBMX 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	9,568	25,677	53,041
+0.4 (proposed)	-0.1	11,809 (+23.4%)	29,228 (+13.8%)	58,141 (+9.6%)

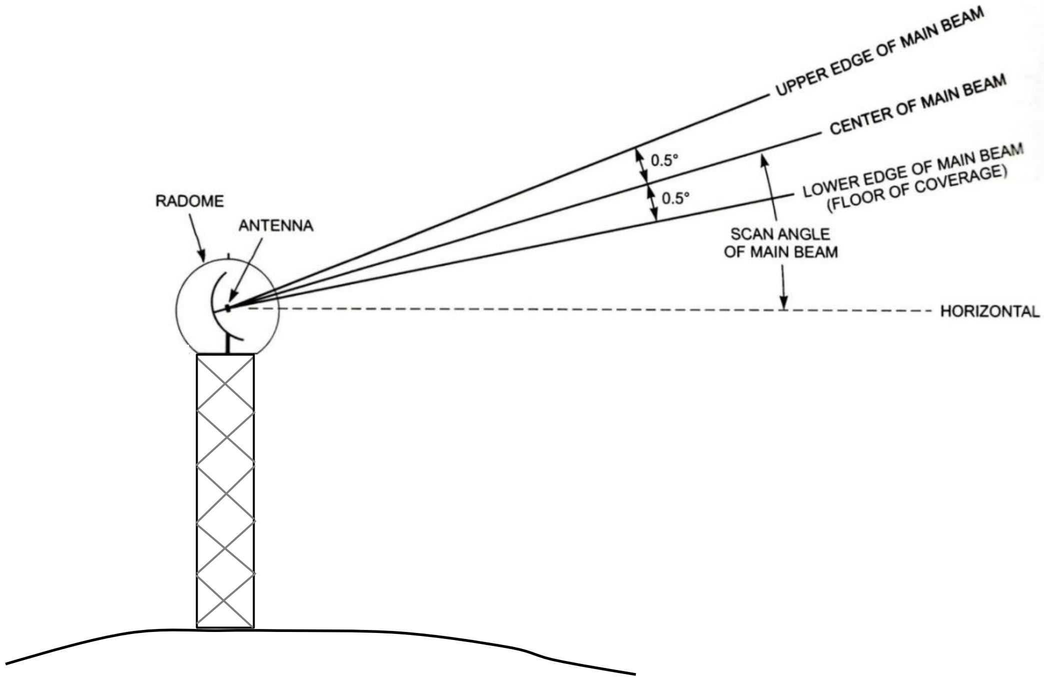

Figure 3: Schematic of WSR-88D Main beam

(Not to scale, width of main beam exaggerated)

