Integrated Natural Resources Management Plan
United States Army Garrison – Redstone
Redstone Arsenal, Alabama

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Integrated Natural Resources Management Plan

(2017 through 2021)

United States Army Garrison – Redstone

Redstone Arsenal, Alabama

APPROVAL

This Integrated Natural Resources Management Plan meets the requirements of Public Law 105-85, the Sikes Act Improvement Act of 1997 (16 U.S.C. 670 et seq.) as amended.

Tom Holliday

THOMAS P. HOLLIDAY, JR.
COL, MI
Commanding

Date 29 Oct 17

CHRISTOPHER M. BLANKENSHIP FRH
Commissioner
Alabama Department of Conservation and Natural Resources

Date 11-13-17

APPROVED LEGAL
MC

FOR
MIKE OETKER
Acting Regional Director, Southeast
US Fish and Wildlife Service

Date 12.4.17

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Integrated Natural Resources Management Plan (2017 through 2021)

Annual Review and Coordination of the INRMP

In accordance with the Sikes Act, as amended, Department of Defense Instruction 4715.03, and Army Regulation 200-1, this INRMP is reviewed and updated on a regular basis "as to operation and effect."

2019 Summary of Changes:

- Inclusion of current and completed PLS projects in Sections 4.1 and 4.2
- Prioritization of unimproved grounds projects as means for invasive species control, timber stand improvement and sensitive species management
- Clarification of Floodplain Management requirements in Section 4.18

FOR A. Keith Cook
Chief, Environmental Management Division

Date 3/25/20

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Integrated Natural Resources Management Plan (2017 through 2021)

Annual Review and Coordination of the INRMP

In accordance with the Sikes Act, as amended, Department of Defense Instruction 4715.03, and Army Regulation 200-1, this INRMP is reviewed and updated on a regular basis "as to operation and effect".

2018 Summary of Changes:

- Update of Figure 2.4 "Flood Zones"
- Clarification of Floodplain Management requirements in Section 4.18
- Update of Appendix F with 2018 Redstone Arsenal Regulation 200-3 and 2017/2018 Hunting Map
- Update of Appendix I with 2018 Redstone Arsenal Landscaping SOP
- Inclusion of "Do Not Plant" List at Appendix I

Terry de la Paz

Date 1/22/2019

Terry de la Paz
Chief, Environmental Management Division

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Executive Summary

ES.1 Type of Document

This is an Integrated Natural Resources Management Plan.

ES.2 Purpose of Document

This Integrated Natural Resources Management Plan (INRMP) serves as a guide to balance the natural resource management program with the military operations at Redstone Arsenal for the next 5-year period (Fiscal Years 2017 through 2021). It has been prepared in accordance with The Sikes Act Improvement Act of 1997 (Public Law 105-85, 111 Statute 1629 (codified and amended at 16 United States Code § 670a et seq. (2000))), as amended through 2011; Department of Defense (DoD) Directive 4715.1E; DoD Instruction 4715.03; DoD Manual 4715.03; Army Regulation (AR) 210-20; AR 200-1; Army Technical Manual (TM) 5-630 (Natural Resources - Land Management); TM 5-631 (Natural Resources – Forest Management); TM 5-633 (Natural Resources – Fish and Wildlife Management); TM 5-635 (Natural Resources – Outdoor Recreation and Cultural Values); the National Environmental Policy Act; and the Endangered Species Act.

The INRMP will provide the basis and criteria for protecting and enhancing natural resources using ecosystem perspectives at Redstone Arsenal, consistent with the military mission. This management plan is an important part of Redstone Arsenal's Master Plan. Implementation is subject to the availability of annual funding, availability of manpower, and mission requirements. Where projects identified in the plan are not implemented due to lack of funding, availability of manpower, mission requirements, or other compelling circumstances, Redstone Arsenal will review the INRMP's goals and objectives to determine whether adjustments are necessary.

ES.3 Goals and Objectives of the INRMP

The overall objective of Redstone Arsenal's INRMP is to provide guidance to Installation Commanders as how to manage and conserve natural resources with adaptive, ecosystem-based management that ensures the Installation lands remain available and in good condition to support the military mission. While this document does describe recreational opportunities associated with natural resources available to the Redstone Arsenal community, it also describes impacts of the military mission upon natural resources and means to mitigate these impacts. It does not evaluate the military mission of Redstone Arsenal, nor does it replace any requirement for environmental documentation of that military mission.

Goals and objectives will be adjusted over time using an adaptive management approach as Redstone Arsenal's military mission and ecological conditions change. Wide-ranging goals include:

- Comply with the Federal, State, and local environmental laws and regulations.
- Manage natural resources on Redstone Arsenal to assure good stewardship of public

lands entrusted to the care of a Federal agency.

- Practice adaptive ecosystem management at Redstone Arsenal using the best available science for decision making. Manage natural resources to maintain or restore ecological processes important to species interactions and ecosystem health. Integrate landscape dynamics to preserve or restore ecosystem connectivity and habitat mosaics.
- Provide management guidelines that will be effective in maintaining and improving the ecosystem's sustainability and biological diversity, while supporting mission needs and emphasizing Team Redstone and inter-agency partnerships as well as public involvement.

ES.4 INRMP Work Plans

Annual work plans will be incorporated into this document and be used to track progress on INRMP implementation, current budget expenses, future budget requests, and manpower coordination for labor intensive work. Projects may be required in order for Redstone Arsenal to fulfill regulatory requirements regarding natural resource management or to enhance existing measures to assure compliance.

Funding for implementation of the INRMP, other than forest management, will come from US Installation Management Command. The level of implementation will be based on the amount of funding received by the Installation. The Natural Resources Program and projects derived from this INRMP are divided into mandatory and stewardship categories to reflect implementation priorities. Funding will be acquired to implement DoD mandatory projects in the timeliest manner possible. Stewardship projects will be funded through forestry revenues, DoD Forestry Reserve Account, US Army 21X5095 account, Legacy Funds and/or other fund sources. All requirements set forth in this INRMP requiring the expenditure of the RSA's funds are expressly subject to the availability of appropriations and the requirements of the Anti-Deficiency Act (31 U.S.C. Section 1341). No obligation undertaken by RSA under the terms of this INRMP will require or be interpreted to require a commitment to expend funds no obligated for a particular purpose.

Executive Summary

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1.0 Overview

1.1 Purpose

This Integrated Natural Resources Management Plan (INRMP) serves as a guide to balance the natural resource management program with the military operations at Redstone Arsenal (RSA) for the next 5-year period (Fiscal Year (FY) 2017 through FY 2021). It has been prepared in accordance with The Sikes Act Improvement Act (SAIA) of 1997 (Public Law 105-85, 111 Statute 1629 (codified and amended at 16 United States Code (USC) § 670a et seq. (2000))), as amended through 2011; DoD Directive 4715.1E; DoD Instruction (DoDI) 4715.03; DoD Manual (DoDM) 4715.03; Army Regulation (AR) 210-20; AR 200-1; Army Technical Manual (TM) 5-630 (Natural Resources - Land Management); TM 5-631 (Natural Resources – Forest Management); TM 5-633 (Natural Resources – Fish and Wildlife Management); TM 5-635 (Natural Resources – Outdoor Recreation and Cultural Values); the National Environmental Policy Act (NEPA); and the Endangered Species Act (ESA).

1.2 Scope

This INRMP delineates conservation efforts for Redstone Arsenal and establishes procedures to ensure compliance with related environmental laws and regulations for FY 2017-2021. The management plan takes into account natural resources on the Arsenal and at regional levels. The INRMP is prepared in coordination with other relevant planning documents at RSA including but not limited to: Installation Real Property Master Plan (RPMP) (US Army Garrison (USAG)-Redstone, 2013), range/test area management plans, Integrated Cultural Resources Management Plan (ICRMP) (USAG-Redstone, 2012), restoration plans, and applicable regulatory permits, requirements, and mitigations. However it is not intended to be a comprehensive compilation of information on all of these interrelated plans and topics. Plans such as these are available upon request from the USAG-Redstone.

Numerous stakeholders have provided input for this INRMP, including Federal and State agencies as well as interested individuals. As required by the SAIA, this INRMP reflects the mutual agreement of the US Fish and Wildlife Service (USFWS) and the Alabama Department of Conservation and Natural Resources (ADCNR) concerning the conservation, protection, and management of fish and wildlife resources. It is neither a replacement nor amendment to any Federal or State laws, responsibilities, or authorities for protecting these resources.

Redstone Arsenal retains a number of properties leased by commercial and federal interests, held in compliance with all applicable Federal, State, and local laws and regulations. This INRMP addresses the entirety of the Arsenal’s property, including these leased lands. Redstone Arsenal will comply with all applicable Federal, State, and local laws and regulations on these leased lands.

1.3 Goals and Objectives

The overall objective of Redstone Arsenal's INRMP is to provide guidance to the Installation commanders as to manage and conserve natural resources in ways that ensure the Installation lands remain available and in good condition to support the military mission. Also, this document describes recreational opportunities associated with natural resources available to the Redstone Arsenal community. The INRMP describes impacts of the military mission upon natural resources and means to mitigate these impacts. It does not evaluate the military mission of Redstone Arsenal, nor does it replace any requirement for environmental documentation of that military mission. Goals and objectives will be adjusted over time using an adaptive management approach and as Redstone Arsenal's military mission and ecological conditions change. Wide-ranging goals include:

- Comply with the Federal, State, and local environmental laws and regulations.
- Manage natural resources on Redstone Arsenal to assure good stewardship of public lands entrusted to the care of a Federal agency.
- Practice adaptive ecosystem management at RSA using the best available science for decision making. Manage natural resources to maintain or restore ecological processes important to species interactions and ecosystem health. Integrate landscape dynamics to preserve or restore ecosystem connectivity and habitat mosaics.
- Provide management guidelines that will be effective in maintaining and improving the ecosystem's sustainability and biological diversity, while supporting mission needs and emphasizing Team Redstone and inter-agency partnerships as well as public involvement.

1.4 Responsibilities

1.4.1 Internal Stakeholders

The USAG - Redstone is directly responsible for operations and maintenance of Redstone Arsenal, including the implementation and enforcement of the INRMP.

The Commander, Army Environmental Command (AEC), is a subordinate command of the US Army Installation Management Command (IMCOM), and is responsible for providing central planning, management, coordination, oversight, and technical support to the Army's environmental programs. This leadership includes restoration of contaminated lands; pollution prevention; technology transfer; reporting and tracking of Army environmental programs; conservation of natural and cultural resources; and compliance with environmental standards and criteria set by laws and regulations.

The Commander of the USAG-Redstone is responsible for managing and operating the Installation. The Commander also bears ultimate responsibility for natural resource management on Redstone Arsenal. The RSA Garrison Commander is responsible for:

- Ensuring coordination of land uses between mission, environmental, legal, and master planning.

- Ensuring that the INRMP is developed, implemented, and fully supported.
- Ensuring all Redstone Arsenal tenants comply with requirements necessary to accomplish objectives of this INRMP together with other measures designed to comply with environmental quality objectives.
- Providing for funding and staffing to effectively manage natural resources on the Installation.
- Planning land utilization to avoid or minimize adverse effects on environmental quality and provide for sustained accomplishment of the mission.
- Entering into appropriate cooperative plans (16 USC § 670a) with Federal and State conservation agencies for the conservation and development of natural resources.
- Inspecting and reviewing mitigation measures for the protection of natural resources as prescribed in environmental documentation in accordance with 32 Code of Federal Regulations (CFR) Part 651.

The Deputy to the Garrison Commander serves as the principal assistant to the Garrison Commander for command and management of Redstone Arsenal. He directs and is responsible for all aspects of Garrison operations at Redstone Arsenal, including the management of natural resources.

Directorate of Public Works

The Director of Public Works (DPW) serves as the principal staff engineer and advisor to the Garrison Commander on all Installation Real Property Management activities. The DPW is responsible for the planning, direction, and execution of all work programs at Redstone Arsenal, including, but not limited to, engineering, construction, operations, maintenance, environmental, housing, and real property. Acting through the Chief of the Environmental Management Division (EMD), the DPW is responsible for:

- Implementing this INRMP.
- Providing for the training of natural resources personnel.
- Reviewing all environmental documents and construction designs and proposals to ensure protection of natural resources.
- Coordinating with Local, State, and Federal Government and Civilian organizations relative to natural resources management at Redstone Arsenal.
- Managing the Natural Resources Program with appropriate personnel.
- Developing and implementing programs to ensure the inventory, delineation, classification, and management of all applicable natural resources.

Directorate of Public Works, Environmental Management Division

The Chief of the EMD is responsible for carrying out the integrated management of natural resources on Redstone Arsenal, including environmental quality and land, forest, wildlife, and endangered species management. The environmental policy at Redstone Arsenal is to comply with environmental laws and regulations, prevent pollution, and continually improve the system for managing these requirements.

Installation Restoration Branch. Responsibilities of the Installation Restoration (IR) Branch include investigation and cleanup of environmental sites managed under the Resource Conservation and Recovery Act (RCRA) and Military Munitions Response Program (MMRP).

- No intrusive or non-intrusive activities are to be performed within any RCRA or MMRP environmental sites without a project specific Installation Restoration Program review. There is no blanket approval for any intrusive or non-intrusive activities mentioned in this INRMP. The Cultural and Natural Resources (CNR) Branch must submit a Job Order Request through DPW for IR review for any management task that requires ground intrusive activities.
- The Garrison Installation Restoration Program of RSA, in conjunction with the Environmental Protection Agency (EPA) and Alabama Department of Environmental Management (ADEM), has implemented enforceable land use controls for the use of installation-wide groundwater (IWGW). RSA's IWGW Interim Record of Decision prohibits the use of groundwater for drinking water purposes. It also requires the management of all current and future non-potable uses to limit human exposure. Additionally, well installation is not permitted with the review and approval of the Garrison IR Branch. Any intrusive activities that may expose workers to groundwater (including seeps and springs) must be reviewed by the IR Branch/DPW through the DPW Job Order Request procedures.

Installation Compliance Branch. Responsibilities of the Installation Compliance (IC) Branch include management of hazardous materials and wastes, drinking water, stormwater, and air quality. This branch also manages programs for wastewater disposal, pollution prevention, solid waste disposal, recycling, unexploded ordnance (UXO), and affirmative procurement.

- No intrusive activities are to be performed within any RCRA, Operational Ranges, or non-MMRP sites without a project specific review by the Installation Compliance Branch to determine UXO probability and if any additional measures will be required prior to the beginning of the intrusive activity.

Cultural and Natural Resources Branch. Responsibilities of the CNR Branch include management of the NEPA Program for Installation planning and actions. The Cultural Resources Program is responsible for protecting and managing cultural resource compliance for both archaeological and historical architectural resources on Redstone. The Natural Resources personnel of CNR are responsible for management of the various components described in this INRMP.

Geographic Information System Working Group. The Geographic Information System (GIS) working group in Redstone Arsenal's EMD is responsible for the transition from the use of US Geological Survey (USGS) topographic quadrangle maps to the use of databases to collect, track, and analyze data. The databases are merged with spatial information to yield geodatabases which are the foundation for Redstone Arsenal's GIS in the EMD. The system allows resource managers to conduct preliminary reviews for proposed construction projects and missions actions from their Project Managers. Proposed project locations are created as shape files which can then be overlain with natural, cultural and other environmental resource data layers in a map

document. The GIS also allows natural resource managers to work with proponent organizations in the early stages of a project to incorporate existing environmental constraints into the design. All data is formatted in compliance with the Spatial Data Standards for Facilities, Infrastructure, and Environment (SDSFIE). The GIS allows EMD personnel to better manage natural resources without compromising the Army mission.

Directorate of Operations

The Directorate of Operations (DOO) is a vital component in the implementation of portions of this plan and is a primary element for coordination and planning between natural resource management and mission operations. It administers RSA programs for law enforcement, physical security, and fire and emergency services in support of the Army Materiel Command (AMC) and tenant activities. The Installation Game Warden is responsible for enforcing natural and cultural resource laws and regulations at Redstone Arsenal, as well as aiding in control of nuisance wildlife.

Directorate of Family and Morale, Welfare and Recreation

The mission of the Directorate of Family and Morale, Welfare and Recreation (DFMWR) is to serve the needs, interests, and responsibilities of each individual in the Army Community. Army FMWR is a comprehensive network of support and leisure services designed to enhance the lives of soldiers, their families, civilian employees, military retirees and other eligible participants. Redstone Arsenal FMWR administers a wide range of outdoor recreation services.

Public Affairs Office

The Public Affairs Office (PAO) provides support for the USAG-Redstone, serving as the focal point for developing and executing programs to keep the Installation's workforce and public informed of Army initiatives and activities, including those relating to natural resources.

Installation Legal Office

The Legal Office at Redstone Arsenal provides legal advice, review, and assistance pertaining to environmental law, including Installation compliance issues, NEPA compliance, and remediation projects.

1.4.2 External Stakeholders

The USFWS and ADCNR are an integral part of the development, review, and revision of Redstone Arsenal's INRMP. The USFWS and ADCNR cooperate in the development of this INRMP and participate in the annual reviews and revisions. Additionally, these two agencies participate with the DoD in the formal five-year revision of RSA's INRMP. Redstone Arsenal can help make the USFWS and ADCNR remain committed as partners with the Army by implementing their recommendations in future reviews and revisions of this INRMP.

US Fish and Wildlife Service

The U.S. Fish and Wildlife Service is the principal federal agency responsible for conserving, protecting and enhancing fish, wildlife and plants and their habitats for the continuing benefit of the American people. Redstone Arsenal is in the USFWS Southeast Region (Region 4), where the regional office is in Atlanta, Georgia. The USAG-Redstone EMD works primarily with the Alabama Ecological Services Field Office in Daphne, Alabama (AL).

Alabama Department of Conservation and Natural Resources

The ADCNR is responsible for the management of freshwater fish, wildlife, marine resources, waterway safety, State Lands, State Parks, and other natural resources in Alabama. Redstone Arsenal is located within District 1 of the ADCNR Division of Wildlife and Freshwater Fisheries (DWFF).

Tribal Governments

Redstone Arsenal is required, by DoD Instructions 4710.02 and 4715.03 to consult on the development of the INRMP with federally recognized Indian tribes when natural resources management may affect tribal treaty rights, sacred sites, burial sites, or other rights to natural and cultural resources. The Cultural Resources Program of EMD coordinated consultation with the 16 tribal governments that have a cultural or historical affiliation to lands within Redstone Arsenal's boundaries on August 11, 2015. The INRMP and associated EA will be provided to these federally recognized tribes for additional comment and consultation during the federal, state, local, and public review.

Access to the installation for exploiting resources of cultural and religious importance was discussed with consulting Federally-recognized Native American tribes in a meeting at Redstone Arsenal on November 3, 2010. Several tribal representatives expressed an interest in procuring whitetail deer hides for traditional crafts. Redstone Arsenal set up a pilot program with the RSA DFMWR Outdoor Recreation program to store deer hides for potential pick-up by tribal members, but no interested parties stepped forward to claim the hides, and the program was discontinued. Redstone Arsenal has not received any additional requests for access, but continues to consult with the tribes on at least an annual basis and would consider any requests in the future.

1.5 Authority

Development and implementation of this INRMP will fulfill the statutory requirements under the Sikes Act Improvement Act of 1997. In 1997, the Sikes Act was amended to require the Secretary of Defense to carry out a program to provide for the conservation and rehabilitation of natural resources on military installations. To facilitate such a program, the SAIA requires the secretary of each military department to prepare and implement an INRMP at appropriate military installations throughout the US under their respective jurisdictions, unless the secretary determines the absence of significant natural resources on a particular installation makes the preparation of such a plan inappropriate. In addition, the Act requires that the

INRMP is prepared in cooperation with, and reflects the mutual agreement of, the Secretary of the Interior (acting through the Director of the USFWS) and the head of each appropriate state fish and wildlife agency for the State(s) in which the military installation concerned is located.

The SAIA is viewed as an "umbrella" law with regard to management of natural resources on military lands. Thus, this INRMP helps ensure that Redstone Arsenal complies with other Federal and State laws, such as the Endangered Species Act, the Migratory Bird Treaty Act (MBTA), and the Clean Water Act (CWA) that require military installations to manage and protect sensitive biological and other natural resources.

The DoD Instruction 4715.03 requires protection and enhancement of natural resources for multiple use, sustainability, and biological integrity. The INRMP requirements include inventory of significant or sensitive natural resources; restoration or rehabilitation of altered or degraded landscapes; provisions for outdoor recreational activities; and application of the principles of ecosystem management.

Army Regulation 200-1 (*Environmental Quality–Environmental Protection and Enhancement*, August 2007) is the implementing regulation that ensures policies, procedures, and standards for conservation, management, and restoration of natural resources on military installations are consistent with and in support of the military mission and in consonance with national policies. Additionally, the AR provides general requirements for the content of INRMPs, as well as criteria for achieving integration with the Installation's mission and other activities. Cooperative agreements with Federal and State fish and wildlife agencies set forth in this regulation are superseded, under the amended Sikes Act, by the agencies' concurrences on the INRMP.

1.6 Stewardship and Compliance

The responsibilities of the Natural Resources Management Program at Redstone Arsenal as provided by the US Army can be classified as either meeting stewardship needs or compliance requirements. Stewardship projects (e.g., watchable wildlife projects) are based upon the land management responsibility of the US Army, and are not required to be implemented to meet regulatory needs. Compliance projects (e.g., endangered and threatened species surveys) are mandatory and are required to be implemented to meet laws and regulations that apply to the operations of Redstone Arsenal.

1.7 Review and Revision Process

In accordance with the Sikes Act Improvement Act of 1997 and DoDI 4715.03, the RSA INRMP will be reviewed no less often than every five years; the plan will be modified and updated as necessary to ensure it meets the SAIA requirements and contributes to natural resource conservation on RSA. These reviews shall use the Natural Resources Conservation Metrics described in Enclosure 5 of DoDI 4715.03. External tri-partite stakeholders (USFWS and the State fish and wildlife agency) shall be invited to participate.

The review will be documented and signed by each party. Regular reviews of the INRMP do not mean that the document be revised when reviewed. Formal revisions of the INRMP

will occur if the tripartite stakeholders determine that the existing INRMP no longer provides for the conservation/rehabilitation of natural resources on RSA; mission or physical features of RSA have changed significantly; or there are substantial natural resources changes (e.g., new species listing, new mission, etc.). The INRMP will be internally evaluated on an annual basis for its implementation, effectiveness, adequacy, and impact on RSA's mission.

1.8 Management Strategy

The purpose of natural resources management at RSA is to support the military mission while maintaining the integrity and biodiversity of the ecosystem. Natural resources management at Redstone Arsenal relies on an ecosystem-based management philosophy. This strategy blends multiple-use needs and provides a consistent framework to managing military installations, while ensuring the integrity of the ecosystem.

1.8.1 Ecosystem-Based Management

The DoD has a long history of managing natural resources in the United States, as well as around the world. The 1994 policy memorandum, "Implementation of Ecosystem Management in the DoD," prompted a shift in decision-making strategies to implement adaptive ecosystem management on the nearly 30 million acres (ac) of DoD land. The policy of adaptively managing natural resources at the ecosystem level had a goal of maintaining and improving the sustainability and native biological diversity of terrestrial and aquatic ecosystems while supporting human needs, including the DoD mission (Benton *et al.*, 2008). The definition of ecosystem management often varies in its focus on human involvement, but it is fundamentally a resource management system designed to maintain ecosystem functions and processes while taking into consideration economic and social concerns.

Many DoD installations are located in biologically rich regions in the United States and are some of the "last best hopes for protecting particular types of ecosystems" (Goodman, 1996). As a result, these Federal agencies are responsible for being good stewards to the land by sensibly managing natural resources while achieving their missions.

Eighteen Federal agencies, along with numerous state and local land owners, have committed to the principles of ecosystem-based management (DoD 1994). Further, numerous elements of ecosystem management are mandated for Federal lands in many pieces of legislation, including the Clean Water Act, Clean Air Act, NEPA, and the Endangered Species Act. Ecosystem management does not mainly focus on the "deliverables" but instead on the sustainability of ecosystem functions and processes necessary to deliver goods and services (Christensen *et al.*, 1996). DoD Instruction 4715.03 requires that ecosystem-based management will:

- Avoid single-species management and implement a multiple species management approach.
- Use an adaptive management approach to manage resources such as climate change.
- Evaluate and engage in the formation of partnerships that benefit the goals and

objectives of the INRMP.
- Use best available scientific information in decision-making and adaptive management techniques in natural resource management.
- Foster long-term sustainability of ecosystem services.

Strategies for adaptive management in the face of climate change include:

- Distinguish data and research needs to effectively respond to climate change impacts. Conduct climate change vulnerability assessments to identify species and communities that are vulnerable/resilient. Utilize science-based models for natural resources management planning. Depict climate change impacts on species ranges and populations in vulnerability assessments.
- Adapt and mitigate adverse impacts of climate change. Manage sensitive species and associated habitats to minimize impacts. Monitor plant communities for status changes. Identify natural resources projects that may restore or provide habitat elements for species impacted by climate change. Prioritize conservation efforts and funding utilizing climate change risks.
- Highlight preventative technologies to address impacts of resource use by humans (water conservation, storm water management, energy-efficient design).
- Educate Team Redstone and provide outreach opportunities on climate change and lifestyle changes to reduce consumption.

1.8.2 Ecosystem Management Goals

Redstone Arsenal has established several management goals to integrate the ecosystem-based management approach. These goals were discussed in detail in Section 1.3 of this INRMP.

1.9 Other Plan Integration

The planning and development of this INRMP is fully integrated into the development of Redstone Arsenal plans which include, but are not limited to the 2013 Real Property Master Plan and the 2012 Integrated Cultural Resources Management Plan.

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2.0 Current Conditions and Use

2.1 Installation Information

2.1.1 General Description

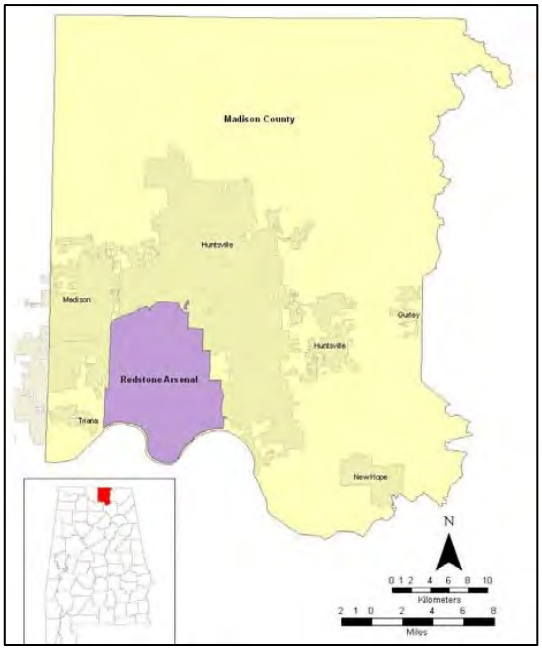

Figure 2.1. Location of Redstone Arsenal, Alabama

Redstone Arsenal encompasses approximately 38,100 acres (ac) in Madison County, Alabama (Figure 2.1). It is located approximately 95 miles north of Birmingham, Alabama; 109 miles south of Nashville, Tennessee; 212 miles southeast of Memphis, Tennessee; and 175 miles northwest of Atlanta, Georgia. The Installation is bordered on the north by Interstate (I) -565, on the east by the City of Huntsville, on the south by the Tennessee River, and on the west by the cities of Madison and Triana. Redstone Arsenal is served by three US highways (US-72, US-231, and US-431), two Alabama state highways (AL-20 and AL-53), and one interstate highway (I-565), all of which intersect in Huntsville. Access to Redstone Arsenal is from the north by I-565/AL-20/AL-53, the central west by Martin Road, the central east by Drake Avenue and Martin Road, and the southeast by Redstone and Buxton Roads. Norfolk Southern Railroad operates an east/west rail line on the north side of I-565/AL-20. A spur link runs south from the main rail line and enters Redstone Arsenal west of Rideout Road. The Huntsville International Airport is located approximately four miles west of the Installation.

Of the 38,100 ac, 5,617 ac consist of a portion of Wheeler National Wildlife Refuge (WNWR), 1,260 ac are owned by the Tennessee Valley Authority (TVA) and 1,864 ac are leased to National Aeronautics and Space Administration (NASA) Marshall Space Flight Center (MSFC). The Redstone Gateway covers 468 ac in the north central portion of the Installation. Approximately 25,000 ac of Redstone Arsenal are used as range and training areas, including research, development, test and evaluation (RDT&E) ranges, heavy and light demolition ranges, and light maneuver training. Most of the Redstone Arsenal ranges and training areas are for RDT&E explosive ordnance. Ten cantonment areas comprise approximately 10,500 ac and consist of administrative offices, military housing, industrial facilities, storage facilities, maintenance facilities, recreational areas, agricultural areas, forested areas, and water bodies.

2.1.2 Regional Land Use

Madison County is Alabama's third most populated county with a per capita income second only to Shelby County, Alabama. The county includes 806 square miles ranging from the southernmost ridges of the Appalachians to the Tennessee River. Regional land use around

Redstone Arsenal is classified as urban/suburban (residential), agricultural, water, wetlands, forests, industrial, pastures, and open vegetated areas.

From 2000-2012, the employment base for the Huntsville Metropolitan Area has grown by 11.1%, outpacing all but two of the peer technology metros in the US (Chamber of Commerce of Huntsville/Madison County, 2013). Local economic growth has historically been driven by a healthy combination of defense and aerospace opportunities; Redstone Arsenal is the leading employer in the area, providing more than 31,000 jobs. The Huntsville-Madison County manufacturing base is a diverse mix of traditional and technology manufacturers. The area's strong interstate, rail and air cargo infrastructure make for an ideal manufacturing location. The Port of Huntsville's Huntsville International Airport is home to Foreign Trade Zone #83 and the International Intermodal Center, as well as being a US Customs Port of Entry.

2.1.3 History and Military Land Use

A full history of land use is available in the 2012 ICRMP for Redstone Arsenal. The installation was established in 1941 as part of the mobilization leading up to US involvement in World War II and exists today as a leader of the Army missile program.

2.1.4 Military Mission

While the distinctive mission sets executed on Redstone Arsenal are complex and as varied as the organizational makeup, there are tremendous synergies across these functional boundaries. Generally, organizations on Redstone support five key operations:

- Logistics services including materiel management, acquisition, and contracting;
- Space operations and missile defense to support the nation’s exploration and defense capabilities;
- Intelligence and homeland defense conducting threat analysis and explosives training and research;
- Research, development, test and evaluation to continue the innovative application of sciences and technologies into systems and equipment; and
- Sustainment of Redstone Arsenal activities to ensure the installation and its workforce are properly cared for and resourced.

The Commander of the USAG–Redstone is responsible for managing and operating the Installation. Management of the Garrison involves serving the needs of many on-post tenant organizations and other governmental organizations, while simultaneously providing state-of-the-art facilities that balance safety and environmental concerns. Currently, the Garrison supports more than 55+ major tenant organizations. These tenants can be broken down into five major groups: Department of Army (DA), DoD, Department of Justice (DoJ), NASA, and private entities. Each tenant generally reports to its own headquarters and does not report programmatically to the RSA Garrison Commander. Tenant organizations typically maintain an Installation Support Agreement with USAG–Redstone. The Army’s aviation, missile, and missile defense program offices and research and development centers employ more than

37,500 government civilian and contractor employees and a little over 1,000 active duty military personnel (USAG-Redstone, 2013). Redstone accounts for more than half of the US Army's weapons procurement budgets, as well as half of the Army's foreign military sales.

Headquarters Army Materiel Command is the senior organization on Redstone Arsenal and has multiple subordinate commands and activities located on the installation (USAG-Redstone, 2013). The current mission of AMC is to develop and deliver global readiness solutions to sustain Unified Land Operations, anytime, anywhere.

2.1.5 Operations and Activities

Major functions on the base are materiel management (logistics/acquisitions), Space Operations & Missile Defense, Research, Development, Test & Engineering and Intelligence & Homeland Defense mainly in the areas of threat analysis and explosives training. Overall, the current land use plan is responsive to mission requirements and environmental and safety considerations. The 2013 Real Property Master Plan for Redstone Arsenal categorizes the Installation's property into four general opportunities:

- Non-developable (5,600 ac) – areas have no plans nor intent to be utilized for future development;
- Developable with major restrictions (17,200 ac) – areas may be utilized for future development but there are significant restrictions (ex. surface danger zones, environmental restoration sites, cemeteries);
- Developable with minor restrictions (6,100 ac) – areas with "less cumbersome" restrictions (ex. wetlands, flora/fauna sensitive areas, archaeological sites); and
- Developable with no restrictions (6,900 ac) – fully developable at this time with no restrictions other than Redstone's master planning requirements.

A map which depicts developable areas at Redstone Arsenal is presented in Figure 2.2.

Test Areas and Explosive Safety Zones

Redstone Arsenal has an extensive inventory of facilities for testing aviation and missile systems and their component parts. In addition, explosive safety-quantity distance arcs exist to separate sites where munitions are stored or used from either inhabited buildings or publicly traveled roads. Explosive safety arcs pose a long-term constraint to unrelated development; thus the adjacent land uses are typically open space, range and testing, or training. More than 25,000 ac of Redstone Arsenal are used as range and test areas (TAs) for explosive ordnance, seeker/tracking systems, lasers, unmanned aerial vehicles, non-live fire activities, and processes for resource recovery and recycling.

Aviation Operations

Redstone Army Airfield (RAAF) is the Installation's primary operation facility and supports fixed wing, rotary wing, civil, military, and unmanned aerial system (UAS) traffic. It is a low-density facility with one Class A runway located west of Rideout Road and north of Martin

Road. The runway classification is not intended to limit the number of larger aircraft operations (C-130, C-5, C-17) operations, which are conducted on the airfield. The runway has a combination of clear zones, transitional zones, and accident potential zones (APZs) which create three-dimensional development constraints.

Maintenance

Operational maintenance activities occur in equipment maintenance shops, a motor pool, and open burning/open demolition of ordnance.

Industrial

Industrial land use includes production facilities and utility operations. Areas designated for industrial are those used for activities historically assigned to either post maintenance and utilities or production land uses. Utility complexes include substations, and water and sanitary sewage treatment plants.

Administration

Administration space consists of one large, consolidated parcel in the center of the Installation and several smaller sites, totaling more than 600 ac. Administrative areas house headquarters, finance centers, and personnel and data processing centers. Additionally, modern research and development facilities with similar office operations, development pattern, and effects on adjacent land uses are considered to be administrative use.

Community Facilities

A variety of community facility sites, located to serve the resident family and minimal troop populations are present on Redstone Arsenal. These facilities include the commissary, exchange, bank, credit union, service stations, youth services centers, chapel, child development centers, and a medical center.

Recreation

Certain areas of the Installation are designated as recreational areas that are excluded from further land development. These areas consist of a 36-hole golf course, clubhouse, stables, outdoor recreation center, picnic, boat launches, sports fields, self-guided nature trail for wildlife viewing and wetland education, and land parcels used for hunting.

Open Space

Open space on the installation includes green space, forests, undevelopable land, grazing land, and the Wheeler National Wildlife Refuge. Redstone Arsenal serves as an enclave of forests and open space within the surrounding community (USAG-Redstone, 2013). There are six closed landfills designated by the Installation Restoration Program, each of which has a mediation plan. These landfills contain contaminants such as volatile organic compounds (VOCs), semi-volatile

organic compounds (SVOCs), polychlorinated biphenyl (PCBs), metals, explosives, and pesticides such as dichlorodiphenyltrichloroethane (DDT). Development is avoided on closed landfills.

Marshall Space Flight Center

On March 15, 1960, the Army granted irrevocable use and occupancy of the lands and facilities known as the Marshall Space Flight Center to NASA for a term of 99 years beginning on July 1, 1960 and ending on June 30, 2059. The grant, which is renewable at NASA's option, gives NASA full control and responsibility for the land and facilities, although the Army retains right of access to all major utility lines, railroad tracks, and main roads. Supplemental agreements have incorporated additional land areas into the initial agreement.

Family Housing

Family housing was privatized at Redstone Arsenal in 2006 when responsibility for providing housing and ancillary supporting facilities was transferred to Redstone Communities, LLC (RCL). A 50-year lease was granted to RCL for the approximately 463 ac area on which the housing and facilities are located. Redstone Arsenal also granted a lease of additional areas for RCL's use to construct new housing and to operate ancillary supporting facilities. This action effectively removed family housing areas from consideration for any future development.

Privatization of Army Lodging

The Privatization of Army Lodging (PAL) program resulted in Army leasing specified lodging facilities to its selected developer, Actus-Intercontinental Hotels-Bovis. It also has granted a 50-year lease of 25 ac of land underlying existing lodging facilities, as well as other land for construction of new lodging facilities.

Redstone Gateway Enhanced Use Lease

Redstone Gateway Enhanced Use Lease (EUL) is a state of the art office and mixed-use park being developed as a joint venture by Corporate Office Properties Trust and Jim Wilson & Associates, LLC, in partnership with the US Army and Redstone Arsenal. The 468 acre, master-planned project is located adjacent to I-565 at Gate 9, the main gate into Redstone Arsenal. Redstone Gateway features both secured and unsecured office buildings as well as retail and hospitality amenities to support the office park and Redstone Arsenal's employees and visitors. The park, which will ultimately contain 4.6 million square feet (sq ft) of space, is being built in three phases over the next 15 to 20 years.

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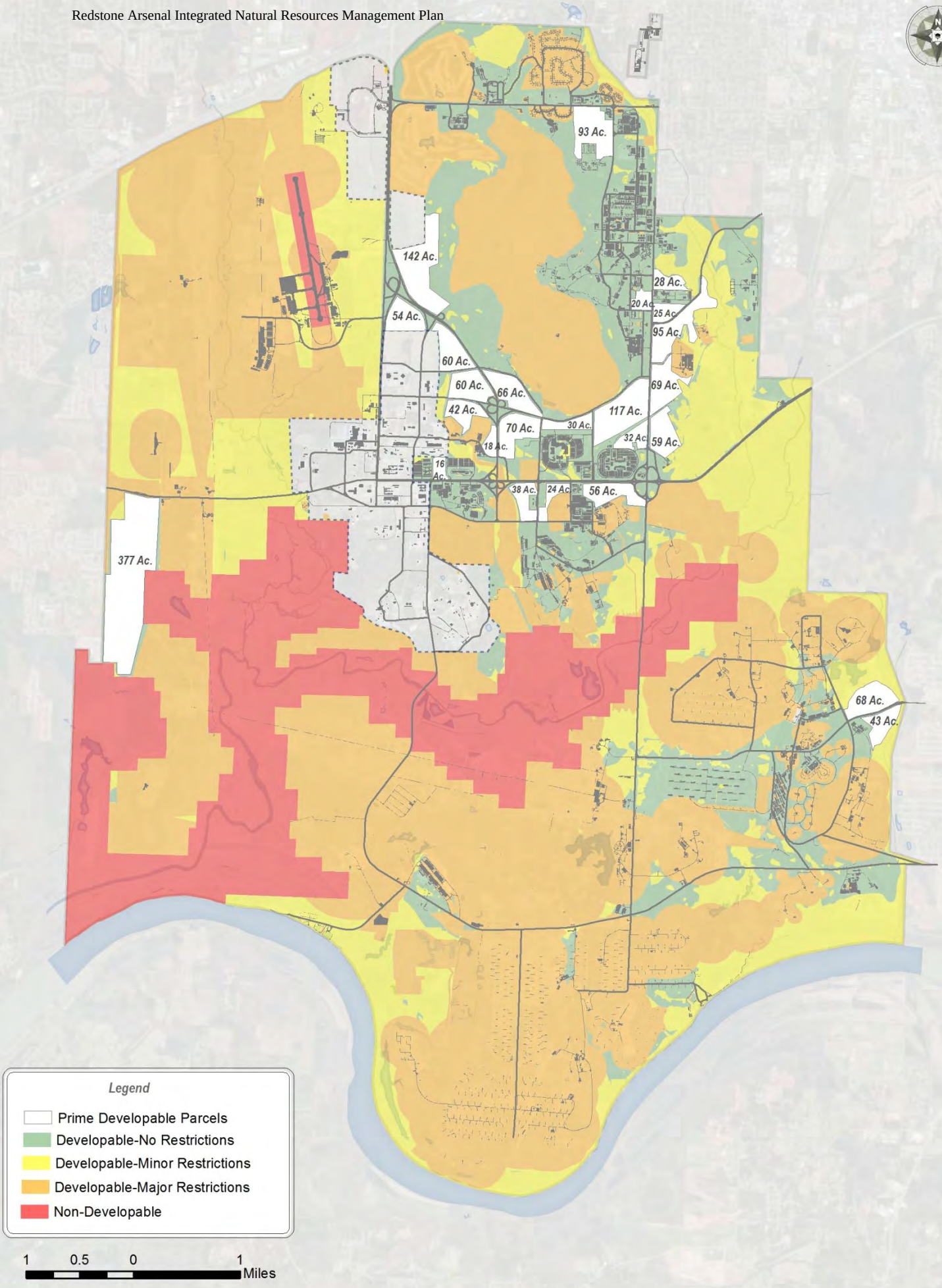

Figure 2.2. Developable Areas Map, Redstone Arsenal

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2.2 General Physical Environment and Ecosystems

2.2.1 Climate

Redstone Arsenal is located in a temperate climatic zone with hot summers and relatively mild winters. Climate information was recorded at the climate station at the airport weather service office in Huntsville, Alabama. The average high temperature ranges from 49 degrees Fahrenheit (°F) in January to 89°F in July. The average low temperature ranges from 31°F in January to 69°F in July. The first frost, on average, is 31 October and the last frost, on average, is 5 April.

The average annual total precipitation is about 50 inches (in). Of this, about 25.5 in, or 51%, usually falls in April through October. The growing season for most crops falls within this period. On average, March is the wettest month with 6.7 in of rainfall; August is the driest with 3.3 in of rainfall. The wettest month recorded at Redstone Arsenal was March 1980 when 17 in of rain fell and the driest was June 1988 with only 0.17 in. Thunderstorms occur on about 57 days each year, and most occur between May and August. The average seasonal snowfall is 2.6 in. The greatest snow depth at any one time during the period of record was 11 in recorded on January 1, 1964. On average, 2 days per year have at least 1 in of snow on the ground. The heaviest 1-day snowfall on record was 15.7 in recorded on December 31, 1963.

Topography

In general, the topography at Redstone Arsenal is gently rolling with elevations primarily in the range of 600 to 650 ft above mean sea level (amsl). The terrain generally slopes southward towards the Tennessee River. High areas include Weeden and Madkin Mountains in the north-central portion of the Installation, with elevations on Madkin Mountain reaching 1,239 ft amsl. Low areas, comprised of valleys and floodplains along the Tennessee River and its tributaries to the north, are characterized by elevations of approximately 556-560 ft amsl. Additional low areas that may or may not be associated with drainage ways are also scattered throughout the Installation (US Army Missile Command, 1994).

2.2.2 Geology

The underlying bedrock in Madison County is sedimentary in origin, consisting predominately of several varieties of limestone, sandstone, and a few acid shales. Most of Redstone Arsenal is underlain by Tuscumbia Limestone, which is the uppermost formation (i.e., surface formation) for more than half of Madison County. This bedrock has an average thickness of 46 m; consists of gray, medium to coarse-grained, fossiliferous limestone; and contains chert nodules. It often contains solution-enlarged openings that have developed along joints, fractures, bedding planes, and faults. These solution cavities are formed by the dissolution of the limestone and contribute to the formation of sinkholes and depressions at the land surface (US Army Missile Command, 1994).

The Tuscumbia Limestone is underlain by the Fort Payne Chert, which is the surface formation

on the northeast and northwest portions of Redstone Arsenal. Fort Payne Chert is generally 47 to 56 m thick, and consists of alternating beds of bluish-gray chert and fine-grained, fossiliferous limestone. The Fort Payne Chert is underlain by the Chattanooga Shale and other older geologic units. Overlying the Tuscumbia Limestone are successively younger formations including the Monteagle Limestone (stratigraphic equivalent of Ste. Genevieve Limestone in the Eastern Highland Rim), and Hartselle Sandstone (US Army Missile Command, 1994).

The surface geology of Redstone Arsenal and much of Madison County consists of unconsolidated material known as regolith, which is mainly derived from weathering of the bedrock. Regolith derived from Tuscumbia Limestone consists of moderate red to moderate red-orange clay and porous, powdery rectangular to irregular blocks of chert. Dense chert or rectangular blocks of fossiliferous chert are also present due to the weathering of the Fort Payne Chert where it is the surface bedrock formation (US Army Missile Command, 1994).

2.2.3 Soils

There are 99 different soils on the Installation making for a highly diversified set of soil conditions (Clendenon, 2002). According to the 2002 US Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Soil Survey of Redstone Arsenal (Clendenon, 2002), 43 map units representing 19 different soil series are mapped within the Installation's grounds. The predominant upland soil type is the Urban land-Decatur-Emory Complex, 0-6 percent slope which consists of a deep, well drained to moderately well drained, silt loam to silty clay loam. These soils typically possess a loamy surface horizon underlain by a loamy to clayey subsoil layer with lenses of silty and/or sandy clay. Rock fragments generally occur throughout the clayey material. The soil colors range from a brownish-red in the northern portion to a brownish-gray in the southern portion of Redstone. Darker gray soils are found in areas of topographic lows. Soil depths range from very shallow on the mountains to much deeper along the larger tributaries of the Tennessee River, where broad floodplain areas have been formed by the river and its tributaries (Clendenon, 2002). Additionally, there are four soil map units on Redstone classified as hydric soil, a soil that is saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions that favor the growth and regeneration of hydrophytic vegetation (Clendenon, 2002).

Throughout the Installation, pavement and other infrastructure reduce soil infiltration. The subsoil is capped with approximately 2,392 ac of impermeable surfaces including structures, roadways, driveways, and parking areas. This represents approximately 6.3% of the land on RSA (M. Kachelman, pers. comm).

Chemical Analysis of the Soils. The results of chemical analyses of several typical pedons in the survey area are given in Table 22 of RSA's soil survey (Clendenon, 2002). Unless otherwise indicated, the pedons are typical of the series, which are described in the Soil Survey of Redstone Arsenal, Madison County, Alabama (Clendenon, 2002). Analysis was for calcium (Ca), magnesium (Mn), potassium (K), and sodium (Na) content.

Soil types within improved lawn areas generally consist of Decatur, Colbert, and Hollywood. Decatur soils are highly productive, low in organic matter, brown to reddish-

brown, very fine sandy loam to silt loam topsoil, and deep friable, permeable red to reddish-brown clay loam subsoil. The Colbert and Hollywood soils (Limestone Valley Soils) are upland soils of medium to low productivity, gray to dark gray silt loam to silty loam topsoil, and reddish-yellow, yellow to dark gray, poorly drained, sticky, plastic, heavy clay or silty clay subsoil. The chemical analysis of Decatur soils revealed a lime deficiency in addition to being low in nitrogen. The chemical analysis of Colbert and Hollywood soils revealed a pH factor of 5.2 to 7.

Mechanical Analysis of the Soils. The mechanical analysis of the soils varies from place to place even within one specific soil type. In addition, there are 99 different soils on the Installation making for a highly diversified set of soil conditions. Soil samples taken from representative areas throughout the Installation reflect the mechanical analysis of the soils shown in Table 2.1.

Table 2.1. Mechanical Analysis of the Soils at Redstone Arsenal, Alabama

Area	Sand	Silt	Clay	Organic Matter
Improved Grounds	8%	35%	55%	2%
Eroded Slopes	10%	30%	59%	1%
Embankments	9%	30%	60%	1%

Prime Farmland

Of the 43 soil units mapped for Redstone Arsenal, 18 phases representing 12 soil series are listed as potential prime farmland (Clendenon, 2002). Prime farmland is protected by the Farmland Protection Policy Act; however, lands that are used for national defense purposes are exempt from the provisions of the Farmland Protection Policy Act (7 CFR Parts 657 and 658).

2.3 General Biotic Environment

2.3.1 Threatened and Endangered (T&E) Species and Species of Concern

A 1992 biological inventory, conducted by the Alabama Natural Heritage Program (ALNHP) of The Nature Conservancy (TNC), was designed to identify Federal and State listed species at Redstone Arsenal. The investigators also were to characterize the natural communities on Redstone Arsenal and to identify the occurrence of any special or significant natural areas found. The investigation, completed in 1995, represents the most comprehensive biological inventory for the Installation to date and provides the initial baseline for the development of management strategies for rare species. A multi-year, installation-wide survey of sensitive species and ecologically significant communities began in 2016. This survey will replace the 1995 planning level survey, once completed.

In 2010, the Endangered Species Management Component of the INRMP for Redstone Arsenal became the leading management document; the current component version lists all endangered and threatened species known to occur, or with the potential to occur, on Redstone Arsenal. Within Redstone Arsenal’s boundaries, the greatest threats to all species in the Endangered

Species Management Component are habitat destruction - groundwater degradation, deforestation, and invasive plant species. Outside the Installation, cave disturbance, deforestation, and other forms of habitat destruction resulting from urban sprawl may pose the greatest threats to all species discussed in this component. White-nose syndrome (WNS) is a devastating fungal disease that has killed unprecedented numbers of hibernating bats in North America, primarily in the east. As of December 2016, bats with white-nose syndrome have been confirmed in 29 states and five Canadian provinces; the fungus that causes this syndrome has been confirmed in three additional other states. Universal precautions to reduce the risk of human-assisted transmission of the disease and minimize disturbance to hibernating bats potentially susceptible to WNS are in effect at the Installation (USFWS, 2016b).

The Alabama cave shrimp, which inhabits flooded caverns, and the Tuscumbia darter, which is found in springs, are primarily threatened by groundwater degradation. The gray bat (*Myotis grisescens*), the Indiana bat (*M. sodalis*), the northern long-eared bat (*M. septentrionalis*), the Bald Eagle (*Haliaeetus leucocephalus*), and the Peregrine Falcon (*Falco peregrinus*) require mature streamside forest and clean water for producing good foraging habitat. On Redstone Arsenal, rare plants are restricted to unique sites, often due to specific geological characteristics. Price's potato bean occurs on limestone outcrops and primarily is threatened by human disturbance. Harper's umbrella plant is restricted to limestone bluffs and glades in only three states and is threatened by habitat destruction and invasive plants. American ginseng occurs in mature hardwood forests and is threatened by timber harvest and over-collection throughout its range. The greatest threats to Alabama least trillium, which requires hardwood bottoms and swamps that are not permanently flooded, are road expansion, clear cutting, and stream channelization.

2.3.2 Wetlands and Deepwater Habitats

A 2002 wetlands inventory of Redstone Arsenal was based on conventional photo-interpretation techniques using mid-altitude photography using vegetation, visible hydrology, and geography (Figure 2.3). Photo-interpretation involved a number of steps, which were outlined in the Wetlands Inventory Report for Redstone Arsenal, Madison County, Alabama (USFWS, 2002). Wetlands and deepwater habitats were classified according to the USFWS official wetland classification system (Classification of Wetlands and Deepwater Habitats of the US (Cowardin *et al.*, 1979). Wetlands were typed to ecological system, subsystem, class, subclass, water regime, and special modifiers. Wetlands were also classified by hydrogeomorphic-type descriptors to indicate a wetland's landscape position, landform, and water flow path (Tiner, 2000).

Redstone Arsenal contains 9,510.1 ac of wetland habitat and 496.7 ac of deepwater habitat. This acreage amounts to about 26% of the facility's total land area. Palustrine forested wetlands (excluding mixtures with other wetland types) were predominant (69%); emergent wetland were second-ranked in abundance (13%). Palustrine wetlands found on the Installation occurred mostly on floodplains. From the hydrogeomorphic perspective, most of the Installation's wetlands occur along rivers and are classified as lotic floodplain wetlands. Rivers and streams total 120 miles, approximately.

Any project proposed by the Installation involving the placement of dredged and/or fill material into waters of the US, including wetlands, is reviewed by the Installation environmental staff and appropriate permits are obtained from the US Army Corps of Engineers (USACE) and ADEM prior to performing the work.

Efforts to minimize impacts to wetlands and other aquatic systems are accomplished on RSA through a rigorous planning and review process and mitigation of any unavoidable impacts. In addition, wetland habitats on Redstone are protected as Ecologically Sensitive Areas, further reducing negative impacts to the valuable resource.

Watersheds

Indian Creek extends upstream through gently rolling country with extensive commercial, industrial, and residential development interspersed with pastureland, strip-cropping, and wooded areas. Conversely, Huntsville Spring Branch (HSB) traverses low, swampy areas on the Installation and then encounters a major urban drainage area for the City of Huntsville. In addition, HSB receives run-off from wooded mountain sides and open pasture or strip-crops within the watershed surrounding Huntsville. McDonald Creek drains the northeastern portion of the Installation and empties into Huntsville Spring Branch.

Size of Drainage System

RSA is located on the north bank of the Tennessee River about 46 miles above Wheeler Dam and 17 miles downstream from Guntersville Dam. Approximately 10,400 ac of RSA are affected by high stages of the Tennessee River and other tributary streams. The HSB, with a drainage area of 86 square miles, flows southwestward to join Indian Creek, a tributary of the Tennessee River. Indian Creek, which enters the northern edge of the Installation, drains an area of 143 square miles and joins the Tennessee River at mile 321. The normal pool of Wheeler Lake, at an elevation of 169 m, backs into the Installation to form permanent pools of 680 and 575 ac at the lower end of HSB and Indian Creek, respectively. Within the Installation boundaries, Indian Creek drains approximately 12,000 ac and the HSB drains approximately 13,000 ac. The southern portion of the Installation drains into the Tennessee River through smaller, unnamed channels.

Description of Principal Channels

Lands within the Indian Creek drainage area have an average slope of 5% and in the HSB the average slope is 3%. The Indian Creek and HSB stream beds both have an average slope of 20%. The computed 10-year frequency interval discharge through Indian Creek is 204 cubic meters per second (cms) and the HSB discharge is 153 cms.

History of Flooding

No significant damage has been experienced due to storm run-off. However, the topography and location of the Installation makes some of the land susceptible to flooding by the Tennessee River. Wheeler Dam at mile 274.9 forms a 74-mile long reservoir with a normal pool elevation

of 550 ft amsl from 1 January to 15 March. Water levels are raised at a uniform rate to elevation 556 ft amsl by 15 April, maintained at that level until about 1 July, and then gradually lowered to 550 ft amsl by 1 January. The regulated maximum flood recorded at the mouth of Indian Creek reached 570 ft amsl. The maximum design flood elevation at this point is estimated to be 579.5 ft above amsl. On 2 February 1957, the river reached flood stage (568 ft amsl) on the Installation. During this flood, approximately 2,790 ac of RSA land was inundated for several days. Additionally, some of the Installation's road and railroad systems were inundated, necessitating the re-routing of traffic. In March 1973, heavy rains in the Tennessee River Valley resulted in the highest flood level in Redstone Arsenal history. On 19 March 1973, floodwaters on Redstone Arsenal reached 575 ft amsl and covered approximately 40%, or an estimated 15,000 ac, of Installation land. Installation road systems were inundated for several days and damage occurred to several buildings situated at lower elevations. The 100- and 500-year flood zones are depicted on the map found at Figure 2.4.

Wetland Areas - Figure 2.3

Wetland Area

0 0.5 1 1.5

Miles

1:77,803

Map Projection: Transverse Mercator
Horizontal Datum: North American Datum 1983
Grid Coordinate System: State Plane Coordinates, Alabama East
Planar Distance Units: Survey Feet (U.S.)

RSA Wetland Area (Overview) - Redstone Arsenal, AL

Date Saved: 6/2/2015 1:07:45 PM

Classification: Unclassified Limited Distribution

Subject Matter Expert: Christine Easterwood

Map Author: Lawrence Crawford
US Army Garrison-Redstone (256) 876-5682

For official use.

Directorate of Public Works
Environmental Mgt
US Army Garrison - Redstone
Redstone Arsenal, AL 35898

Path: N:\Crawford\Projects\Ecology_Endangered Species\Final\Map Documents\RSA_Wetland_Area.mxd

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Flood Zones - Figure 2.4

FLOODZONE

500 Year Flood

100 Year Flood

0 0.5 1 1.5

Miles

1:77,803

Map Projection: Transverse Mercator
Horizontal Datum: North American Datum 1983
Grid Coordinate System: State Plane Coordinates, Alabama East
Planar Distance Units: Survey Feet (U.S.)

Flood Zones (Overview) - Redstone Arsenal, AL

Date Saved: 12/4/2018 2:21:43 PM

Classification: Unclassified Limited Distribution

Subject Matter Expert: Christine Easterwood

Map Author: Lawrence Crawford
US Army Garrison-Redstone (256) 876-5682

For official use.

Directorate of Public Works
Environmental Mgt
US Army Garrison - Redstone
Redstone Arsenal, AL 35898

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2.3.3 Fauna

The State of Alabama has one of the richest faunal biodiversities in the United States (Mirarchi, 2004). This is largely due to the state's diverse physiographic regions. Redstone Arsenal encompasses a variety of habitats within its 38,100 secured ac. It contains extensive wetland areas associated with the Tennessee River, several local springs, woodlands, and fields. While no complete faunal inventory of RSA was attempted by the ALNHP (Godwin and Hilton, 1995), sufficient specimens were collected or observed during the rare species surveys to provide preliminary information on the common species of Redstone Arsenal.

The ALNHP estimated that 48 species of mammals inhabit Redstone Arsenal, which are likely evenly distributed across the Installation's various habitats; common species include beaver (*Castor canadensis*), coyote (*Canis latrans*), raccoon (*Procyon lotor*), white-tailed deer (*Odocoileus virginianus*), and a variety of bats. Common reptile and amphibian species that are often observed include eastern box turtle (*Terrapene carolina carolina*), cottonmouth (*Agkistrodon piscivorus***)**, American toad (*Anaxyrus americanus*), dusky salamander (*Desmognathus fuscus***)**, eastern fence lizard (*Sceloporus undulatus*), and American alligator (*Alligator mississippiensis***)**.

The varied habitats attract a large percentage (~290 species) of Alabama's avifauna (420 species (Haggerty *et al.*, 2004)) either as residents, migrants, or rare visitors (Porter, 2001). The area's variable water level in ponds, sinks, and cypress swamps (much of which is maintained by the WNWR) attracts many winter waterfowl, herons, egrets and shorebirds (Porter, 2001). The Redstone Arsenal area also attracts many raptors and passerines of both woodland and field species (Appendix C). Common bird species include Northern Bobwhite (*Colinus virginianus*), Eastern Wild Turkey (*Meleagris gallopavo*), Mourning Dove (*Zenaida macroura*), Mallard (*Anas platyrhynchos*), Wood Duck (*Aix sponsa*), and Eastern Bluebird (*Sialia sialis*).

In terms of aquatic fauna, the absence of many mussels, snails, insects, and fishes can be generally attributed to a lack of appropriate habitats on Redstone Arsenal and perhaps to a decline in overall water quality. The influx of debris from Huntsville, coming down McDonald Creek and HSB, is undoubtedly a contributing factor to the general degradation of the stream systems of RSA. Also, historically, some species were simply never present on RSA due to impoundment of the Tennessee River, pollution, siltation and perhaps due to the small size of many of the Installation's streams.

2.3.4 Flora

Redstone Arsenal exhibits a large variety of native vegetation characteristic of the Cumberland Plateau physiographic region. This area is characterized by mixed mesophytic forests dominated by oaks, hickory, and historically American chestnut (*Castanea dentata*) with various pine species dominating the drier sites. The ALNHP (Godwin and Hilton, 1995) identified six general community types at RSA, including two upland areas, three wetland areas, and one subterranean area. The classifications used in this study combined successionally-related types and disturbances together and did not account for ecotones between communities or for variation in vegetation caused by moisture gradient, aspect, or

another microfeature.

The commercial forestry program on Redstone Arsenal currently manages approximately 4,607 ac of commercial loblolly pine (*Pinus taeda*) stands as well as an additional 4,750 ac of mixed pine-hardwood forests available for commercial harvest. Approximately 1,382 ac of grassland is leased for agricultural purposes; of this, approximately 991 ac are leased for grazing. Wetland areas (10,007 ac) consist of permanently and occasionally inundated land and associated areas, often including bottomland hardwood forest. The developed and disturbed areas, which may be landscaped with native and/or nonnative vegetation, include roadways, parking lots, administrative and industrial buildings, personnel/family housing and specialized facilities, park/recreational land, landfill areas, and vacant previously disturbed open areas.

Upland Communities

Oak-Hickory-Eastern Red Cedar Forest. The best examples of the oak-hickory-eastern red cedar (*Quercus* spp.-*Carya* spp.-*Juniperus virginiana*) community type are on Madkin and Weeden Mountains. Disturbed variations of this community type can be observed on Ward, Hatton, and Bradford Mountains, as well as the uplands above the Tennessee River (Bell and Lehman's Bluffs). Disturbed alluvial areas within this forest type are often dominated by maples (*Acer* spp.). Under natural conditions, these forests are uneven-aged, with old trees present and reproduction occurring primarily in canopy gaps (Schafale and Weakley, 1990).

Included within this forest type are flat exposed sheets of limestone, or open treeless areas with rocky, shallow soils often dominated by grasses and sedges. These areas are small in size (<1.2 ac) and they are scattered across the mountains along bands of limestone rock. The growth of these grasses and sedges is often associated with seeps or ephemeral drains. The presence of rock near the soil surface excludes woody species, thus allowing for a unique assemblage of plants including the characteristic species listed in Godwin and Hilton 1995.

Depending upon the aspect of slope, the oak-hickory-eastern red cedar forest type includes both mesic and semi-xeric woods. North- to northeast-facing slopes contain more mesophytic closed-canopy woods, with herbaceous species such as spotted wakerobin (*Trillium maculatum*), Jack-in-the-Pulpit (*Arisaema triphyllum*), fourleaf milkweed (*Asclepias quadrifolia*), and mayapple (*Podophyllum peltatum*). South- to southwest-facing slopes typically contain dry open woods typified by eastern red cedar. Limestone boulder fields are included within both mesophytic and dry forest components; these areas contain characteristic species such as whiteflower leafcup (*Polymnia canadensis*), widowcross (*Sedum pulchellum*), fernleaf phacelia (*Phacelia bipinnatifida*), blackstem spleenwort (*Asplenium resiliens*), and purple cliffbrake (*Pellaea atropurpurea*) occur.

Bradford and Hatton Mountains are included within the previously described forest type, but with some differences. Bradford and Hatton Mountains are lower in elevation and do not have a layer of Bangor limestone over their sandstone caps as do Weeden and Madkin Mountains. These mountains have been subject to recent and frequent fire, and they have some planted pine at the base with others scattered to some extent within the natural hardwood forest. The

midstory is greatly reduced on these two mountains, as is the herbaceous species diversity. In contrast to Weeden and Madkin, Bradford and Hatton mountains have an understory dominated by vine species. Fire was once an important part of the ecology of this forest type, although not naturally as frequent as the cycle generated on Bradford and Hatton Mountains. Unfortunately, very little is known about the frequency and effect of fire on this community type due to the practice of fire suppression with the advent of European settlement.

Rare plant species found in this community include Price's potato bean, typically found on northeast slopes; pinesap, typically found in mesophytic woods; Cumberland rosinweed and southern (whorled) rosinweed, both typically found in calcareous openings; and Michaux's gladecress (*Leavenworthia uniflora*), limestone adderstongue (*Ophioglossum engelmannii*), and Elliott's fanpetals (*Sida elliottii*), all typically found in limestone glades.

Calcareous Cliffs. Examples of this community type occur on Bell and Lehman's Bluffs. These sites are characterized by steep bluffs over the river with shelves of exposed limestone dominated by shrubby and herbaceous species immediately bordered by the oak- hickory-eastern red cedar community type. Characteristic species of this community are listed in Godwin and Hilton 1995.

Wetland Communities

Wet-Mesic River Floodplain Forest. Vegetation of this community covers the Huntington-Lindside-Hamblen soil association of Huntsville Spring Branch, McDonald and Indian Creeks. Forest cover of this area is described as three areas of zonation from riverfront to the edge of the uplands. The edges of these forest types are intermingled, continually changing, and therefore best treated as a single community. Characteristic species of forested wetlands are listed in Godwin and Hilton 1995.

Oak Flat Terrace Forest: Oak flat terraces seldom flood, but they have a high seasonal water table. These are very low energy wetlands that support a large macroinvertebrate population and an abundance of oak mast for a number of organisms in the food web. Migratory waterfowl use the ponded areas heavily in winter.

River Birch (*Betula nigra*)-Sycamore (*Platanus occidentalis*)-Elderberry (*Sambucus* spp.) Riverfront Forest: These plants are conditioned to overbank flooding, and they are fairly stable in the backwater area or on the river levee. Water tupelo (*Nyssa aquatica*) is located along the spring fed streams, which are fairly low energy environments.

Swamp Chestnut Oak (*Quercus michauxii*)-Cherrybark Oak (*Q. pagoda*) Bottomland Forest: These species occupy a slightly higher area in the landscape situated along the fringes of the floodplain.

Beech-Mixed Oak-Sweetgum Bottomland Forest: The American beech (*Fagus grandifolia*)-mixed oak-sweetgum (*Liquidambar styraciflua*) forest contains a Federal species of concern, such as the Alabama least trillium. This forest type occurs along the periphery of the swamp forest on elevated islands within shallow standing water, or on the upland edge of the flooded floodplain forest. Although periodically flooded, this habitat does not remain inundated. The

soil type is Melvin Silty Clay Loam, a fine-textured poorly drained soil derived from high-grade limestone. Trillium occurs within this habitat type on elevated hummocks of moss and around the bases of trees away from the inundated swamp forests. Stands of pawpaw (*Asimina triloba*) are often associated with this habitat type. The best example of this community occurs along the eastern perimeter of Redstone Arsenal adjacent to Byrd Spring Swamp, a small tributary of HSB. Rare animal species typical of this community include the yellow sandshell (*Lampsilis teres*) and giant floater (*Anodonta grandis*). This community type also occurs on the south side of Martin Road, east of the intersection with Patton Road.

Forested Palustrine Wetlands. These areas of forest coverings are created by backwaters of the Tennessee River and from beaver activity. This includes open water areas and adjacent tupelo swamp forests. The forested palustrine wetlands, including tupelo swamps, overcup oak (*Q. lyrata*)-water hickory (*Carya aquatica*) bottomlands, and sweetgum-mixed oak bottomlands, contain a great deal of variation from site to site, and grade into the floodplain forest. There are no federally listed or candidate plant species potential to this habitat type, but there are several plants considered rare in the state of Alabama. One rare aquatic species, featherfoil (*Hottonia inflate*), was documented within the tupelo swamp at the Path to Nature Area. This species occurs in lakes, ponds, pools, swamps, ditches, and canals. Other rare aquatic plants such as lake cress (*Armoracia aquatica*) and sweet flag (*Acorus calamus*) have the potential to occur on RSA. Lake cress inhabits quiet waters of springs, lakes, and sluggish streams. Sweet flag occurs in meadows, marshes, and swamps, often in shallow water. Rare animal species typical of this community include the gray bat and northern long-eared bat.

Springs. A spring is defined as an issue of water, from the substrate, at a point where the groundwater table intersects the land surface. Springs consist of a pool at the head and a channel which delivers water to the receiving stream. Characteristic plant species in springs are listed in Godwin and Hilton 1995. Dominant animal species in springs include southern two-lined salamander (*Eurycea cirrigera*), centrarchids, and freshwater snails.

William's Spring is the most noticeable one on RSA, with a discharge rate of approximately 3,800 liters per minute. A second, unnamed spring, although smaller in size and with a discharge rate of lesser magnitude than Williams Spring, is located on McDonald Creek at Hansen Road. Numerous small springs are present through the Installation which feed Indian Creek, McDonald Creek, and HSB. The Tuscumbia darter is a rare animal species which occurs at Williams Spring.

Subterranean Community

Aquatic Cave Subcommunity. Aquatic caves are habitable voids surrounded by walls of rock or similar inorganic material; they often contain a stream or connection to an underground aquifer. The aquatic subset of the cave supports aquatic cavernicolous species (i.e., troglobites, troglophiles) and/or trogloxenes.

The best examples of this community type are Bobcat and Matthews caves. Both caves have extensive underground aquatic habitats. Rubble and breakdown of rocks on the mud floor provide numerous crevices and interstices for the small invertebrate and vertebrate fauna. Rare

animal species found in cave communities include the Alabama cave shrimp, southern cave crayfish (*Orconectes australis australis*), and southern cavefish (*Typhlichthys subterraneus*).

Terrestrial Cave Subcommunity. Terrestrial caves are dry, habitable voids surrounded by walls of rock or similar inorganic material supporting terrestrial cavernicolous species (i.e., troglobites, troglophiles) and/or trogloxenes. Several examples of this community type are present on RSA, such as the very small Adams Cave. Also, terrestrial community components can be recognized in caves which are better known for their aquatic elements, such as Bobcat and Matthews caves. Rare animal species include amphibian vertebrates and troglobitic invertebrates.

Non-Native Flora

In 2012, the Alabama Invasive Plant Council (ALIPC) Board of Directors approved a list of invasive plants for the state of Alabama. The list ranks plants based on their invasive characteristics and is provided as a reference in Appendix D. This list has no regulatory authority but provides useful information to help guide agencies, private landowners, and water managers in making responsible decisions about plant use and management decisions.

A 2003 survey of invasive species (Tetra Tech, Inc.) reported 31 species of invasive plants at Redstone Arsenal. Other than the four target species, or species chosen for detailed study (trifoliate orange (*Poncirus trifoliata*), Chinese privet (*Ligustrum sinense*), bush honeysuckle (*Lonicera* spp.), and Japanese honeysuckle (*Lonicera japonica*)), and five frequently encountered non-target species (multiflora rose (*Rosa multiflora*), sericea lespedeza (*Lespedeza cuneata*), Nepalese browntop (*Microstegium vimineum*), ailanthus, or tree of heaven, (*Ailanthus altissima*), and sacred bamboo (*Nandina domestica*)), 22 other species were found. Most of the occurrences of these other 22 species were at a density of 0-5%, though three species (English ivy (*Hedera helix*), liriope (*Liriope spicata*), and periwinkle (*Vinca* spp)) were found at densities of 75-100%. These other species were most common in the ground layer, but four species – including two vine species (English ivy and kudzu (*Pueraria montana*), as well as Siberian elm (*Ulmus pumila*) and an unknown species – were found in the canopy layer. Because of their aggressive nature and ability to out-compete native plants and animals, many of these species have become prolific in scattered areas across the Installation.

Management recommendations, based on the results of the survey and the available information about the ecological threat of the invasive species encountered, can be found in the 2003 Final Invasive Species Survey for Redstone Arsenal (Tetra Tech, Inc.).

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3.0 Environmental Management Strategy and Mission Sustainability

3.1 Supporting Sustainability of Military Mission and Natural Environment

The ability to provide for the needs of the current mission while precluding damage to the future mission's ability to maintain its needs is referred to as sustainability. A sustainable process should be able to be duplicated without negatively impacting the environment or creating insurmountably high costs to anyone involved.

Sustainability is an overarching, on-going effort of reevaluating standard practices with the intent of preserving current resources. This Installation-wide effort of ensuring "no- net-loss" will continue to grow in importance as best-management and waste reduction initiatives are implemented. Sustainable practices will be incorporated into all aspects of Army actions and plans, requiring reductions and elimination of waste generation and an increase in reuse and recycling.

The monitoring and measurement of environmental resources at Redstone Arsenal is elemental to adaptive ecosystem management and mission sustainability. These actions ensure the effectiveness of management, plans, controls and training, as well as facilitate Redstone Arsenal in identifying its progress toward achieving objectives, targets, and the reasons for the Installation's level of achievement. Insufficient monitoring and measurement activities would make it difficult for Redstone Arsenal to continually support mission sustainability.