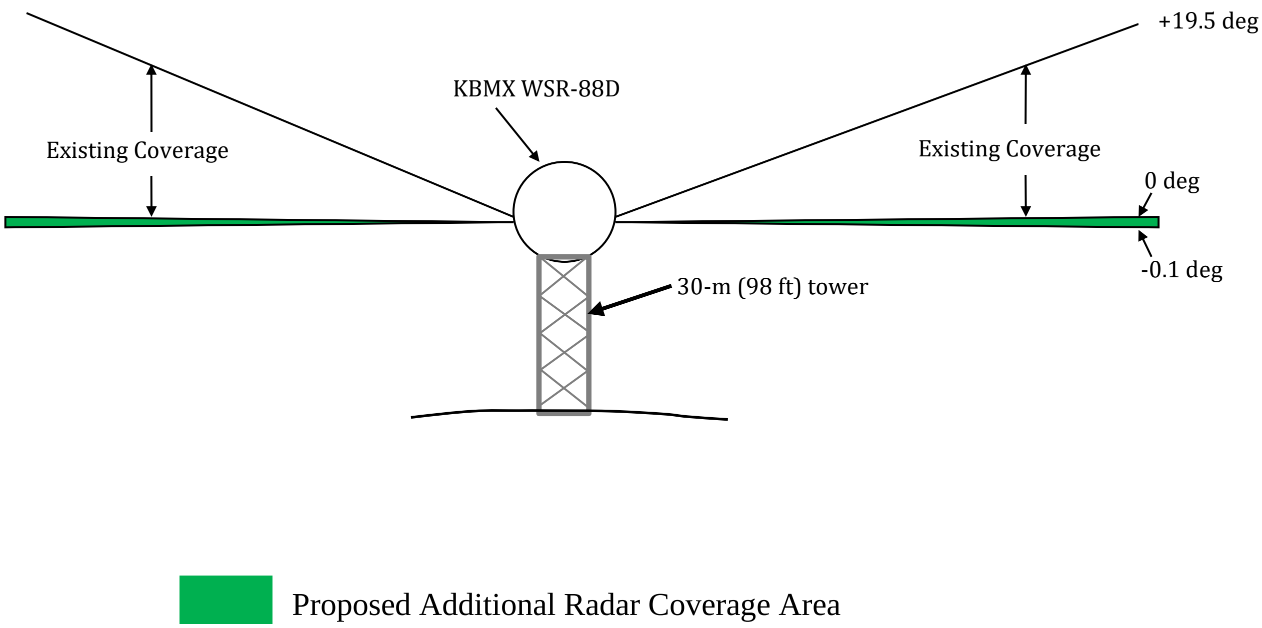

Figure 4: Drawing of Proposed Additional Radar Coverage

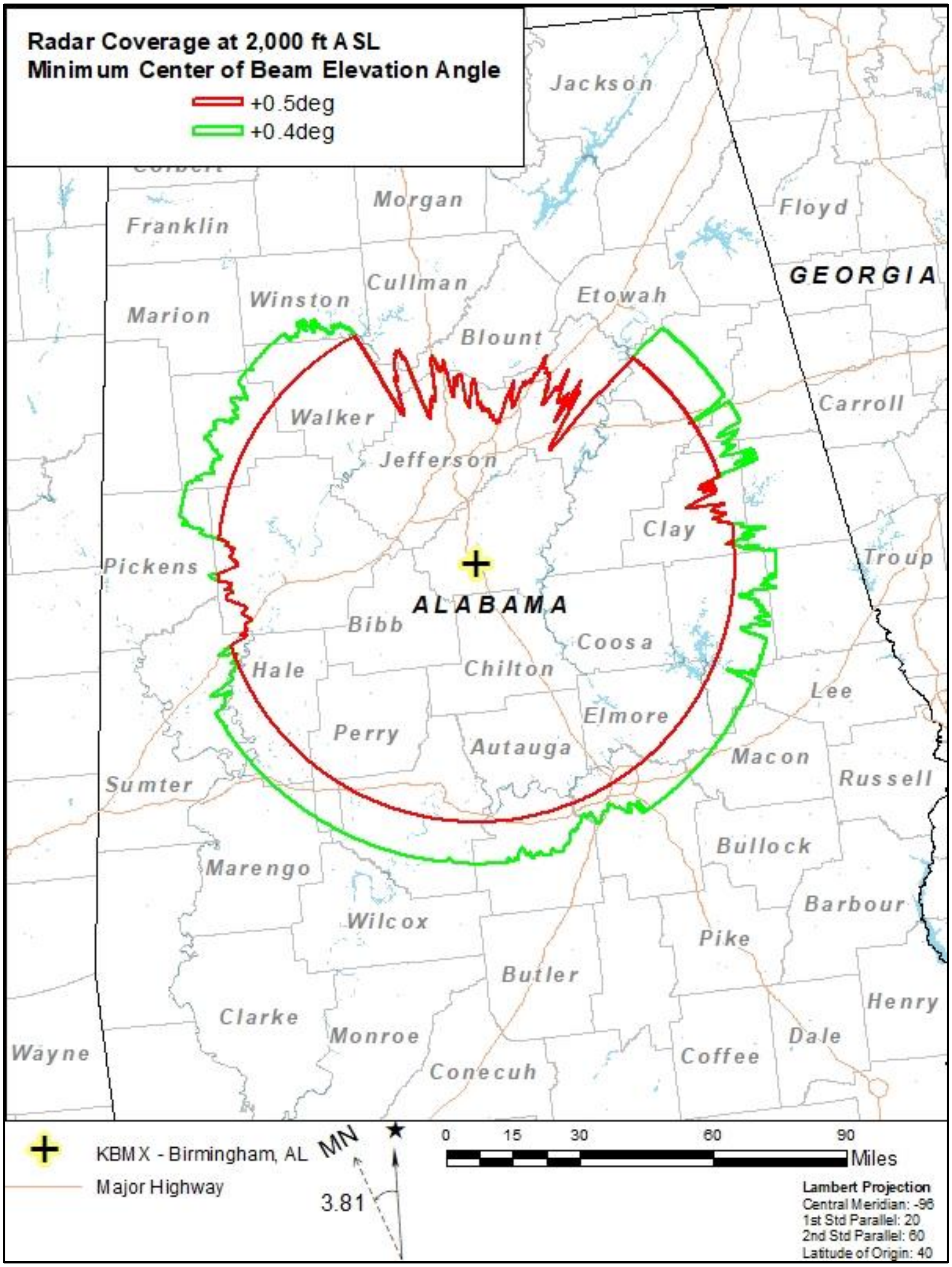

Figure 5: Existing and Proposed KBMX WSR-88D Coverage at 2,000 ft ASL

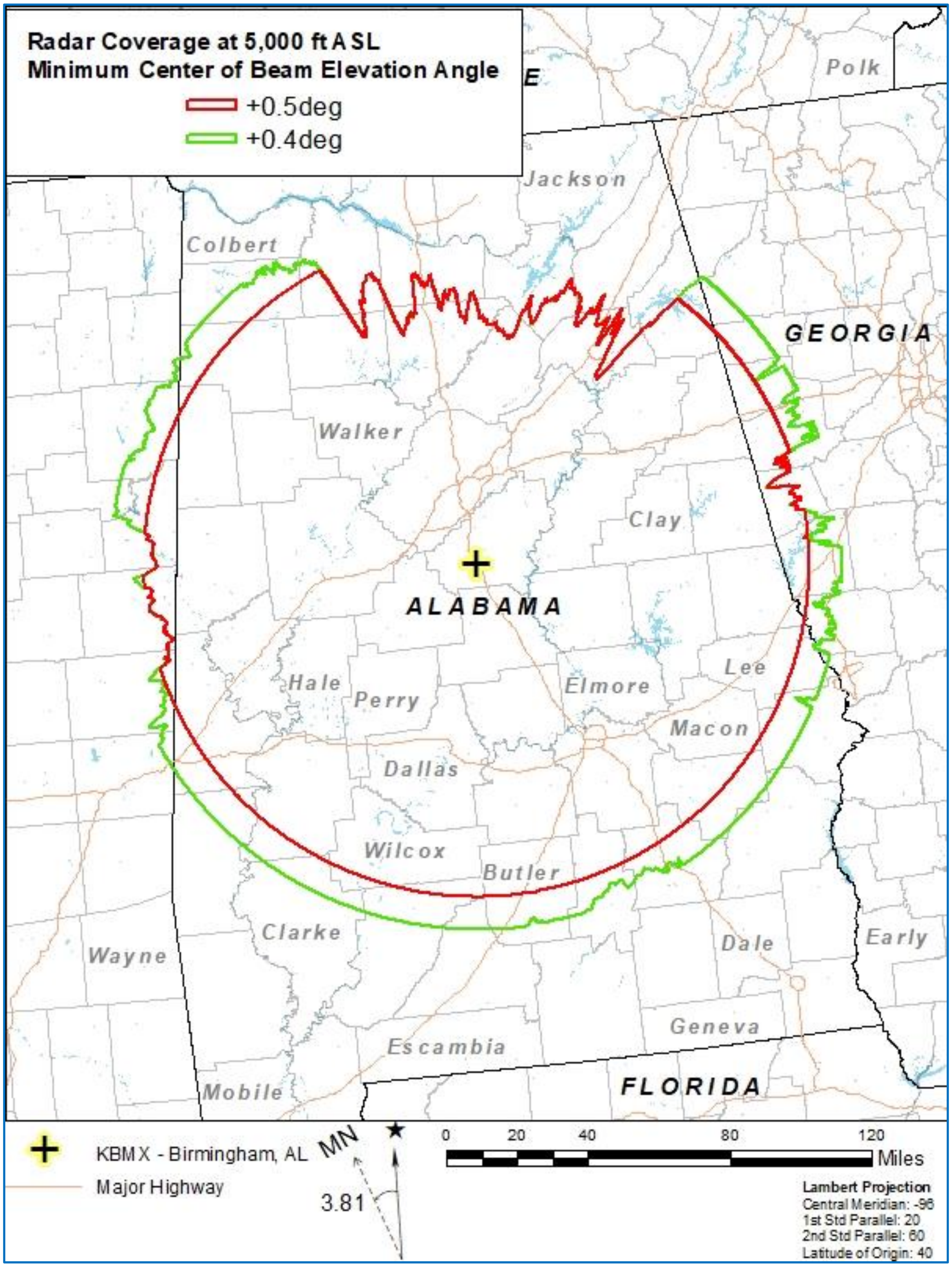

Figure 6: Existing and Proposed KBMX WSR-88D Coverage at 5,000 ft ASL

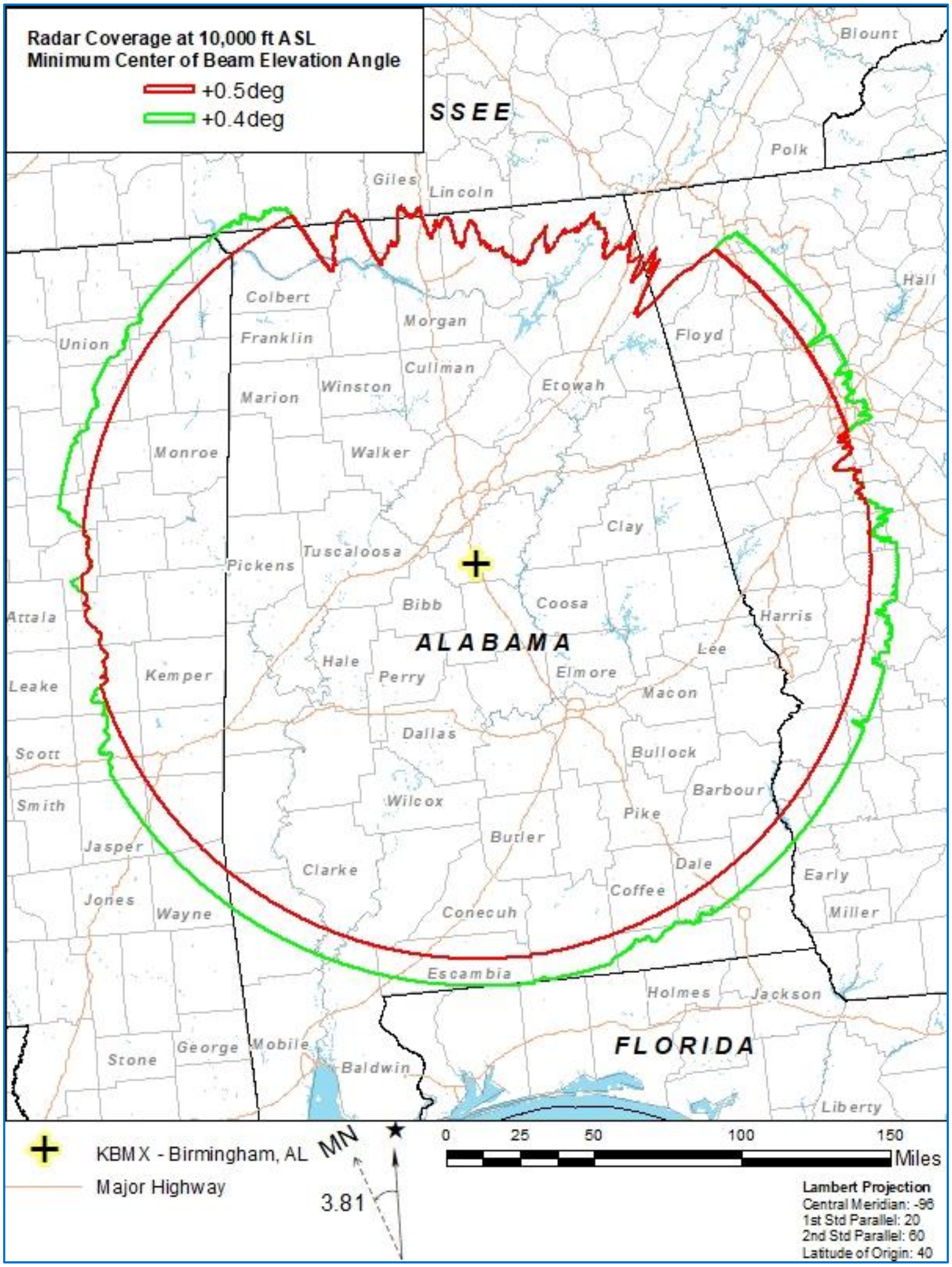

Figure 7: Existing and Proposed KBMX WSR-88D Coverage at 10,000 ft ASL

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 KBMX WSR-88D serving the Birmingham, AL, 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 center of beam minimum scan angles between +0.3 and 0.0 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 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 KBMX WSR-88D transmits a radio signal at a frequency of 2,740 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 KBMX 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 KBMX WSR-88D operating frequency is 2,740 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 KBMX WSR-88D is mounted on a 30 m tall steel-lattice tower. Ground surface elevation is 645 ft MSL. The center of the antenna is at 758 ft MSL and the lower edge of the antenna is at 744 ft MSL or 99 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 within 3 miles of the radar (see Appendix C). Operating at the proposed minimum scan angle of +0.4 deg; the closest terrain illuminated by the main beam would 15,840 feet (3 miles) north (N) of the WSR-88D. The closest structure within the main beam would be a cell phone tower located 1,400 ft southeast (SE). RF power density levels at the nearest illuminated ground and the cell phone tower are shown in Table 3.

Compared to the existing minimum scan angle of +0.5 deg, lowering the minimum scan angle to +0.4 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 KBMX WSR-88D, and the RF exposure that would result if ROC lowers the minimum scan angle to +0.4 deg. Table 3 summarizes the results from Appendix A.

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

Location / Distance from KBMX 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	8.3
Closest Structure: Cell phone tower 1,400 ft SE	0.0042	1.0	238	5.0	1,190
Closest Terrain: 15,840 ft (3 miles) N	0.000032	1.0	31,200	5.0	156,000

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. During stationary antenna operation, RF exposure levels at the nearby tower would exceed general public safety levels but would comply with occupational safety levels. Since the general public would not be expected at the upper portions of a cell phone tower risks to human health would not 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 KBMX WSR-88D would continue to operate at 2,740 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 +0.4 deg would not result in the main beam impinging on the ground surface within 3 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 EEDs as safe, susceptible, or unsafe and unreliable, based on compliance with MIL-STD 664 (series). HERO safe EEDs are considered safe in all RFR environments. HERO susceptible EEDs may be detonated by RF energy under certain circumstances. HERO unsafe or unreliable EEDs have 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:

$$D = (781)\ (f)^{-1}(\text{average power x antenna gain})^{1/2}$$

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

$$D = (781)\ (2{,}740)^{-1}\ (475{,}000\ \text{W} \times 0.0021 \times 35{,}500)^{1/2}\ \text{ft}$$
$$D = 1{,}709\ \text{ft}$$

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

$$D = (2{,}873)\ (f)^{-1}(\text{average power x antenna gain})^{1/2}$$
$$D = (2{,}873)\ (2{,}740)^{-1}\ (475{,}000\ \text{W} \times 0.0021 \times 35{,}500)^{1/2}\ \text{ft}$$
$$D = 6{,}285\ \text{ft}$$

HERO concerns are only applicable in locations illuminated by the main beam of the radar. When operating at a minimum scan angle of +0.4 deg, the KBMX WSR-88D main beam would not illuminate the ground within the safe setback distance for HERO safe EEDs. Under current WSR-88D operations the upper portion of the nearby cell phone tower is illuminated by the WSR-88D main beam and lowering the minimum scan angle to +0.4 deg would increase the amount of illuminated tower by about 2 ft. The cell phone tower would be within the safe setback distance for HERO safe and unsafe/unreliable EEDs, but it is very unlikely that that EEDs would be in use on the upper portion of a cell phone tower.

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 auto, 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 2,740 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:

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

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):

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

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 +0.4 deg, the main beam of the KBMX WSR-88D would not illuminate the ground within 2,060 ft of the radar. The nearby cell phone tower would be within that distance but workers who access the upper portion of the tower are expected to be trained in RF safety.

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 KBMX WSR-88D would comply with the FCC safety standards. Exposure of persons wearing implantable medical devices to the KBMX 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. Six astronomical observatories are within 150 miles. Five of the six observatories would not be affected by a lower scan angle. The University of Montevallo's James Wylie Sheperd Observatory would be illuminated by the WSR-88D main beam at +0.3 deg scan angle, but not at +0.4 deg (see Appendix C).

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 KBMX 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	1,709 ft / 6,285 ft	Only upper portions of cell phone tower to SE	Very low

Equipment / Activity	Applicable Standard	Setback Distance	Would Main Beam Impinge Within Setback Distance?	Potential for Significant Effects
Fuel Handling	U.S. Navy Hazards to Personnel, Fuel, and Other Flammable Material	537 ft	No	None
Active Implantable Medical Devices	AAMI PC69:2007, FCC 47 CFR Part 95.1221	2,060 ft	Only upper portions of cell phone tower to SE	Very Low
Astronomical Observatories	Direct Exposure to WSR-88D Main Beam	n/a	n/a	Yes at +0.3 deg, No at +0.4 deg

4.3 LAND USE AND COASTAL ZONE MANAGEMENT

Alabama is a coastal state and has a Coastal Management Program (CMP) administered by the Alabama Department of Conservation and Natural Resources, State Lands Division, Coastal Section. The coastal management zone extends from the 10-ft elevation contour to three miles seaward from the shoreline. The KBMX WSR-88D is not located in the coastal management zone (Alabama Coastal Area Management Program, 2023). The proposed action would not adversely affect coastal resources or conflict with policies of Alabama's Coastal Area Management Program.