Redstone Arsenal utilizes an Environmental Management System (EMS) in its overall management system, integrating environmental concerns and issues into management processes. The EMS addresses organizational structure, planning activities, responsibilities, processes, and resources for developing, implementing, reviewing, and maintaining environmental policy. This system enables the USAG-Redstone and other tenant organizations to control the impact of their activities on the natural environment, thus achieving and maintaining compliance with current environmental requirements while proactively managing future issues that might impact mission sustainability.

3.1.1 Integrate Military Mission and Sustainable Land Use

The US Army's Integrated Training Area Management (ITAM) program is an Army-wide, comprehensive approach to land management and is an integral part of the implementation of an INRMP on any installation. It was developed with the recognition that Army training lands were being degraded to the point where their capabilities to sustain military missions were in jeopardy. It has since become the US Army's standard for sustaining the capability of installation land units to support their military training missions. However, proper management to support both the military mission and other multiple-use activities remains a challenge.

The primary goal of land management is to ensure the long-term availability of land and natural resources for mission activities. Currently, there is no formal, overarching range control/coordination at Redstone under which ITAM would fall. However, EMD coordinates

with individual range and training area management personnel, striving to meet the goals outlined in a standard ITAM.

3.1.2 Impact to Military Mission

The military mission at Redstone Arsenal requires available land for research, development, and training. However, the Installation must comply with federal, state, and local environmental laws and regulations and make an effort to conserve the natural resources on which effective research, development, and training rely. Through the coordination of the various environmental programs and individual range/training area coordinators, Redstone Arsenal ensures the availability of quality training lands while protecting the natural resources on these lands.

During the planning phase of natural resources or training management, the CNR Branch and range/training area manager personnel closely coordinate to ensure the compatibility between natural resources and the military mission. During this planning process, resolutions are established to ensure environmental regulations (e.g., Ecologically Sensitive Areas) are being upheld while still providing sufficient land use to meet the military mission.

3.1.3 Relationship to Range Complex Management Plan/Other Operational Area Plans

Through the INRMP, planning for both natural resources activities and testing activities are coordinated between DPW and individual range/test area managers. This coordination prevents the military mission from being compromised while Redstone Arsenal continues to meet mandated environmental regulatory requirements. Through this coordination, environmental resources are considered during the planning of future sites to support the military mission. Additionally, CNR considers future test area plans, when available, in an effort to develop natural resources projects.

3.2 Natural Resources Consultation Requirements

The ESA requires Federal agencies to ensure that their activities do not have an adverse impact on any species listed as threatened or endangered by the USFWS. It further requires that Federal agencies implement measures to conserve, protect, and, where possible, enhance any listed species and its habitat. Redstone Arsenal coordinates with USFWS on any actions that have the potential to impact threatened, endangered, and sensitive species. The Installation maintains a dialogue with USFWS and conducts Section 7 consultations as needed. Early informal consultation with the USFWS is the primary, and preferred, consultation tool Redstone utilizes to resolve potential problems in a proactive and positive manner. Informal consultation includes all discussions and correspondence between USFWS and Redstone Arsenal and occurs prior to formal consultation to determine whether a proposed Federal action may affect listed species or critical habitat.

If it is determined through the informal consultation process, or simply by the nature of the proposed action, that formal consultation is required for an action, Redstone Arsenal engages in

formal consultation with USFWS as required under Section 7 of the ESA. Formal consultation determines whether a proposed action is likely to jeopardize the continued existence of listed species, destroy or adversely modify designated critical habitats, or potentially results in the incidental take of a species. The consultation process begins with Redstone Arsenal's written request and submittal of a complete initiation package and concludes with USFWS's issuance of a biological opinion (BO) and "incidental take" statement, if applicable.

Migratory birds are specifically protected under the Migratory Bird Treaty Act of 1918, as amended and Executive Order (EO) 13186 of 10 January 2001, Responsibilities of Federal Agencies to Protect Migratory Birds. The MBTA makes it illegal to pursue, hunt, kill, capture, possess, buy, sell, purchase, or barter any migratory bird, including the feathers or other parts, nests, eggs, or migratory bird products, except as allowed by the implementing regulations. EO 13186 requires that Federal agencies avoid or minimize the impacts of their activities on migratory birds and make efforts to protect birds and their habitat. However, the National Defense Authorization Act of 2003 allows incidental take of migratory birds as a result of military readiness activities. The intention of this allowance was to require the Armed Forces give appropriate consideration to the protection of migratory birds when planning and executing such activities, but not at the expense of diminishing their effectiveness. So, while exempt, the US Army is still responsible for evaluating potential impacts to migratory birds and conferring with the USFWS to develop appropriate and reasonable conservation measures to minimize or mitigate adverse impacts. This monitoring will be carried out in conjunction with monitoring and management conducted under EO 13186 as specified in the 2014 Memorandum of Understanding between the DoD and the USFWS to Promote the Conservation of Migratory Birds.

3.3 Climate Change Impacts to Natural Resources

The DoD's ability to fulfill its mission in the future will be undoubtedly and significantly impacted by climate change. A DoD Climate Change Adaptation Roadmap (CCAR) was created in 2014, using the DoD's unique Climate Change Adaptation Plan. This road map adopts a proactive, flexible approach to vulnerability assessments (VAs) and adaptation planning on a regional level. The military is as vulnerable to climate change as the rest of society. Rising temperatures and changes in precipitation patterns are only two of the phenomena which may present significant impacts to military operations, training/testing, built and natural infrastructure, and acquisition.

Baseline surveys to assess the vulnerability of all the military's bases and installations are currently underway. These assessments will allow the DoD to integrate climate change considerations into plans, operations and training in order to manage associated risks, as well as collaborate with other agencies and institutions on ways to handle and mitigate the challenge.

As climate science advances, the DoD will routinely revaluate risks and opportunities to develop plans to manage climate change effects on the operating environments, missions, and facilities. These plans must be integrated into existing management processes, as adaptation to climate change cannot be a separate decision-making process. Infrastructure managers are already adapting to changing climate factors by considering climatic conditions when designing

buildings. DoDI 4715.03 and DoDM 4715.03 require INRMPs incorporate climate change, primarily through adaptive management approaches to ecosystem sustainment. Potential impacts may include amplified management challenges for wetlands, sensitive species, and non-native, invasive species; increased erosion and flooding damage; and increased energy costs.

3.3.1 Regional Trends

Carter *et al.* (2014) discuss three key messages for the southeastern United States and Caribbean region, including the widespread threat of sea level rising; increasing temperatures and associated extreme heat events; and decreased water. Historic temperatures have cycled between warm and cool periods, with an increasing number of warm days and decreasing number of cold days. Rainfall intensities have increased over the past century; yet summers have been either increasingly dry or extremely wet. Temperatures in this region are expected to increase during this century, with shorter fluctuations over time. Precipitation amounts are more difficult to project, however many models are showing a future decrease (Carter *et al.*, 2014). Water availability is still expected to decrease, however, with increased evaporative losses and growing populations taxing water supplies. In the southeastern US, global sea level rise is expected to accelerate past the historic eight inch rise of the past century. However, the amount the sea rises in any one place is also dependent on local subsidence and offshore currents. Areas in Louisiana and Mississippi, as well as south Florida, North Carolina, and Virginia will likely be the most vulnerable to sea level rise. In Alabama, average temperatures are increasing and are accompanied by more frequent dry summers and extreme heat. Locally, residents may experience more health risks from poor air quality, storms, infectious diseases, drought, extreme heat waves, and flooding.

3.3.2 Sustainability in the Face of Climate Change

Traditionally, natural resource managers have focused on protecting and managing ecosystems to maintain a current state or restore to a more desirable state. Climate change will require these managers to adopt forward-looking goals and implement policies to prepare for and adjust to change. Environmental sustainability depends, more than ever, on adaptive and ecosystem based management (Section 1.8.1).

At Redstone Arsenal, natural resource managers will continue to survey and monitor ecosystems to identify species and habitats which may be vulnerable to climate change, or conversely, which may be resilient to change. The scope and scale of vulnerability assessments will be tailored to the level of detail which meets Redstone's information needs. Priority will be given to VA preparation for ecologically sensitive areas, where adaptive capacity may be lower with regards to accommodating change. Regional conservation partnerships will be used to share information and collaborate across jurisdictions. Information from these VAs will be integrated into funding models for implementing INRMP projects.

Efforts are already underway at Redstone Arsenal to address the impacts of climate change with regards to construction design and community outreach. The DPW Master Planning Division has incorporated various efforts into the Installation Real Property Master Plan. Such concepts include long range visions of mass transit; incorporating low-impact development for stormwater

management; requiring Leadership in Energy and Environmental Design (LEED) standards for new construction; improving utility security and efficiency (centralized building controls, reduced consumption), as well as producing renewable energy (Waste-to-Energy, Solar Arrays); environmental clean-up of contaminated land; and utilizing life-cycle planning with prioritizing maintenance activities.

The Environmental Management Division will continue to emphasize protection and restoration of natural ecosystems, such as bottomland hardwood forests, native warm season grasses, and seasonal wetlands, in an effort to improve terrestrial carbon sequestration. This INRMP encourages proactive management practices and maintenance of large, intact ecosystems within the installation boundaries. The EMD will continue to host and participate in outreach events to educate the tenant community, as well as the public, about the effects of climate change on wildlife and other natural resources.

3.4 NEPA Compliance

The National Environmental Policy Act of 1969 (42 USC § 4371 *et seq*.) established the requirement for Federal agencies to integrate environmental values into decision making processes by considering the environmental impacts of proposed actions and reasonable alternatives to those actions. The intent of this act is to protect, enhance, or restore the environment through well-informed Federal decisions. The 32 CFR Part 651 (*Environmental Analysis of Army Actions*) requires full public disclosure of damage to the environment. The NEPA was enacted to identify environmental impacts and to provide an opportunity to resolve them using planning at early stages of project development. It was not legislated to prevent Federal actions, but to ascertain what potential environmental impacts may result from those actions and to determine the best way to mitigate those issues.

Redstone Arsenal actively integrates environmental considerations into decision-making in a manner consistent with NEPA and Council on Environmental Quality (CEQ) regulations (32 CFR Part 651). In the process of carrying out this obligation, the NEPA program promotes environmental stewardship of natural and cultural resources at RSA for future operations and use.

The EMD maintains a procedure for the environmental impact analysis of all programs and planned activities at RSA. This process currently is used for all similar type of action(s) when addressing environmental issues. A work order review process, directed by the DPW Business Operations and Integration Division, allows for RSA decision makers to be mindful of the impact associated with project activities on the air and water quality, cultural resources, soil, forests, fish, wildlife, threatened and endangered species, and other natural resources under their keeping and, as appropriate, in the context of regional ecosystems (32 CFR Part 651). The NEPA program at Redstone follows requirements set forth in 32 CFR Part 651 and is initiated through the project review process.

Timely integration of the NEPA process into RSA planning actions prevents disruption to the decision making process, thus ensuring the implementation of environmental policy that leads to good decisions. The majority of actions at RSA are individually reviewed for possible

adverse effects to natural resources and other environmental resources. Exceptions include on-going and routine undertakings such as repair and maintenance of buildings, structures, and roads, some landscape maintenance undertakings, and some types of military mission undertakings.

Project reviews, comments, mitigation/legal requirements, and administrative records are tracked and recorded in the Projects Tracking Database; they are maintained by the NEPA Program staff. Redstone Arsenal has no NEPA documentation for the Natural Resources Program as a whole. The EA prepared for this INRMP fulfills that requirement. If significant revisions are proposed for this INRMP that may result in environmental effects not previously analyzed, Redstone will conduct a new or supplemental environmental impact analysis of the proposed action under NEPA.

3.5 Beneficial Partnerships and Collaborative Resource Planning

3.5.1 US Fish and Wildlife Service

The USFWS has a field office at Daphne, Alabama, which provides technical advice and formal/informal consultation for management of natural resources on Redstone Arsenal, particularly endangered and threatened species. The SAIA and AR 200-1 provide cooperative guidance to be followed by installations with the USFWS regarding endangered and sensitive species management on Army lands. The USFWS is a signatory cooperator in the development, review, and implementation of this INRMP.

3.5.2 Alabama Department of Conservation and Natural Resources

The State of Alabama, through the Director of the Alabama Department of Conservation and Natural Resources, Division of Wildlife and Freshwater Fisheries, provides technical advice and assistance for programs relating to natural resources. The mission of the ADCNR DWFF is to manage, protect, conserve, and enhance the wildlife and aquatic resources of Alabama for the sustainable benefit of the people of Alabama. The DWFF is the primary support within ADCNR for assisting with the implementation of RSA's Fish and Wildlife Program. Under the SAIA and AR 200-1, the ADCNR DWFF is a signatory cooperator in the development, review, and implementation of this INRMP.

3.5.3 Wildlife Services

Wildlife Services (WS), a division of the USDA Animal and Plant Health Inspection Service (APHIS), has assisted Redstone Arsenal in the removal of nuisance wildlife, primarily raccoon, coyote, and beaver. This support is expected to continue during this INRMP period. The WS personnel are an integral part of the Prescribed Burning Program at Redstone Arsenal. WS is also a cooperator in a research initiative at RSA to study seasonal habitat use of beaver on the Installation.

3.5.4 Alabama Department of Environmental Management

The Alabama Department of Environmental Management (ADEM) serves as the state agency responsible for administering federally approved or federally delegated environmental compliance programs. This agency provides for a coordinated statewide program for the implementation of environmental programs and policies (i.e., air pollution, hazardous waste management, solid waste disposal, water pollution). Some state regulatory compliance matters, including the prevention and control of new and existing water pollution, may affect natural resources management at Redstone Arsenal.

3.5.5 Geological Survey of Alabama

The Geological Survey of Alabama (GSA) provides services and information to Alabama and its citizens as a natural resource data gathering and research agency. As part of its mission, GSA explores and evaluates the mineral, water, energy, biological, and other natural resources of the State of Alabama and conducts basic and applied research in these fields. Redstone Arsenal has contracted with the GSA to monitor the Tuscumbia darter population, Alabama cave shrimp population, water quality at Bobcat and Matthews Caves, and survey macro-invertebrate species on the Installation.

3.5.6 Municipalities

Communities adjacent to or in proximity to Redstone Arsenal are positively affected by natural resources management on the Installation. RSA provides hunting, fishing, trapping, and recreational opportunities to its military personnel, employees, contractors, and guests. In addition, surrounding counties are impacted positively by the distribution of funds from timber sales on the Installation. There are currently no significant conflicts between natural resources management on Redstone Arsenal and surrounding communities.

3.6 Public Access and Outreach

3.6.1 Public Access and Outdoor Recreation

AR 200-1 states that “installations will provide recreational access where feasible to these land and water areas suitable for recreational use. Installations will provide access to uniformed personnel, family members, and the public to hunting, fishing, and trapping consistent with security requirements and safety concerns. Army lands with suitable natural resources will be managed to allow for outdoor recreational opportunities.” The Natural Resources Program of CNR endeavors to manage the resources on Redstone Arsenal for these recreational opportunities within the constraints of the military mission. Additionally DoDM 4715.03 states, this document shall “identify areas available to the general public for hunting, fishing and trapping programs, subject to access restrictions and safety requirements.” Existing access procedures for Redstone Arsenal are restricted to military personnel, employees, contractors, and their guests due to security of military missions, personnel access restrictions, and current safety standard requirements.

RSA allows hunting, fishing, and trapping in designated areas on the Installation and Wheeler National Wildlife Refuge. Due to safety and confidentiality concerns, ranges and test areas are typically restricted from hunting/fishing/trapping, unless prior coordination and scheduling has permitted these activities. Approximately 34% (13,000 ac) of the Installation is available for hunting, fishing, and trapping, managed by season and in coordination with WNWR and the military mission. Information concerning this program is further detailed in Sections 4.4 and 4.13 of this INRMP.

3.6.2 Public Outreach

To increase the awareness of the importance of ecosystem management, Redstone Arsenal fosters personnel participation in ecosystem education and stewardship and participates in regional stewardship/research programs. The CNR participates in several educational events throughout the year.

The Path to Nature is home to an outdoor classroom facility and an approximately 3,800 foot ecological interpretative trail with 30 educational signs and wetland boardwalks. It is available for use by local school systems (public, private and home schools), universities/colleges, employees and soldiers at Redstone Arsenal, and various clubs/groups such as Boy and Girl Scout troops. At this area, several hundred school-age children are given tours and talks on the value of wetlands, wildlife, and other natural resources annually.

Annual events for Earth Day activities are coordinated through the Natural Resource Program of the CNR at the Path to Nature. These often include exhibits on cultural resources/history, live wildlife, tours for the various ecosystems represented at the Path to Nature, and interactive, mock environmental clean-up activities. Natural resource personnel also set up informational displays at events such as AMCOM's Bring Your Child to Work Day, Madison County Drinking Water Festival, and Team Redstone tenant activities.

3.7 Encroachment Partnering

Redstone Arsenal has not entered into formal agreements with Madison County or the surrounding cities. Formal agreements have not been necessary, in part, because the RDT&E missions of RSA do not present the chronic noise problems or other disturbances to the surrounding urban development typical of many military installations. While formal encroachment coordination and/or agreements do not exist between RSA and the surrounding communities, increasing urban development due to increasing Installation tenant/mission presence are beginning to present complications. Specifically, Redstone Arsenal is near reaching, or has reached, capacity for range expansion on its property, especially for explosive operations.

3.8 State Comprehensive Wildlife Plans (SCWP)

The Teaming with Wildlife (TWW) coalition, comprised of more than 6,300 state fish and wildlife agencies and their governmental/non-governmental partners, has historically encouraged the support of new Federal funding sources to complement and expand State

wildlife conservation programs. Beginning in FY 2001, funding support via State and Tribal Wildlife Grants (SWG) was provided in the form of annual appropriations to the States. Under this program, Congress provided a remarkable opportunity for State fish and wildlife agencies and their partners, to design and implement a more comprehensive approach to the conservation of the Country's wildlife.

The SWG program required that each state and territory develop a Comprehensive Wildlife Conservation Strategy (CWCS) by the start of FY 2005 and required review/revision of these documents at least every 10 years. These plans were aimed at outlining the steps needed to conserve wildlife and habitat before they are too rare or costly to restore. The Strategies were to "identify and focus on species in greatest need of conservation, yet address the full array of wildlife and wildlife-related issues (http://www.teaming.com/, accessed 2 June 2015)."

In Alabama this CWCS effort began in 2002 when the ADCNR DWFF sponsored a Non-game Symposium that tasked scientists and stakeholders to compile the best available information on Alabama's wildlife (http://www.outdooralabama.com/al-comprehensive-wildlife-conservation-strategy, accessed 30 June 2015). This two year effort resulted in the comprehensive four volume publication *Alabama Wildlife* (Mirarchi, 2004), which is the foundation for the Alabama CWCS. Coverage of taxonomic groups in the action plan has been expanded to include crayfish, of which Alabama has more species than any other state.

The 2015-2025 Alabama strategy defines those wildlife species in greatest need of conservation in Alabama and describes the actions necessary for their restoration. It is through this tool that ADCNR has the opportunity to work with conservation partners and the greater public to best utilize available resources to ensure that declining species are restored and common species remain common. Information about the Alabama CWCS can be obtained at http://www.outdooralabama.com/alabama-cwcs. The RSA INRMP utilizes the state strategy for conservation planning of the installation's species of concern.

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4.0 Program Elements

4.1 Threatened and Endangered Species Management Component

Chapter 4 of AR 200-1 establishes a goal to systematically conserve biological diversity on military lands and to do so requires protecting and sustaining naturally occurring organisms and their habitats. Conservation and restoration of biological diversity on Army lands can be expected to minimize the number of species that must be protected under the ESA and therefore preclude impacts to mission requirements. It is the goal of this plan to maintain and protect biological diversity on RSA through the management of ecologically significant communities. These Ecologically Sensitive Areas are significant or rare natural communities which may also support "species of concern" (Table 4.1). Species of concern are federally or state listed species and otherwise identified as imperiled. The protection, management, and recovery of species of concern populations through discretionary management and responsible planning is considered preferable to mandatory requirements under the ESA.

On RSA, species of concern encompass multiple categories of protection. Species federally protected under the ESA include those currently listed as endangered or threatened, as well as Candidate and Petitioned species. Candidate species, both proposed and former proposed, are those species for which the USFWS has sufficient information to propose them as endangered or threatened under the ESA, but for which development of a listing regulation is precluded by other higher priority activities. Petitioned species refer to those species that have been petitioned for listing under the ESA and for which the Service has found substantial information indicating that listing may be warranted. State Status categories include species protected by state laws as well as species identified as imperiled to varying degrees; the Alabama SWAP and CWCS are utilized for determining Installation species of concern. Partners in Flight (PIF) priority species and Army Species at Risk also are included in RSA Species of Concern. In hopes of avoiding federal listing of additional species, RSA considers ways to minimize or eliminate threats to the non-federally listed species that occur on its property.

RSA is home to fifty-two species of concern (Appendix E), thirteen of which are currently listed as Threatened or Endangered under the ESA and one of which is part of a nonessential experimental population (Whooping Crane). The T&E Species Program at RSA can be categorized into three functional areas: protection, management, and monitoring. The first line of defense for T&E species, and the most important tool to avoid "take," is protection of threatened and endangered species (individuals and populations) and their habitats from impacts due to training, development, or other actions. For most T&E species on the Installation, this protection comes in the form of restricted access to a particular area or restrictions on the type of activities that may occur within a given area. Areas where activity is restricted due to the presence of threatened or endangered species are clearly delineated with signs, fencing, or other obvious markings. Protective measures for each species are specified in their respective sections in this document.

To most effectively promote survival and recovery, RSA has identified specific management needs for each federally-listed species. Intensity of management for each species will vary depending on available scientific knowledge, and the ability of RSA to take actions that will

effectively promote recovery of a given species. For example, in the case of Price's potato bean, forest succession is controlled by removing shrubs and invasive species that create shade which could prevent the vine from reproducing. Alternatively, there is comparatively little that can be done to manage for the Alabama cave shrimp. Protection, rather than management, is the most effective tool to promote the continued existence of the species, so the area directly surrounding the cave is protected from development and the water quality of the cave is monitored monthly. For T&E species, RSA has relied on available scientific literature, expert advice, and local experience to devise plans and protocols that promote the survival and recovery of each species.

To gauge the effectiveness of management activities and to assess any population trends, an effective monitoring program must be implemented for each species. Also, monitoring is an essential aspect of any adaptive management program. RSA has implemented monitoring protocols of the threatened or endangered species known to be within the Installation boundaries. . As with management activities discussed above, the intensity of the monitoring will depend on the type and amount of information needed to carry out an effective program.

The T&E Species Program at RSA has several overarching requirements that direct conservation management and more specific goals for each T&E species. First, RSA will conserve and manage T&E species in accordance with environmental laws, regulations, and the terms and conditions outlined in applicable USFWS biological opinions. Compliance with the ESA is an important part of protecting RSA's primary mission of testing and development. To do this, RSA can implement recovery plan guidelines, as well as any terms and conditions of past and future biological opinions. RSA will actively manage for recovery of known populations of threatened and endangered species and will periodically and systematically survey for new populations.

Second, RSA will incorporate principles of ecosystem management into threatened and endangered species management. Although the threatened and endangered species program must ensure that each species receives appropriate management attention, much of the management that benefits each species can also benefit other species and the ecosystem as a whole. A good example of this is habitat management for Alabama least trillium. By managing Alabama least trillium, RSA is maintaining wetland ecosystems that many other species, such as Wood Thrush, American Woodcock, and various rare plants, depend on.

4.1.1 Critical Habitat

Critical habitat is the specific areas within the geographic area, occupied by the species at the time it was listed, that contain the physical or biological features that are essential to the conservation of endangered and threatened species and that may need special management or protection. Critical habitat may also include areas that were not occupied by the species at the time of listing but are essential to its conservation.

The USFWS will, to the best of its ability, propose and finalize critical habitat designations concurrent with issuing proposed and final listing rules. A final designation of critical habitat is made on the basis of the best scientific data available but also takes into consideration of the probably economic, national security, and other relevant impacts.

In accordance with 50 CFR 424.12(h), the USFWS will not designate as critical habitat land or other geographic areas owned or controlled by the Department of Defense, or designated for its use, that are subject to a compliant or operational INRMP if the Secretary determines in writing that such plan provides a conservation benefit to the species for which critical habitat is being designated. In determining whether such a benefit is provided, the Secretary will consider:

(1) The extent of the area and features present;
(2) The type and frequency of use of the area by the species;
(3) The relevant elements of the INRMP in terms of management objectives, activities covered, and best management practices, and the certainty that the relevant elements will be implemented; and
(4) The degree to which the relevant elements of the INRMP will protect the habitat from the types of effects that would be addressed through a destruction-or-adverse-modification analysis.

The USFWS must mutually agree to this INRMP before it can be relied upon for making any area within the Installation boundaries ineligible for designation of critical habitat.

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Table 4.1. Ecologically Sensitive Areas at Redstone Arsenal

Ecologically Sensitive Area	Habitat	Size	Species	Management
Bobcat Cave Ecologically Sensitive Area Figure 4.1	Oak-Hickory Forest, Early Successional Grassland, Forested Wetlands	333 Acres	Alabama Cave Shrimp	Groundwater Protection, Monthly Groundwater and Population Monitoring
Indian Creek (formerly Williams Spring) Ecologically Sensitive Area Figure 4.2	Beech-Mixed Oak-Sweetgum Bottomland Forest, Unnamed Tributary of Indian Creek, Indian Creek, Springs	TBD	Tuscumbia Darter, Gray Bat, Indiana Bat, Northern Long-eared Bat	Water Quality Protection, Annual Population Monitoring
Ward Mountain Ecologically Sensitive Area Figure 4.3	Oak-Hickory-Eastern Red Cedar Forest	90 Acres	Ginseng, Gray Bat, Indiana Bat, Northern Long-eared Bat	Forest Retention, Invasive Control
Weeden and Madkin Mountain Ecologically Sensitive Area Figure 4.4	Oak-Hickory-Eastern Red Cedar Forest with Calcareous Openings and Limestone Boulder Fields	1480 Acres	Price's Potato Bean, Ginseng, Gray Bat, Indiana Bat, Northern Long-eared Bat	Forest Retention, Invasive Control
Almond Road Ecologically Sensitive Area TBD	McDonald Creek Wetland and Spring Complex	TBD	Tuscumbia Darter, Gray Bat, Indiana Bat, Northern Long-eared Bat	Water Quality Protection
Huntsville Spring Branch Ecologically Sensitive Area Figure 4.5	River Birch-Sycamore-Elderberry Riverfront Forest, Swamp Chestnut Oak-Cherrybark Oak Bottomland Forest, Tupelo Swamp, Huntsville Spring Branch, McDonald Creek	795 Acres	Alabama Least Trillium, Gray Bat, Indiana Bat, Northern Long-eared Bat	Forest Retention, Water Quality Protection
Bradford Sinks-Swan Pond Ecologically Sensitive Area Figure 4.6	Intact, Unspoiled Wetland Complex	640 Acres	Gray Bat, Indiana Bat, Northern Long-eared Bat	Forest Retention, Water Quality Protection
Lehman's Bluff Ecologically Sensitive Area Figure 4.7	Oak-Hickory-Eastern Red Cedar Forest, Calcareous Cliffs	40 Acres	Harper's Umbrella Plant, Green Salamander	Forest Retention, Invasive Control, Minimize Human Disturbance
Bell's Bluff Ecologically Sensitive Area Figure 4.8	Oak-Hickory-Eastern Red Cedar Forest, Calcareous Cliffs, Sandstone Outcrops	100 Acres	Green Salamander	Forest Retention, Invasive Control

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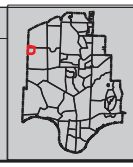
Ecologically Sensitive Areas - Figure 4.1

Ecologically Sensitive Area



0 125 250 500 750

Feet

1:1,240

4-7

Map Projection: Transverse Mercator
Horizontal Datum: North American Datum 1983
Grid Coordinate System: State Plane Coordinates, Alabama East
Planer Distance Units: Survey Feet (U.S.)

Bobcat Cave

Name: EcologicallySensitiveArea(ArchE)

Date Saved: 5/1/2014 8:53:09 AM

Last Update: N/A

Classification: Unclassified Limited Distribution

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Map Author: Lawrence Crawford
US Army Garrison-Redstone (256) 876-5682

Directorate of Public Works - Environmental Mgt
US Army Garrison - Redstone
Redstone Arsenal, AL 35898

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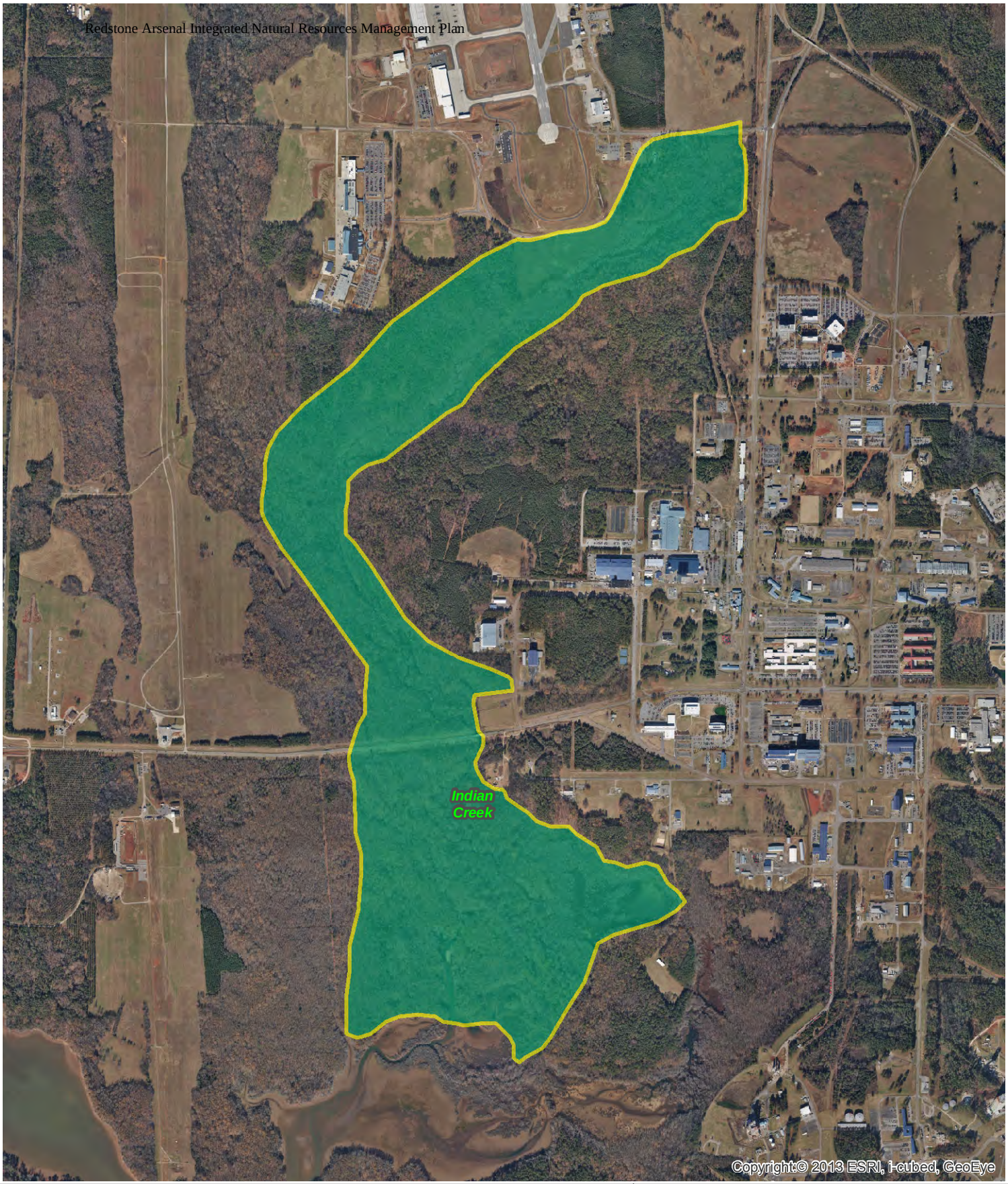

Ecologically Sensitive Area - Figure 4.2

Indian Creek Complex

0 0.15 0.3 0.45
Miles

1:22,210

Map Projection: Transverse Mercator
Horizontal Datum: North American Datum 1983
Grid Coordinate System: State Plane Coordinates, Alabama East
Planar Distance Units: Survey Feet (U.S.)

Indian Creek (Overview) - Redstone Arsenal, AL

Date Saved: 9/3/2015 11:10:50 AM

Classification: Unclassified Limited Distribution

Subject Matter Expert: Shannon Allen

Map Author: Lawrence Crawford
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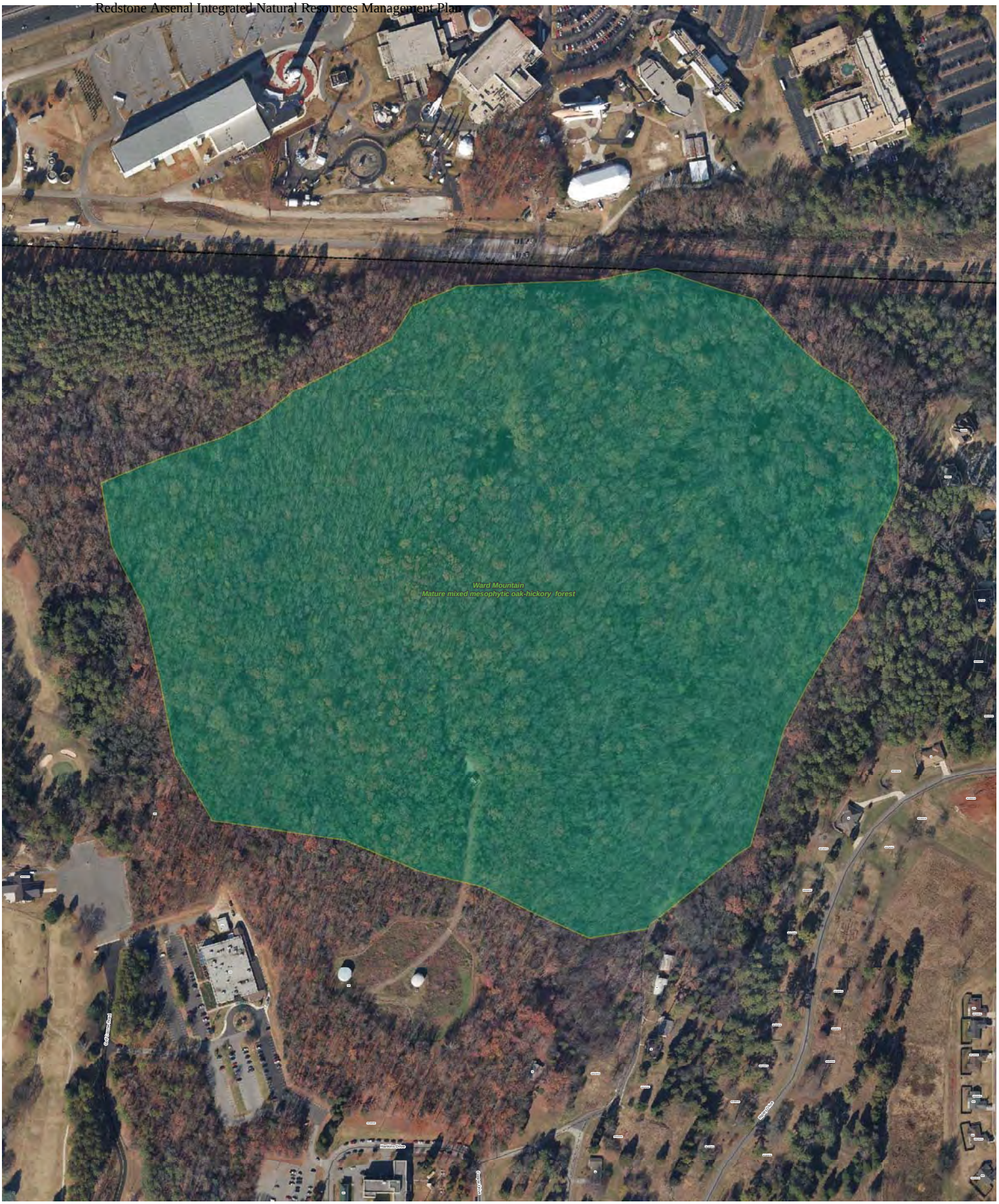

Ecologically Sensitive Areas -

Figure 4.3

Ecologically Sensitive Area

0 112.5 225 450 675

Feet

1:1,110

4-11

Map Projection: Transverse Mercator
Horizontal Datum: North American Datum 1983
Grid Coordinate System: State Plane Coordinates, Alabama East
Planer Distance Units: Survey Feet (U.S.)