The KBMX WSR-88D is located at an Alabama Power maintenance facility and nearby land uses consist of storage buildings and pads for electric power equipment and maintenance shops. The area surrounding the Alabama Power grounds are developed with industrial and commercial uses. The nearest residential uses area is 0.5 mile to the NW. The proposed action would not change land uses at the KBMX WSR-88D site or vicinity and would not adversely affect nearby land uses.

4.4 GEOLOGY, SOILS, AND SEISMIC HAZARDS

The WSR-88D site is underlain by Paleozoic Era folded and faulted sedimentary layers (American Association of Petroleum Geologists 1975). Soil is Minvale-Fullerton-Urban land complex on 6 to 25% slope (MuE), which forms from cherty limestone. MuE soil is deep, gravelly silt loam and well drained. The water table is more than 80 inches below the ground surface and this soil is not hydric. The frequency or flooding or ponding is "none." MuE soil is not hydric and not considered prime farmland (Natural Resources Conservation Service, 2023).

U.S. Geological Survey (USGS) considers Shelby County to have moderate risk of seismic hazards (USGS, 2014). The proposed action would not affect the WSR-88D tower structure or change its seismic risk level.

Lowering the minimum scan angle of the KBMX 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 KBMX WSR-88D site drains via overland flow to the Camp Branch of the Coosa River, which is tributary of the Alabama River (USGS, 1969; USGS, 2020a). Lowering the minimum scan angle of the KBMX 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 KBMX WSR-88D is located at an Alabama Power maintenance facility. Vehicle access is via Interstate 65, a divided four-lane highway, County Road 87, a two-lane paved road and internal roads of the Alabama Power facility. The local roads have low traffic volumes. The proposed action requires modification of the software used by the WSR-88D to support scan at angles below +0.5 deg. To implement the change in scan angle, ROC technicians and engineers would travel to the KBMX 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 KBMX WSR-88D is equipped with a standby generator that is used if primary power is interrupted and 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 KBMX WSR-88D site outside the 100-year floodplain (FEMA, 2013). 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 wetland is a riverine intermittent streambed, seasonally flooded wetland (R4SBC), located about 700 ft SE (USFWS, 2023l). 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 KBMX WSR-88D is located within the area served by the USFWS Alabama Ecological Services Field Office in Daphne, AL. The EA preparers obtained a protected species list from that office (see Appendix B). Table 5 list threatened, endangered, and candidate species that may occur in the vicinity of the WSR-88D site:

Table 5: Threatened, Endangered, and Candidate Species that may Occur in the Vicinity of the KBMX WSR-88D

Species	Scientific Name	Type	Status	Critical Habitat at Site?
Gray bat	*Myotis grisescens*	mammal	Endangered	None designated for this species
Indiana bat	*Myotis sodalios*	mammal	Endangered	None designated for this species
Northern long-eared bat	*Myotis septentrionalis*	mammal	Endangered	None designated for this species
Alligator snapping turtle	*Macrochelys temminckii*	Reptile	Proposed Threatened	None designated for this species
Finelined pocketbook	*Hamiota altilis*	Clam	Threatened	Designated, not at site
Ovate clubshell	*Pleurobema perovatum*	Clam	Endangered	Designated, not at site
Southern clubshell	*Pleurobema decisum*	Clam	Endangered	Designated, not at site
Southern pigtoe	*Pleurobema georgiana*	Clam	Endangered	Designated, not at site
Upland combshell	*Epioblasma metastriata*	Clam	Endangered	Designated, not at site

Species	Scientific Name	Type	Status	Critical Habitat at Site?
Monarch butterfly	*Danaus plexippus*	Insect	Candidate	None designated for this species
Tennessee Yellow-eyed grass	*Xyris tennesseenis*	Plant	Endangered	None designated for this species

Three bat species could potentially occur in the area -- gray bat (*Myotis grisecens*), Indiana bat (*Myotis sodalist*), and Northern long-eared bat (*Myotis septentrionalis*). All three species are listed as endangered.

The gray bat is long-eared with light brown to brown fu that is listed as endangered. Historically the gray bat occurred from West Virginia to Florida and west to Oklahoma and Kansas, but the current range is reduced. Critical habitat has been designated for this species but does not include the WSR-88D site. Gray bats hibernate in limestone caves during the winter and migrate up to 300 miles to maternity caves during the March and April. They forage over water along reservoirs and river and summer caves are almost always within one mile of water (USFWS, 2023a). The KBMX WSR-88D site does not contain caves or suitable foraging habitat for gray bats.

Indiana bat is a medium-sized grayish chestnut colored migratory bat that ranges widely throughout the eastern, north-central, and south-central U.S. and is listed as endangered. Indiana bats hibernate in caves and mines, and migrates to wooded areas to raise young. Summer roosts are typically behind exfoliating bark of large, often dead, trees (USFWS, 2023b). Critical habitat has been designated for this species but does not include the WSR-88D site. The KBMX WSR-88D site does not contain suitable habitat for the Indiana bat.

Northern long-eared bat is medium-sized bat that occurs widely throughout the eastern and north-central U.S. but has declined in population due to white-nose syndrome. Critical habitat has not been designated for this species. Northern long-eared bats hibernate in caves, mines, and culverts and migrate to wooded areas to raise young (USFWS, 20323c). The KBMX WSR-88D site does not contain suitable habitat for the northern long-eared bat.

Alligator snapping turtles (*Machrochelys temminckii*) and the five freshwater clam species depend on aquatic habitat (USFWS, 2023d, e, f, g, h, and i). The proposed action would not disturb water bodies or impact water quality and would not impact these species.

One candidate species for listing as threatened or endangered could potentially occur in the local area: Monarch Butterfly (*Danaus plexippus*). The KBMX WSR-88D is not located within designated monarch butterfly critical habitat. 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, 2023j). The proposed action would not result in ground disturbance or removal of vegetation and would not impact monarch butterfly habitat.

Tennessee yellow-eyed grass is a perennial monocot that inhabits high pH seeps and streambanks. It is a wetland obligate species (USFWS, 2023k). Suitable habitat is not present at or near the WSR-88D site and no vegetation removal would occur as part of the proposed action. Tennessee -eyed grass would not be affected.

In addition to threatened, endangered, and candidate species USFWS is responsible for protecting migratory birds under the Migratory Bird Treaty Act and Executive Order 13186 *Responsibilities of Federal Agencies to Protect Migratory Birds* and bald and golden eagles under the *Bald and golden Eagle Protection Act*. Lowering the minimum scan angle to +0.4 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 near the WSR-88D – less than 2 ft thick at 900 ft from the WSR-88D and increasing in thickness with distance from the radar. At 1 mile it would be 9 ft thick and at five miles it would be 46 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 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 a bird or butterfly flies 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 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 remain within the WSR-88D main beam for any length of time.

No impacts would result to threatened or endangered species, monarch butterfly, migratory birds, or bald and golden eagles. 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 KBMX WSR-88Ds where RF exposure of persons within the WSR-88D main beam could potentially exceed safety levels (see Appendix A). The National Register of Historic Places database was searched to identify places listed or eligible for listing on within the APE. No listings were found (National Park Service, 2023a). All existing structures within the APE are industrial and commercial facilities. All of these structures are of modern construction and lack historic attributes. No places listed or eligible for listing on NRHP are located within the APE and the proposed action would not affect historic properties. Under Section 106 Regulations 36 CFR Section 800.4 (d)(1), *No Historic Properties Affected*, if the proposed action does not have the potential to affect historic properties, the ROC shall provide notification of this determination to the SHPO. If the SHPO does not object to the determination within 30 days, ROC's section 106 responsibilities are fulfilled. [ecfr, 2023).

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 KBMX WSR-88D is located at an electric power maintenance facility and nearby land uses are industrial and commercial. The closest residences are 0.5 mile to the NW. The proposed action would not generate air or water pollutants or hazardous waste. The project would modify the operation of the KBMX WSR-88D by reducing the minimum scan angle from +0.5 deg to +0.4 deg. The 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 KBMX WSR-88D site is not classified as prime farmland (NRCS, 2023). Additionally, the WSR-88D site is committed to non-agricultural utility use. 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 KBMX 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 KBMX WSR-88D is the Sipsey Fork of the West Fork River in William Bankhead National Forest, Lawrence and Bankhead Counties, AL about 80 miles NW of the WSR-88D (National Park Service, 2023b). 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 +0.3 AND 0.0 DEG

ROC evaluated the benefits and potential impacts of lowering the minimum center of beam scan angle of the KBMX WSR-88D to each angle between +0.4 and 0.0 deg in 0.1 degree increments (see Appendix C). That analysis found that the proposed action of lowering the minimum scan angle to +0.4 deg would result in the significant improvement in radar coverage.

Minimum scan angles of +0.3 or +0.2 deg would result in additional increases in radar coverage area (above that achieved at +0.4 deg), but could potentially affect operation of the University of Montevallo's James Wylie Sheperd Observatory, located 8 miles SW of the KBMX WSR-88D. Minimum scan angles of +0.1 or 0.0 deg would not increase coverage area (i.e., coverage would be same as for +0.2 deg) and would have the drawbacks of increasing ground clutter returns and also potentially affecting the James Wylie Sheperd Observatory.

Because a minimum scan angle of +0.4 deg would result in significant improvement in radar coverage area while avoiding the potential for significant environmental impacts, ROC selected +0.4 deg as the proposed minimum scan angle for the KBMX WSR-88D.

5.2 NO ACTION

The no action alternative consists of continued operation of the KBMX 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 KBMX WSR-88D from the current minimum of +0.5 deg to +0.4 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 ROC forecasters and others users of the data. This may indirectly benefit the residents and businesses of the Birmingham, AL, area, improving the accuracy of forecast and severe weather alerts, which could result in environmental benefits if weather dependent economic or government activities (e.g., agriculture, construction, outdoor recreation, transportation, military operations, 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 ROC Radar Operations Center (ROC) in Norman, OK.