Ward Mountain

Name: EcologicallySensitiveArea(ArchE)

Date Saved: 5/1/2014 8:53:09 AM

Last Update: N/A

Classification: Unclassified Limited Distribution

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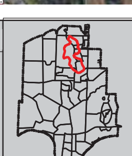
Ecologically Sensitive Areas -

Figure 4.4



0 550 1,100 2,200 3,300

Feet

1:5,420

4-13

Map Projection: Transverse Mercator
Horizontal Datum: North American Datum 1983
Grid Coordinate System: State Plane Coordinates, Alabama East
Planer Distance Units: Survey Feet (U.S.)

Weeden-Madkin Mountains

Name: EcologicallySensitiveArea(ArchE)

Date Saved: 5/1/2014 8:53:09 AM

Last Update: N/A

Classification: Unclassified Limited Distribution

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Ecologically Sensitive Area

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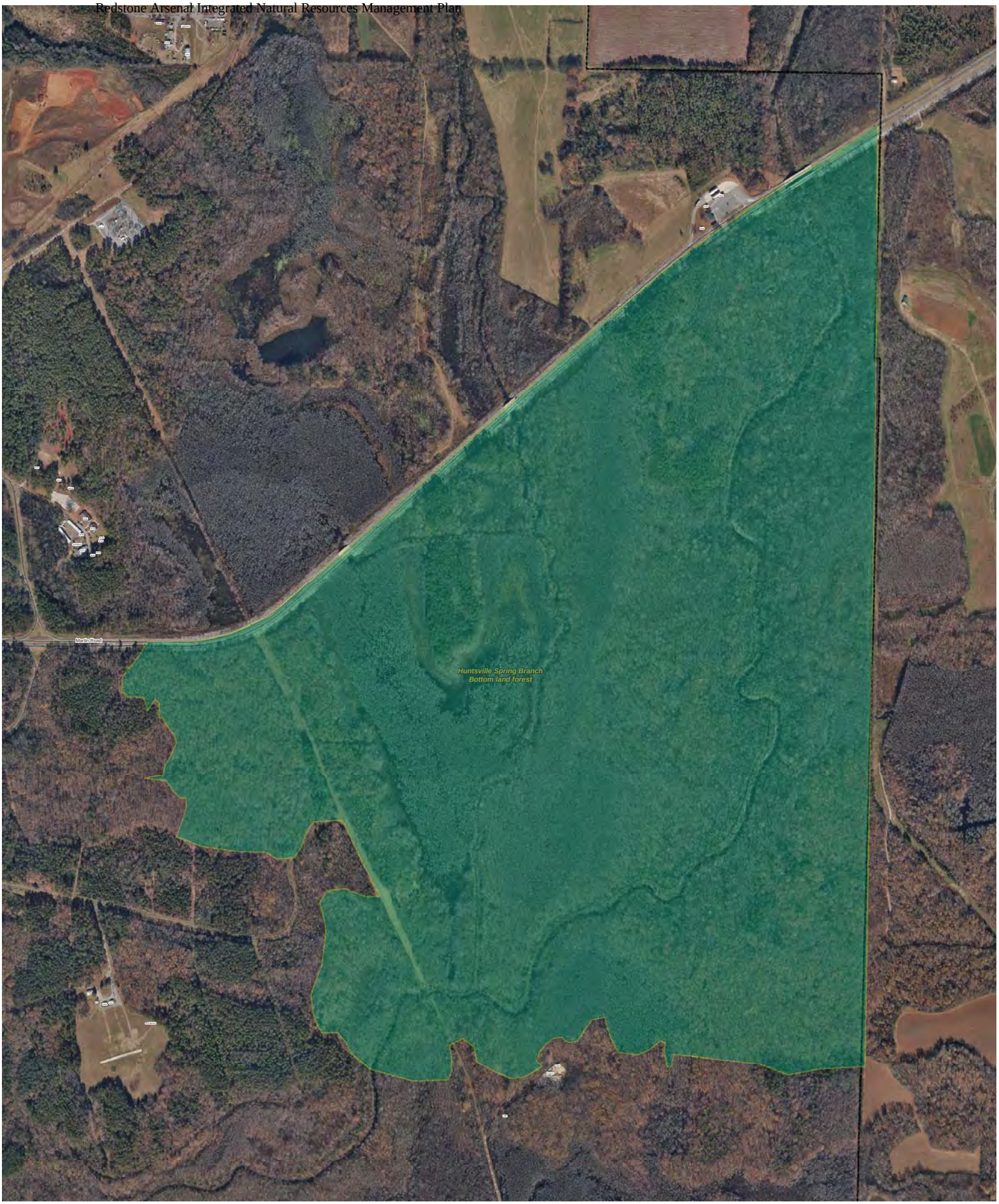

Ecologically Sensitive Areas - Figure 4.5

Ecologically Sensitive Area

0 310 620 1,240 1,860
Feet

1:3,060

4-15

Map Projection: Transverse Mercator
Horizontal Datum: North American Datum 1983
Grid Coordinate System: State Plane Coordinates, Alabama East
Planer Distance Units: Survey Feet (U.S.)

Huntsville Spring Branch

Name: EcologicallySensitiveArea(ArchE)

Date Saved: 5/1/2014 8:53:09 AM

Last Update: N/A

Classification: Unclassified Limited Distribution

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Map Author: Lawrence Crawford
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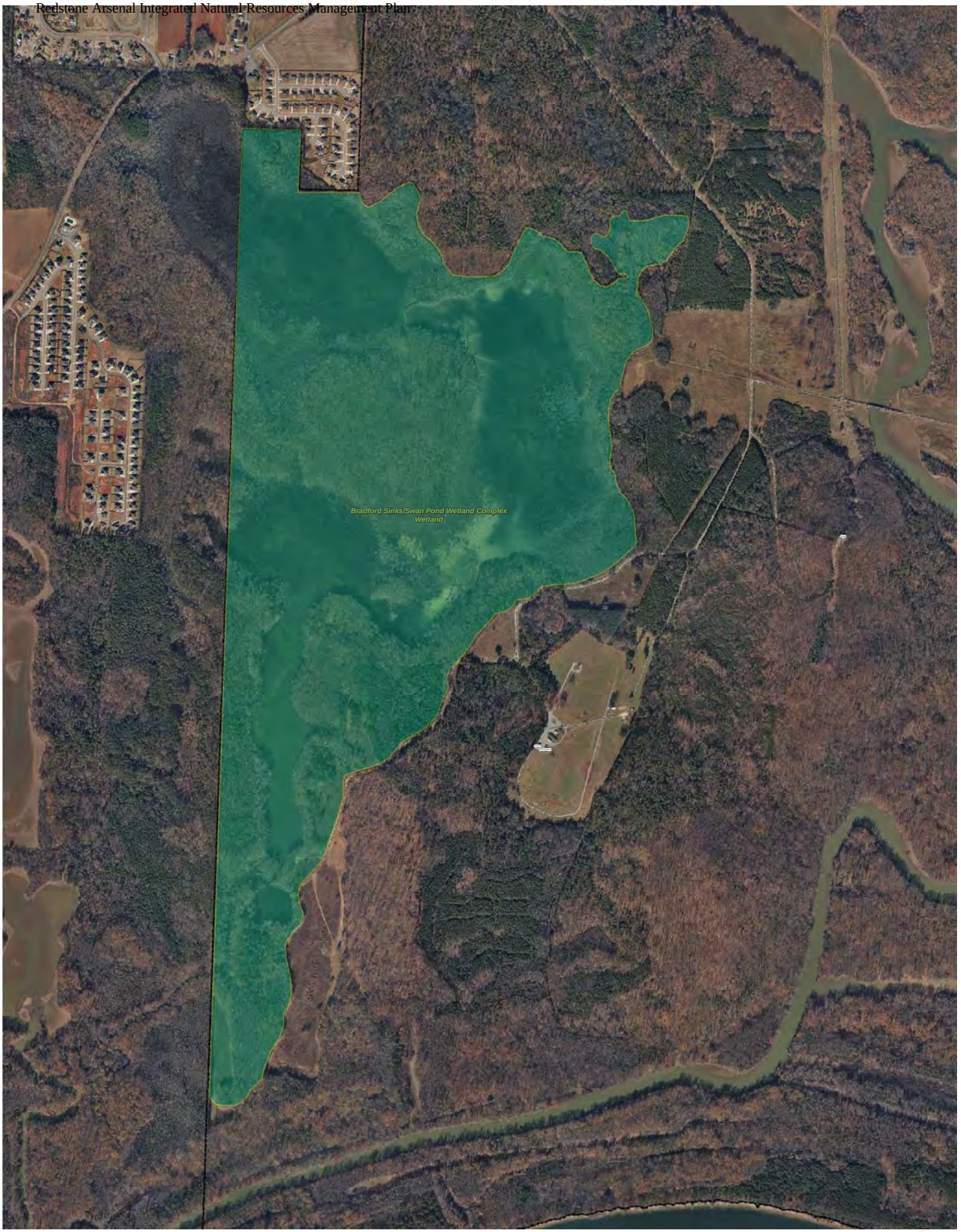

Ecologically Sensitive Areas - Figure 4.6

Ecologically Sensitive Area

0 400 800 1,600 2,400
Feet

1:3,960

4-17

Map Projection: Transverse Mercator
Horizontal Datum: North American Datum 1983
Grid Coordinate System: State Plane Coordinates, Alabama East
Planer Distance Units: Survey Feet (U.S.)

Bradford Sinks/Swan Pond Wetland Complex

Name: EcologicallySensitiveArea(ArchE)

Date Saved: 5/1/2014 8:53:09 AM

Last Update: N/A

Classification: Unclassified Limited Distribution

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Map Author: Lawrence Crawford
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Redstone Arsenal, AL 35898

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Ecologically Sensitive Areas - Figure 4.7

Ecologically Sensitive Area

0 137.5 275 550 825

Feet

1:1,370

4-19

Map Projection: Transverse Mercator
Horizontal Datum: North American Datum 1983
Grid Coordinate System: State Plane Coordinates, Alabama East
Planer Distance Units: Survey Feet (U.S.)

Lehman's Bluff

Name: EcologicallySensitiveArea(ArchE)

Date Saved: 5/1/2014 8:53:09 AM

Last Update: N/A

Classification: Unclassified Limited Distribution

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Map Author: Lawrence Crawford
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Redstone Arsenal, AL 35898

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Ecologically Sensitive Area - Figure 4.8

Ecologically Sensitive Area

0 155 310 620 930
Feet

1:1,510

4-21

Map Projection: Transverse Mercator
Horizontal Datum: North American Datum 1983
Grid Coordinate System: State Plane Coordinates, Alabama East
Planer Distance Units: Survey Feet (U.S.)

Bell Bluff

Name: EcologicallySensitiveArea(ArchE)

Date Saved: 5/1/2014 8:53:09 AM

Last Update: N/A

Classification: Unclassified Limited Distribution

For official use. For general location purposes only.

Map Author: Lawrence Crawford
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4.1.2 Threatened and Endangered Species Management

Outlined below are programs that address protection, management, and monitoring for all T&E species which regularly occur at RSA. This INRMP provides a conservation benefit to each of these species and their associated habitats. Management actions given in annual work plans outline a clear, measurable path to implementation. In the past, the programs described in this section met the necessary requirements to obviate the need to designate critical habitat on RSA. Based on the recent addition of section 424.12(h) to 50 CFR Part 424, the USFWS must mutually agree with this INRMP before that determination can be made. Redstone Arsenal will continue to regularly consult with the USFWS with regard to the synthesis of these programs.

Alabama Cave Shrimp (*Palaemonias alabamae*) – Endangered

Description. The Alabama cave shrimp is an albinistic, decapod crustacean up to 30 millimeters (mm) in length and nearly transparent. It is distinguished from most other shrimp by the almost equal length of the first and second periopods, spines on the carapace, and by rudimentary eyestalks (Smalley, 1961). First discovered in 1958, it was one of only two shrimps in the Atyidae family known from the Eastern United States, the other being the endangered Kentucky cave shrimp. Subsequently, additional cave shrimp species have been identified in Colbert County (1999) and Lauderdale County (2009) Alabama, but have not yet been described and named (Kuhajda and Fluker, 2010, McGregor and O'Neil, 2014).

Distribution. The Alabama cave shrimp is historically known to have occurred in only six caves (four cave systems) in Madison County, Alabama (Figure 4.9). However, an exciting find was made in 2018, when a team of scientists discovered an Alabama cave shrimp population in Fern Cave, Jackson County (Niemiller *et al.,* 2019) – a separate watershed than the caves in Madison County. The population in Shelta cave, the type locality, has not been observed since 1973 (Rheams *et al.,* 1994). It was discovered in Bobcat Cave on RSA in 1973 by Bill Torode and reported by Cooper (1975). The Brazleton, Hering, and Glover Caves Alabama cave shrimp population was discovered in the eastern part of Madison County during a cooperative study conducted by the US Army, USFWS, and the Geological Survey of Alabama in 1991 (Rheams *et al.,* 1994). A population in Muddy Cave, also in Madison County, was discovered in 2005. The Alabama cave shrimp is believed to be extirpated from Shelta Cave, most likely the result of groundwater pollution from adjacent housing developments. Because of its limited distribution and extreme rarity, very little is known about actual population densities of the cave shrimp in any of the known locations.

Bobcat Cave is in the northwestern portion of the RSA within the safety fan of Test Area 3. The area within its surface watershed was formerly used for cattle grazing. Just outside the Installation, but within ground water influence for Bobcat Cave, the historic land uses of forest, pasture, and row crops have been rapidly lost to suburban expansion of the City of Madison. Land use in cave recharge areas directly affects the quality of groundwater that enters the cave

(Hobbs, 1992). Other than a 1992 incident of cave shrimp discovery during the drilling of a well at Marshall Space Flight Center, no other shrimp sightings have occurred on RSA. However, due to the underlying karst geography, additional cave shrimp habitat in the caverniculous systems throughout the Installation is likely.

Management. The area immediately surrounding Bobcat Cave was removed from the Agriculture Lease Program in 2001, mainly due to poor stewardship by the lessee (interference with monitoring, unauthorized dumping, unauthorized chemical use, etc.). The area (333 ac) was then designated as Bobcat Cave Ecologically Sensitive Area. The area is gated and closed to unnecessary vehicle traffic. Military use of this area is restricted to laser testing, as no foot or vehicle training occurs. The use of pesticides, herbicides, saline solutions, or other toxic substances are not permitted in this area without consultation with the USFWS. Approximately 200 ac of the open pasture were planted with hardwoods in 2002, but the planting was less than 50% successful. Natural regeneration of woody plants has been allowed to occur for the past decade. However, due to encroachment of the invasive Callery pear (*Pyrus calleryana*) from the adjacent suburban development, herbicides were used to target the invasive species in the early successional areas of Bobcat Cave Ecologically Sensitive Area in 2014 and 2016. Invasive control will be continued, per consultation with the USFWS, in an effort to support additional native tree planting and establishment of native warm season grasses.

The northwestern quadrant of the Installation was designated as the Alabama Cave Shrimp Groundwater Protection Buffer Zone during Section 7 Consultation with the USFWS in the early 1990s. This is the area encompassed by I-565, Rideout Road, Martin Road, and Zierdt Road. The goal of the designation was to protect the groundwater quality of the karst ecosystem of the Alabama cave shrimp and the boundaries were based on the best scientific and hydrogeologic information available at the time, with knowledge that karst geography is especially difficult to delineate. During Section 7 Consultation with the USFWS, a number of measures were agreed upon to protect the water quality in the Groundwater Protection Buffer Zone:

- Provision of spill kits on-site during project activities and use of spill catch pans when fueling;
- Restriction of on-site routine maintenance to earthmoving equipment and trucks;
- Prohibition against hazardous waste/oil dumping;
- Secondary containment for fuel, oil, lubricants, batteries, other hazardous materials, and for devices (ex. elevators, storage tanks) which contain them;
- Prohibition against pest management operations without EMD and USFWS approval;
- Use of natural gas instead of fuel storage tanks;
- Implementation of Construction Best Management Practices;
- Transition septic systems use to sewer system use;
- Operation of oil-water separators for wash racks and parking lots; and
- Inclusion of an appropriately sized bioretention/bioremediation/biofiltration area to manage contaminants in runoff from impermeable surfaces.

One of the initial recovery actions outlined in the 1997 USFWS Alabama cave shrimp recovery plan, as well as subsequent five-year reviews, included protection of populations and their habitats, which would be partially fulfilled by the creation of cave management plans. In an

effort to contribute to these recovery actions, RSA EMD has contracted with the US Army Engineer Research and Development Center (ERDC) to develop a Bobcat Cave Management Plan, which is due for completion in 2021. Overarching long term management goals for the Bobcat Cave Ecologically Sensitive Area include (1) retention of the forested areas; (2) hardwood planting in designated early successional areas; (3) control of invasive species in early successional areas; (4) management of designated early successional areas as Oak Savannah with periodic prescribed fire; and (5) protection of stormwater runoff quality. The ERDC management plan will provide prescriptions for achieving these goals.

In accordance with NEPA, all projects on the Installation must undergo an environmental review to assess potential impacts on environmental resources. Any proposed projects in either the Bobcat Cave Ecologically Sensitive Area or in the surrounding Groundwater Protection Buffer Zone must be coordinated with the RSA's EMD and, if necessary, the USFWS.

Bobcat Cave Ecologically Sensitive Area is home to RSA's only known breeding population of Bachman's Sparrow (*Peucaea aestivalis*), a PIF priority species and an ADCNR Priority 2 species. Their use of the area was discovered during a 2008 Breeding Bird Survey by Auburn University (Best *et al.,* 2010; Ortman, 2012). Though not typical of Bachman's Sparrow habitat, maintaining the existing forest and management of an Oak Savannah habitat will be beneficial to this species.

Monitoring. Since 1990, the US Army has engaged in numerous cooperative studies with local, State and Federal agencies to better understand the Alabama cave shrimp, its habitat requirements, and the hydrogeography (McGregor *et al*., 1994; Rheams *et al*., 1992, 1994; Campbell *et al.*, 1996; Campbell, 1998; McGregor *et al*., 1997, 1999). In 1996 the Army initiated a series of contracts with GSA to monitor cave shrimp population levels in Bobcat Cave (McGregor and O'Neil, 1996-2014; McGregor *et al*., 2015). The number of shrimp observed both monthly and yearly is highly variable and probably is a function of ground water levels. While it is important to confirm the presence of the shrimp through a regular monitoring program, it is probably more important to the survival of the shrimp to monitor the groundwater quality in and around Bobcat Cave. Therefore, GSA also monitors water quality monthly so that should contamination occur, it can be detected early and allow rapid mitigation response to limit adverse impact to shrimp. The results of these studies have provided information on the approximate size of the Bobcat Cave local recharge area, the long term trends in cave water quality, and some insights into cave shrimp population dynamics.

On RSA, the groundwater recharge areas connected to Bobcat Cave, but located outside of the Installation, are difficult to control. Urbanization of the lands surrounding Bobcat Cave poses threats of contamination to the aquifers from several sources, including sewage leakage; industrial contaminants; road and highway runoff; toxic spills; runoff from residential sites; and siltation (USFWS, 1997).

The EMD Restoration Branch installed monitoring wells on the north end of the Installation to screen for contaminants from sources outside the Installation. In 1996 trichloroethene (TCE) and

other VOC contaminants were detected in water samples taken from these wells. Other wells installed in this area also have shown varying amounts of VOCs during periodic groundwater monitoring. It has been determined that the contamination migrated to RSA through the groundwater from Wyle Laboratories, which is located northwest of the Installation boundary (Shaw Environmental & Infrastructure, Inc., 2013). This is a concern for our groundwater cleanup program as well as for the Alabama cave shrimp. The Army will continue to monitor its northern boundary for contamination coming from sources coming from outside RSA boundaries, however investigation and cleanup of this source falls under ADEM regulatory authority.

The data and literature review completed by the Army Public Health Command Water Resources Group (2015), as well a hydrogeologic assessment of Madison County and Redstone Arsenal (Cook *et al.*, 2015), identified data gaps and prioritized additional studies (dye trace, isotope dating, etc). Additional hydrogeographic work in the area has been accomplished by the Restoration Branch of the Environmental Management Division as part of their remediation investigations (Shaw Environmental, Inc., 2004a, 2004b, 2009; Excel Geophysical Services, Inc., 2010) since the 1990s.

We have fairly certain knowledge of the shallow groundwater recharge area for Bobcat Cave but the deep groundwater area of influence is much less understood. PELA GeoEnvironmental, Inc. (PELA) and Auburn University performed work from 2015-2019 in an effort to delineate the deep groundwater recharge area. This study did not provide data to justify modification of the Bobcat Cave shallow water recharge area delineated by the aforementioned GSA studies. It lent support to the supposition that recharge is meteoric in origin. Results indicated that the cave is well connected to groundwater via conduits or geologic fractures and could not conclude that deep water recharge was bounded by Indian Creek, as is the shallow recharge area. The study found evidence of dye actually crossing the creek in both directions. Overall, the RSA EMD does not concur with PELA's proposed new boundaries of the groundwater habitat buffer area, based on the inconclusive nature of this work. Until the buffer area is reconsidered, we will continue to consult with the USFWS regarding potential impacts to this species as a result of DoD actions will continue to be conducted.

However, without support and groundwater protection efforts from the Cities of Madison and Huntsville, efforts on RSA may be for naught. RSA personnel will also continue to support education programs that increase public awareness of groundwater pollution issues (e.g., Madison County Drinking Water Festival).

Conservation Goals. The primary goal is to protect extant populations of the Alabama cave shrimp. Because karst habitats are highly vulnerable to contamination by surface activities, protection of the Alabama cave shrimp requires proper stewardship of lands within the recharge area.

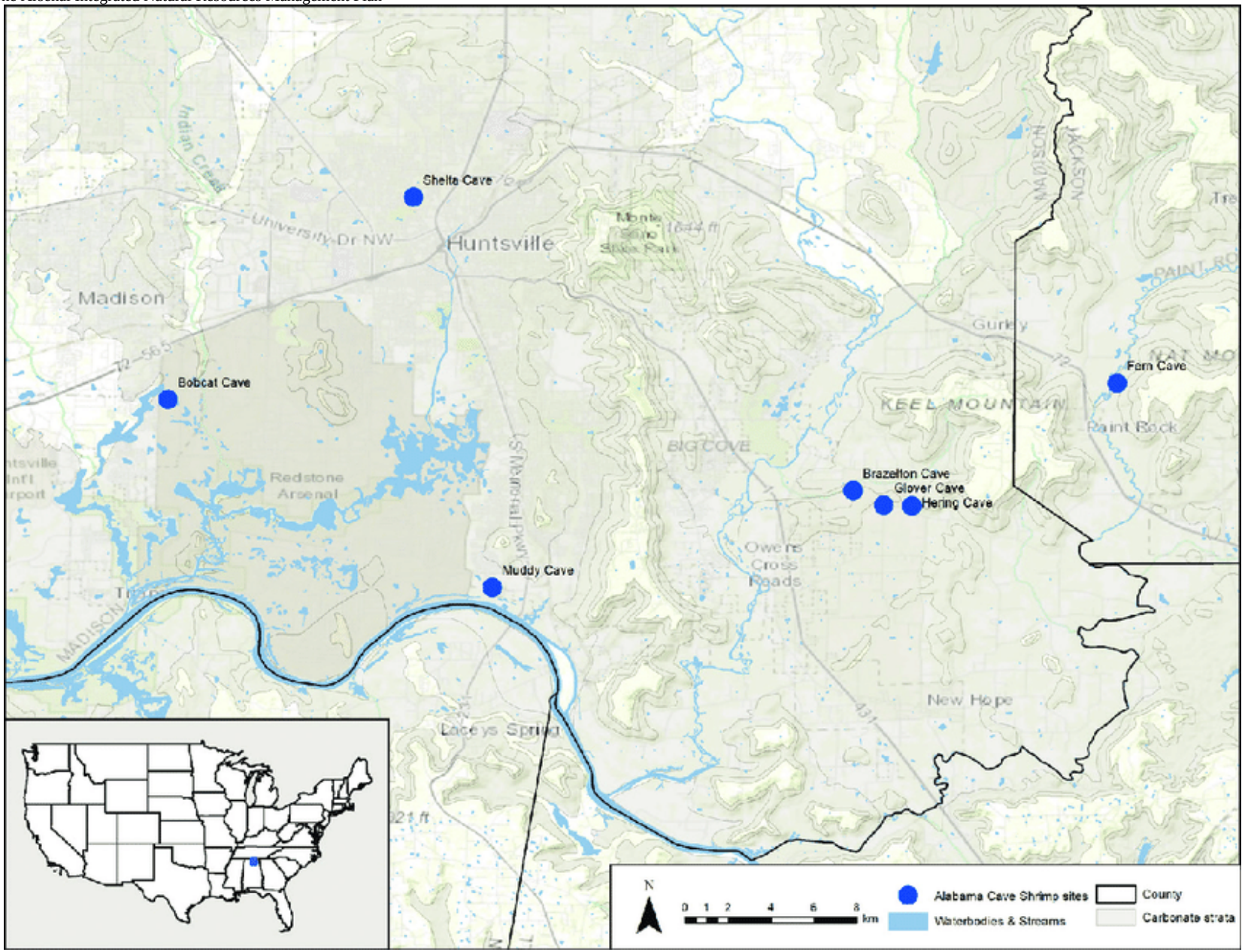

Figure 4.9. Distribution of the Alabama cave shrimp (*Palaemonias alabamae*) in Madison and Jackson counties, Alabama, USA. Carbonate strata are depicted in gray. Alabama cave shrimp sites are shown as blue dots (source: Niemiller *et al*, 2019).

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Gray Bat (*Myotis grisescens*) – Endangered

Description. The gray bat is the largest member of the genus *Myotis* in the eastern US. The wingspan measures 11-13 in, and the bat weighs from 0.3-0.4 ounces (Harvey *et al.*, 1999). The gray bat is easily distinguished from other bats by unicolored dorsal fur. All other eastern bats have distinctly bi-or tricolored fur on the back. Following molt in July and August, gray bats are dark gray, but often bleach to chestnut brown or russet between molts. The wing membrane connects to the foot at the ankle rather than at the base of the first toe as in other *Myotis* species (USFWS, 1982).

Distribution. The gray bat was officially listed as endangered by the USFWS in 1976. A recovery plan with the objective of de-listing was subsequently prepared and approved in July 1982 (USFWS, 1982) and updated in 2009 (USFWS, 2009a). Since the preparation of the initial recovery plan, initiatives to purchase and protect hibernacula and maternity caves have led to an increase in the population of gray bats. However, their restriction to certain types of caves that provide adequate thermoregulatory capabilities probably limits their expansion to new cave habitats (hibernacula: 41-52^{o}F and maternity colonies: 57-79^{o}F).

The gray bat is a monotypic species that occupies a limited geographic range in the karst limestone region of the Southeastern United States. Populations are found mainly in Alabama, Tennessee, Kentucky, Missouri, and northern Arkansas (USFWS, 1982). Within Alabama, 95% of the gray bat population hibernates in only nine caves (Harvey *et al.*, 1999). Almost all of these caves are associated with the Tennessee River Valley. The gray bat is more restricted to caves than any other mammal in the United States. It roosts year round in large colonies in caves. During the ALNHP investigations, no caves on RSA were found to have gray bat colonies. However, mist netting has demonstrated that the gray bat does forage along waterways on RSA, specifically along Huntsville Spring Branch and Indian Creek, but are likely to be widespread on Installation creeks.

Several large colonial caves are located within 10 miles of Installation boundaries. A migratory species known to move up to 465 miles from sites of hibernation to summer roosts, they travel more than 25 miles per night to and from summer foraging sites (Johnson *et al.*, 2002) so their presence on RSA is no surprise. Though no gray bat colonies have been found here, their existence cannot be completely ruled out and caves on Redstone continue to be investigated.

Once well on its way to recovery and delisting, White-nose syndrome was discovered to affect gray bats in 2012. The full effects of this disease on the species have yet to be determined, but the lack of significant mortalities in gray bat hibernacula may indicate the species is not yet negatively impacted (Powers *et al*., 2015).

Management. Management for gray bat habitat includes protection, retention, and maintenance of forested corridors along Installation waterways. Protection of foraging habitat (swamps, sloughs, open water fringes, and saturated emergent wetlands) is important for a diversity of aquatic insects upon which the bats depend, particularly flies, mayflies, and beetles. Management for healthy populations of aquatic insects is accomplished by protection of water quality through construction best management practices (BMPs) and when possible, forest retention. On RSA, all forested wetlands and 100-year floodplain have been identified as environmentally restricted areas for planning purposes in the 2014 RSA Real Property Master Plan.

Management of WNS on RSA consists of cooperating in the efforts to prevent its spread. DoD is a member of the White-Nose Syndrome National Plan team. RSA utilizes universal precautions and the most recent USFWS Decontamination Protocol when entering caves bats and when netting or trapping for bats. Cave access is restricted from use except by RSA environmental personnel with a need to enter. RSA participates in the Alabama Bat Working Group, a partnership of state, federal, and nongovernmental organizations dedicated to the study and protection of bats in Alabama. Bats also are included in our educational programs to children and adults (Earth Day Celebration, Madison County Drinking Water Festival, Wetland Tours, etc.).

Monitoring. An Installation-wide bat survey that was completed in 2007 by Auburn University (Gardner, 2008) indicated specific areas that gray bats utilized as foraging and travel corridors existed in forested riparian areas (Huntsville Spring Branch, Indian Creek, and McDonald Creek). In 2014 during the Alabama Bat Blitz hosted by EMD, gray bats were captured on Ward Mountain and in/near wetlands on the south end of the Installation. Additional Installation-wide bat surveys were conducted by Copperhead Environmental Consulting Inc. in 2016 and 2019 to specifically investigate the ecology of Indiana and northern long-eared bats. Gray bats were acoustically detected as well as netted at various locations across the Arsenal. Their use of RSA for foraging is widespread and has been consistent for many years now. Caves are monitored annually for colonies but none have been detected. The 2016 Copperhead survey also investigated a number of earth-covered magazines for evidence of bats during the winter. However, the temperature and lack of airflow through these structures likely precludes the inhabitance by gray bats.

Conservation Goals. The recovery plan (USFWS 1982, 2009a) states that actions to recover gray bat populations should include acquisition and protection of caves, prevention of habitat destruction and degradation, public education, and further research, particularly on the effects of environmental disturbances Continued protection of wetlands and other important foraging areas on RSA will aid in gray bat recovery.

Indiana Bat (*Myotis sodalis*) - Endangered

Description. The Indiana bat is a member of the family Vespertilionidae weighing 0.2-0.3 ounce with a wingspan of 9-11 in (Harvey *et al.,* 1999). It has gray-brown fur with the basal portion of the individual hairs being dark gray. The chest is pinkish to light red-brown. The heel of the foot is strongly keeled. The Indiana bat, which feeds on flying insects, forages in both forested riparian and upland areas. The 2015 population in the United States is estimated to be approximately 525,000 individuals with nearly 100% of them utilizing caves and mines as hibernacula in 16 states. During the summer they roost under the peeling bark of mostly dead and dying trees.

Distribution. The Indiana bat occurs in what is roughly the eastern half of the United States. Its distribution includes cave regions and, during summer, areas surrounding cave regions. There are six counties within 50 miles of the Installation with known hibernacula for the Indiana bat (Figure 4.10). While the Indiana bat has not been detected or observed on RSA, the proximity to the Tennessee River, the presence of appropriate foraging habitat, and the continuous range of the bat throughout the Eastern United States, its presence is assumed.

Despite recovery efforts to protect hibernacula and foraging habitat, Indiana bat populations have continued to decline for reasons that are not apparent. General land use practices may be a contributing factor and preliminary studies suggest that the use of agricultural pesticides may have deleterious effects on insectivorous bats in North America. In addition, it is one of the bat species in which WNS has been detected.

Management. Management prescriptions for the Indiana bat at Redstone Arsenal include protection of forested habitats. Emphasis is placed safeguarding the size and species of trees that are preferred as roosts as well as on retaining snags that can be used as Indiana bat summer roost sites. Protection of foraging habitat is also an important management action, to provide for a diversity of insects upon which the bats depend. On RSA, all forested wetlands and 100-year floodplain have been identified as environmentally restricted areas for planning purposes in the 2014 RSA Real Property Master Plan.

In September 2015, the USFWS concurred that all Redstone Arsenal projects designed to fully meet the required terms of the previous Army's IMCOM Biological Evaluation of northern long-eared bats (AEC, 2015) would only have effects on Indiana bat that are insignificant, discountable, or wholly beneficial. Environmental review of all Installation actions (mission, testing, construction, forestry, pest management, etc) will continue to prescribe these required terms or, if not possible, require USFWS protocol surveys be conducted or pursue further consultation. Redstone Arsenal has begun to collaborate with Fort McClellan to develop a Forestry Management Plan and consult with the USFWS regarding the impacts of typical forestry actions on Indiana bats.

In certain hibernacula, Indiana bat populations have greatly decreased since the introduction of WNS and there is great concern for their recovery. The disease has caused the mortality of thousands of hibernating bats throughout their range. We are less certain how WNS is affecting the species in the southern states and many monitoring projects across the state are underway to assess this.

Management of WNS on RSA consists of cooperating in the efforts to prevent its spread. DoD is a member of the White-Nose Syndrome National Plan team. RSA utilizes universal precautions and the most recent USFWS Decontamination Protocol when entering caves bats and when netting or trapping for bats. Cave access is restricted from use except by RSA environmental personnel with a need to enter. RSA participates in the Alabama Bat Working Group (ABWG), a partnership of state, federal, and nongovernmental organizations dedicated to the study and protection of bats in Alabama. Bats also are included in our educational programs to children and adults (Earth Day Celebration, Madison County Drinking Water Festival, Wetland Tours, etc.).

Monitoring. An Installation-wide bat survey was completed in 2007 by Auburn University (Gardner, 2008) and no Indiana bats specimens were captured or detected. Further, no Indiana bats were captured or acoustically detected during the 2014 Alabama Bat Blitz on RSA (ABWG 2014). Subsequent Installation-wide bat surveys, were conducted by Copperhead Environmental Consulting, Inc. in 2016, 2017, and 2019, to specifically investigate the ecology of Indiana and northern long-eared bats. No Indiana bats were captured through netting activities however this species was acoustically reported by automated identification software in 2016 and 2017. Manual vetting was performed but, due to the reality that many Myotis species are difficult to discern between, no confidant identification of this species was made. Further, the raw acoustic data from the 2016 Copperhead study were re-analyzed in 2019, using the same settings but the current version of Kaleidoscope Pro (5.1.0, Kpro, Wildlife Acoustics, Inc. Maynard, MA), and produced different results. Based on the overall maximum likelihood estimator score and number of sites with probably Indiana bat presence, Indiana bats are not considered to be present at Redstone. The lack of captures through extensive netting efforts supports this conclusion.