Mr. James Manitakos, CEO, served as Sensor's Project Manager. Huntington Ingalls Industries (HII)/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 HII Alion's Project Manager. Ms. Jessica Schultz, Deputy Director of the ROC, and Mr. Ryan Groce, Centuria Corporation Program Manager, from the ROC 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 BIRMINGHAM, AL, 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 Birmingham, Area (KBMX)

Parameter	**Value**
Operating Frequency	2,740 megahertz (MHz)
Wavelength at 2,705 MHz)	0.3589 ft, 10.9 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 ROC proposes to modify the minimum center of beam scan angle used during operation of the KBMX 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. ROC 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 +0.4 deg (i.e., lower half power point of -0.3 deg), the lowest scan angles under consideration by ROC. 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 +0.4 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

For VCP 31 operation of the WSR-88D, the values of U_1, U_2, U_3, U_4 and U_5 are unchanged from the values derived in 1993 Appendix A. 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, 2019]and 2020. We use six minutes as the averaging time as a worst-case analysis. The time-averaged power density for VCP 31, considering the contributions from both the main beam and the first five sidelobes is given by U_5, below:

$$U_{5,\ VCP\ 31} = 5{,}804 / R^2 \ \text{mW/cm}^2$$

At this point the analysis must consider the proposed modifications to VCP 31, which will change the values of U_4 and U_5. 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

$$U_{4,\ mod} = [(2.4/6)\ (1.0) + (2.4/6)\ (0.5) + (1.2/6)\ (0.012)]\ U_3$$

$$U_{4,\ mod} = (0.602)\ U_3$$

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

$$U_{4,\ mod} = 8{,}130\ /\ R^2\ \ mW/cm^2$$

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:

$$U_{5,\ mod} = 8{,}130 \times 10^3/R^2 + 4/R^2 = 8{,}134/R^2\ \ mW/cm^2$$

4.2 Near Field

Appendix A of the 1993 SEA contains the following formula for power density in the WSR-88D main beam during VCP 31 operation:

$$U_{6,\ VCP\ 31} = 9800/\ (R^2 + 800R)\ mW/cm^2$$

Which is based on calculation of 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 +0.4. +0.5, and +1.5 degs, the angular range is 1.1 deg, and we recalculate Y as follows:

$$Y = 28 + R \times \mathrm{Tan}\ (1.1\ deg) = 28 + 0.019R$$

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

$$A = 2\pi RY = 176R + 0.12R^2$$

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):

$U_{6, mod} = 2 \times 10^6 / (929) (176R + 0.12R^2) = 17{,}940 / (R^2 + 1{,}467 R)$ mW/cm^2

$U_{6, mod}$ 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 KBMX 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 KBMX 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	744*	0.598	n/a	0.603
Closest Structure: Cell Phone Tower	1,400 ft SE	744*	0.0030	742	0.0042
Closest Illuminated Ground	15,840 ft (3 miles) N	744*	0.000023	716	0.000032

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

ROC may infrequently operate the KBMX 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

ANSI/IEEE. *IEEE Standard for Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 3 kHz to 300 GHz*. IEEE Std C95.1-2019 (February 8, 2019).

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APPENDIX B

PROTECTED SPECIES LIST

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Alabama Ecological Services Field Office
1208 B Main Street
Daphne, AL 36526-4419
Phone: (251) 441-5181 Fax: (251) 441-6222
Email Address: alabama@fws.gov

In Reply Refer To: July 22, 2023
Project Code: 2023-0107805
Project Name: KBMX 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 enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

Project consultation requests may be submitted by mail or email (Alabama@fws.gov). **Ensure that the Project Code in the header of this letter is clearly referenced in any request for consultation or correspondence submitted to our office.**

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. 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. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF

Migratory Birds: In addition to responsibilities to protect threatened and endangered species under the Endangered Species Act (ESA), there are additional responsibilities under the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA) to protect native birds from project-related impacts. Any activity, intentional or unintentional, resulting in take of migratory birds, including eagles, is prohibited unless otherwise permitted by the U.S. Fish and Wildlife Service (50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)). For more information regarding these Acts see https://www.fws.gov/birds/policies-and-regulations.php.

The MBTA has no provision for allowing take of migratory birds that may be unintentionally killed or injured by otherwise lawful activities. It is the responsibility of the project proponent to comply with these Acts by identifying potential impacts to migratory birds and eagles within applicable NEPA documents (when there is a federal nexus) or a Bird/Eagle Conservation Plan (when there is no federal nexus). Proponents should implement conservation measures to avoid or minimize the production of project-related stressors or minimize the exposure of birds and their resources to the project-related stressors. For more information on avian stressors and recommended conservation measures see https://www.fws.gov/birds/bird-enthusiasts/threats-to-birds.php.

In addition to MBTA and BGEPA, Executive Order 13186: *Responsibilities of Federal Agencies to Protect Migratory Birds*, obligates all Federal agencies that engage in or authorize activities that might affect migratory birds, to minimize those effects and encourage conservation measures that will improve bird populations. Executive Order 13186 provides for the protection of both migratory birds and migratory bird habitat. For information regarding the implementation of Executive Order 13186, please visit https://www.fws.gov/birds/policies-and-regulations/executive-orders/e0-13186.php.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. **Ensure that the Project Code in the header of this letter is clearly referenced with any request for consultation or correspondence about your project that you submit to our office.**

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".

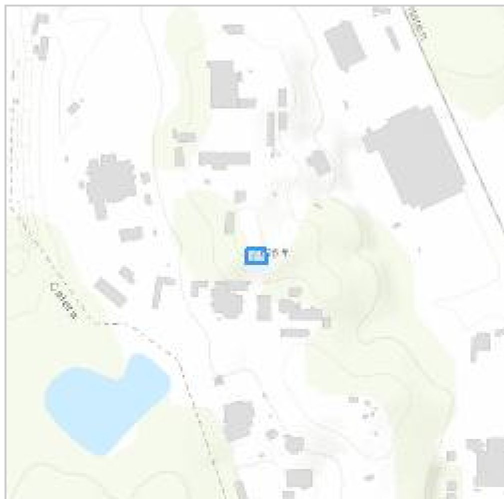
This species list is provided by:

Alabama Ecological Services Field Office
1208 B Main Street
Daphne, AL 36526-4419
(251) 441-5181

PROJECT SUMMARY

Project Code: 2023-0107805
Project Name: KBMX WSR-88D Lower Scan Angle
Project Type: Maintenance/Modification Meteorological Tower
Project Description: Lowering the minimum scan angle of the WSR-88D
Project Location:

The approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/@33.172185150000004,-86.76981224895792,14z



Counties: Shelby County, Alabama

ENDANGERED SPECIES ACT SPECIES

There is a total of 11 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
Gray Bat *Myotis grisescens* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/6329	Endangered
Indiana Bat *Myotis sodalis* There is **final** critical habitat for this species. Your location does not overlap the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/5949	Endangered
Northern Long-eared Bat *Myotis septentrionalis* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/9045	Endangered

REPTILES

NAME	STATUS
Alligator Snapping Turtle *Macrochelys temminckii* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/4658	Proposed Threatened

CLAMS

NAME	STATUS
Finelined Pocketbook *Hamiota altilis* There is **final** critical habitat for this species. Your location does not overlap the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/1393	Threatened
Ovate Clubshell *Pleurobema perovatum* There is **final** critical habitat for this species. Your location does not overlap the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/5430	Endangered
Southern Clubshell *Pleurobema decisum* There is **final** critical habitat for this species. Your location does not overlap the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/6113	Endangered
Southern Pigtoe *Pleurobema georgianum* There is **final** critical habitat for this species. Your location does not overlap the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/1520	Endangered
Upland Combshell *Epioblasma metastriata* There is **final** critical habitat for this species. Your location does not overlap the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/317	Endangered

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
Tennessee Yellow-eyed Grass *Xyris tennesseensis* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/6010	Endangered

CRITICAL HABITATS

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

YOU ARE STILL REQUIRED TO DETERMINE IF YOUR PROJECT(S) MAY HAVE EFFECTS ON ALL ABOVE LISTED SPECIES.

IPAC USER CONTACT INFORMATION

Agency: National Weather Service
Name: James Manitakos
Address: 296 West Arbor Avenue
City: Sunnyvale
State: CA
Zip: 94085
Email jmanitakos@sensorenvirollc.com
Phone: 4084980077

APPENDIX C

TECHNICAL MEMORANDUM AND TRIP REPORT

SENSOR ENVIRONMENTAL LLC
www.sensorenvirollc.com

TECHNICAL MEMORANDUM

TO: Ryan Groce, 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, Huntington Ingalls Industries Mission Technologies Group (formerly Alion Science and Technology Corp.)	**SUBJECT:** Analysis of Lower Scan Angles for Weather Surveillance Radar, Model 1988 Doppler (WSR-88D) Serving Birmingham, AL, Area
DATE: August 12, 2023	

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 the Birmingham, AL, area. Information on this radar is shown in Table 1. This WSR-88D was commissioned on May 1994 and has been in operation at its current location since then.

TABLE 1: Information on WSR-88D Serving the Birmingham, AL, Area	
Location	Alabama Power Maintenance Facility near Shelby County Airport, 24 miles south (S) of Birmingham, AL
Commissioning Date	May 1994
International Civil Aviation Organization Designator	KBMX
Elevation, ground surface at tower base (mean sea level, MSL)	645 feet (ft)
Elevation, center of antenna (MSL)	758 ft
Tower Height (m)	30 m (98 ft)
Latitude (WGS84)	33˚10’20” N
Longitude (WGS84)	86˚46’11” W
Operating Frequency	2,740 megaHertz (MHz)
Spot Blanking or Sector Blanking used	No
Weather Forecast Office	465 Weathervane Lane Calera, AL 35040 (205)664-3010

NWS currently operates the KBMX 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 KBMX WSR-88D, The WSR-88D Radar Operations Center (ROC) proposes to operate the radar with a lower center-of-beam minimum scan angle and is considering angles between +0.4 and 0.0 deg. This would result in the lower half power point of the main beam at -0.1 to -0.5 deg, depending on the minimum scan angle selected.

2. INVESTIGATIONS PERFORMED

To analyze the benefits and potential impacts of lowering the minimum scan angle of the KBMX WSR-88D, Sensor Environmental LLC and our subcontractor Huntington Ingalls Industries Mission Technologies Group (formerly Alion Science and Technology Corporation) performed the following tasks:

1. Visited the KBMX WSR-88D to ascertain site conditions and activities in the vicinity (see Attachment A, Trip Report).
2. Obtained 360-degree calibrated panoramic photograph taken at 25-m level of the KBMX WSR-88D tower, which is about 30 ft lower than the center of antenna height.
3. 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 0.0 degree (See Attachment B).
4. 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).
5. Identified astronomical observatories within 150 miles and analyzed the potential for a lowered WSR-88D main beam to directly impinge on each observatory.
6. Identified wind turbines within 50 miles and analyzed potential for a lowered WSR-88D main beam to directly impinge on each observatory.

3. WSR-88D COVERAGE

KBMX WSR-88D is located on elevated ground within an Alabama Power maintenance facility in Calera, Shelby County, AL, about 24 miles south (S) of downtown Birmingham, AL (see Attachment 1). 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 KBMX 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 KBMX 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: KBMX WSR-88D Radar Coverage Areas by 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	9,568	n/a
2,000	+0.4	-0.1	11,809	+23.4%
2,000	+0.3	-0.2	12,897	+34.8%
2,000	+0.2, +0.1, 0.0	-0.3, -0.4, -0.5	13,080	+36.7%

When operating at the current minimum center of beam minimum scan angle of +0.5 deg, the KBMX WSR-88D is subject to significant terrain blockage to the north (N) and minor terrain blockage to the east-northeast (ENE) and west (W) (see Attachment B). A minimum scan angle of +0.4 would improve radar coverage in all directions except the N, ENE, and W. A minimum scan angle of +0.3 would result in additional coverage improvements to the southwest (SW), southeast (SE), and NE. A minimum scan angle of +0.2 would result in very minor additional coverage improvement to the SW. Lowering the scan angle below +0.2 deg would not result in additional coverage improvements. Because minimum scan angles of +0.2, +0.1, and 0.0 deg would result in negligible improvement in radar coverage while increasing ground clutter returns, those scan angles are not considered further in this memorandum.

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. 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>
<tr><th colspan="4">TABLE 3: Safe Setback Distances for Human Exposure and Potentially RF-Sensitive Activities Directly Illuminated by the WSR-88D Main Beam</th></tr>
<tr><th>Activity</th><th colspan="2">Safe Setback Distance (ft)</th><th>Source</th></tr>
<tr><td rowspan="2">Human Exposure</td><td>Rotating Antenna</td><td>20</td><td rowspan="2">American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE)</td></tr>
<tr><td>Stationary Antenna</td><td>1,740</td></tr>
<tr><td>Implantable Medical devices</td><td colspan="2">2,060</td><td>ANSI/Association for the Advancement of Medical Instrumentation (AAMI)</td></tr>
<tr><td>EEDs (Safe/Unsafe)</td><td colspan="2">1,696 / 6,240</td><td>Naval Sea Systems Command</td></tr>
<tr><td>Fuel Handling</td><td colspan="2">537</td><td>Naval Sea Systems Command</td></tr>
<tr><td colspan="4">Sources: ANSI/AAMI, 2007; ANSI/IEEE, 2029 and 2020; Naval Sea Systems Command, 2003 and 2008</td></tr>
</table>

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 6,240 ft and 1,696 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).

5. DIRECTLY ILLUMINATED TERRAIN AND STRUCTURES

Photographs 3A through 3D in Attachment A Trip Report are panoramic photographs taken from the 25-m level of the KBMX WSR-88D tower and show a 360 deg view of the horizon. As shown in these figures, the only nearby structure rising above WSR-88D antenna elevation is a communications tower to the southeast, which is analyzed in the next paragraph.

A search of the Federal Communications Commission (FCC) Antenna Structure Registration site identified seven tower registrations (not including cancelled registrations) within 3 miles of the KBMX WSR-88D. Table 4 provides additional information. The existing/planned towers in the listings are 0.27 to 2.5 miles from the WSR-88D. The nearest tower (Registration Number 1019994) is 1,400 feet SE of the radar. It rises above the WSR-88D antenna elevation and is within the WSR-88D main beam during current operations. The tower is closer than the safe setback distances for human exposure during WSR-88D stationary antenna operations, which occurs very infrequently), implantable medical devices, and HERO safe/unsafe EEDs. It is improbable that EEDs would be used at the upper portions of a communications tower. The general public would not be expected to access the uppermost 60 ft of the 168-ft tall tower which would be illuminated by the main beam at a +0.3 scan angle. Workers who might access the upper tower are expected to have received RF safety training and be familiar with RF occupational procedures and equipment. Because the tower is illuminated by the WSR-88D main beam at the currently used +0.5 deg scan angle, lowering the main beam minimum scan angle to +0.4 or +0.3 deg would result in negligible change in RF exposure levels more of the tower would be within the main beam. Potential RF hazards to personnel on the tower could result during operation of the WSR-88D with a stationary antenna directed at the nearby tower, and that operation should be avoided.

Registration Number 1250159 is for a tower located 4,400 ft SE of the WSR-88D. That top of that tower is at elevation 720 ft, which is below and outside the WSR-88D main beam during current operations. Lowering the main beam scan angle to +0.4 deg or +0.3 deg would result in a lower half-power point of 736 ft and 728 ft, respectively, which would be clear the top of the tower. Since the tower would not be within the main beam, no hazards would result from minimum WSR-88D scan angles of +0.4 or 0.3 deg.

The other five towers included in the FCC listings would be within the WSR-88D main beam at a minimum scan angle of +0.3 deg but are farther from the WSR-88D than all safe setback distances. A minimum scan angle of +0.4 or +0.3 deg would not result in RF hazards to personnel or RF-sensitive activities at those towers.

TABLE 4: FCC Antenna Structure Registrations within 3 miles of KBMX WSR-88D					
Registration Number	**Distance and Direction from WSR-88D**	**Top of Tower Elevation (ft MSL)**	**Registrant**	**Status**	**Would WSR-88D main beam impinge at scan angle of +0.5 deg / +0.3 deg?**
1025709	2.1 miles (11,270 ft) SE	859	STC Five, LLC	Constructed	Yes/Yes
1019994	0.27 mi (1,400 ft) SE	797	Pinnacle Towers LLC	Constructed	Yes/Yes
1222496	2.5 mi (13,300 ft) N	764	WGTT, Inc.	Constructed	Yes/Yes
1250159	0.84 mi (4,400 ft) SE	720	State of Alabama D.O.T.	Constructed	No/No
1254343	1.97 mi (10,400 ft) SW	727	SBA Monarch towers I, LLC	Constructed	No/Yes
1291248	2.37 mi (12,500 ft) WNW	736	Cellco Partnership	Constructed	No/Yes
1316421	1.82 mi (9,600 ft) W	786	CitySwitch II, LLC	Granted, not constructed	Yes/Yes

Attachment C contains maps showing terrain directly illuminated by the KBMX WSR-88D main beam at minimum center of beam scan angles of +0.5 seg (current operation) through 0.0 deg. At the current minimum scan angle of +0.5 deg or a scan angle of +0.4 deg, the only affected terrain is a hillside located 3 miles N of the radar. At a minimum scan angle of +0.3 deg, the main beam would additionally impinge on hilltops located 1.8 miles NW, 2 miles NE, and 3 miles E of the radar. At any of the lower scan angles under consideration, illuminated terrain would be farther from the WSR-88D than all safe setback distances.

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 the states of Alabama, Georgia, Mississippi, and Tennessee are within 150 miles of the KBMX WSR-88D and were evaluated to identify observatories. Six observatories are within 150 miles (www.go-astronomy.com, 2023). Table 5 lists these observatories and whether the WSR-88D beam at a scan angle of +0.4 or +0.3 deg would impinge on them. Lowering the minimum scan angle of KBMX WSR-88D main beam to +0.4 or +0.3 deg would not result in the main beam impinging on any of the observatories except possibly the James Wylie Sheperd Observatory, operated by the University of Montevallo in Montevallo, AL.

The James Wylie Sheperd Observatory, is 7.9 miles SW of the WSR-88D at ground elevation 600 ft and the single telescope protective dome is located directly on the ground, resulting in an estimated telescope elevation of 610 ft. A minimum scan angle of +0.4 deg would place the lower edge of the main beam at elevation 670 ft and the main beam would not impinge on the observatory. A minimum scan angle of +0.3 deg would place the lower edge of the main beam at elevation 610 ft -- the same elevation as the telescope at the observatory. The forest surrounding the observatory rises above the telescope and would provide some attenuation of the WSR-88D signal, but additional analysis would be needed to determine the extent of the attenuation and possible effects on observatory operations.

TABLE 5: Astronomical Observatories within 150 miles of KBMX WSR-88D

Observatory	Location	Distance and Direction	Elevation (ft MSL)	Would WSR-88D main beam impinge at scan angle of +0.4 or +0.3 deg?
Univ of North Alabama	Florence, AL	124 mi NNW	660	No, earth curvature places main beam at least 5,500 ft above observatory

TABLE 5: Astronomical Observatories within 150 miles of KBMX WSR-88D				
Observatory	**Location**	**Distance and Direction**	**Elevation (ft MSL)**	**Would WSR-88D main beam impinge at scan angle of +0.4 or +0.3 deg?**
James Wylie Shepherd (Univ of Montevallo)	Montevallo, AL	8 mi SW	610 ft	+0.4 deg: No. Lower half-power point would be 60 ft above observatory +0.3 deg: Potential impingement
Univ of Alabama	Tuscaloosa, AL	45 mi NW	310 ft	No, earth curvature places main beam at least 630 ft above observatory
Westrock	Columbus, GA	113 mi SE	290 ft	No, earth curvature places main beam at least 4,800 ft above observatory
Cordell-Lorenz	Sewanee, TN	150 mi NNE	2,030 ft	No, earth curvature places main beam at least 7,200 ft above observatory
Howell (MS State Univ)	Starkville, MS	119 mi w	355 ft	No, earth curvature places beam at least 5,300 ft above observatory

7. WIND TURBINES

Wind turbines are a special concern because they produce Doppler radar returns that can mask meteorological returns. The U.S. Wind turbine Database (U.S. Geological Survey [USGS], 2023) was searched for wind turbines within 50 miles of the KBMX WSR-88D. The search did not identify any wind turbines within 50 miles.

8. SUMMARY AND RECOMMENDATION

Compared to the current minimum scan angle of +0.5 deg, lowering the minimum scan angle of the KBMX WSR-88D to +0.4 would increase coverage area at 2,000 ft above site level by 23.4%. Lowering the minimum scan angle of the KBMX WSR-88D to +0.3 deg would increase 2,000-ft coverage area by 34.8%. Minimum scan angles of +0.2 deg or less would result in little additional improvement.

A minimum scan angle of +0.4 or +0.3 deg would not result in hazards to personnel, implantable medical devices, safe EEDs, or fuel handling. A minimum scan angle of +0.3 deg could result in the WSR-88D main beam impinging on the University of Montevallo's James Wylie Sheperd Observatory, located 7.9 miles SW of the WSR-88D. Additional analysis would be needed to determine if adverse effects would result to observatory operations. A minimum scan angle of +0.4 deg would avoid the main beam impinging on the observatory.

No wind turbines are present within 50 miles of the KBMX WSR-88D and lowering the minimum scan angle would not result in new or more intense doppler returns from wind turbines.

A minimum center of beam scan angle of +0.4 deg is recommended for the KBMX WSR-88D.

9. 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. Huntington Ingalls Industries Mission Technologies Group prepared radar coverage maps and calculated coverage areas under subcontract to Sensor. Mr. Andre Tarpinian, Radio Frequency Engineer, served as Huntington's Project Manager.