Presence/absence surveys, in accordance with the most recent Range-wide Indiana Bat Summer Survey Guidelines (USFWS, 2019), will be conducted for Installation activities that do not adhere to the 2015 informal consultation between RSA and USFWS or fall outside of the scope of the 2017 blanket clearance for Redstone Arsenal. The objectives of Indiana bat summer survey guidelines are to (1) standardize range-wide survey procedures; (2) maximize the potential for detection/capture of Indiana bats at a minimum acceptable level of effort; (3) make accurate presence/absence determinations; and (4) aid in conservation efforts for the species by identifying areas where the species is present. Natural resource planners will adhere to the Range-wide Indiana Bat Protection and Enhancement Plan Guidelines (USFWS, 2009c) to avoid impacts to potential spring/summer roosting and maternity colonies of this species.

Installation-wide bat surveys may be planned every five years, depending on funding availability. Caves on the Installation are monitored annually for colonies. The Copperhead survey determined that earth covered igloos on Redstone are not suitable as hibernacula due to the lack of airflow and warm temperatures.

Conservation Goals. The latest Recovery plan (USFWS, 2009b) states that actions to recover Indiana bat populations should include conservation and management of habitat, public education, and further research, particularly on the effects of environmental disturbances. Suitable habitat on RSA will be managed and protected to aid in Indiana bat recovery. Installation actions will be required by EMD to abide by all USFWS requirements. The species is currently under USFWS recovery plan review again.

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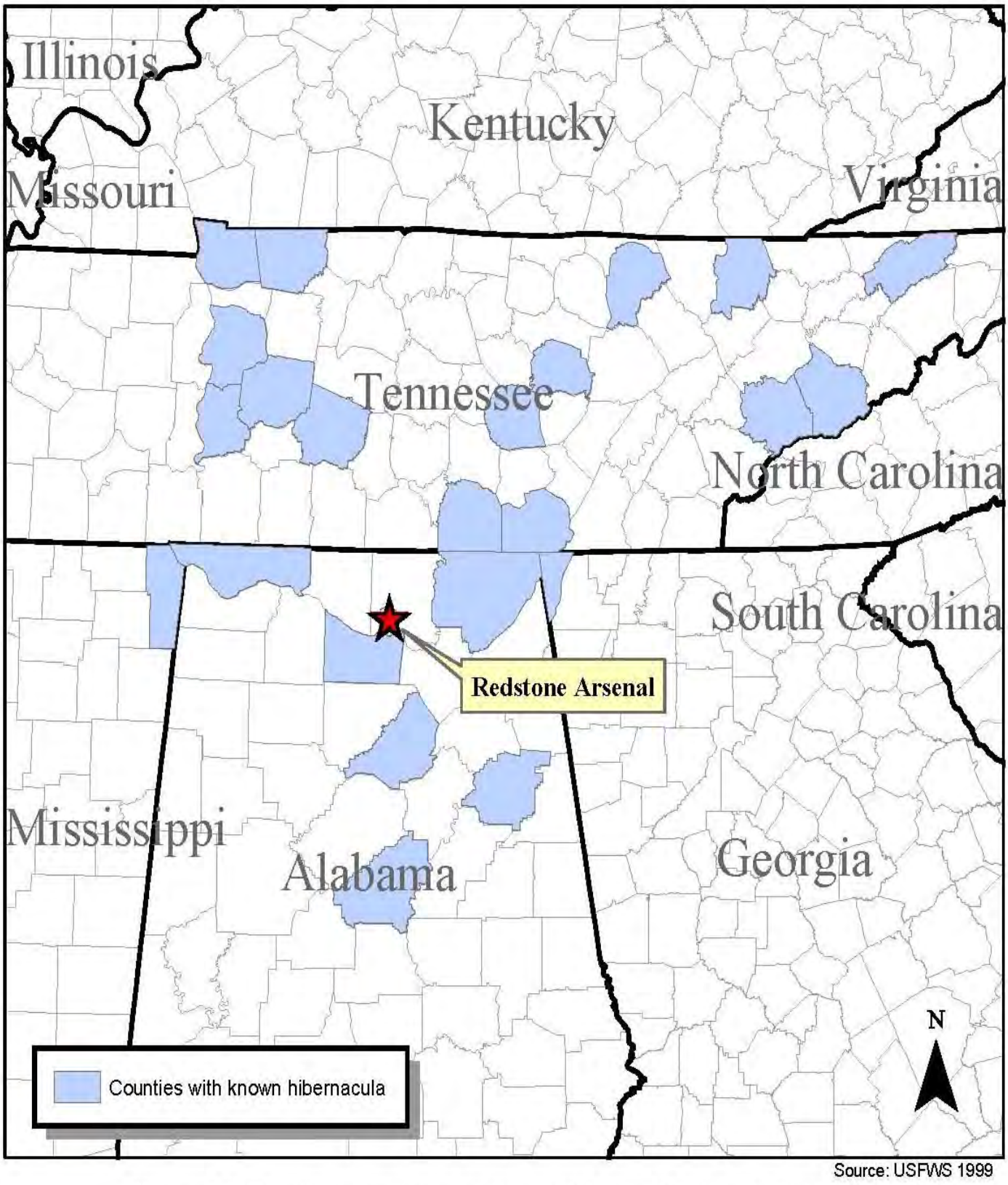

Figure 4.10. Counties in contiguous states with known hibernacula for *Myotis sodalis*

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Northern Long-eared Bat (*Myotis septentrionalis*) –Threatened

Description. The northern long-eared bat is a medium-sized bat, weighing about 0.2-0.3 ounces, with a wingspan of 9 to 11 in (Harvey *et al.*, 1999). Its fur color is medium to dark brown on the back and tawny to pale-brown on the underside. As its name suggests, this bat is distinguished by its long ears. The northern long-eared bat, which feeds on insects, forages in cluttered understories of forested areas (both wetland and upland). These bats hibernate in caves and mines during the winter season and move to summer habitat in forested areas. They will opportunistically roost underneath bark, in cavities or in crevices of both live and dead trees.

Distribution. The northern long-eared bat's range includes much of the eastern and north central United States and all Canadian provinces from the Atlantic Ocean west to the southern Yukon Territory and eastern British Columbia. The species' range includes 37 States and the District of Columbia.

Until the discovery of WNS in 2006, the northern long-eared bat was not considered an at-risk bat species. However, population numbers have decreased by 99% in the northeast due to White-nose Syndrome and now once minor threats such as wind farms, loss of summer habitat, or impacts to hibernacula, are now considered of extreme importance for the species to persist. The USFWS listed this species as Threatened under the ESA in April 2015.

Management. Management actions for northern long-eared bats at Redstone are similar to those for Indiana bats, focusing on protection of forested habitats, ensuring the presence of preferred size and species of roost trees and retaining snags when possible. Protection of foraging habitat is also an important management action, to provide for a diversity of insects upon which the bats depend. On RSA, all forested wetlands and 100-year floodplain have been identified as environmentally restricted areas for planning purposes in the 2014 RSA Real Property Master Plan.

In September 2015, the USFWS concurred that all Redstone Arsenal projects designed to fully meet the required terms of the previous Army's IMCOM Biological Evaluation of northern long-eared bats (AEC, 2015) would only have effects that are insignificant, discountable, or wholly beneficial at RSA. Environmental review of all Installation actions (mission, testing, construction, forestry, pest management, etc.) will continue to prescribe these required terms or, if not possible, require USFWS protocol surveys be conducted or pursue further consultation. Redstone Arsenal has begun to collaborate with Fort MacClellan to develop a Forestry Management Plan and consult with the USFWS regarding the impacts of typical forestry actions on the northern long-eared bats.

Management of WNS on RSA consists of cooperating in the efforts to prevent its spread. DoD is a member of the White-Nose Syndrome National Plan team. RSA utilizes universal precautions

and the most recent USFWS Decontamination Protocol when entering caves bats and when netting or trapping for bats. Cave access is restricted from use except by RSA environmental personnel with a need to enter. RSA participates in the Alabama Bat Working Group, a partnership of state, federal, and nongovernmental organizations dedicated to the study and protection of bats in Alabama. Bats also are included in our educational programs to children and adults (Earth Day Celebration, Madison County Drinking Water Festival, Wetland Tours, etc.).

Monitoring. An Installation-wide bat survey that was completed in 2007 by Auburn University (Gardner, 2008) acoustically detected northern long-eared bats at a number of locations/habitat types across the arsenal as well as captured individuals in riparian areas. During the 2014 Alabama Bat Blitz hosted by EMD, northern long-eared bats were acoustically detected at a number of monitoring sites across the Installation however no individuals were captured in nets. Subsequent Installation-wide bat surveys were conducted by Copperhead Environmental Consulting, Inc. in 2016, 2017, and 2019, to specifically investigate the ecology of Indiana and northern long-eared bats.

No northern long-eared bats were captured through netting activities however this species was acoustically reported by automated identification software. Manual vetting was performed but no confidant identification of this species was made. The lack of captures through extensive netting efforts supports this conclusion.

Because there are no species specific survey prescriptions for the northern long-eared bats at this time, presence/absence surveys will be conducted in accordance with the most recent Range-wide Indiana Bat Summer Survey Guidelines (USFWS, 2019) for Installation activities that do not adhere to the 2015 consultation requirements between RSA and the USFWS or fall outside the scope of the 2017 blanket clearance for Redstone Arsenal.

Installation-wide bat surveys may be planned every five years, depending on funding availability. As time allows, the Environmental Management Division will conduct their own acoustic monitoring projects in more remote locations of the Arsenal. Caves on the Installation are monitored annually for colonies. The Copperhead survey determined that earth covered igloos on Redstone are not suitable as hibernacula due to the lack of airflow and warm temperatures.

Conservation Goals: Conservation and management of suitable habitat on Redstone Arsenal as well as public education will continue. Installation actions will be required by EMD to abide by all USFWS requirements. Redstone Arsenal will also develop further strategies for management actions once the USFWS publishes a conservation plan for the species.

Price's Potato Bean (Apios priceana) – Threatened

Description. Price's potato bean is a member of the pea family (Fabaceae). One of only two members of this genus, Price's potato bean is an herbaceous perennial vine from a single, thickened tuber up to 18 centimeter (cm) in diameter. The stem is twining, somewhat twisted, and appears to climb on any available structure. The compound leaves are alternate and odd-pinnate, having 5-9 leaflets. Three leaflets are often seen on early shoots, whereas in the fall 5-7 are more common. The leaflets are on petioles 3-5 mm long, and are broadly to narrowly ovate. At maturity the upper surface is yellow-green and reticulate. The lower surface is paler, puberulent and reticulate-veiny. Flowers are one or more in the axils of pale green bracts. The corolla is similar to many of the peas or beans, bearing at the lower edge a very narrow projecting lobe. The flower color ranges from brownish green with maroon tints to bright pink, bearing at its tip a thickened mucro-like appendage (USFWS, 1993).

Price's potato bean images from Redstone Arsenal, Alabama.
(A) Tuber exposed by erosion; (B) inflorescences with open flowers; (C) maturing legumes.

Distribution. Price's potato bean is found in the physiographic provinces of the Coastal Plain, the Interior Low Plateaus, and the Appalachian Plateaus (USFWS, 1993). It is known from less than 30 populations in Mississippi, Kentucky, Tennessee, and Alabama. It was last seen in the state of Illinois in 1977 and is now presumed extirpated. The USFWS listed the species in 1990 as threatened due to the downward trend displayed by the loss of a number of populations. The major threats to populations are destruction of habitat and its low reproductive potential (USFWS, 1993). When the recovery plan for Price's potato bean was published in 1993, the RSA population had not been discovered. Price's potato bean was found on RSA during the 1994-1995 T&E flora and fauna survey conducted under contract by ALNHP (Godwin and Hilton, 1995). At that time, the ALNHP documented populations on seven sites on Madkin Mountain and a total population of over 200 plants. This site is a northeastern facing slope with plants extending beyond the clearing into the surrounding forest. Common woody plants at this site include fragrant sumac (*Rhus aromatica*), American beautyberry (*Callicarpa americana*), cedarglade St. Johnswort (*Hypericum frondosum*), eastern redcedar, Carolina buckthorn (*Frangula caroliniana*), Ohio buckeye (*Aesculus glabra*), shagbark hickory (*Carya ovata*), chinquapin oak (*Quercus muehlenbergii*). Common herbaceous plants at this site include American bellflower (*Campanulastrum americanum*), Cumberland rosinweed, whiteflower leafcup, woodland pinkroot (*Spigelia marilandica*), trumpet creeper (*Campsis radicans*), American hogpeanut (*Amphicarpaea bracteata*), and giant cane (*Arundinaria gigantea*).

In 1997 another large population was found on Monte Sano Mountain, some 13 kilometer (km) east of Redstone (Figure 4.11). There is a population on Rainbow Mountain in Madison, AL and one in Blevin's Gap in Huntsville, AL. Sauta Cave National Wildlife Refuge, approximately 40 miles east of RSA in Scottsboro, AL, also has a Price's potato bean population. The RSA population is among the largest populations of this species in Alabama with over 2,000 individuals and is possibly the most protected population.

Management. Prior to their discovery in 1995, the Price's potato bean population found along the Gray Road extension and the power line had been subject to bush hogging and line clearing activities. The Weeden-Madkin Mountain ESA has since been designated as an Ecologically Sensitive Area for this species. Regular growing season mowing of this area was stopped and a gate was installed on the access road about 100 m from the plants. Another gate was installed further up Madkin Mountain to keep maintenance vehicles off the trails which lead to the power line. These actions have significantly reduced signs of disturbance, mostly from illegal trash dumping and trampling of plants near footpaths. The power line and road are now maintained during the winter when the plants are dormant. This decreases the intrusive vegetation that competes with the seedlings.

While Madkin and Weeden Mountains once were used for military training, the training was restricted to land navigation and orienteering which involved mostly foot traffic. This type of training was compatible with protection for Price's potato bean, but for the most part it has ceased.

Once training ended, both consumptive (hunting) and non-consumptive (mountain biking, hiking) recreational trail use on the mountains has become popular. The USFWS has agreed with the EMD that mountain biking and hiking on trails where Price's potato bean may be on or near that recreational use may impact but will not likely adversely impact the protected species. The use of motorized recreational vehicles (e.g., ATVs, dirt bikes) is prohibited on RSA. A standard operating procedure for trail maintenance is in place with the USAG-Redstone, defining maintenance activities and requiring their coordination with DFWMR prior to action, in order to further reduce impact potential.

Monitoring. Monitoring data indicates that the *Apios priceana* population on Madkin Mountain is increasing and remains one of the largest populations in Alabama. In 1997, 21 vines were recorded along the Gray Road extension. In 2008, nearly 100 vines were reported. However, much of the initial monitoring of other Redstone populations were conducted as representative samples from what were discernable patches along the power line. Over the last several years, those groups of plants have increased in number and vigor such that they now overlap and are no longer discernable as individual patches. It also appears that the plants are slowly colonizing the wooded areas adjacent to the Madkin power lines, roads, and trails. Using global positioning system (GPS) and GIS technology, the populations have been well mapped. While updating the planning level survey for sensitive species and habitats (ALNHP in-progress, 2019), qualified botanists have thoroughly investigated the mountains on RSA and have found no additional populations of Price's potato bean.
EMD contracted with USGS Alabama Cooperative Fish and Wildlife Research Unit at Auburn University in 2010 to complete an intensive, multiyear study reproductive ecology research,

pollination biology, and seed biology and collection and vegetative propagation for ex situ preservation. The project has provided RSA and USFWS valuable information regarding basic ecology of the species and ex situ propagation and seed banking (Boyd, 2014), all of which were listed in the recovery plan. Though the project was affected by drought, discoveries included: 1) larger plants are more likely to be reproductively active; 2) high juvenile plant mortality; 3) reproductive attrition is very high with most flower buds failing to produce flowers and most flowers failed to produce either initiated or mature fruits; 4) rainfall is a major factor influencing reproductive success in *A. priceana*; 5) plants rely on cross-pollination for reproduction; 6) visits by medium to large pollinators are necessary for pollination; 7) no single bee species is responsible for pollination in Price's potato bean; 8) pollen limitation affects seed production; 9) post-dispersal predation levels are not high; and 10) ex situ collection and propagation techniques that do not harm the existing plants were established for any future work on the species.

In addition, in 2011 and 2012 Redstone Arsenal agreed to the Center for Plant Conservation proposal to collect seeds from our Price's potato bean population as part of a DoD Legacy funded project. It had been determined that there were no ex situ seeds from our population even though ex situ propagation was part of the Recovery Plan. Unfortunately due to drought conditions, the RSA population had very poor seed production that year. Instead, EMD aided the collection of seeds from the other locations in Madison County, Alabama. Fortunately, seeds from the Auburn University study were accepted by the Center for Plant Conservation from its partner the Atlanta Botanical Garden who facilitated price's potato bean propagation during the project.

Conservation Goals. The primary conservation goal is to continue to protect the existing population of Price's potato bean on RSA. This species thrives in openings that lack major disturbances; however some maintenance of the road and power line is necessary to maintain an open canopy and to discourage weedy competitors. Any vegetation maintenance in this area is carried out in the winter and without the use of heavy equipment that could disturb the dormant plants. Invasive species such as tree of heaven (*Ailanthus altissima*) and bush honeysuckle (*Diervilla* spp.) is controlled in adjacent areas to prevent infestation in the Price's potato bean population. Protection of the pollinator populations is critical for seed production.

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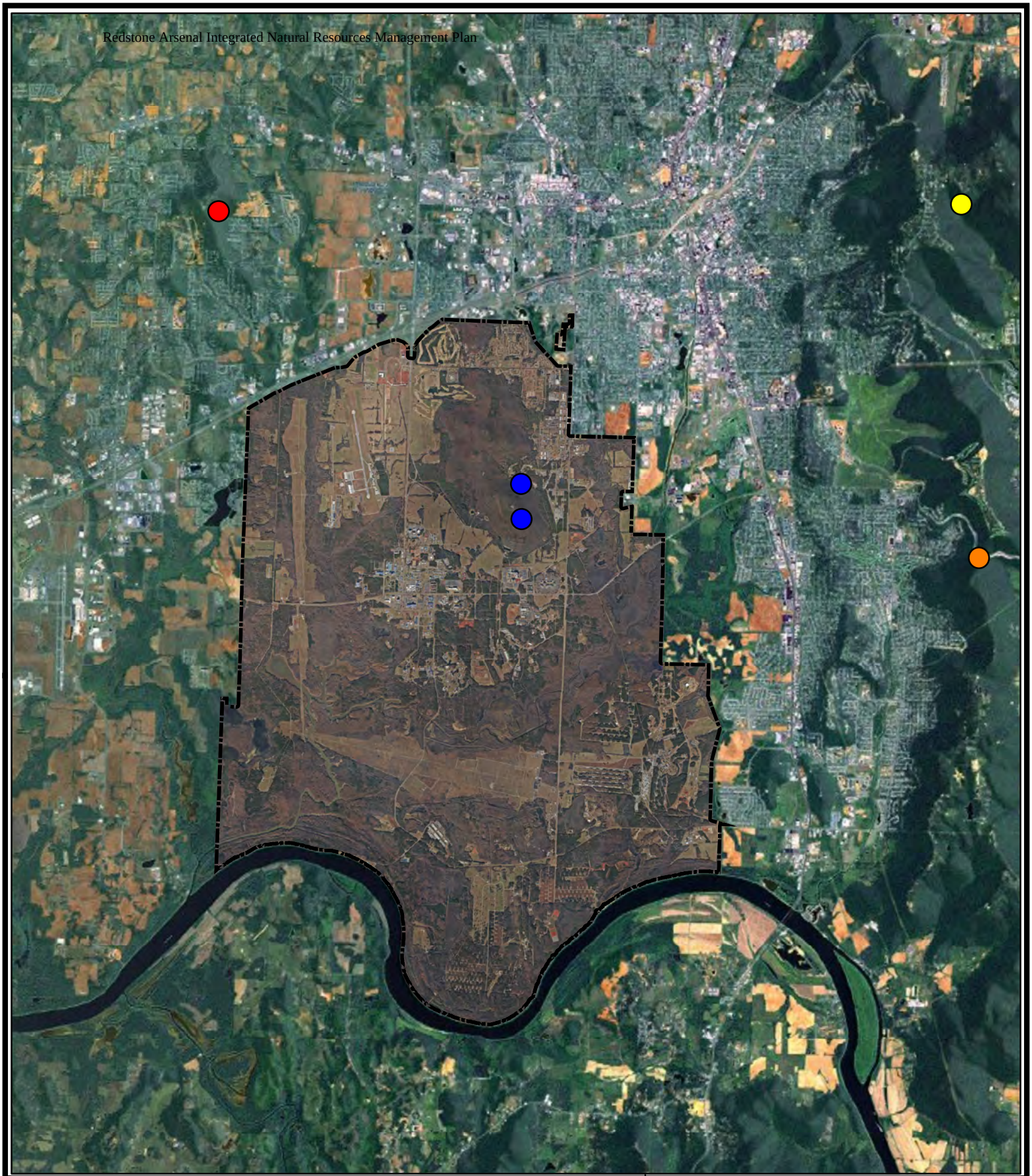
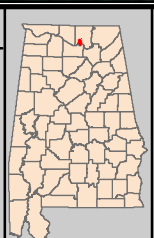


Apios priceana Locations - Figure 4.11

- Rainbow Mountain
- Blevins Gap
- Monte Sano
- Redstone



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Miles

1:125,000

Map Projection: Transverse Mercator
Horizontal Datum: North American Datum 1983
Grid Coordinate System: State Plane Coordinates, Alabama East
Planar Distance Units: Survey Feet (U.S.)

Date Saved: 2/27/2015 11:10:24 AM

Classification: Unclassified Limited Distribution

Map Author: Lawrence Crawford
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For official use.

Directorate of Public Works
Environmental Mgt
US Army Garrison - Redstone
Redstone Arsenal, AL 35898

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American Alligator (*Alligator mississippiensis*) – Threatened

Description. The American alligator is a large reptile with a broadly rounded snout. Adults are six to 12 ft long and can reach lengths of 15 or more feet. They are blackish in appearance, but have pale cross-bands on the back and vertical markings on the sides.

The American alligator has made a tremendous population comeback in past decades and as a species was removed from Federal listing. However, some related animals, such as several species of crocodiles and caimans, are still imperiled. For this reason, the USFWS lists the American alligator as threatened and regulates the legal trade in alligator skins, or products made from them, to protect endangered crocodile and caiman species with skin that is similar in appearance (USFWS, 1987).

Distribution. Alligators range through the coastal plain of the Carolinas, Georgia, and Florida, west to Texas. In Alabama, the alligator once spread as far north as the Fall Line, but is now most common in swamplands and backwaters along the coastal regions of Alabama. The population on RSA and Wheeler National Wildlife Refuge was introduced in 1980. Several alligators can be seen during the spring in the swamps and open waters of RSA. In their normal breeding range, up to 40 eggs might be laid by a female, often in nests of rotting vegetation. However, alligators in the northern area of Alabama may not grow and reproduce at the same pace as those in the southern range. Nests have been found on RSA and newly implemented spotlight surveys tentatively documented young in October 2016. The presence of these hatchlings could not be confirmed during daylight hours but the positive identification of young alligators on Wheeler National Wildlife Refuge makes it likely there is a breeding population on RSA.

Management. No active management of this species will occur on the Installation except to protect wetlands and riparian areas, which are the primary habitat of this species. Management is accomplished through existing wetland, NEPA, and environmental project review programs as well as the management of the Huntsville Spring Branch and Bradford Sinks-Swan Pond Ecologically Sensitive Areas. Hunting of alligators is not permitted on RSA. Nuisance incidents are managed per Alabama DCNR's guidance.

Monitoring. Sightings are recorded upon occurrence.

Conservation Goals. Protection of the Huntsville Spring Branch and Bradford Sinks-Swan Pond Ecologically Sensitive Areas, which serve as corridors, feeding, or nesting sites, is the primary method of conservation for the American alligator on RSA.

Whooping Crane (*Grus americana*) – Threatened

Description. The Whooping Crane occurs only in North America and is North America's tallest bird, with males approaching 5 ft tall and a wingspan of 7-8 ft (Walkinshaw, 1973). Adults have a red patch on forehead, black mustache and legs, and their black wing tips are visible in flight. Juveniles have cinnamon-brown feathers. The common name "whooping crane" probably originated from the loud, single-note vocalization given repeatedly by the birds when they are alarmed. Whooping cranes are a long-lived species; estimates suggest a longevity in the wild of 25 years (Urbanek and Lewis, 2015). Whooping cranes are omnivorous (Walkinshaw, 1973), probing the soil subsurface with their bills and taking foods from the soil surface or vegetation.

Distribution. Though this bird remains an endangered species, it has rebounded from a low of just 15 cranes in the 1940s to about 600 today. It was declared Endangered in 1970 by the USFWS and then an experimental population (Eastern Migratory Population) was established in the eastern US in 2001. Members of this population overwinter on RSA, utilizing mudflats and wetlands onto TA-1 and TA-6 which occur within WNWR boundaries (Figure 4.12). Whooping Cranes in the experimental population that occur outside of National Refuges or National Parks have been determined by the USFWS to be part of a nonessential population. As part of the eastern migratory population, and since these birds are located within National Wildlife Refuge boundaries, these birds are protected as a threatened species and consultation requirements of Section 7 of the ESA apply (50 CFR Part 17). The Whooping Crane breeds, migrates, winters, and forages in a variety of habitats, including coastal marshes and estuaries, inland marshes, lakes, ponds, wet meadows and rivers, and agricultural fields.

Management. Protection of foraging habitat (swamps, sloughs, open water fringes, mudflats, and saturated emergent wetlands) is important for a diversity of aquatic insects and vegetation upon which the Whooping Crane depends. Protection of water quality will occur with retention, whenever possible, of forests surrounding the known foraging areas. Construction BMPS will be utilized for any mission essential projects that occur within the foraging area. Existing wetland, NEPA, and environmental project review programs will also aid in management, to assess impacts to migratory populations during Redstone mission activities. Test Area tenants, the USAG-Redstone, and the USFWS have a mutually agreed upon protocol in an effort to avoid adverse impacts to the Whooping Crane as a result of test area missions. The protocol requires daily observances of test areas during the normal overwintering period (roughly November 1 – March 31), reporting any observances to the EMD, and suspense of testing activities if possible. If not possible, the cranes will be sensibly flushed. The EMD will report observances to WNWR.

Monitoring. Since the Whooping Cranes began using RSA in 2013, we have cooperated with Wheeler National Wildlife Refuge and its partner Organizations (Saving Cranes, Friends of Wheeler National Wildlife Refuge, International Crane Foundation) on access and telemetry. RSA will continue to accommodate all partner organizations.

Conservation Goals. Goals for Whooping Cranes on RSA include continuing to cooperate with Whooping Crane partner Organizations and provide suitable habitat for the Whooping Cranes to utilize when on RSA/Wheeler National Wildlife Refuge.

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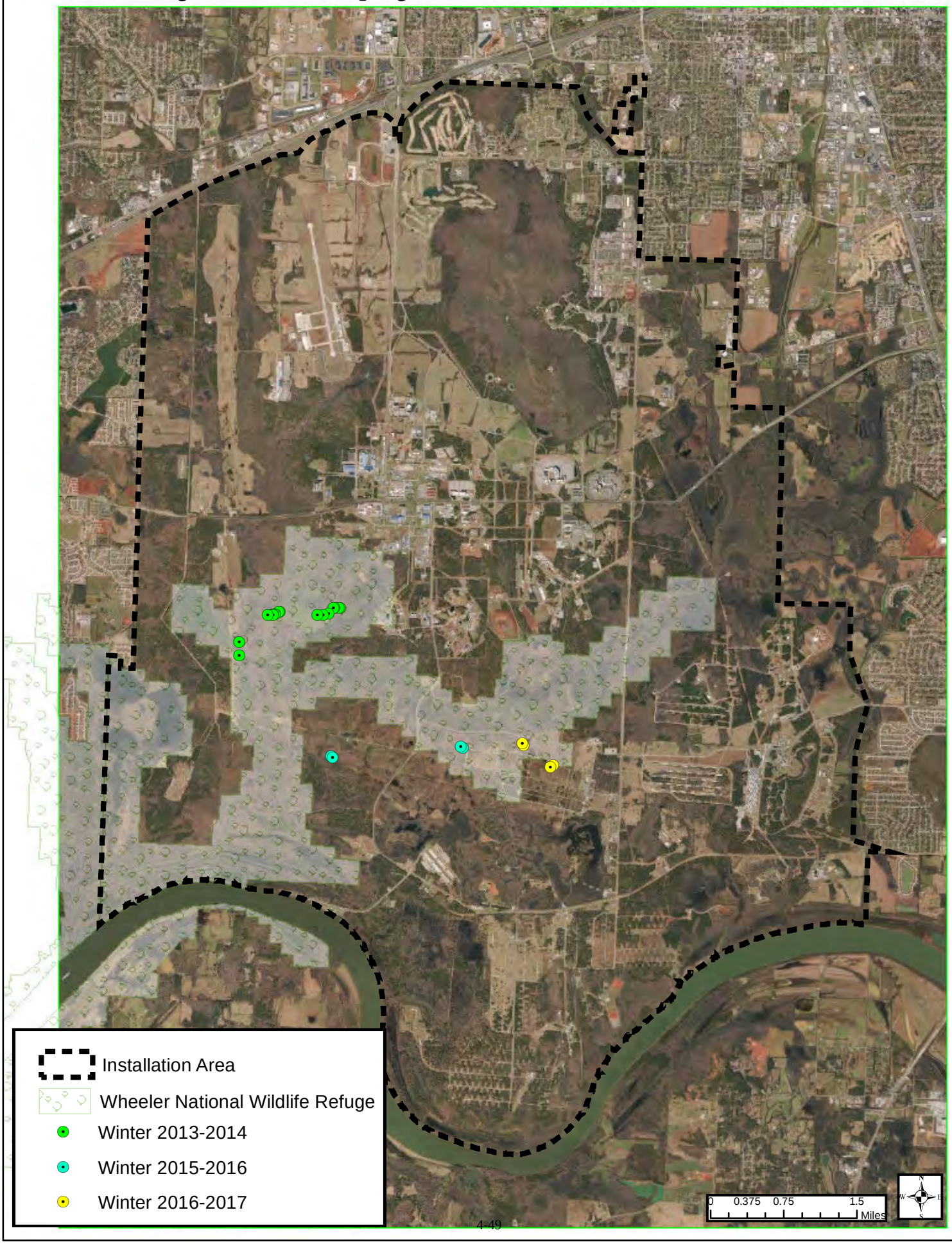
Figure 4.12. Whooping Crane Locations on Redstone Arsenal



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Tricolored Bat (*Perimyotis subflavus*) – Petitioned for Listing

Description. One of the smallest bats in North America, the tricolored bat weighs 0.1-0.3 ounces, with a wingspan of 8-10 in (Fujita and Kunz, 1984 and Harvey *et al*, 1999). Its fur is yellowish-brown however, when examined individually, is brown at the tip, yellow in the middle, and dark at the base ("tricolored"). This bat's forearm skin is reddish; it has long, oblong ears with a short and blunt tragus. The tricolored bat feeds on small insects and forages over waterways and at forest edges (Fujita and Kunz, 1984). *Perimyotis subflavus* hibernate in caves, mines, and other man-made structures, roosting often singly rather than in clusters. Summer roosts can be variable and include man-made structures and caves but most likely occur in tree foliage.

Distribution. The tricolored bat's range includes much of the eastern North American and Central America, as well as in parts of the Midwestern US. Until the discovery of WNS in 2006, the tricolored bat was considered a common inhabitant throughout its range. Population numbers of this species have plummeted in a similar number as northern long-eared bats and little brown bats (*Myotis lucifugus*). Other threats to their populations include loss of roost and foraging habitat, toxicity from pesticides and other contaminants, climate change, and collisions with vehicles, buildings, and wind farms. The tricolored bat was petitioned for listing under the ESA in June 2016.

Management. Management actions for tricolored bats are essentially similar to those for gray, Indiana and northern long-eared bats. Actions include focusing on protection of forested and riparian habitats for roosting. Tricolored seem to prefer roosting in tree foliage of live trees rather than cavities or under bark of dead trees like these other two species. Protection of foraging habitat is also an important management action, to provide for a diversity of insects upon which the bats depend. On RSA, all forested wetlands and 100-year floodplain have been identified as environmentally restricted areas for planning purposes in the 2014 RSA Real Property Master Plan.

Management of WNS on RSA consists of cooperating in the efforts to prevent its spread. DoD is a member of the White-nose Syndrome National Plan team. RSA utilizes the most recent USFWS Decontamination Protocol when entering caves bats and when netting or trapping for bats. Cave access is restricted from use except by RSA environmental personnel with a need to enter. RSA participates in the Alabama Bat Working Group, a partnership of state, federal, and nongovernmental organizations dedicated to the study and protection of bats in Alabama. Bats also are included in our educational programs to children and adults (Earth Day Celebration, Madison County Drinking Water Festival, Wetland Tours, etc.).

Monitoring. An Installation-wide bat survey that was completed in 2007 by Auburn University (Gardner, 2008) reported that tricolored bats associated more frequently with wetland/riparian areas and deciduous forest. Captures from both acoustic detection and mist nets were documented across the Arsenal during that project. During the 2014 Alabama Bat Blitz hosted by

EMD, tricolored bats were acoustically detected at a number of monitoring sites across the Installation while only one was captured in a net in a forested riparian area.

Another Installation-wide bat survey was conducted by Copperhead Environmental Consulting, Inc. in 2016 to specifically investigate the ecology of Indiana and northern long-eared bats. *Perimyotis subflavus* were captured in mist nets as well as acoustically detected across the Installation landscape. Transmitters were affixed to two male individuals however one was not located after capture, likely due to transmitter failure. The remaining male was tracked to a diurnal roost for eight days, in the vicinity of capture (riparian woodland). The bat returned to the same dead leaf clump to roost for 7 of those days. The majority of time that this bat spent foraging was in woody wetlands. No tricolored bats were captured during the 2019 installation wide survey (Copperhead, 2019).

Caves are monitored annually for bats; there have been a few instances of single tricolored bats roosting in Matthew's Cave in the past (most recently the winter of 2016). Caves will continue to be monitored annually. The 2016 Copperhead survey also investigated a number of earth-covered magazines for evidence of bats during the winter. However, the temperature and lack of airflow through these structures likely precludes the inhabitance by tricolored bats. Installation-wide bat surveys may be planned every five years, depending on funding availability.

Conservation Goals: Conservation and management of suitable roosting and foraging habit on Redstone Arsenal as well as public education will continue. By following the USFWS Decontamination Protocol when appropriate, RSA will ensure that it does not contribute to the spread of WNS. Education of the public also will contribute to the understanding and promotion of bat conservation. Redstone Arsenal will also develop further strategies for management actions as the listing process continues.

Golden-winged Warbler (*Vermivora chrysoptera*) – Under Review for Listing

Description. The Golden-winged Warbler is a small-sized passerine, weighing 0.31 ounces. Total body length is 4.75 in, with a wingspan of 7.5 in (Sibley, 2000). Diagnostic features include slate gray plumage on the chest, breast, nape and mantle, with contrasting yellow patches on the upper wing coverts (sets of small feathers that cover the upper wing area) and crown. The diet of the golden-winged warbler consists of small bugs, larvae, and spiders. The Golden-winged Warbler was petitioned for listing in 2011 and the USFWS determined that a status review is necessary. This is currently underway.

Distribution. The Golden-winged Warbler is a neotropical migrant, breeding in North America and wintering in Central and South America. Golden-winged Warblers breed across the north-central and eastern United States, expanding into southeastern Canada. For breeding sites, the Golden-winged Warbler depends mostly on early successional habitats. These are habitats that have previously undergone an amount of disturbance by a natural or human-caused event that creates a structurally diverse landscape. Landscapes that consist of forest edge, shrubs, forests with open canopy, habitats with grassy openings, and wetlands with scattered trees can be viable nesting habitats. Populations have been declining across its range since the 1960s.

Management. Habitat loss and modification are identified as the main causes of population declines. The species is dependent on early successional habitat, which also has been on the decline due to reforestation and urban development. In addition, the species is being displaced by the Blue-winged Warbler and nest success is being impacted by the Brown-headed Cowbird. If compatible with other goals in the INRMP, we will continue to increase availability of early successional habitat for the species on RSA (see Native Warm Season Grass (NWSG) Management Plan).

Monitoring. The 2008 Breeding Bird Survey by Auburn University ((Best *et al.*, 2010; Ortman, 2012) found Golden-winged Warblers in one location on the Installation. The Carrol D. Hudson recreational area, bounded by the Tennessee River on the south and Tupelo Swamp on the north, held a breeding pair. This area should remain early successional due to its continued recreational use. In addition, we are improving early successional habitat at the Path to Nature, located adjacent to the tupelo swamp.

Conservation Goals. To promote the conservation of the species and its habitat on RSA. Once listing status is determined, RSA will develop strategies for following actions identified in the Recovery Plan.

Monarch Butterfly (*Danaus plexippus*) – Under Review for Listing

Description. The Monarch (*Danaus plexippus*) is a large butterfly, approximately 3 ½ to 4 in long (Pyle, 1981). It is cinnamon-orange with black veins and white dots (Brock and Kaufman, 2003). The veins on the wings of the female are smudged (Pyle, 1981). The Queen, Soldier, and Viceroy butterflies are similar in appearance to the Monarch. The Viceroy is known to mimic the Monarch in appearance to avoid predation by birds, which avoid the Monarch because poisonous chemicals produced by the ingestion of milkweed by the caterpillar are distasteful (Opler and Malikul, 1998). The life cycle of the Monarch includes a pale green egg, an off-white caterpillar, up to 2 in long, with black and yellow stripes, and a pale green chrysalis just under an inch long before emerging as an adult butterfly (Pyle, 1981).

Distribution. The Monarch can be found in much of North America, in open habitat from Canada to South America. Monarchs are known for their annual migration and is the only butterfly to regularly migrate north and south (Pyle, 1981). Monarchs in central and eastern North America migrate to the mountainous forests of central Mexico while those in the western portions of North America migrate to the California coast. Monarchs in southern Florida, Texas, and Hawaii are non-migratory (Brock and Kaufman, 2003). Individual Monarch butterflies do not make the round-trip migration. Rather, they breed along the way and by instinct only the offspring return to the northern habitat (Pyle, 1981).

Management. Managing for this species includes the current ecosystem-based management program and is accomplished through existing project review and NEPA processes. National Public Lands Day grants and events are allowing the EMD to plant small pollinator gardens and test plots for pollinator habitats If compatible with other goals in the INRMP, we will continue to increase availability of early successional habitat, as well as wildflower mixes, for the species on RSA (see Native Warm Season Grass (NWSG) Management Plan).

Monitoring. No monitoring programs exist at this time.

Conservation Goals. To protect and preserve Monarch butterfly habitat.

Tuscumbia Darter (*Etheostoma tuscumbia*) – Under Review for Listing

Description. This small fish (1.4 to 2.5 in) is characterized by heavy scalation on the top of the head, a short snout, small mouth, and well developed frenum (the fleshy bridge on the upper edge of the snout) (Mettee *et al.*, 1996). The back and sides have small blotches along the midline. Both sexes are olive with goldbrown spots. Orbital bars are present as well as a distinct bar at the base of the caudal fin. The fins are mostly clear, with weak banding. The Tuscumbia darter is a Federal species of concern, an Army Species-at-risk, and has been petitioned for listing under the ESA.

Distribution. This species is endemic to the Tennessee River drainage, and is represented by several widely scattered populations restricted to vegetated limestone springs within the Highland Rim and is uncommon throughout its range. The first population discovered on RSA was at William's Spring.

William's Spring is in the forested floodplain of Indian Creek, which forms a large complex of wetlands and associated bottomlands. Huntsville Spring Branch is a downstream tributary of Indian Creek, and the two bottomland and wetland complexes form an important habitat corridor through RSA. The fact that this spring is in the midst of contiguous bottomland and upland forested areas is important to many aspects of its water quality and is unique because undisturbed springs are increasingly rare in karst regions.

Godwin (1999) presents a detailed description of William's Spring; the mean annual flow is five cubic feet per second (cfs) and ranges from 2.7 to 10.5 cfs. The main pool is about 30 m long and 5-7 m wide, with a pool depth ranging from less than 0.5 to 2.0 m. The spring run is approximately 3-5 m wide and 10-12 m in length, at which point it flows into a drainage ditch and then into Indian Creek. The substrate in the spring run is composed of sand and very fine gravel with patches of submersed aquatic vegetation, water starwort (*Callitriche* sp.), watercress (*Nasturtium officinale)*, marsh seedbox (*Ludwigia palustris*), liverworts, and several aquatic mosses, important for cover from predatory fish such as bass. Canopy trees around the spring include water tupelo, sugar maple (*Acer saccharum*), and river birch. Aquatic fauna includes banded sculpin (*Cottus carolinae*), bluegill (*Lepomis macrochirus*), largescale stoneroller (*Campostoma oligolepis*), black darter (*Etheostoma duryi*) and various gastropods.

Management. Management is accomplished through existing wetland, NEPA, and environmental project review programs, as well as the management of the relevant Ecologically Sensitive Areas. This includes beaver control to prevent excessive ponding of the spring. Excessive ponding would alter the habitat and allow proliferation of predatory fish species and probably reduction of Tuscumbia darter populations.

Monitoring. Monitoring of the Tuscumbia darter and water quality of William's Spring is conducted annually through our partnership with GSA. Populations in Williams Spring fluctuate annually but have remained stable overall.

Unfortunately, many of the historic populations in the Tennessee River drainage seem to have been extirpated. It appears that RSA is an important holdout of the species so continued protection of their habitat here is imperative. In 2011, RSA partnered with GSA to perform a long-term Installation-wide survey and historic location survey, as part of a larger GSA study in north Alabama. This project concluded in December 2015 and yielded many new subpopulations of Tuscumbia darter on RSA.

Due to the presence of the additional subpopulations throughout portions of Indian Creek and associated springs; the USFWS review of the species for listing under the ESA; and the need to maintain water quality, the original William's Spring ESA was expanded in 2015 and renamed Indian Creek ESA. The unnamed tributary east of Indian Creek and north of William' Spring, portions of Indian Creek itself, and a wetland complex east of Indian Creek entail the expanded ESA. Water quality of the area will be maintained by forest retention at least 80 ft from the high water line; construction BMP's when mission critical development occurs; and beaver control when deemed appropriate.

A cooperative agreement between RSA EMD and GSA was formed in 2019, to conduct a delineation of the watershed that feeds into Jaya Spring, and eventually into Indian Creek. The goal of this work is to define BMPs for the heavy development occurring north of the spring. It is anticipated that BMP definitions for this area will also be applicable to the development impacting Bobcat Cave.

Another newly discovered subpopulation in a wetland complex associated with McDonald Creek will be protected with the same measures. However, much of the northern and southern boundaries of the wetland complex has been early successional habitat for decades as part of one of the Installation's main power line corridors. Properly maintained early successional habitat also can protect water quality, so we are not concerned with this difference in habitat.

Conservation Goals. To protect and preserve the Tuscumbia darter populations and Indian Creek and McDonald Creek ESA through water quality protection. RSA will continue annual monitoring of William's Spring population and begin annual monitoring of other subpopulations where appropriate and as funding allows. Annual monitoring will detect changes in populations so that cause can be identified and corrected. Also, long-term population trends can be beneficial to the overall knowledge of the species.

Green Salamander (*Aneides aeneus*) – Under Review for Listing

Description. The green salamander is a medium-sized (5.5 in), lungless, terrestrial salamander of the Plethodontidae family. The dorsum is dark brown or gray with metallic greenish or yellow green mottling, resembling the color of lichens on tree bark or wet rock. The belly is light yellow to white and unmottled (Mount, 1975; Petranka, 1998). The head is flattened and broader than the body in adults while the tail is rounded and the same length or slightly longer than the body. The toes end in distinctly squared toe pads with light to moderate webbing between the digits. Reproductive males have a mental (chin) gland lacking in females. Sexual maturity is not reached in either sex until the third year (Canterbury, 1991).

Distribution. The green salamander range extends from Pennsylvania South to Georgia and from North Carolina West to Mississippi. Subpopulations that are isolated, disjunct, or at the periphery of the range tend to be threatened or declining. Since Alabama represents the southern limits of its distribution, its populations may be more sensitive to habitat alteration. In Alabama, the green salamander is found in the Cumberland Plateau and the Highland Rim provinces. The salamander occupies crevices in cliff faces, rock outcrops, and caves in shaded, mesic hardwood forests, where the crevices are moist but not permanently wet. It is occasionally found in trees, under fallen tree bark, or in rotting logs and stumps. The species is locally scarce throughout the region due to habitat loss, reduction of habitat suitability, chemical threats, and possibly over collection. On RSA, the green salamander has been observed within the Bell Bluff Ecologically Sensitive Area and in areas with well-shaded rock outcrop features in TA-5 (Rebecca John, pers comm). The dominant community type within the Bell Bluff Ecologically Sensitive is oak-hickory-eastern red cedar forest.

Management. Bell Bluff is an Ecologically Sensitive Area due, in part, to the presence of the green salamander. In addition, Natural Resources personnel continue to monitor known green salamander populations and increase efforts to identify populations and eliminate impacts to the species from loss of habitat and habitat suitability on RSA. Silvicultural practices such as clear-cutting or replacement of hardwoods with faster growing pines will not occur within 100 m of identified populations. Construction of roads and other large corridors adjacent to emergent rocks and outcrops, as well as removal of trees that shade rock outcrops can result in an increase in airflow and greater insolation thus increasing temperatures and decreasing moisture (Cline, 2009). Collection of individuals is restricted to research and is regulated by state permit.

The main management recommendation is prevention of further development and/or fragmentation of the forest surrounding rock outcrops. Maintenance of service roads and existing buildings should be performed with minimal impact on the surrounding environment. Disturbed areas outside the natural areas could be restored or, at the very least, serve as a buffer around the existing forest (Godwin and Hilton, 1995). These areas should not be timbered, which would result in excessive opening of the forest canopy with a concomitant rise of surface temperature

and reduction in ambient humidity. A localized increase in long-term temperatures and decrease in humidity would be detrimental to this arboreal, terrestrial species of salamander which is dependent upon the cool, shaded rock exposures, cracks, crevices, and fissures of rock outcrops (Godwin and Hilton, 1995; Petranka, 1998).

Monitoring. A survey of macro- and microclimate habitats for green salamanders (Vaughan, 2009), coupled with the current petition for listing under the ESA, prompted the need for a more comprehensive study at Redstone Arsenal to evaluate salamander occupancy. A three year survey of the northern mountainous areas and southern bluff habitats, as well as other locations indicated as appropriate habitat by the USGS National Gap Analysis Program, began in 2015. It was intended to determine presence of green salamanders in these areas and develop an occupancy model specific to RSA. In addition, this study was combined with work at the Bankhead National Forest in an effort to examine movement patterns such as crevice use, arboreal habits, microhabitats, genetics and influence of biotic factors in this part of their range.

This research project optimized detection probability and provided insight of green salamander occupancy at RSA, showing that the shorter, more scattered rock outcrop habitat on the Arsenal is unique from traditional habitat in other areas of their range (large rock escarpments and cliffs). Rock characteristics, such as rock height and percent rock cover, proved to be important for occupancy probability. It was determined that the bluff areas of Redstone could possibly provide over 80 acres of occupied green salamander habitat (John, 2017).

Conservation Goals. To protect and preserve *Aneides aeneus,* the Bell Bluff Ecologically Sensitive Area, Adam's Cave, and other potentially suitable habitat through forest management, occupancy probability, and protection of newly discovered populations.

Bald Eagle (*Haliaeetus leucocephalus*) – Delisted from ESA, Bald and Golden Eagle Protection Act

Description. The Bald Eagle is a large raptor (31 in) with a wingspan of about 80 in (Sibley, 2000). It has dark brown plumage, except for the pure white head and tail in the adults. Juveniles are dark brown to nearly black, sometimes with a mottling of white under the tail, belly, and underwings.

Distribution. The Bald Eagle is found throughout North America from Northern Alaska and Canada South to Southern California and Florida. Most nesting in the southeast occurs in three primary areas: peninsular Florida, coastal South Carolina, and coastal Louisiana with sporadic breeding in the remaining southeastern states. In Alabama, Bald Eagles were hacked in the Mud Creek-Lake Guntersville area and many return to the area to nest.

Bald Eagles are found near open water, specifically lakes, large rivers, impoundments, and coastal bays. They prefer large trees for roosting that provide an open flight line and line of sight to the feeding areas. Bald Eagles are opportunistic predators and scavengers, feeding on a variety of foods including fish, birds, mammals, and turtles. The eagle usually mates for life. Breeding in the Southeast tends to begin in September with nesting activities generally beginning in early September. Egg laying begins as early as late October and peaks in late December.

On RSA, most sightings have been, and are expected to continue to be, around the lower reaches of Huntsville Spring Branch and Indian Creeks (particularly at their confluence), the Tennessee River, and the Bradford Sinks-Swan Pond Ecologically Sensitive Area. There are several old/abandoned nests along the Tennessee River, between RSA's boundary fences. The ALNHP documented an active nest in a large pine tree near Bradford Sinks in 2018 (A. Schotz, pers comm).

Management. Management is accomplished through existing wetland, NEPA, and environmental project review programs, as well as the management of the Huntsville Spring Branch and Bradford Sinks-Swan Pond Ecologically Sensitive Areas.

Monitoring. Annual nest surveys are conducted on the southern boundary of RSA along the Tennessee River by ADCNR. Upon discovery, active nests will be protected with the required 200 m buffer zone of restricted activities (USFWS, 2007).

Conservation Goals. To protect and preserve potential Bald Eagle habitat and nests.

Harper's Umbrella Plant (*Eriogonum longifolium* var. *harperi*)

Description. Harper's umbrella plant is an herbaceous biennial in the buckwheat family (Polygonaceae). Stems emerge from a strong, woody taproot into a slightly spiral basal rosette. The leaves are dark green on the upper surface and creamy white and densely tomentose on the lower surface, with a prominent central vein. The basal leaves are the longest (3-4 decimeter (dm)), progressively decreasing in size upward along the stem. The inflorescence develops in the second year or later, growing to a height of 1.5-2.5 m, with small pale yellow flowers on densely branched cymes from July to August. The plant dies after blooming, but the dried inflorescence persists until the following year. The fruit is a 3 winged utricle with reddish brown seeds (Kral, 1983).

Distribution. *E. longifolium* var. *harperi* is known from 11 sites in the southeast. It occurs on calcareous shale barrens, river bluffs, and limestone glades in Smith and Putnam Counties, Tennessee and in Franklin, Lawrence, and Madison Counties, Alabama. The RSA population is in the Lehman's Bluff Ecologically Sensitive Area below The Cliffs (formerly the Rustic Lodge) on a bluff of the Tennessee River. This location is the only known occurrence of Harper's umbrella plant in the calcareous cliff community of the Tennessee River, which is dominated by herbs and an eastern red cedar-oak-hickory community. Fire suppression and subsequent mowing to control vegetation has resulted in understory vegetation changes and competition from at least eight invasive species.

Management. General public activities near the plants are restricted by fencing. Interpretive signs have been placed at the lodge to inform guests of the importance of protecting the plants and personnel operating The Cliffs have agreed to help protect them (i.e., restrictions are included in lease arrangements). This species prefers an open canopy so management includes clearing of understory vegetation (native and invasive) and partial removal of upper canopy. Chemical control is used to target the invasive ailanthus as funding permits.

Monitoring. Largely because it is the only calcareous cliff population found on the Tennessee River and only 10 other sites are known, monitoring began in 1997 and continues regularly.

Conservation Goals. To protect and preserve Harper's Umbrella plant and Lehman's Bluff Ecologically Sensitive Area. Partners include TVA (this is TVA property), ALNHP and the USFWS because it is likely that this plant will eventually be listed under the Endangered Species Act.

Alabama Least Trillium (*Trillium pusillum* var. *alabamicum*)

Description. A member of the lily family, least trillium is a small (11-21 cm) rhizomatous perennial. The stem has 3 bracteole leaves, and 3 petals and 3 sepals on a single flower. The flowers bloom in March, and fruit forms in April and May. The varietal designation *alabamicum* is not an official taxon, but simply serves to distinguish it from two other members of the same species, from which it differs morphologically (Freeman, 1994; Timmerman-Erskine *et al.*, 2002).

Distribution. The plant occurs in wooded swampy habitats, usually in temporarily flooded/saturated wetlands. Populations are restricted to spring-fed areas, rather than areas of headwater flood scour and prefer areas of dappled sunlight. It is found in 12 locations in Alabama, five in Kentucky, one in Mississippi, one in North Carolina, and nine in Tennessee. On RSA, least trillium occurs in two locations, about 1,100 m apart, both of which occur in the Huntsville Spring Branch Ecologically Sensitive Area. The habitat is characterized by temporary flooding and mossy hummocks formed by wind thrown trees. This spring-fed and high groundwater community type is found on Melvin silty clay loam, which is the oldest soil type in North Alabama. Dominant canopy trees include cherrybark, willow (*Q. phellos*), swamp chestnut, and water oaks (*Q. nigra*); American beech, and red maple (*Acer rubrum*). Understory species are ironwood (*Carpinus caroliniana*), red buckeye (*Aesculus pavia*), possumhaw (*Ilex decidua*), and pawpaw.

Management. Martin Road bisects (East-West) a large tupelo swamp and constricts water flow to the south. The shorter hydroperiod established from the dam effect of the road has allowed the least trillium population to flourish, but also has increased populations of invasive plants such as Chinese privet and Japanese honeysuckle. When Martin Road was widened in 2001, approximately 130 stems were transplanted south of the road, on both the east and west sides of the existing powerline. In 2014, the powerline right-of-way was widened to 150’ and patches of trillium that were within the clear zone were relocated, again to the south. Herbicide is used along the riprap of the road edge however its use beyond that is restricted. The powerline is maintained by bi-annual mowing and no herbicide is used. No more encroachment into the woodline has occurred.

Water quality degradation from upstream and off-Installation threatens the least trillium. The City of Huntsville relocated its discharge from a sewage treatment plant north of the Installation directly to the Tennessee River, but years of by-passing the plant during floods may have left pollutants in the over bank areas around Huntsville Spring Branch (HSB). In an attempt to prevent trash carried in HSB from off-Installation, RSA has requested grates to be installed over drainage gates. Also, the City of Huntsville is increasing efforts for environmental education about non-point source pollution.

Monitoring. Annual monitoring of reproductive success is essential for management of this species; in 1997 ALNHP established a monitoring program using permanent plots (1 m^2) to observe small numbers of individuals scattered throughout the site. This method is useful for tracking the reproductive activity of a few individuals but it does not allow for statistical inferences regarding the overall population trends for least trillium on the Installation. Therefore, in 2004, new sampling grids were installed in the population South of Martin Road and flowering is monitored annually by natural resources personnel.

A multi-year, multi-purpose study with Auburn University began in 2016 in an effort to investigate population biology and impacts of vertebrate herbivores and EMD began receiving results in 2019, with implications that management actions for the Alabama least trillium may be re-evaluated beginning in 2020.

The powerline right-of-way and forest edge effects impact the least trilliums' life stage distribution and fruiting success. No seed bank is present beyond the two-growing-season period. And while deer herbivory is present at other least trillium sites, it was not detected as a threat to the plants on Redstone. Lastly, while the least trillium is able to produce seeds through self-pollination, insect pollination produces significantly more seeds (Swick, 2019).

Conservation Goals. To protect and preserve *Trillium pusillum* var. *alabamicum* and Huntsville Spring Branch Ecologically Sensitive Area through prevention of forest fragmentation and control of invasive species.

Ginseng (*Panax quinquefolius*)

Description. Ginseng is an herbaceous, perennial plant of the Araliaceae family. The roots are large, fusiform shaped and produce short rhizomes. Stems are glabrous, about 1-3 cm tall, and have 2-4 palmately compound leaves that occur in a whorl at the top of the stem. The leaflets are elliptical with serrate margins and the two leaflets closest to the petiole are smaller than the other three. The greenish yellow flowers occur in an umbel in the spring, and the bright red berries ripen early in the fall. Plants produce flowers and seeds when they are three years old (Hou, 1978).

Distribution. Ginseng ranges from Louisiana North to Quebec, Canada and from the Atlantic Ocean West to South Dakota. In Alabama, it is distributed in the rich woods of the mountains and Piedmont. The plant prefers the cool, moist habitats of North and East facing slopes and the shelter of humid coves. It is becoming locally scarce throughout the region due to over-collection and is regulated by state permit. On RSA, it occurs on Ward Mountain and possibly on Madkin and Weeden Mountains, all of which are characterized by upland limestone outcropping features (eroded remnants of the Cumberland Plateau). The dominant community type on Ward Mountain is oak-hickory-eastern red cedar forest.

Management. Ginseng is threatened by collection and many wild populations have diminished because of indiscriminate collection for the herbal medicine market. Several states have enacted legislation to protect the plant, including Alabama. The Alabama Ginseng Protection Act (Act No. 87-582) and the Alabama Department of Agriculture and Industries Ginseng Rules (Chapter 80-10-13) legislate guidelines for collection, sale, export, dealer registration and records, and monitoring of ginseng populations in the state. Ward Mountain is an Ecologically Sensitive Area due to the presence of ginseng. In addition, Natural Resources personnel continue to monitor ginseng populations and increase efforts to eliminate any harvest or collection on RSA. However, the most important conservation action may be increasing the level of awareness and enforcement effort by the Redstone conservation officer and grounds maintenance personnel.

Monitoring. No monitoring programs exist at this time.

Conservation Goals. To protect and preserve *Panax quinquefolius* and Ward Mountain Ecologically Sensitive Area through harvest prevention and protection of any new population.

Engraved Elimia *(Elimia perstriata)* – Under Review for Listing

Description. The Engraved elimia is a freshwater snail up to 10 mm in length. Its shell is conic with a tall spire and reddish interior. The Engraved elimia lives in springs and small streams with sand, gravel, or cobble substrate, but not silt. Little is known about the life history and ecology of this species, but it has a limited distribution and specific habitat requirements, and is sensitive to habitat changes associated with urbanization (Bogan, 2004).

Distribution. The Engraved elimia occurs only in northern Alabama, including Big Spring Branch and Indian Creek in Madison County (Bogan, 2004). A survey was conducted of freshwater mollusks and crayfish on and near Redstone Arsenal in 2008 and 2009 by GSA and ADCNR. During this survey the Engraved elimia was identified in McDonald Creek, Williams Spring, and Indian Creek (McGregor *et al.*, 2009).

Management. During all Installation Restoration remediation activities at McDonald Creek near Hanson Road, disturbance in the stream will be limited to foot traffic. Any snails encountered during restoration activities in the immediate vicinity will be relocated upstream to prevent crushing and exposure to sedimentation. General management includes maintaining clean aquatic habitats through standard construction best management practices, minimizing forest fragmentation and clearing that would contribute to erosion, and protecting and preserving the existing habitat.

Monitoring. No monitoring programs exist at this time.

Conservation Goals. To protect and preserve Engraved elimia habitat.

Species of Concern with Potential to Redstone Arsenal

The biodiversity of plants and animals in Alabama is so rich that the state ranks first among states east of the Mississippi in overall species diversity. Detailed planning level surveys for flora and fauna at Redstone Arsenal have been conducted in the past 20+ years, yet the possibility that even the most thorough of surveys can document every rare species on the Installation is not likely. This INRMP focuses primarily on the management of known federally designated or state protected species at Redstone Arsenal. A few examples of species with potential to occur within the boundaries follow.

Morefield's Leather Flower (*Clematis morefieldii*) – Endangered

Morefield's leather flower is a member of the buttercup family (Ranunculaceae); a vine growing up to 16 ft in length, it is known to grow near seeps on limestone slopes under mixed hardwoods, especially on rocky south/southwest facing mountain slopes. This species is endemic to Jackson and Madison Counties of Alabama, as well as in the Cumberland Plateau region in neighboring Tennessee (Davenport and Oberholster, 2015).

While updating the planning level survey for sensitive species and habitats (ALNHP in-progress, 2019), qualified botanists have thoroughly investigated the mountains on RSA and have found no populations of this endangered plant, however suitable habitat exists in several of RSA's Ecologically Sensitive Areas. Management actions and conservation goals that apply to both Price's potato bean and Harpers umbrella plant would also encompass this species and its potential habitat. Management is also accomplished through existing project review and NEPA processes. The current ecosystem-based management program promotes diversified habitats of grasses, mature forests, and forest openings; protects mountain and bluff ecologically sensitive areas; and educates the public.

Golden Eagle (*Aquila chrysaetos*) - Bald and Golden Eagle Protection Act

Golden Eagle is a large raptor with a wingspan averaging 2 m and dark brown plumage except for a golden crown and nape. Golden Eagles progress through three juvenile plumages that include white patches at the base of the tail and in the wings before developing adult plumage around four or five years of age. A booted eagle, the Golden Eagle has feathers on its legs to its toes (Clark and Wheeler, 2001).

Golden Eagles often nest on cliff faces or large trees (USFWS, 2011) and perch on rocks and utility poles (Crossley, 2011). Golden Eagles in the eastern United States hunt primarily in forests (Crossley, 2011). They typically hunt small mammals such as rabbits and squirrels, but may capture large birds, including Canada Geese,

and rarely take larger mammals such as adult coyotes and deer. Golden Eagles also feed on carrion and may associate with Bald Eagles in areas with high concentrations of waterfowl. Mated adult Golden Eagles may hunt in pairs (Clark and Wheeler, 2001). Nests are typically constructed on cliff faces or tall trees with unobstructed views away from urban and densely forested areas. Golden Eagles lay between one and four eggs in a season (USFWS, 2011).

The Golden Eagle is found worldwide; the North American subspecies is *Aquila chrysaetos canadensis* and is most common in western and northern hilly and mountainous areas (Clark and Wheeler, 2001), but is also found in grasslands and deserts (USFWS, 2011). Golden Eagles are present in the Appalachian Mountains as far north as Maine. Northern birds may move south in the fall and individuals have occasionally been found as far south as Florida in the winter (Clarkand Wheeler, 2001).

While no documented sightings have occurred on Redstone Arsenal, multiple camera trapping studies performed in North Alabama have successfully documented Golden Eagles in surrounding counties. Management for the Golden Eagle is accomplished through existing project review and NEPA processes. The current ecosystem-based management program promotes diversified habitats of grasses, mature forests, and forest openings; protects mountain and bluff ecologically sensitive areas; and educates the public. Redstone Arsenal was a long time participant of a regional survey with West Virginia University and the ADCNR for Golden Eagles that began in 2012. This survey ended in 2019 but RSA may occasionally continue a camera survey and provide monitoring information to the ADCNR.

Mussels and Snails

Historically, Redstone Arsenal may have been home to number of species of mussels and snails. However, creeks within the boundaries of Redstone Arsenal have suffered from pollution and discharge and are highly sedimented. Historically, the land north of Indian Creek was agricultural, resulting in influx of runoff in the form of agriculture chemicals and soil erosion. The creek was considered terminal during a survey by Billy Isom in the late 1960s. The land more recently has been developed and the construction process has resulted in even greater siltation of Indian Creek. Also, until about 40 years ago, the City of Huntsville discharged its sewage directly into Huntsville Spring Branch. It is highly sedimented due to development of its headwaters. These activities paired with past pollution by activities on Redstone Arsenal leave little hope that any but the most resilient mussel species remain. Anecdotal observations of herpetologists, geologists, and biologists during decades of work on the Arsenal support this idea, i.e. no endangered, threatened, or species of concern have been observed or collected. Realistically, suitable habitat to support a healthy, diverse mussel fauna does not exist on the Redstone Arsenal.

McGregor *et al*. (2009) documented two paired, weathered dead valves of the Tennessee clubshell (*Pleurobema oviforme*, currently petitioned for listing). This study also documented live skirted hornsnail (*Pleurocera pyrenella*), also currently petitioned for listing. Other species with the potential to occur on Redstone Arsenal, or on its southern boundary with the Tennessee River, include (but are not limited to) the spectaclecase (*Cumberlandia monodonta*, Endangered), pink mucket (*Lampsilis abrupta*, Endangered), longsolid (*Fusconaia subrotunda*,

petitioned for listing), and the round-rib elimia (*Elimia nassula*, petitioned for listing).

General water quality management (standard construction best management practices, minimizing forest fragmentation and clearing that may contribute to erosion and sedimentation) and protecting and preserving the existing habitat would benefit sensitive mussel or snail species that may still inhabit the Installation. The Alabama Natural Heritage Program will be conducting an Installation-wide survey for ecologically sensitive invertebrates in 2018-2020. Federally or state protected mussels, snails and insects will be documented if discovered.

Fishes

Neither slackwater (*Etheostoma boschungi*, Threatened) nor snail (*Percina tanasi*, Threatened) darters have been collected from Redstone Arsenal, but the slackwater darter is known from sites to the north and west. Spring pygmy sunfish (*Elassoma alabamae*, Threatened) are also not known from the Installation however they have been documented in springs immediately west of the Installation. There does not seem to be suitable habitat to support populations of these fish species.

General water quality management (standard construction best management practices, minimizing forest fragmentation and clearing that may contribute to erosion and sedimentation) and protecting and preserving the existing habitat would benefit sensitive fish species that inhabit the Installation. The Alabama Natural Heritage Program will be conducting an Installation-wide survey for ecologically sensitive fish in 2018-2020. Federally or state protected species will be documented if discovered.

4.1.3 Goals and Objectives

(1) Complete the T&E Species PLS currently being conducted by the ALNHP.

(2) Continue current management and monitoring of Alabama cave shrimp at Bobcat Cave.

- Erect gate/fence at the entrance to Bobcat Cave.
- Continue bimonthly groundwater level survey and population monitoring by GSA.
- Develop and implement Bobcat Cave Management Plan. (ERDC, 2020-2021).
- Support education programs that increase public awareness of groundwater pollution issues.
- Investigate source of TCE and possible effects on aquatic cave fauna.
- Establish hardwood forest and/or native warm season grass areas to protect groundwater near cave; continue herbicide treatment of Callery Pear as needed, in the Ecologically Sensitive Area

(3) Continue current management and monitoring of gray, Indiana, northern long-eared, and tricolored bat populations at RSA.

- Protect and maintain forested corridors along Installation waterways. Require streamside management zones.

- Chemical and mechanical control of invasive species in forested Ecologically Sensitive Areas to remove thick understory clutter.
- Annually monitor Installation caves for bat occurrences.
- Promote public education on effects of environmental disturbance.
- Adhere to 2015 consultation with USFWS regarding tree clearing and other actions with potential to impact Indiana and northern long-eared maternity habitat. Utilize the 2017 blanket clearance to maximize mission success.

(4) Continue current management and monitoring of Price's potato bean on Madkin and Weeden Mountains.

- Enforce time of year grounds maintenance on access road and power line right-of-way by restricting to dormant season. Support maintenance activities to manage for canopy closure and prevent weedy competition.
- Maintain GIS documentation of population areas.
- Obtain updated reports from seed bank and ex situ propagation.
- Continue environmental representation on the quarterly mountain bike trail committee to ensure proposed activities will not impact sensitive species.

(5) Complete the Jaya Springs/Indian Creek Recharge Area Study in support of the Tuscumbia darter.

4.2 Wetlands and Deep Water Habitat Management Component

Approximately 9,510 ac of wetland habitat and 497 ac of deepwater habitat exist within the boundaries of Redstone Arsenal. These habitats account for nearly 26% of the Installation's total land area. Palustrine forested and emergent wetlands are the dominant type of inland wetlands at Redstone Arsenal, comprising 69% and 13%, respectively. The palustrine wetlands found on Redstone Arsenal occur primarily on floodplains and dominant classes include broad-leaved deciduous forested wetlands, emergent wetlands and deciduous scrub-shrub wetlands (USFWS, 2002).

As highly productive ecosystems, wetlands provide benefits to neighboring aquatic and terrestrial systems as well as support a vast diversity of plant and animal species. In addition to the numerous benefits to fish, wildlife and plant species, wetlands also improve water quality, reduce the potential for flood or storm damage, control shoreline and upland erosion, prevent downstream siltation/sedimentation, and provide aesthetically pleasing spaces, natural products, and unique spaces for numerous recreational activities. The following regulations, laws, and Executive Orders are pertinent to wetlands and deepwater habitats for the state of Alabama: the Rivers and Harbors Act of 1899; EO 11990, Protection of Wetlands; Sections 401 and 404 of the CWA; the Coastal Zone Management Act of 1972; AR 200-1; 40 CFR Parts 22, 230-233 (includes Compensatory Mitigation Rule issued by EPA and USACE in 2008); and the Tennessee Valley Authority Act of 1933.

Tupelo gum wetland

The Clean Water Act of 1972 was established with the goal to eliminate pollution in the "waters of the United States," which include wetlands. Section 404 of the CWA establishes a Federal program, administered by the USACE, which regulates and permits activities within wetlands. Section 401 of the CWA allows States to regulate wetland water quality, according to state-

specific concerns. A Section 401 certification review is typically conducted at the same time as Federal Section 404 review and many states, including Alabama, have instituted a joint permit process.

To better meet the goals of the CWA, the DoD, in conjunction with other Federal Agencies, has adopted a unified watershed-based approach for protecting water quality and aquatic ecosystems. The Unified Federal Policy for a Watershed Approach to Federal Land and Resource Management (65 Federal Regulation 62565–62572) provides a foundation for Federal agencies to sustainably manage land and resources. In addition to the CWA and the Unified Federal Policy for watershed management, protection and management of wetland ecosystems requires compliance with Executive Order 11990, Section 10 of the Rivers and Harbors Appropriation Act, Section 26a of the TVA Act, 40 CFR Parts 22, 230 through 233 and AR 200-1.

Redstone Arsenal adheres to Federal and state regulations concerning the conservation of wetlands and wetland functions, following a "no net loss" of wetlands policy during action planning stages. In support of the mission, Redstone Arsenal takes actions to minimize damage and/or destruction of wetlands. Activities involving new construction fill, or dredging within wetlands on the Installation are avoided to the greatest degree possible. If building, filling, dredging, or discharging into jurisdictional wetlands cannot be circumvented, appropriate permits, as described above, are obtained from the USACE, ADEM, and/or the TVA.

Redstone Arsenal has identified and will continue to maintain a current inventory of wetlands and surface water resources through planning level surveys. A Memorandum dated 21 March 1997, Army Goals and Implementing Guidance for Natural Resources Planning Level Surveys and INRMP provides guidance for planning level surveys.

The USFWS performed a National Wetlands Inventory (NWI) of Redstone Arsenal in 2002. Approximately 10,007 ac of wetland and deepwater habitats were inventoried, described, and mapped as a result of this project. The NWI data has since been incorporated into Redstone Arsenal's GIS and the digital data is used during project planning to minimize possible wetland damage or destruction. The following actions are taken to reduce adverse impacts to wetlands at RSA:

- Through NEPA and planning level surveys, proposed actions and their alternatives are evaluated for possible, unavoidable impacts to wetlands. Reducing or avoiding the amount of wetlands affected by the action alternatives provide economic benefits to RSA and the US Army.
- Wetland delineation and subsequent mapping for jurisdictional purposes is planned on a case by case basis, in the event that wetlands will be impacted by proposed actions.
- The presence/absence of wetlands and special aquatic sites are identified in the field using routine on-site delineation methods outlined in the *Corps of Engineers Wetlands Delineation Manual* (USACE, 1987) and the *Regional Supplement to the Corps of Engineers Wetlands Delineation Manual: Eastern Mountains and Piedmont Region* (Version 2.0) (USACE, 2012). These delineations are validated by the USACE Nashville District; demarcation lines are digitized and integrated into Redstone

Arsenal's GIS Spatial Database.