10. REFERENCES

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ATTACHMENT A

TRIP REPORT, KBMX WSR-88D

TRIP REPORT

Traveler: James Manitakos, Sensor Environmental LLC

Destination: KBMX Weather Surveillance Radar, Model 1988 Doppler (WSR-88D) serving the Birmingham. AL, area

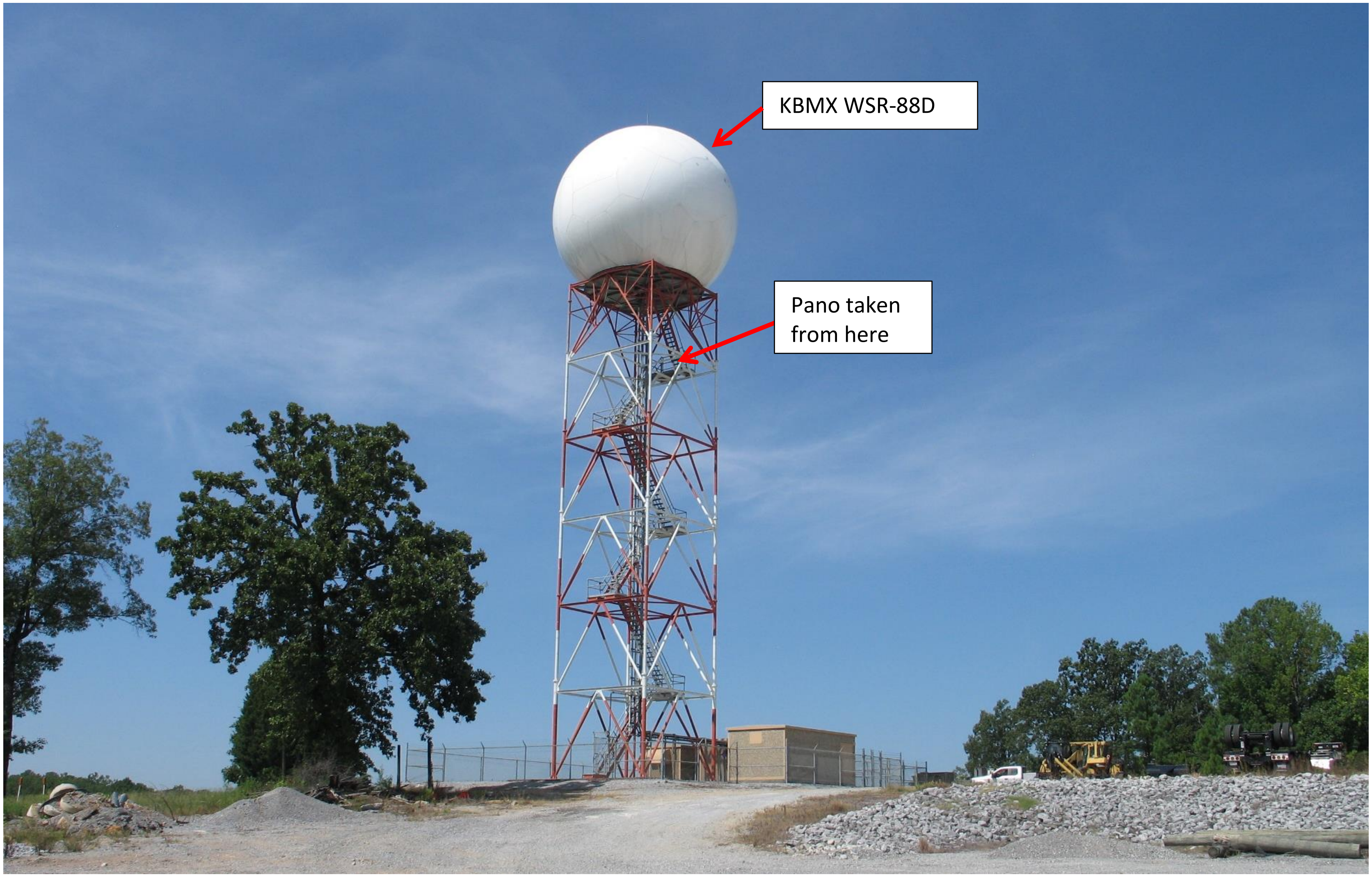
Dates: August 1 to August 3, 2023

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

Summary: August 1: Mr. Manitakos drove from Mobile, AL to Calera, AL

August 2: Weather: 90° F, sunny. Mr. Manitakos took pictures of the KBMX WSR-88D (photographs 1 and 2) and investigated land uses in the vicinity of the radar. He took panoramic photographs (Photograph 3) from the 25-m level of the KBMX WSR-88D, which is about 30 ft below the center of the WSR-88D antenna.

June 29: Mr. Manitakos drove to Atlanta, GA and flew to San Francisco, CA



Photograph 1: KBMX WSR-88D serving Birmingham, AL, area viewed from NE

Photograph 2: Sign at Birmingham, AL WFO

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

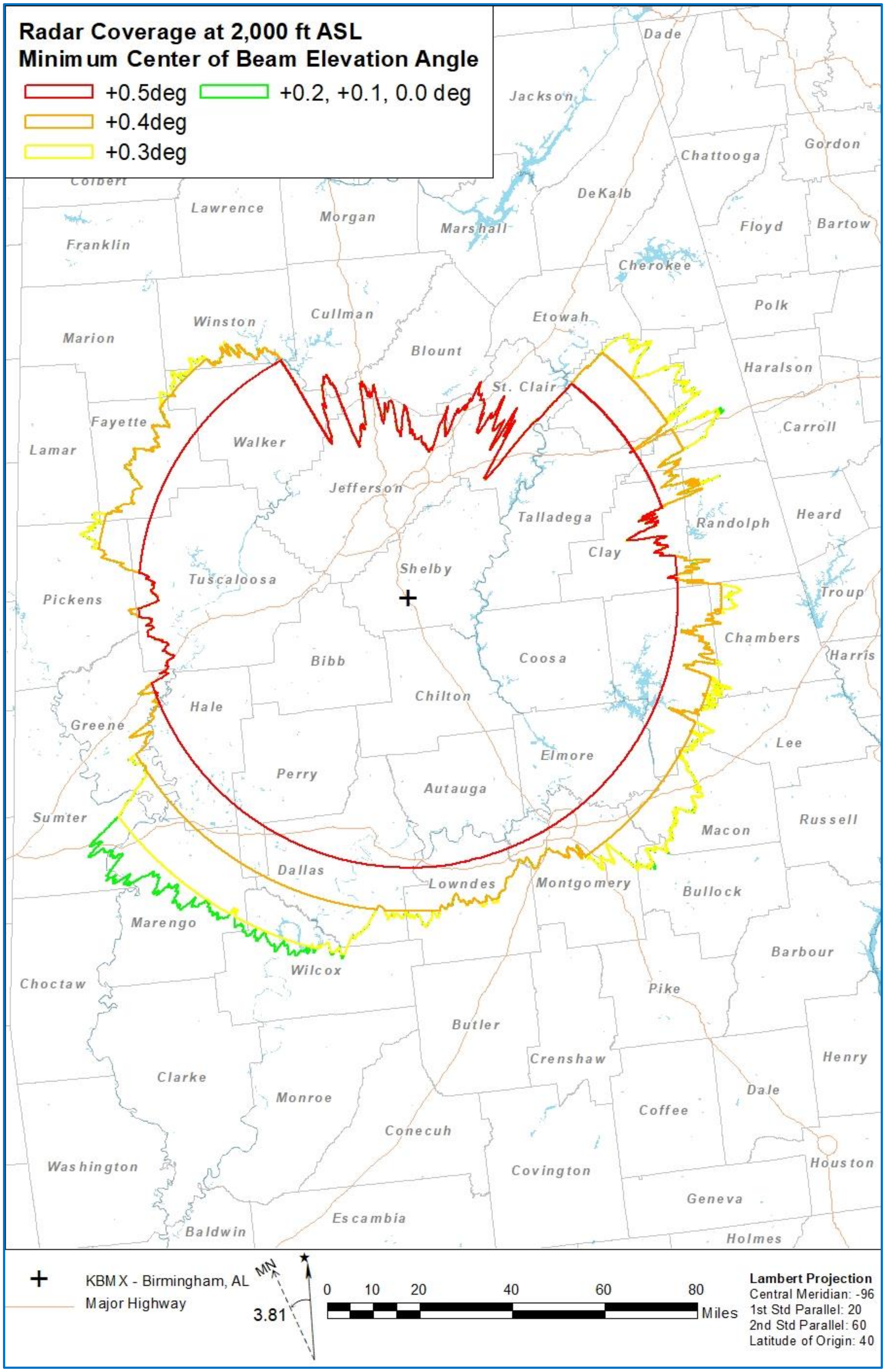
Photograph 3B: Panoramic photograph from KBMX WSR-88D tower [— 0 deg]