- A USACE determination as to whether a Section 404 permit (Individual or Nationwide) is required in the event that a proposed action will impact jurisdictional wetlands will then be requested. If a 404 permit is required, a detailed design and permit application is prepared and submitted, along with the Section 401 Water Quality Certification application.
- No work associated with the discharge of dredged or fill material into the wetland is performed until the Section 404/401 permit is obtained from the USACE and ADEM.
- In the event that the wetland to be impacted is isolated and the USACE does not have jurisdiction, Natural Resources personnel will determine whether ADEM requires a Section 401 certification or if the local Government authority has individual permit requirements related to watersheds, wetlands, or stream quality. A Section 401 Water Quality Certification or local permit will be completed and submitted, if required.
- A Finding of No Practicable Alternative (FONPA) request will be submitted to the Deputy Chief of Staff, G-9 Installations for any action that presents potential to destroy or modify wetlands or directly or indirectly support new constructions in wetlands. This is in accordance with EO 11990 and 44 CFR 9 (*Floodplain Management and Protection of Wetlands*).
- If the project requires Section 404 permits, project managers will demonstrate avoidance and minimization of wetland impacts followed by mitigation as a last resort, per the Memorandum of Agreement (MOA) between USACE, EPA, and USFWS.

The *Alabama Handbook for Erosion Control, Sediment Control and Stormwater Management on Construction Sites and Urban Areas* (Alabama Soil and Water Conservation Committee, 2009) provides guidance for preventing or minimizing the related problems of erosion, sediment and stormwater on construction sites and eroding urban areas. It provides a basis for developing sound plans and implementing appropriate measures, commonly referred to as Best Management Practices. It can help users meet environmental and regulatory objectives. Streams and creeks on RSA are protected by these BMPs; guidance for buffer zones is provided in this handbook. Typically buffer zones may range from 10-50 ft of undisturbed vegetation, depending on the land-disturbing activity. Where practical, CNR Branch personnel at Redstone Arsenal recommend wider strips of buffer areas (>50 ft).

4.2.1 Advanced Compensatory Wetland Mitigation Site

A wetland credit site of 51.68 ac for Advanced Mitigation Credits was established in the southern portion of Redstone Arsenal in 2002 to provide compensation for unavoidable impacts to inland wetlands through restoration, enhancement and preservation of the numerous values and functions of wetland ecosystems. The original proposal for the site's construction was due to the need to mitigate impacts from an Alabama Department of Transportation road-widening project on RSA (Martin Road East), which resulted in the loss of 5.35 ac of forested wetland. The mitigation site was designed to be larger than what was needed for that specific project in anticipation of future growth and development, proposed by the USAG-Redstone, on the Installation.

Credits are an appropriate form of compensation for mitigation of unavoidable impacts to

waters of the United States resulting from activities authorized under Sections 404 and 401 of the CWA, Section 10 of the Rivers and Harbors Appropriation Act, and other Federal, State, or local wetland regulatory programs. The original goal of this plan was to generate a 51.68 credit acre wetland site to be available for use on future RSA projects requiring DA permit and/or State permit approval and compensatory wetland mitigation. The original Martin Road widening wetland impacts were mitigated by deducting 12.4 credits from the Advanced Credit Wetland Mitigation Site on RSA. A total 39.28 credits remain for use, contingent on the approval of this site.

Potential wetland mitigation sites on Redstone Arsenal are limited by mission requirements and site characteristics. T he site was chosen because it provided an opportunity to restore a previously drained and modified wetland. The area is a large linear channel scar of the Tennessee River that formed once a new channel eroded to the south, effectively altering the river's course. The basin left behind in this scar gradually filled in from annual flooding and was in part a tupelo swamp prior to the 1930s, surrounded by bottomland hardwoods.

Advanced Mitigation Credit Site

This channel scar was drained in the 1930s in an effort by TVA to control mosquito populations. A large ditch was excavated from the Tennessee River northeast through the river levee and into the backwater area. Connecting lateral ditches were dug the length of the channel scar to achieve complete drainage of this swampy area. Mixed hardwood forest, pasture land, and wildlife food plots have since encompassed the hydrologically altered area.

An earthen dam and flow control structure were constructed as major parts of this mitigation site, to restore wetland hydrology and saturated soils, expand the wetland/upland habitat interface, and allow wetland vegetation to naturally reestablish and regenerate with minimal management effort. The reestablishment of hydrophytes was to be achieved through natural colonization of species from the seed bank and planting of seeds and seedlings in different landscape areas according to the frequency and duration of the hydrology.

Performance standards for measuring success of the mitigation site included a minimal surviving rate for vegetative plantings and monitoring reports on vegetation, soils, and hydrology. The initial five-year monitoring report (2007) indicated adequate wetland hydrology had not yet been established and hydrophytic vegetation, particularly tupelos, did not meet the minimal survival rate. A severe drought hindered the success of this mitigation site (D. Dunn, pers. comm. 2009). A minimal survival rate of at least 300 mast-producing trees per acre was set as the success criterion for this bank. Remedial actions were taken to plant additional tupelo

seedlings, reduce competition, and monitor survival.

Annual field observations were continued during the growing seasons until 2011, to assess the establishment of hydrophytic vegetation, hydrology and hydric soil conditions. In 2012, the EMD let a contract for the preparation of a Final Monitoring Report for the Advance Compensatory Wetland Mitigation Report (Aerostar Environmental Services, Inc., 2014). This report recommended that the 51.68 ac (credits) at this mitigation site be released. It was submitted to the USACE Nashville District in February 2015 for review and determination as to whether or not the success criteria were met. A site visit by the Nashville District in December of 2015 resulted in the decision that the USACE would not approve the site as recommended by Aerostar's report. As of the date of this INRMP publication, RSA is working with the USACE to address outstanding mitigation requirements, with the goal of formulating a new plan for achieving future success.

4.2.2 Goals and Objectives

(1) Integrate wetland conservation into Redstone Arsenal's facility and land management processes.

- Continue to delineate jurisdictional wetlands on an "as needed" basis for installation actions and update the Installation GIS wetland layer.
- Update the wetlands planning level on a 5-10 year basis, with emphasis on future development projects prioritized by the DPW Master Planning Division.
- Comply with Section 404 and 401 CWA permits issued by the USACE and ADEM for DoD actions on RSA.
- Identify and conserve forested wetland habitat which supports the federal and state listed species of concern in Section 4.1, as well as non-listed flora and fauna.
- Monitor sensitive wetland areas to ensure impacts are minimized or mitigated.
- Use Best Management Practices for all forestry- and construction-related activities.

(2) Establish full success criteria in the Martin Road Advanced Credit Mitigation Site.

- Continue maintenance and monitoring of the mitigation site.
- Perform Annual Inspections of the mitigation site.
- Confer with the Nashville Regulatory District on remedial actions to improve hydric soil conditions, hydrology and hydrophytic vegetation, as the USACE determined the site does not currently meet the success criteria.

(3) Continue to utilize watershed-based approach to manage operations, activities, and lands to avoid or minimize impacts to wetlands, ground water, and surface waters on or adjacent to Redstone.

- Support Installation Restoration Branch in RCRA site clean-up operations and groundwater monitoring.

4.3 Law Enforcement Program

Section 107 of the Sikes Act (16 USC 679e-2) requires, to the extent practicable and using available resources, professionally trained CNR Managers and Law Enforcement personnel be available and assigned responsibility to perform tasks to carry out Title I of the Sikes Act. In accordance with DoDI 5525.17, the roles and responsibilities of the Conservation Law Enforcement Officer are integrated into this INRMP.

The Conservation Officer works closely with CNR Program Managers, providing enforcement for these programs. The Conservation Officer enforces rules pertaining to safe participation in natural resources recreation activities, trespassing, theft/vandalism of government property, and hunting, fishing, and trapping regulations. The responsibilities and policies for hunting, fishing, and trapping on RSA are established in RSA Regulation 200-3 (Appendix F).

4.3.1 Responsibilities

Specific responsibilities of the Redstone Arsenal Game Warden Section include, but are not limited to:

- Enforces federal, state, and RSA laws and regulations pertaining to natural and cultural resources, boating safety, and illegal dumping. Execute warrants pertaining to the violation of laws and regulations.
- Record game kills and maintain other records to ensure compliance with season bag limits.
- Arrest, with or without an arrest warrant, any person found violating laws or regulations pertaining to cultural and natural resources.
- Seize and take possession of all wildlife or parts thereof taken, caught, killed, captured, possessed or controlled in any manner or for any purpose contrary to the laws and regulations pertaining to fish and wildlife.
- Seize as evidence, with or without warrant, any device other than a boat, vehicle or aircraft when there is probable cause to believe that its possession or use is in violation of any provisions of laws or regulations dealing with cultural and natural resources.
- Recommend and enforce suspension of access privileges for specified infractions of laws and regulations pertaining to cultural and natural resources.
- Coordinate with Redstone DOO, CNR Branch, and other state and federal law enforcement agencies as necessary for the proper completion of cultural and natural resources law enforcement duties and responsibilities. Enforce any law within the enforcement jurisdiction of the USFWS, in any location when with a USFWS agent.
- Ensure Redstone Arsenal Wildlife Law Enforcement personnel are qualified, trained, and sufficiently equipped to carry out all assigned duties and responsibilities.

4.3.2 Goals and Objectives

(1) Maintain an effective and safe enforcement program integrated with conservation management and the military mission.

4.4 Wildlife Management Component

4.4.1 Overview

Wildlife management at RSA is accomplished as a by-product of, or with modifications to, the major Land Use Programs on RSA; these programs cover significant acreage and include forestry, agriculture, and mission activities. Integrating wildlife management into these programs ensures continued species diversity. In addition, some measures specifically adapted for wildlife enhancement are included within the overall Natural Resource Management Program.

The military mission receives direct benefits from these management strategies through enhanced testing opportunities from chemical/mechanical control of nuisance vegetation (e.g., kudzu, bush honeysuckle) that aids in maintaining open areas. Prescribed fire, herbaceous vegetation management, and the upkeep of fire lanes aid in maintaining line of sight and fire suppression on missile ranges. Sight barriers, which are considered necessary on the laser range, are provided through selected plantings of pine and hardwood trees. The loss of test areas due to habitat conversion by wildlife activity, such as beavers, is also prevented by the means of nuisance animal control.

The Army's program objectives regarding Wildlife Management are to:

- Maintain and enhance wildlife resources in a manner consistent with both accepted scientific practices and military mission requirements.
- Improve natural surroundings for Installation personnel.
- Enhance public relations and recreational opportunities and stimulate community support for the military presence.
- Comply with all State and Federal laws that pertain to the management of fish and wildlife resources.
- Provide recreational hunting, fishing, and trapping opportunities as part of Installations' FMWR programs, as allowed by the Fish and Wildlife Conservation Fund (21X5095).

The primary goal of RSA's Wildlife Management Program is to maintain a variety of native flora and fauna at levels that support biodiversity and will allow for a sustainable yield for recreational purposes, in conjunction with supporting the military training mission in a multiple land use strategy. Since the first planning effort, the Wildlife Management Program has evolved from a featured species strategy to a landscape level approach focusing on ecosystems. The strategy to restore and maintain native landscapes in an open ecosystem and adaptive management framework in support of military testing benefits the widest range and diversity of both game and non-game species. Focusing attention on habitat components versus individual species ensures long term sustainability and viability of wildlife populations on the Installation. Ecosystem management decisions are based on sound scientific research and history of past management successes at Redstone Arsenal. Biodiversity/ecosystem management strategies are incorporated in multiple land use management actions.

A variety of game and non-game fish inhabit the deepwater habitats at RSA, particularly the HSB/Indian Creek systems. Fish populations have historically been affected by poor water quality, due to both on and off Installation pollution. Fish management is not implemented at Redstone Arsenal due to known environmental contamination in existing quarries, lakes, and ponds; waterway connections to the Tennessee River that result in frequent flooding and prevention of effective fertilization regimes and fish stocking; restrictions on chemical use in waterways; and insufficient funding for fisheries management projects such as dredging existing ponds plagued by eutrophication. The USAG-Redstone (IR Branch) tested contaminant levels in several water bodies in 2019 and found that the level of contamination that would create health advisories and preclude recreational fishing was not of concern in the majority of RSA's larger ponds. USAG-Redstone leadership now allows more fishing opportunities, contingent on mission restrictions and availability through DFMWR Outdoor Recreation. However, fisheries management and recreational harvest does not constitute a significant part of RSA's Wildlife Management Program and will not be discussed in this INRMP in detail.

Wildlife management at RSA is a broad program that includes game species, non-game species, wildlife clearing, and wildlife damage management. The majority of wildlife habitat improvements on the Installation occur through the Forest Management Program and through the CNR staff actions. Wildlife management is primarily concerned with maintaining quality habitat as it exists in the native landscape, and in providing specific habitat improvements where deficiencies are identified. This approach to management and the understanding that wildlife and their habitats are part of natural communities and systems lends itself to the broader application of ecosystem management and maintenance of native biological diversity.

4.4.2 History of Fish and Wildlife Management at Redstone Arsenal

The first records of wildlife management activity on Redstone Arsenal come from the mid-1950s. Beginning in 1954, bicolor lespedeza (*Lespedeza bicolor*) plots were established for Northern Bobwhite Quail and in the early 1960s, agricultural lessees on the Installation were required to establish bicolor lespedeza plots at selected sites. Due to the discovery of the invasive nature of lespedeza, this program was eventually halted.

In 1959, the ADCNR unsuccessfully attempted to restock Eastern Wild Turkeys by releasing 24 pen-raised turkeys on the Installation. A successful 1973 restocking attempt utilized nine wild birds (six hens and three gobblers) from Clarke County, Alabama, which increased the population; gobbler-only hunts began in 1981.

Deer were extirpated from Alabama in the early 1900s and Redstone Arsenal was no exception. In 1960, ADCNR released 31 white-tailed deer (26 does and five bucks) onto the Installation from Marengo County and Lane Park Zoo in Birmingham, Alabama. Due to the success of this stocking, the first hunt was held in 1967 with a harvest of nine deer. To maintain the stability and health of the herd, stricter harvest regulations were initiated in 1971. Concurrently, WNWR agreed to include refuge lands within Arsenal boundaries into the deer-hunting program. This arrangement was made with the stipulation that hunting participation would be on a 1:1 military/civilian hunter ratio during hunts involving refuge lands.

For many years the military game wardens and the Redstone Arsenal Rod and Gun Club administered the hunting, fishing, and trapping programs on the Arsenal. In 1978 the Directorate of Community and Family Activities (now the DFMWR), through the Outdoor Recreation Branch, undertook this responsibility.

In 1987, due to an excessive doe population and high deer/vehicle strike incidents, Redstone Arsenal began participation in the Alabama Deer Management Assistance Program administered by the ADCNR. This program effectively increased the number of antlerless deer harvested and strived to maintain a buck/doe ratio indicative of a healthy deer herd. Initial doe harvest quotas were arbitrarily set at 500 animals with an unlimited buck harvest; however, doe harvest never exceeded 250 animals due to hunter bias towards bucks. A thorough review of the harvest data in 1996 indicated that fawn recruitment was low and the buck/doe ratio was greatly distorted. In response, harvest quotas changed throughout the years based on harvest data in an attempt to correct these ratios. Data collected by the Wildlife Research Unit at Mississippi State University indicated that changes to harvest quotas resulted in positive changes to the buck/doe ratio and increased fawn recruitment (Jones *et al*., 2001). During the 2007-2008 hunting season, the harvest of antlered bucks was restricted to 3 per season, in accordance with the State of Alabama's hunting regulations. A recommendation by CNR in 2011 was made to enforce stricter buck harvest requirements. The new restriction was implemented in 2012; harvested bucks must now have at least a 15" outside spread or length of one antler from base to tip. Harvest quotas will be maintained in this range until the buck/doe ratio approximates 1:3.

4.4.3 Ecosystem Management

Ecosystem management at Redstone encompasses four important initiatives. First, interagency and multiple landowner cooperation is important since ecosystem processes do not conform to property boundaries. Natural characteristics of the land base and habitat use by organisms often extend across landscapes and regions. Cooperation and coordination with WNWR and TVA can address landscape concerns such as watershed protection, prevention of forest fragmentation for species that require large forest tracts, and conservation of migratory animals, such as waterfowl and Neotropical migratory birds.

Second, managers at RSA must identify and analyze the geographic and cumulative impacts of mission and land management requirements to use this information to minimize disruption of ecosystem processes. Ongoing and future wildlife and natural resource monitoring and habitat mapping through the use of GIS will aid in indicating trends in ecosystem integrity and diversity of indicator species.

The natural integrity and appearance of the landscape is a third component on many public lands, such as bottomland hardwood forests and wetlands. The RSA forestry management, as well as initiatives to protect mature hardwood forests, sensitive habitats, and wetlands/streams addresses this component.

Fourth, ecosystem management is closely linked to modern theories of conservation biology and it involves protection of biological diversity (Hunter, 1990; Cubbage *et al.*, 1993). Biological

diversity protection at RSA includes conservation of native organisms and their habitats at three major levels as follows:

Genetic Diversity. Faunal surveys, including breeding bird survey (Best *et al.*, 2010; Ortman 2012; Sterling, 2013), wildlife inventories (Godwin and Hilton, 1995; Jones *et al*., 2001), bat surveys (Gardner, 2008; Samoray, 2016; Samoray, 2019), and the recent green salamander survey (John, 2017), have produced information on diversity of breeding and spring transient birds and nongame species in different habitat types at RSA. Management and conservation practices that retain breeding populations are featured to increase the potential for a diverse gene pool across the land base over the long term.

Species Diversity. Different habitats support various species assemblages depending on the species' life requirements; therefore, management will be implemented using the concept of indicator species as a "barometer" for species diversity and habitat quality. Wetland and sensitive habitat protection and forest management that limits fragmentation, restores native forest ecosystems, and enhances or maintains food and cover resources are goals promoting conservation of species diversity.

Ecosystem Diversity. At least 14 broad habitat types, which form a mosaic of different habitats across the landscape, have been identified at RSA (Godwin and Hilton, 1995) and are managed to retain diversity. These include bottomland hardwood forests, tupelo-cypress wetlands, temporary-ephemeral pools, slope upland hardwood forests, mixed pine-hardwood forest, glades, caves, seepages and springs, pine forests, streams, ponds, early successional habitats (e.g., pine plantations of 10 years or less), open fields, pastures, and maintained, mowed areas.

Currently, the Installation's habitat diversity provides quality habitat for many game and nongame species due to upland pine management, interspersion of forest and field habitats, protection of older age class hardwoods, and the prevalence of wetland and alluvial floodplain habitats. Ecosystem integrity and diversity can be measured by biological monitoring of indicator species assemblages and use of GIS databases. This diversity is maintained by protection of unique and sensitive forest ecosystems across the landscape and use of selected land management approaches. Integrative management practices that can enhance species richness and maintain biological diversity include, but are not limited to the following methods:

- Protection and management of threatened and endangered species habitats.
- Wetland restoration and protection. Maintenance of streamside management zones and protective forested buffer strips along streams, creeks, rivers, and wetlands of 80 ft or greater in width.
- Retention and protection of hardwoods of 45 years of age and greater.
- Prescribed burning in upland forests.
- Selective thinning and/or small group selection cuts in pine forest to basal areas (BA) of <70 sq ft per acre.
- Retention of forest openings. Retention of cavity trees and snags.
- Control of non-native, invasive plants.
- Cessation of mowing during nesting season (April - July) in selected areas.

Key Management Species

To integrate fish and wildlife management and biodiversity conservation with the land base mission, three categories of organisms are identified for planning, management, and monitoring:

Indicator Species. Organisms with a narrow range of ecological tolerance whose presence/absence is an indication of environmental conditions are defined as indicator species. All indicator species at RSA are also featured species and can be used to monitor habitat conditions in reservation ecosystems. In general, state-listed and federally protected flora and fauna can be used as indicator species within ecosystems to which they are adapted. Managers can assess ecosystem condition and land use impacts by monitoring the occurrence, distribution, and population trends of indicator species. Criteria for selection of indicator species include the following:

- Ecological sensitivity, role, and presence in the featured ecosystem.
- Potential for indicator of ecological integrity or diversity of the featured ecosystem.
- Regional or global population status (declining, state-listed, or federally protected).

Feasibility of monitoring will be based on budget allocations, personnel resources, and avoidance of potential damage to existing populations or sensitive habitats.

Featured Species. Featured species are those species that are specifically managed for and/or protected. Featured species may or may not be indicator species. Selection of featured species is generally based on the following criteria:

- Ecological sensitivity and role in the featured ecosystem. Potential for indicator of ecological integrity or diversity of the featured ecosystem.
- Regional/global population status (declining, protected, special concern-rated species).
- Potential for conflict with training mission.
- Consumptive or non-consumptive use value.
- Ability for personnel to monitor presence or population trends.

Keystone Species. Keystone species are those organisms that influence ecosystem integrity, species diversity, and biological community composition, succession, and stability. Two keystone species, the white-tailed deer and American beaver, occur at RSA and influence ecosystems through their presence, population levels, and life habits. Browsing by white-tailed deer at high population levels negatively impacts woody plant regeneration, plant species diversity, structure, cover, and consequently, animal communities. Beaver activity can influence habitat type through dam building and feeding. Damage to timber and property may result; however, beaver wetlands can produce habitat for a variety of fish and wildlife. The RSA beaver wetlands typically support high species diversity of game and non-game birds.

4.4.4 Wildlife Habitats

To maintain and enhance the wildlife at Redstone Arsenal, a variety of habitat types will be

maintained. A greater variety of habitat types will allow for a greater diversity of wildlife species living on the Installation. Most efforts are directed toward activities that will benefit multiple species, both game and non-game. A few species-specific activities will be utilized for the more popular game species on RSA.

Stream and wetland habitats will be protected from drainage, channelization, diversion, and pollution. Forested buffer strips around wetlands and along streams, of 80 ft or greater in width, shall be maintained to protect habitats from nonpoint source pollution and water temperature changes due to adjacent silvicultural or development activities. Undisturbed herbaceous and shrub cover will also be retained in wetland and stream bank habitats devoid of forest cover. Protection of streams, seepages, and moist glades can effectively protect habitat for a large number of mammals, reptiles and amphibians (herpetofauna). Featured wildlife species in aquatic habitats include protected fish, gray bats, salamanders, cave shrimp, mollusks, aquatic furbearers, non-game birds, and waterfowl. Major habitat categories are man-made impoundments, alluvial floodplain wetlands, beaver wetlands, seepages, springs, and temporary pools (vernal and ephemeral).

Forested habitats are mosaics of upland pine, upland hardwood, upland mixed hardwood/pine, and riparian and bottomland hardwoods. At Redstone, forest management concurrently produces timber products while maintaining quality habitat for featured wildlife, which includes game and nongame mammals, Neotropical migrant birds, and a variety of native herpetofauna.

4.4.5 Game Wildlife Species

The wildlife species found on Redstone Arsenal are discussed in Section 2.3.3 of this INRMP and a list of wildlife game species is provided as Table 4.2. Major game species managed through population and habitat management at the Installation include white-tailed deer, Eastern Wild Turkey, fox and gray squirrels (*Sciurus niger* and *S. carolinensis*), and Mourning Dove. Other game species that inhabit RSA include Northern Bobwhite, Wood Duck, Common Snipe (*Gallinago gallinago)*, American Woodcock (*Scolopax minor)*, swamp and eastern cottontail rabbits (*Sylvilagus aquaticus* and *Sylvilagus floridanus*), and migratory waterfowl.

The primary means for game species management at Redstone is through habitat manipulation. Emphasis is placed on activities such as silvicultural operations, prescribed fire, land reclamation, planting of wildlife food plots, control of nonnative plants, limitation on mowing and overgrazing, and riparian area protection. Due to the popularity of hunting for certain game species, specific management actions will be conducted to enhance and maintain the populations of those animals. The most sought after game species on RSA are white-tailed deer and Eastern Wild Turkey.

Table 4.2. Game and Furbearer Species Found on Redstone Arsenal, Alabama

Common Name	Scientific Name
Mammals	
White-tailed deer	*Odocoileus virginianus*
Fox squirrel	*Sciurus niger*
Gray squirrel	*Sciurus carolinensis*
Swamp rabbit	*Sylvilagus aquaticus*
Eastern cottontail	*Sylvilagus floridanus*
Raccoon	*Procyon lotor*
Beaver	*Castor canadensis*
Woodchuck	*Marmota monax*
Coyote	*Canis latrans*
Opossum	*Didelphis virginiana*
River otter	*Lontra canadensis*
Mink	*Neovison vison*
Red fox	*Vulpes*
Muskrat	*Ondatra zibethicus*
Gray fox	*Urocyon cinereargenteus*
Bobcat	*Lynx rufus*
Feral swine	*Sus scrofa*
Birds	
Eastern Wild Turkey	*Meleagris gallopavo*
Wood Duck	*Aix sponsa*
Northern Bobwhite	*Colinus virginianus*
Mourning Dove	*Zenaida macroura*
Common Snipe	*Gallinago*
American Woodcock	*Scolopax minor*
Waterfowl	Ducks & geese, only

Harvest. The harvest of game animals on Redstone Arsenal is allowed under the Sikes Act; hunting, fishing and trapping are regulated activities and controlled according to Alabama, federal (migratory waterfowl), and Installation regulations (RSA Regulation 200-3, Appendix F).

As set forth in AR 200-1, user fees may be collected to recover expenses of managing natural resources for outdoor recreation. At Redstone Arsenal, these fees are collected in the form of hunting, fishing, and trapping licenses, as well as from the Agricultural Outleasing Program. All collected fees are accounted for in accordance with guidance provided for the appropriation titled *Wildlife Conservation Military Installations*, Army account 21X5095 (AR 37-100 and AR 37-108). The 21X monies may only be used for wildlife management on the Installation on which they were collected. AR 215-1 states the collected fees are to be used for the protection, conservation, and management of fish and wildlife, including habitat restoration and improvement, biologist staff and support costs, and related activities. Funds expended to support the administration of license sales will not exceed 10% of the annual revenues collected. To hunt/fish/trap on RSA, hunters must have an Alabama state hunting license, any state hunter education certification, RSA hunter orientation, and a RSA hunting permit. Fishermen must have

an AL state fishing license and a RSA fishing license to fish on RSA (no RSA license required to fish only on the Tennessee River). Trappers must have an Alabama state trapping license and a RSA trapping permit. Redstone Arsenal hunting, fishing, and trapping permits are sold by DFMWR at the Outdoor Recreation Branch on Sportsman Drive.

DA guidelines require Redstone Arsenal's Forestry and Fish and Wildlife Programs to implement management actions for reasons other than game management. The most effective management actions available to the CNR Program at RSA are prescribed burning, strip disking, and forest thinning. Prescribed fires conducted for wildfire control purposes, timber stand management, wildlife habitat enhancement, and military training land management will be accomplished in accordance with RSA's Wildland Fire Management Plan (available upon request from the EMD).

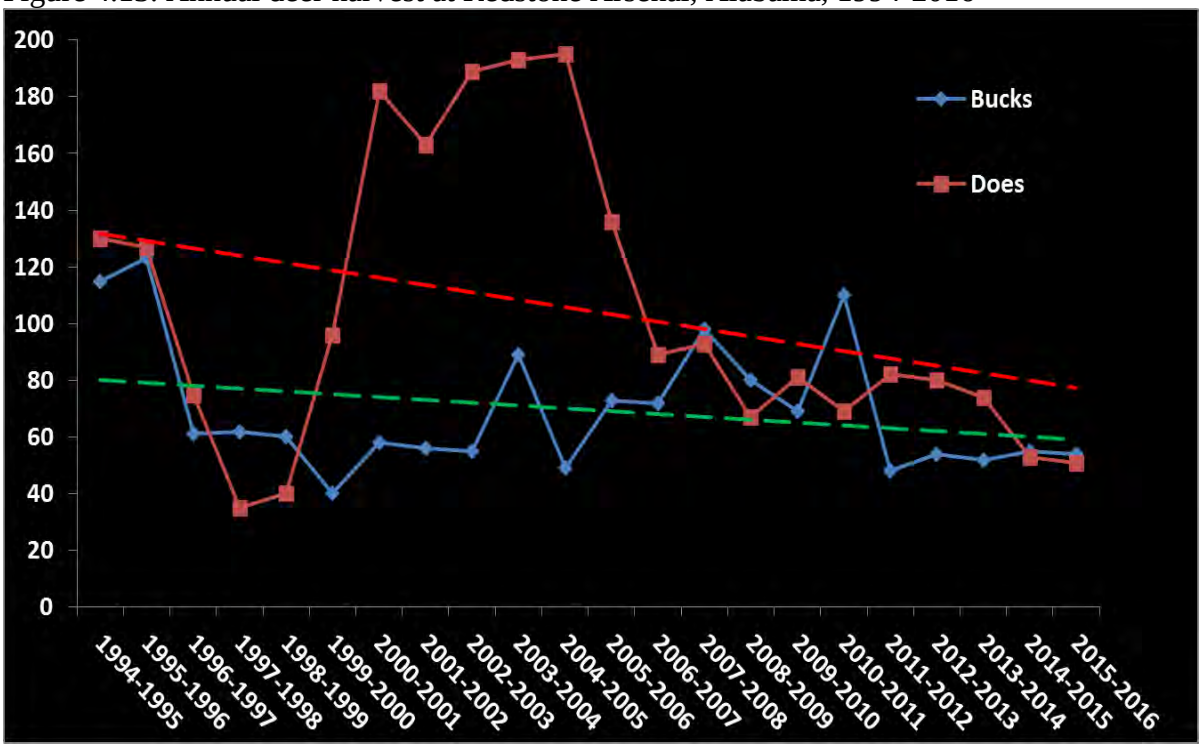
The budget for actions pertaining only for hunting and fishing is largely supported by user fees (21X monies) generated from the sale of Redstone Arsenal hunting and fishing permits. The costs of these permits are set by the USAG-Redstone so that all individuals who wish to participate can afford to. On average, approximately 500 hunting, fishing, and trapping permits are sold annually by the Outdoor Recreation Branch. This number does not include the free permits granted to individuals under 16 years of age or over 65 years of age. In FY 2016, 422 permits were sold, generating $21,130 worth of revenue for the management of the Hunting and Fishing Program at RSA (one-half allocated to the CNR Branch for wildlife resource management; one-half retained by the Outdoor Recreation Branch for support costs and associated activities, per AR 215-1).

Deer. The goals for management of deer on RSA include maintaining a healthy, stable deer population at levels that allow for hunting and recreational opportunities within the carrying capacity of RSA; limiting deer-vehicle collisions; limiting deer damage on ornamentals, shrubs, and trees; creating a 1:3 ratio of bucks/does; and improving recruitment of 0.5 year-old deer into the population. Deer harvest information from 1994 to 2016 is depicted in Figure 4.13. The annual deer harvest for the past 20 years at Redstone Arsenal averages approximately 177 deer.

White-tailed deer have very definite habitat requirements. They prefer wooded areas with an abundance of borders or edges created by breaks between vegetation types, fields, or small clear-cuts. This type of habitat provides a variety of food sources and cover types. Browse plants are located in most habitat types and are encouraged by controlled burning and midstory control.

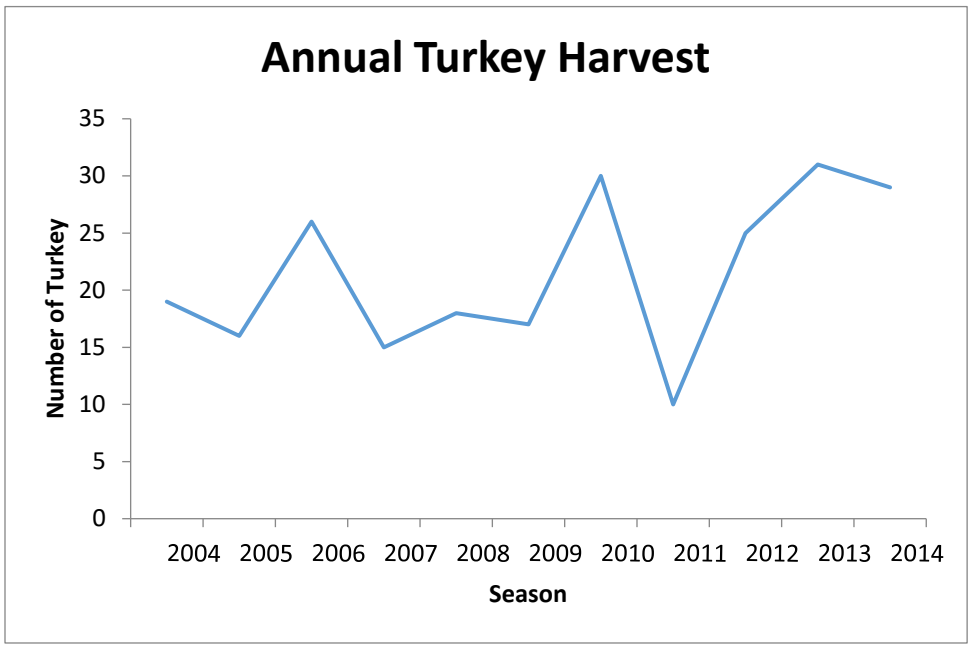
To manage deer harvest regulations, several monitoring activities are conducted on an annual basis at RSA. Pre-harvest (mid-October) and post-harvest (mid-February) spotlight surveys are conducted to estimate the deer population. Mineral stations have been established to assist in trail camera surveys. Data on the age, sex, weight, and condition of deer are collected at the time of hunter check-out at the Outdoor Recreation Branch. Further, gestation data is collected post-hunting season to determine population health and recruitment, on a biannual basis.

Figure 4.13. Annual deer harvest at Redstone Arsenal, Alabama, 1994-2016



Eastern Wild Turkey. Suitable Eastern Wild Turkey habitat contains mature hardwood stands for mast production; scattered conifers for roosting sites; open understories allowing for predator detection; scattered clearings for feeding, nesting and strutting areas; well distributed water supplies; and sufficient prescribed fire to stimulate plant production, improve palatability, and nutrition. Much of Redstone Arsenal has a poor distribution of mixed hardwood species, resulting in high annual variability in mast production. Missile ranges and wildlife clearings both fallow and planted with chufa, wheat, or clover provide good breeding, nesting, bugging and brooding areas. Fallow disking of fire breaks allow certain amounts of bare ground and natural regeneration of native forbs and grasses during non-burn years, providing suitable habitat conditions for wild turkey broods. Relatively open understory preferred by the Eastern Wild Turkey are lacking in many of the Installation's woodlands, due to the overgrowth of Chinese privet and other undesirable plant species. Turkey hunting at Redstone Arsenal is limited to gobblers only, during a spring-only season. Turkey harvest information from 2004 to 2014 is depicted in Figure 4.14. The Eastern Wild Turkey harvest averages approximately 21 turkeys per year on the Installation.

Figure 4.14. Annual Eastern Wild Turkey harvest at Redstone Arsenal, Alabama, 2004-2014.



Northern Bobwhite Quail. Good habitat for Northern Bobwhite exists in many areas of RSA due to the interspersion of open fields, pastures, upland hardwoods, early successional upland forests, and managed pine stands. This mix of habitat supports cover and forage opportunities for quail. The enhancement of quail habitat is challenging at Redstone Arsenal due to the dense coverage of fescue in pastures and roadsides, fencerow clearing, densely stocked pine stands, intensive grazing in pastures, and dense stands of various invasive plant species. Attempts are currently being made to replace fescue with native warm season grasses in parts of the Arsenal, which will improve foraging habitat of Bobwhite Quail.

4.4.6 Nongame Wildlife Species

Alabama state law prohibits the taking of non-game wildlife (Alabama Regulation 220-2-92). Management activities that may incorporate non-game species require a scientific collection permit from the ADCNR or written permit from the Commissioner of ADCNR. Enforcement of these regulations, as well as prescribed burning, forest management, and wildlife management are essential tools in the management of non-game species at RSA. Other actions that benefit non-game species include artificial nest structures (i.e., Eastern Bluebirds, Wood Ducks) and wildlife plantings.

Bat conservation is important due to their ecological significance, global population declines of some species, and ecological role. Pest insect control can be a benefit of bat conservation. Management of bats includes enhancement of roost and nursery sites, protection from taking, and implementation of USFWS management guidelines for mission and construction operations. Ample foraging sites exist over open fields and pastures, wetlands, surface water courses, ponds,

and near streetlights. Natural roosting and nursery sites are expected to result from select forest management that retains a variety of age classes of trees and cavity trees. By following the USFWS Decontamination Protocol when appropriate, RSA will ensure that it does not contribute to the spread of White-nose Syndrome. Education of the public also will contribute to the understanding and promotion of bat conservation.