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

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

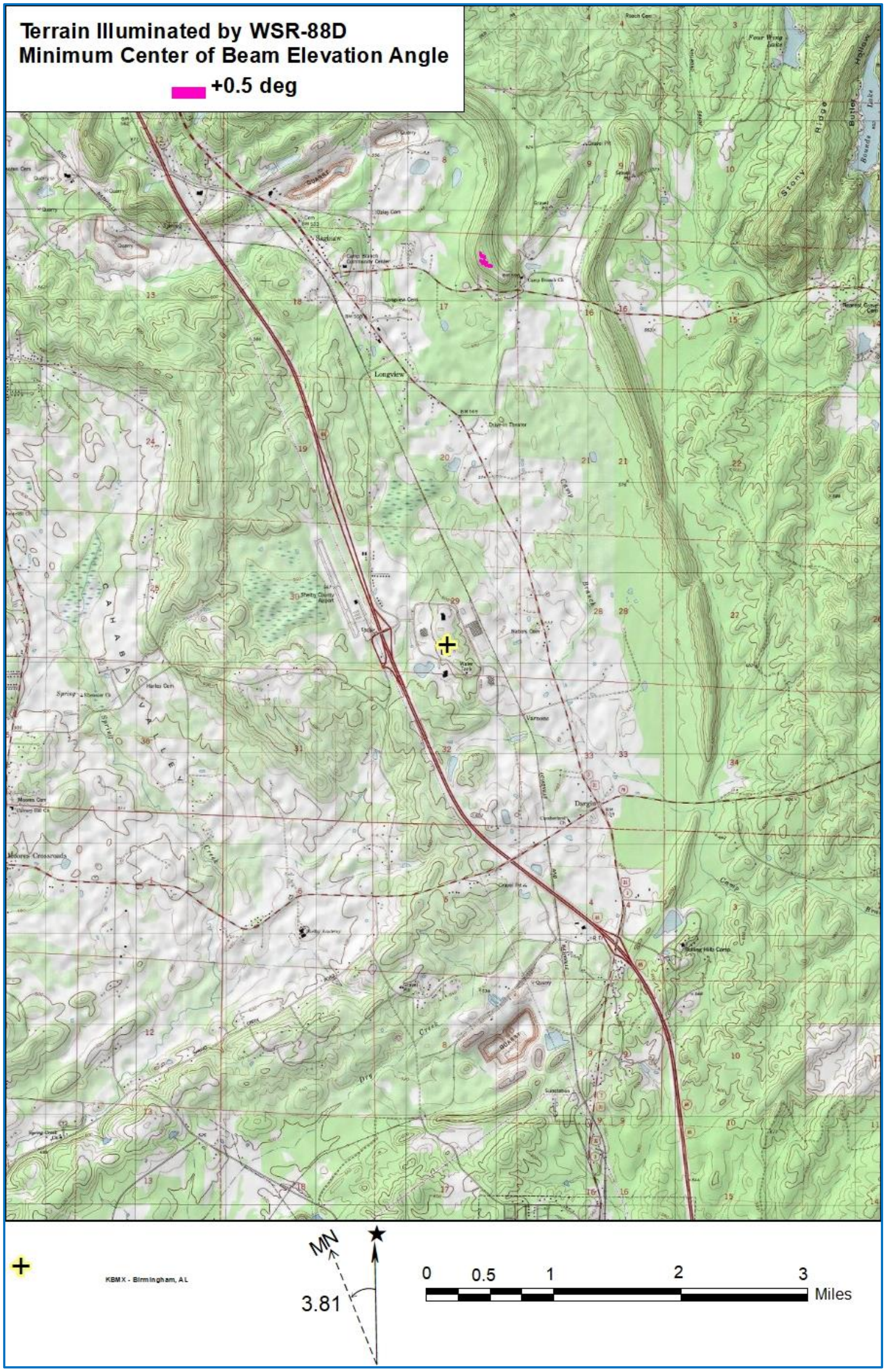
ATTACHMENT B

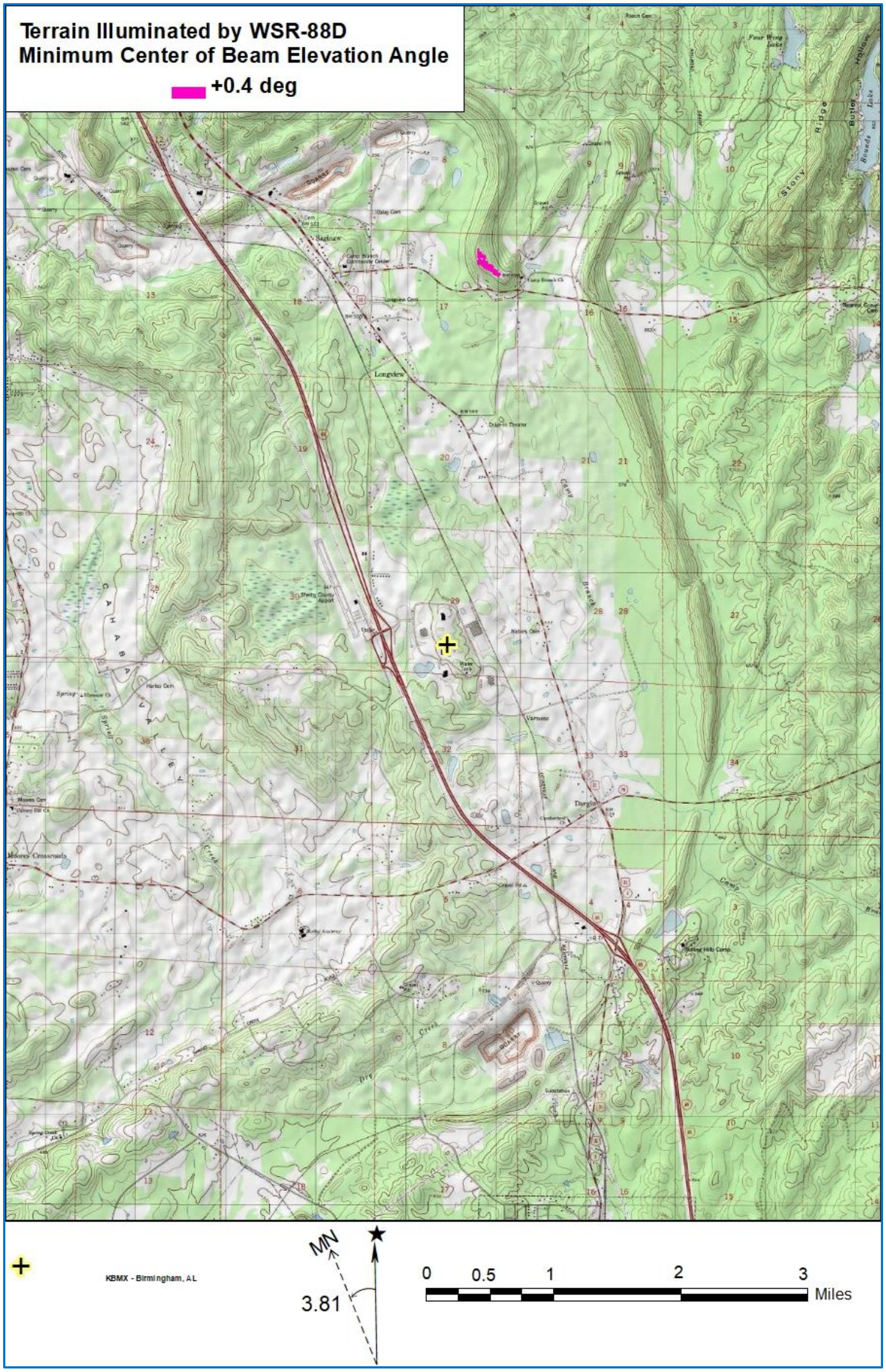
KBMX WSR-88D COVERAGE MAP
MINIMUM SCAN ANGLES +0.5 deg to 0.0 deg

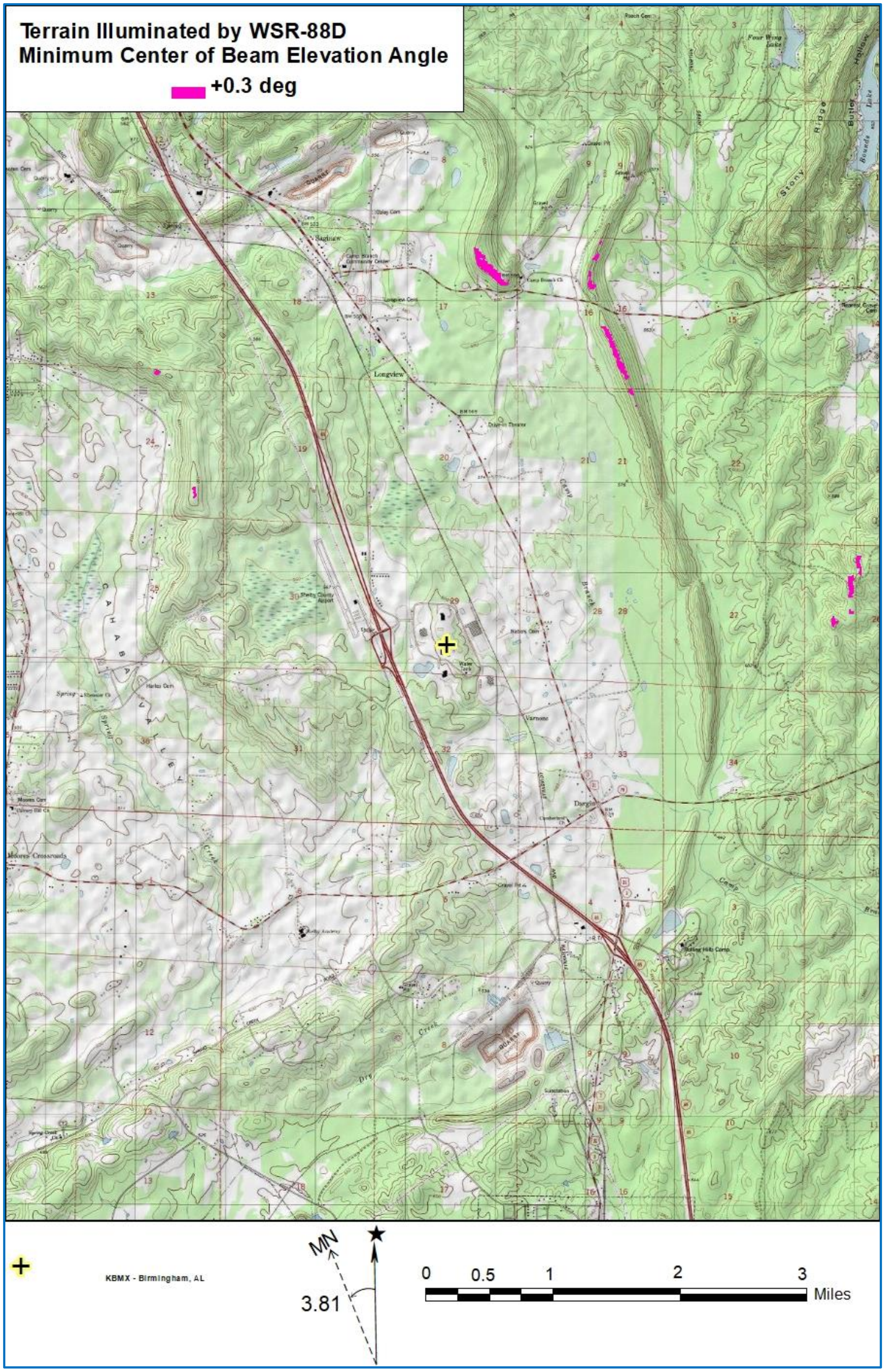

Radar Coverage at 2,000 ft ASL
Minimum Center of Beam Elevation Angle
+0.5deg
+0.2, +0.1, 0.0 deg
+0.4deg
+0.3deg
Dade
Jackson
Chattooga
Gordon
Colbert
DeKalb
Lawrence
Morgan
Marshall
Floyd
Bartow
Franklin
Cherokee
Polk
Winston
Cullman
Etowah
Marion
Blount
Haralson
St. Clair
Fayette
Walker
Carroll
Lamar
Jefferson
Heard
Talladega
Randolph
Clay
Shelby
Tuscaloosa
Troup
Pickens
Chambers
Harris
Bibb
Coosa
Chilton
Hale
Greene
Lee
Elmore
Perry
Autauga
Sumter
Russell
Macon
Dallas
Lowndes
Montgomery
Bullock
Marengo
Barbour
Wilcox
Choctaw
Pike
Butler
Henry
Crenshaw
Clarke
Dale
Monroe
Coffee
Conecuh
Houston
Washington
Covington
Geneva
Escambia
Baldwin
Holmes
KBMX - Birmingham, AL
Major Highway
MN
3.81
0 10 20 40 60 80
Miles
Lambert Projection
Central Meridian: -96
1st Std Parallel: 20
2nd Std Parallel: 60
Latitude of Origin: 40

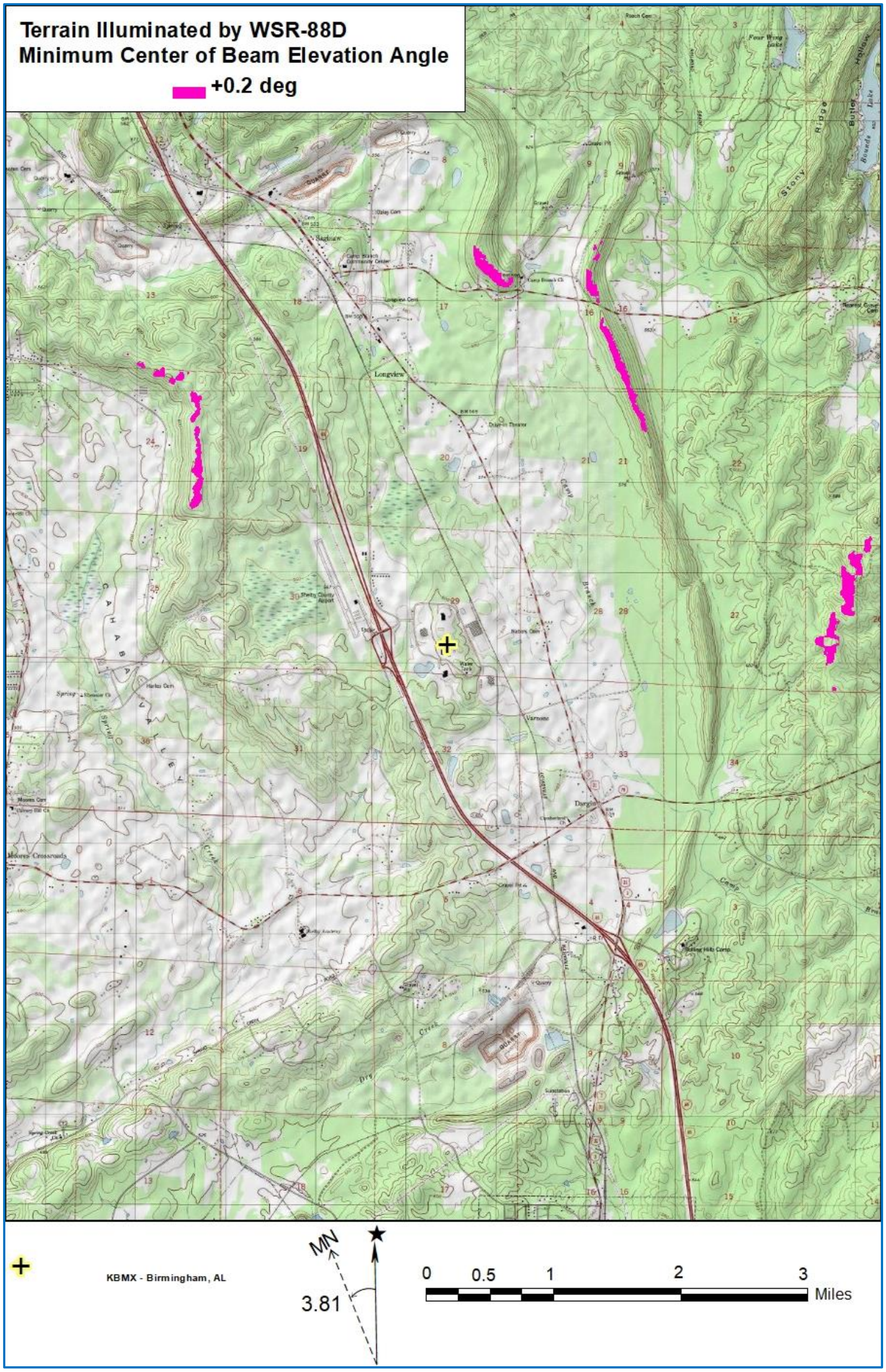
ATTACHMENT C

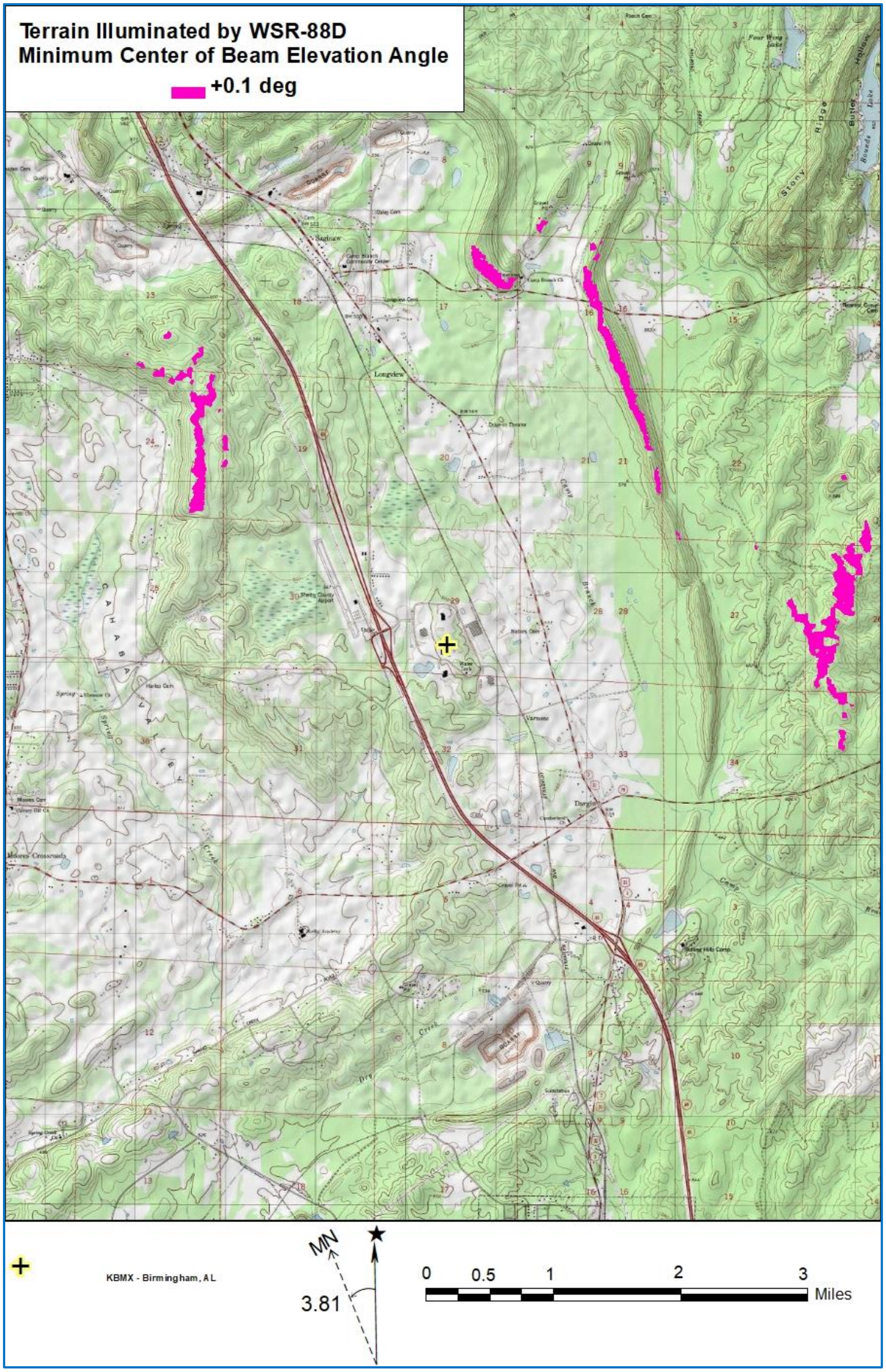
KBMX WSR-88D NEARBY DIRECTLY ILLUMINATED TERRAIN AT SCAN ANGLES OF +0.5 to 0.0 deg

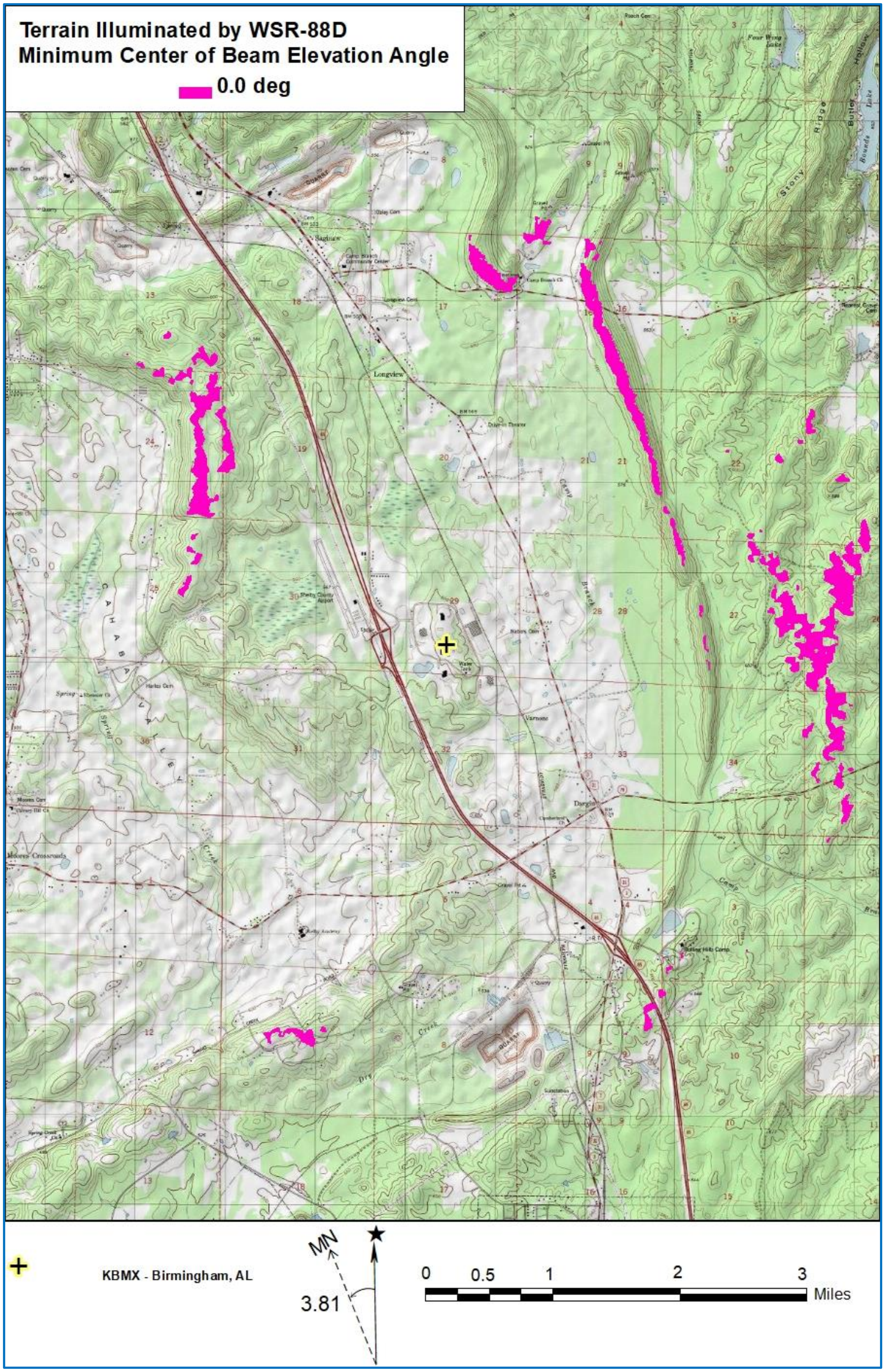

Terrain Illuminated by WSR-88D
Minimum Center of Beam Elevation Angle
+0.5 deg
KBMX - Birmingham, AL
MN
3.81
0
0.5
1
2
3
Miles


Terrain Illuminated by WSR-88D
Minimum Center of Beam Elevation Angle
+0.4 deg
KBMX - Birmingham, AL
MN
3.81
0 0.5 1 2 3
Miles


Terrain Illuminated by WSR-88D
Minimum Center of Beam Elevation Angle
+0.3 deg
Longview
KBMX - Birmingham, AL
MN
3.81
0
0.5
1
2
3
Miles


Terrain Illuminated by WSR-88D
Minimum Center of Beam Elevation Angle
+0.2 deg
KBMX - Birmingham, AL
MN
3.81
0 0.5 1 2 3 Miles


Terrain Illuminated by WSR-88D
Minimum Center of Beam Elevation Angle
+0.1 deg
KBMX - Birmingham, AL
MN
3.81
0 0.5 1 2 3
Miles


Terrain Illuminated by WSR-88D
Minimum Center of Beam Elevation Angle
0.0 deg
KBMX - Birmingham, AL
MN
3.81
0
0.5
1
2
3
Miles