Native herpetofauna are protected from harvest and collection. Protection of wetlands, riparian corridor, ephemeral pools, and seepage/springs help maintain habitat for many amphibians. The retention of snags and downed deadwood, prevention of forest fragmentation, and retention of hardwood forests also contribute to habitat maintenance for herpetofauna. Habitat management recommendations from the southeastern Partners in Amphibian and Reptile Conservation (PARC) will be implemented in an effort to manage Installation lands in a manner that is compatible with herpetofauna (Bailey *et al.,* 2006).

Conservation of non-game birds at RSA will be promoted as part of global and national conservation programs, such as Partners in Flight and the American Bird Conservancy. Consideration of Neotropical migrants, temperate migrants, and resident birds is a priority in forest and land management planning. A breeding bird study at RSA that examined biodiversity, ecology, distribution, and habitat associations of RSA avifauna was completed in 2010 (Best *et al*., 2010; Ortman, 2012). Avian biodiversity was found to rank highest in upland oak savannah, followed by pasturelands and small stream and riparian habitats. These results will contribute to the formation of habitat management prescriptions at Redstone.

Nongame birds are managed through protection from collection or harvest and habitat management. Birds selected as indicator species will be selected based on criteria, such as Federal or State protection status, concern scores designated by Partners in Flight, ecological role, and/or specificity of habitat needs.

Redstone Arsenal supports many rich and varied ecosystems which are important for migratory birds. However, native grassland habitat loss across the southeast has led to at least a 2% decline of migratory song birds in the US, such as the Northern Bobwhite, Field Sparrow (*Spizella pusilla*), Grasshopper Sparrow (*Ammodramus savannarum*), Prairie Warbler (*Setophaga discolor*), Dickcissel (*Spiza americana*), and Eastern Meadowlark (*Sturnella magna*). Redstone Arsenal, as part of the Wildlife Habitat Council's Corporate Campaign for Migratory Bird Conservation, joined the Tennessee River Valley Migratory Bird Focus Area, a partnership focused on improving conditions for wildlife in the Tennessee River Valley. The partnership encourages planting of native grasses, wildflowers, native tree species, and the removal of invasive species on public and private lands in the region. The use of native grass species helps the Installation and the Army meet natural resource sustainability goals.

The current goals of the partnership are 1) continued restoration and management of habitat on existing corporate partners' landholdings, 2) development of more public outreach tools, and 3) identification and recruitment of new public and private partners along the Tennessee River corridor to create more continuous migratory bird habitat. To date, Redstone Arsenal has converted 216 ac of fescue pasture to native warm season grasses to fulfill its obligation to the partnership. Future plans include conversion of approximately 100 ac of fescue in the Bobcat

Cave Ecologically Sensitive Area. Restoration of native grasses will also have several economic and ecological benefits. Maintenance costs will be reduced because once established, native grasses do not require mowing or pesticide-herbicide treatments.

As one of the largest landholders in the Tennessee River Valley, the Army is in the unique position to demonstrate leadership by implementing management practices that will improve habitat quality for migratory songbirds without compromising mission activities. In addition to ensuring compliance with the Sikes Act and the Migratory Bird Treaty Act, regional partnerships designed to improve habitat for declining species may prevent the need for future listings under the Endangered Species Act. Further, Executive Order 13186 designates Federal responsibilities for protecting migratory birds and includes items to promote the conservation of migratory birds.

4.4.7 Wildlife Habitat Management Practices

Forest Management

During forest management activities, soft and hard mast producing trees in multiple age classes will be retained. Many mast producing tree species peak in mast production at > 45 years of age; uneven age forest regeneration will be managed to maintain these older age classes in stands over time. Benefits to wildlife include increased and sustained food production and cavity production for roosting and nesting.

Uneven age management in pine forest stands through small group selection, single tree selection, and patch cutting will be implemented. Selective thinning to a basal area of less than 70 sq ft/acre and prescribed burning can create multi-layer canopies and increase herbaceous and seed plants in pine forests with limited forest fragmentation.

Soft mast-producing vines and shrubs in forest ecotones, wetland edges, and forested watersheds will be favored. Bottomland and riparian hardwood forests shall be protected from fire to allow upper canopy development of woody vines and midstory development of soft mast producing shrubs, both of which provide valuable food and cover for wildlife.

Understory improvement operations will be conducted to improve wildlife habitat. This will allow more light to penetrate to the ground, thereby encouraging native grasses, forbs, and shrubs that are used as a food source by many wildlife species. Treatment areas will be surveyed to determine the quality of the existing ground cover. Methods of understory control may include prescribed fire, herbicide, mechanical, and hand clearing.

Herbicides may be used to kill undesirable species thereby opening the understory forest, allowing light to reach the forest floor. Herbicides will be applied following the manufacturer’s directions and application rates. All herbicides will be applied in accordance with DoD and other applicable laws and regulations. Herbicides will not be used in the Groundwater Protection Buffer Zone (Section 4.1) without proper approval from natural resources personnel and the USFWS.

In areas where the understory encroachment is not as severe, or where herbicide use is restricted and there is higher quality ground cover, mowing will be used to reduce undesirable understory vegetation. Equipment to be used will include a rubber tire tractor with bush hog attachment, skid steer with Fecon head, and Kodiak Kutter. Hand clearing with chainsaws, axes, and bank blades may be used in areas where understory encroachment is minor or to remove vegetation very close to the base of large trees.

Once areas have been cleared of excess understory vegetation, prescribed fire will be the primary means for maintaining this habitat. If fire fails to maintain the open understory, a site assessment will be conducted by the Natural Resources staff and additional appropriate control methods will be used.

Living cavity trees, standing snags, and downed deadwood in forested habitats will be maintained, as applicable and allowable. Optimally, living cavity trees shall be retained at densities of $\geq$3 trees per acre. Older age classes (>45 years) of deciduous trees provide natural nesting cavities and roost sites for bats, squirrels, and cavity-dwelling raptors and songbirds. Standing snags should be retained at similar densities unless timber must be removed for control of pine beetles or the snags present a safety hazard. A wide size range will provide diverse species use with primary excavators as well as smaller secondary cavity users. Downed deadwood resulting from fallen trees and snags will produce habitat for invertebrates, forest-dwelling herpetofauna, rodents, and to enhance soil fertility by increasing mycorrhizal and annelid activity (Hunter 1990). Benefits include an increase in nesting and escape cover for many birds and herpetofauna as well as retention of site productivity.

Prescribed Fire

Prescribed fire is one of the most cost-effective and beneficial methods to set back plant succession over large acreages (USDA, Forest Service Southern Region, 1989). It will be one of the main techniques for wildlife habitat management at Redstone. Featured game species with regard to prescribed fire are Northern Bobwhite, Eastern Wild Turkey, and white-tailed deer. In pine habitat, prescribed fire benefits deer by improving the palatability and nutritional level of understory plants; reducing large, woody understory stems; encouraging production of new sprouts; reducing roughs that suppress forbs and grasses; keeping browse vegetation within reach of deer; and encouraging understory fruit and mast production.

Prescribed fire is also used for the prevention of large wildfires within impact and firing ranges. With a few exceptions for ranges and quail management areas, most areas will be burned on a three to five year rotation. Fire maintains an open understory that will provide native grasses and legumes, recycle nutrients, and provide bare mineral soil for seed germination. These results will provide a valuable food source in seeds and bugging grounds for many animal species.

Strip Disking

Strip disking is used to change the composition of plants and improve habitat for early succession wildlife species. Disking breaks up areas with thick mat-forming grasses and also enables seed producing plants to grow between parcels of thicker vegetation. Where feasible,

strip disking will be used to encourage weedy ground cover. This will produce brood and feeding habitat for quail, turkey, and songbirds.

Disking is used to encourage the development of native food plants such as ragweed and partridge pea. Strip disking may be done in areas that have been thinned or burned, and/or within wind rows of older plantations. Disking during November through January will create brood habitat the following summer, therefore any areas such as food plots, skid lanes, logging decks, firebreaks, and open woodland patches near acceptable cover are suitable for this method of habitat management (Moser and Palmer, 1997). This technique not only aids in food production but increases “edge” which is very important in habitat management.

Additionally, annual wildlife plantings in established clearings are planted on a rotational basis. This enables ground that was harrowed the previous year to produce native food plants the following year. Disking will be coordinated with the Cultural Resources Manager to protect archaeological sites eligible for listing on the National Register of Historic Places.

Wildlife Clearings

Redstone Arsenal currently manages approximately 310 ac of wildlife clearings in 47 plots. The number and size of clearings within individual forest compartments vary. The interspersion of clearings supplements native forage availability and provides additional cover, nesting, and brood range for a variety of game and non-game species. Current planting/maintenance schedules are devised to promote site-soil relationships, reduce annual tillage requirements, provide a continuous flow of forage opportunities for various wildlife species, and maintain a quality recreational hunting experience associated with managed wildlife clearings.

Each spring, approximately 190 ac are planted in grain-type crops (clover, millets, sunflowers, legumes) specifically for doves and quail. Fall or cool season plantings (clover, wheat, rye, oats) on the remaining acreage are tailored toward deer, turkey, quail, and other game species. A number of clearings are left fallow within each forest compartment to evenly distribute simple grassy openings for wildlife. Hunters benefit from the interspersion of managed clearings by having breaks in contiguous forestland that provide a variety of hunting opportunities.

The decision to create new wildlife clearings is based on identified need, soil type, interspersion of existing clearings, proximity to other forest openings, and relationship/integration with other land management activities. Future planned maintenance of mission support openings (e.g. access roads and rights of way) will provide a better balance of habitat requirements for game and non-game wildlife. Management of wildlife clearings will be coordinated with the Cultural Resources Manager to protect archaeological sites eligible for listing on the National Register of Historic Places.

Streamside Management Zones

Streamside management zones (SMZ) and vegetated wetland buffers will be maintained (Section 4.2). Tree harvest and equipment operation will be limited in SMZs and buffers to

protect riparian and wetland ecotone habitat. Benefits to wildlife include undisturbed mesic and aquatic habitats; maintenance of habitat quality for protected flora, forest-dwelling Neotropical migrants, and amphibians; and retention of wildlife travel corridors.

Native Warm Season Grasses

Historically, portions of the southeastern United States were covered with large tracts of open grasslands and savannahs maintained by natural fire events. Native warm season grasses, a major component of these ecosystems, were important for many species of migratory birds and other wildlife because their growth form provides structural cover and abundant seed. Over the last century, most of these areas have been replaced with non-native grasses, agricultural crops, forest cover (due to suppression of fire regime), and urban/suburban development. Throughout North America, efforts are underway to restore native grasslands and other essential habitats for migratory birds through private and public partnerships.

Native warm season grass restoration is a recent and on-going management objective at Redstone Arsenal. These NWSG areas on Redstone Arsenal will provide important habitat for numerous bird species, including species of special concern in Alabama such as the American Kestrel (*Falco sparverius*) and Dickcissel. A short prescribed burn cycle will maintain a sparse shrub layer and promote high quality ground cover/understory habitat. Reference Appendix H for the 2017 Native Warm Season Grasses Management Plan.

4.4.8 Wildlife Damage Management

Wildlife damage management, or control, is defined as the alleviation of damage or other conflicts caused by or related to the presence of wildlife. An integrated wildlife damage management approach involves a combination of methods used or recommended to reduce wildlife damage. Currently the Installation applies both preventive (habitat modifications, education) and corrective (live trapping, lethal control) measures to achieve the desired results. All techniques used on the Installation conform to Federal/State permitting authorities.

On 3 April 1997 Redstone Arsenal and the USDA/APHIS/WS signed an Interagency Cooperative Agreement to conduct wildlife damage management. Wildlife Services provides staff under the direction of the Installation Wildlife Biologists to assist in control of nuisance wildlife. These annually renewable services are subject to the availability of funds.

In the past, beavers have dammed low water crossings, causing roadways to become impassable and damaging trees in managed forest stands. Further, beaver impoundments alter stormwater runoff at RSA and potentially impact surface water quality. Beavers are typically controlled by use of trapping; all methods utilized at RSA for beaver control are in accordance with USDA Wildlife Services' policies and procedures.

In the event that other animals (e.g., raccoons, coyotes, woodchucks, and armadillo (*Dasypus novemcinctus*)) present nuisance problems, they are trapped using any and all approved methods and euthanized. Animal relocation to areas away from the original problem area is not supported at RSA due Alabama State restrictions for relocation, the potential for the spread of

disease, the potential for a new nuisance problem in the area of relocation, and the high potential for nuisance animals to return to the original problem area.

4.4.9 Plants

Redstone Arsenal's geographical setting provides for diversity of plant communities and species. Vegetation on the Installation is discussed in detail in Sections 2.3, 4.5, and 4.10.

4.4.10 Education and Safety

Natural Resources personnel in RSA's EMD participate in several education events throughout the year. Events conducted or attended by Natural Resources personnel were discussed in Section 3.5. A number of Hunter Safety Orientation classes are provided by the DFMWR on an annual basis.

4.4.11 Goals and Objectives

(1) Conserve sensitive animal species and species that are indicators of habitat and ecosystem health
- Initiate new and complete ongoing wildlife research studies. Coordinate with the Alabama DCNR to collect white-tailed deer herd and disease data.
- Maintain artificial nest boxes for Eastern Bluebirds and other cavity-nesting migratory birds.
- Continue implementation of NWSG habitat creation. Restore native vegetative structure and composition.
- Conduct annual prescribed burns to support nesting, foraging, shelter, and loafing habitats of approximately 2,000-4,500 acres.
- Minimize impacts to 500 aces sensitive habitats by proper use of mechanical clearing and chemical herbicides and pesticides in accordance with Installation Pest Management Plan.
- Continue mechanical clearing of 150 acres of understory of forest stands to reduce invasive species present and restore native vegetative structure and composition.
- Monitor recreational trail maintenance activities in accordance with the Mountain Bike Trail Maintenance SOP.

(2) Provide quality and sustainable hunting opportunities by monitoring and managing game species populations.
- Conduct annual/biannual deer surveys.
- Maintain artificial nest boxes for Wood Ducks.
- Collect data from harvested game species.
- Support Conservation Law Enforcement Officer(s).
- Conduct annual prescribed burns to support nesting, foraging, shelter, and loafing habitats of approximately 2,000-4,500 acres.
- Continue mechanical clearing of 150 acres of understory of forest stands to improve forest structures and composition for white-tailed deer and Eastern Wild Turkey.
- Develop and implement annual Wildlife Clearing Management Plan.

(3) Protect the health and safety of Installation tenants from animal-vehicle collisions, nuisance situations, and zoonotic diseases.

- Implement Wildlife Damage Management/Control Program.
- Maintain/update special depredation permits to address wildlife damage control situations.
- Develop education materials for Installation residents or other tenants on preventative measures to reduce wildlife/human interactions.
- Respond to nuisance wildlife complaints.
- Discourage relocation of nuisance animal species.

4.5 Forestry Management Component

4.5.1 Mission Statement

The Forestry Management Component (FMC) will support the military mission on Redstone Arsenal by providing the necessary landscape conditions for the testing and training requirements for the various tenants of the Installation, while protecting the environment and complying with all applicable laws and regulations. These services will be provided to the customer through sustainable income from the sale of forest products.

4.5.2 Plan Objective

The Redstone Arsenal FMC will be used as a planning tool by Natural Resources personnel as well as others in the USAG-Redstone to provide the most accurate information and appropriate support to the Installation's many customers. This plan will cover the five year period FY 2017 through FY 2021 and undergo a complete revision every five years; however many factors such as funding, testing requirements, local forest product market fluctuations, and changes in command may warrant more frequent updates. The Forest Management Program is administered by the Installation Forester of the CNR Branch, Environmental Management Division of the Directorate of Public Works. Plan implementation and oversight will be coordinated by the Installation Forester using available government and contract personnel, interagency agreements, and local Installation expertise as available. The overall objective of the FMC will be to support the various missions of the tenants on RSA through ecologically sound and scientifically based forest management while providing a sustainable income from forest products.

4.5.3 General Information for the Forest Management Plan

<u>Forest and Fire Management History</u>

Before Army Acquisition. A history of the land now comprising Redstone Arsenal is available in the 2012 ICRMP. Many of the areas that are now in timber were used for row crop production prior to acquisition.

Since Army Acquisition. Logging operations were carried on during 1953 and 1954 for range clearing. Managed timber harvesting through sales has been carried out from 1958 to the present.

Prescribed burning was not frequently used in forest management before the property was acquired by the Army. Most of the property was in agricultural or grazing use; fire would have been used mainly to clear areas of timber for conversion to agriculture. An aggressive national policy for fire protection and suppression was started after damaging wildfire seasons in the western United States in the early 1900s; this was the policy for public land holdings until the mid-1980s when a Prescribed Burning Program was initiated on RSA. No major fires have occurred on the woodland areas since the land was acquired for military use.

Until 1996, the RSA Fire Department and Installation Forester cooperatively conducted prescribed fire. After which, the Installation Forester, Wildlife Biologists, and contract personnel

with USDA-Wildlife Services were deemed responsible for wildland fire prevention through prescribed burning and fire lane construction and maintenance. The RSA Fire Department maintains primary responsibility for wildland fire response and suppression with the current grounds maintenance contractor and CNR personnel providing additional support. Since the reintroduction of fire on Redstone, the goal has been to burn approximately 2,000 to 4,500 ac of rangeland and timber stands with the majority of acres being of high risk for ignition due to mission activities. Prescribed burns are performed according to an Annual Prescribed Burn Plan (Appendix G), reviewed by the Fire Department as well as other appropriate Installation personnel. Daily burn plans are input into a prescribed fire database with all the appropriate smoke screening, predicted and current weather conditions, and location as well as an ignition plan. Maps and GIS shape files have been maintained since 2004 and historical records have been added to the geodatabase.

Military Use. The various missions of RSA require a supportive forestry program for increased fire prevention and to shape the landscape for the testing and training in a sustainable and ecological manner.

Reforestation. The primary species planted will be loblolly pine, red and white oaks (*Q. rubra* and *Q. alba*), and other hardwoods, as needed. These species are favored as they are adaptable, indigenous to this locale, and can be expected to produce at maximum rates. Natural reproduction is expected once the stand is re-established, when the trees are of such a size that seed are produced. Artificial regeneration may be necessary if stands have poor genetics or forest health problems. Technical provisions of planting contracts will cover such points as:

- Species of trees to be planted, planting location, and planting method to be used.
- Spacing of the trees to be planted, example 6'x10' or 726 trees per acre.
- Months during which the planting will be accomplished, normally from 15 November to 15 March.
- Any special treating of planting stock to prevent damage from insects, rodents, or diseases.

Forest Products

Wood products utilization industries in the vicinity of Redstone Arsenal are identified by the USACE. Forest Product Industries are located in nine counties in northern Alabama,one county in southern Tennessee, and one county in northwest Georgia.

Table 4.3 is the summary of the forest inventory of nearly 15,000 ac of managed woodland at RSA, prepared under contract by Virginia Tech University during the spring and summer of 2007 (Conservation Management Institute, 2007). The values are given on a per acre basis. A cooperative agreement with Auburn University is in place to update the RSA forest inventory in 2020-2021.

Table 4.3. Inventory of Managed Forest at Redstone Arsenal, Alabama

Compartments	HST* (MBF)	PST (MBF)	HPW (cords)	PPW (cords)	Acres
1	4.30	1.96	6.1	2.0	663.5
2	5.01	1.94	9.9	0.1	1089.3
3	1.73	5.79	2.9	1.8	978.0
4	9025.0	5.38	4.1	4.2	200.7
5	1.73	1.97	6.5	2.9	2313.4
6	1.48	2.42	4.4	5.9	459.5
7	5.33	5.26	6.1	1.2	644.1
8	3.28	4.55	4.1	0.7	517.6
9	2.42	3.78	3.7	3.8	745.1
10	3.59	3.09	1.6	0.3	186.4
11	2873.0	7.46	2.7	1.9	80.3
A	2.37	3463.0	8.6	7.5	291.1
B	1.67	5.98	4.4	0.6	85.0
C	3.28	2.53	4.5	0.6	810.0
D	N/A	11.86	1.1	N/A	5.7
E	4.33	2.18	7.3	0.6	1438.2
F	3.28	4.13	6.6	0.8	334.7
G	4.47	4.31	5.3	2.4	1285.3
H	4.69	1.69	7.5	0.6	1252.6
I	3.32	3.74	7.1	2.4	732.8
J	2.58	2.08	7.0	10.6	494.8

* HST = Hardwood Sawtimber
PST = Pine Sawtimber
HPW = Hardwood Pulpwood
PPW = Pine Pulpwood
1 cord = 90 cubic feet (cu ft) of wood
MBF = thousand board ft.

Harvest

The current allowable harvest is calculated based on current volumes and the stocking level for each compartment (Table 4.4). Harvest volumes and prices will vary depending on market demand, environmental conditions, mission requirements, and environmental regulations.

Table 4.4. Estimated Income for FY 2015 Forest Harvest, Redstone Arsenal, Alabama

Product	Unit	Price/unit ($)	Income ($)
PPW	6359.12 tons	10.00	$63,591.2
PST (grade)	139.33 tons	31.00	$4,319.23
PST	214.44 tons	20.00	$4,288.8
HPW	2433.27 tons	10.00	$24,332.70
Total			$96,531.93

The present cycle for harvesting timber at RSA is seven years for all pine products and 10 years for all hardwood products. Average total rotation cycles are presented in Table 4.5. Due to the fact that there are 21 compartments in the timber inventory, it is feasible to schedule harvests in three compartments each year for the pine stands. There will be limited harvest of hardwood except in areas for mission construction projects or as deemed appropriate for wildlife management. Hardwood products may be included in sales with insect or health problems mainly for the purpose of salvage.

Table 4.5. Average Total Rotation Cycle for Timber Harvest at Redstone Arsenal, Alabama

Timber	Years
Pines	70
Miscellaneous Hardwoods	85
Red cedar	50
Black locust	15
Virginia pine	30

Estimated Operating Cost and Value by Fiscal Years 2017 through 2021

Estimated operating costs and forest product values for the plan period are presented in Section 5.0. The estimated costs are presented by forest management activity and total for the appropriate Fiscal Year. Total estimated values are based on harvests necessary for construction as well as planned silvicultural thinning practices.

4.5.4 Description of Forest Types and Tree Species

Tree and shrub species consists of conifers and upland hardwoods that are indigenous to this area. Bottomland hardwood species are found in creek and stream bottoms and on low flat lands. Conifers consist of loblolly, shortleaf (*P. echinata*), Virginia pines (*P. virginiana*) and eastern red cedar. There is an unusually large volume of red cedar on the Installation mountain areas. The most common species of trees and the relative abundance of each in relation to timber production are as follows in Table 4.6.

Table 4.6. Relative Abundance of Timber Trees at Redstone Arsenal, Alabama

Common Name	Scientific Name	Relative Abundance
Mockernut hickory	*Carya tomentosa*	Abundant
Eastern red cedar	*Juniperus virginiana*	Abundant
Loblolly pine	*Pinus taeda*	Abundant
Willow oak	*Quercus phellos*	Abundant
Black locust	*Robinia pseudoacacia*	Abundant
Red maple	*Acer rubrum*	Common
Bitternut hickory	*Carya cordiformis*	Common
Pignut hickory	*Carya glabra*	Common
Hackberry	*Celtis occidentalis*	Common
White ash	*Fraxinus americana*	Common
Sweetgum	*Liquidambar styraciflua*	Common
Tupelo gum	*Nyssa aquatica*	Common
American sycamore	*Platanus occidentalis*	Common
White oak	*Q. alba*	Common
Cherrybark oak	*Q. falcata* var. *pagodaefolia*	Common
Water oak	*Q. nigra*	Common
Red oak	*Q. rubra, Q. falcata* & *Q. borealis*	Common
Black willow	*Salix nigra*	Common
Sassafras	*Sassafras albidum*	Common
Winged elm	*Ulmus alata*	Common
Boxelder	*Acer negundo*	Occasional
River birch	*Betula nigra*	Occasional
Shagbark hickory	*Carya ovata*	Occasional
Eastern redbud	*Cercis canadensis*	Occasional
Flowering dogwood	*Cornus florida*	Occasional
Persimmon	*Diospyros virginiana*	Occasional
American beech	*Fagus grandifolia*	Occasional
Green ash	*Fraxinus pennsylvanica* var. *lanceolota*	Occasional
Black Walnut	*Juglans nigra*	Occasional
Yellow poplar	*Liriodendron tulipifera*	Occasional
Black gum	*Nyssa sylvatica*	Occasional
Shortleaf pine	*Pinus echinata*	Occasional
Eastern cottonwood	*Populus deltoides*	Occasional
Black cherry	*Prunus serotina*	Occasional
Chestnut oak	*Q. prinus*	Occasional
Post oak	*Q. stellata*	Occasional
Silver maple	*Acer saccharinum*	Rare
Osage orange	*Maclura pomifera*	Rare
Slash Pine	*Pinus elliottii*	Rare
Chinkapin oak	*Q. muehlenbergii*	Rare
Shumard oak	*Q. shumardii*	Rare
Basswood	*Tilia americana*	Rare
American elm	*Ulmus americana*	Rare

Forestland Classification

Reference Table 4.7. The coniferous forest type is well distributed over the well-drained, low ridges and in some of the low areas on the Installation. Pine plantations have been established over the years since 1948. Mixed forest sites occupy the better quality sites on the Arsenal. The pure deciduous stands are mainly in the low-lying land where the soil tends to be wet or swampy. Logging in some of these areas is difficult due to the high water level and the wetland restrictions. Cedar and hardwood (mixed) is the predominant growth in the limestone outcrop areas on the mountain sides. Red oak, white oak, hickory, ash (*Fraxinus* spp.) and miscellaneous hardwood occurs throughout the area, however, these rocky rough areas are best suited to eastern red cedar.

Table 4.7. Acreages of Forest Types at Redstone Arsenal, Alabama

Types	Acres
Coniferous	4318.2
Deciduous	6601.4
Mixed	4978.2
Total	15897.8

US Army regulations currently specify two Forestland Classifications – reimbursable (commercial) and non-reimbursable (noncommercial) forestland. Reimbursable forestland is described as land that is capable of economically producing crops of industrial wood in excess of 20 cu ft per acre per year under management. The acreage of RSA lands by Forestland Classification are presented in Table 4.8. All reimbursable forestland (RFL) is presently available for management with minimum restrictions. The amount of acreage with stricter restrictions on the types of forest management activities carried out on it is subject to significant increases during the period covered by the FMC. Restrictions may result from increased emphasis on such things as ground cover; T&E species; community tier levels; Federal and State laws and regulations; and DoD/US Army regulations and guidance.

Current Federal law and DoD/US Army policy prohibits the use of reimbursable forestry funds for activities that cannot reasonably be expected to produce forest revenues or in areas that are classed as non-reimbursable forestland (NRFL). An increase in NRFL acres will increase the need for other funds to cover forest ecosystem management and protection activities, which historically have been paid for with reimbursable forestry funds.

Table 4.8. Forestland Classification at Redstone Arsenal, Alabama

Forestland Classification	Area (ac)
Reimbursable	9296.4
Non-reimbursable	
Deciduous	6601.4
Non-Forestland	14370.0
Forested Wetland, Water	765.0
Other Federal agencies	6877.2
Total	37145.0

4.5.5 Management

General

The timber crops grown include veneer logs, poles, sawtimber, crossties, pulpwood, fence posts, and Christmas trees. Christmas trees will be harvested from young red cedar stands that are underutilized for any other reasonable purpose; and these trees are currently provided at no charge to the patrons or expense to the government.

Intensive woodland management is practiced at this Installation, in areas containing valuable timber or areas capable of producing valuable timber. This includes pine sawtimber and poles, red cedar sawtimber, and high value sawtimber and veneer hardwoods such as black walnut, yellow poplar, white oak, sweet gum, and tupelo gum. Due to economic feasibility, areas incapable of producing the above-mentioned products do not typically receive intensive management. The Installation Forester is responsible for guiding and directing all phases of work outlined in the FMC.

Primary Forest Tree Species for Management

The reason for selecting the species listed in Table 4.9 is for their abundance, adaptability, grade, and value as timber products. The pine species, black walnut, and white oak are most important for the requirements listed above and are favored first. Eastern red cedar is a high valued tree species, resistant to insects and disease, and capable of producing on the poor soils and on limestone mountain outcroppings. The remaining hardwoods were selected because of their abundance, adaptability to the site, and capability to produce high quality sawtimber and veneer logs. Virginia pine was selected because of its tolerance to very poor, dry, rocky sites and its production of pulpwood. Due to the relative abundance and capability of regenerating hardwoods naturally, limited effort will be made for the planting of hardwoods as described in the Planting Section.

Table 4.9. Primary Tree Species for Management at Redstone Arsenal, Alabama

Common Name	Crops to be produced
Loblolly pine	Pulpwood, Poles, Sawtimber
Shortleaf pine	Pulpwood, Poles, Sawtimber
Eastern red cedar	Christmas trees, Sawtimber
Black walnut	Sawtimber, Veneer logs
Yellow poplar	Sawtimber, Veneer logs
White oak	Sawtimber, Veneer logs
Cherrybark oak	Sawtimber, Veneer logs
Red oak	Pulpwood, Crossties, Sawtimber, Veneer logs
Shumard oak	Pulpwood, Crossties, Sawtimber, Veneer logs
Water oak	Pulpwood, Crossties, Sawtimber
Tupelo gum	Pulpwood, Sawtimber, Veneer logs
Sweetgum	Pulpwood, Crossties, Sawtimber, Veneer logs
Eastern cottonwood	Pulpwood, Sawtimber, Veneer logs
Basswood	Pulpwood, Sawtimber, Veneer logs
White ash	Pulpwood, Sawtimber, Veneer logs
Green ash	Pulpwood, Sawtimber, Veneer logs
American sycamore	Pulpwood, Sawtimber, Veneer logs
Black cherry	Pulpwood, Sawtimber, Veneer logs
Black locust	Fence posts
Virginia pine	Pulpwood, Sawtimber

Stand Rotation, Cutting Cycle, and Prescription

The rotation for a given species is the age at which that species should be harvested (Table 4.5). This does not preclude harvesting trees before that age to thin the stand or to salvage weak and diseased individuals.

Due to extreme variations in site condition and productivity at the Installation, no fixed cutting cycle is established. Following the first reimbursable thinning of a pine pulpwood stand at age 15 to 30 years, the stand will be examined approximately five years later and a second cut scheduled, if necessary. Following this second cut, a 10-year interval can be anticipated before any further cutting is considered. No cycle is established for bottomland hardwood. Buildup of beaver populations in stream systems imposes an unknown variable on future regulation of bottomland hardwood cutting. Beaver control measures where viable will be coordinated with RSA Wildlife Biologists and done in accordance with the nuisance wildlife management standard operating procedures (SOPs).

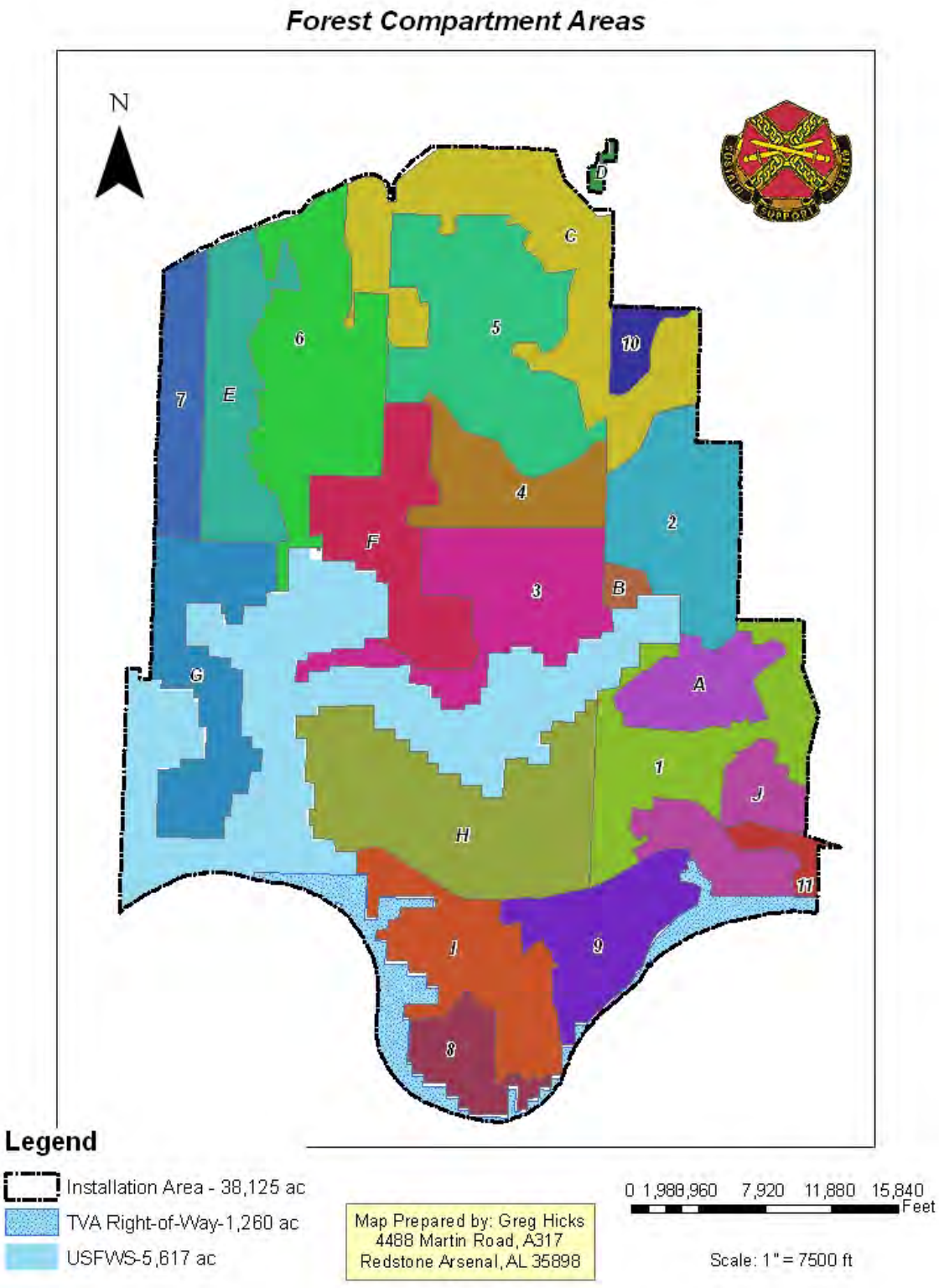
A major salvage sale of bottomland hardwood took place in the mid-1990s, as an improvement cut. Surveys around this time revealed an inordinate amount of beaver damage to residual high

quality, large diameter stems. The decision was made to market this area to preclude loss of this resource. Harvesting in these drainages was completed around FY 2000. No cycle is currently established for upland or bottomland hardwood, due to critical habitat concerns in bottomland areas and limited quality in upland stands. Another major hardwood management project was undertaken in cooperation with Auburn University in 2008. Research was needed over large blocks for behavioral patterns of Neotropical migrant songbirds according to certain forest management actions. Approximately 400 ac on the installation were chosen that had the appropriate tree species composition for this study and certain management actions were applied to measure the effects. This project will likely be ongoing and the study area may be used in the future for other research projects. These projects are done with full consideration of all environmental and mission requirements.

The total woodland areas at RSA have been divided into 21 compartments for the purpose of management planning (Table 4.3 and Figure 4.15). Sawtimber and/or pulpwood will be harvested from one or more compartment(s) each year. Compartments of Regulated Commercial Forest Land are numbered 1 through 11 and the Compartments of Modified Commercial Forest Land are lettered A through J. Boundaries are delineated on the ground by roads, fire trails, natural openings, fences and streams. Modified Areas are so designated because there is some factor which prevents regular forest management activity on a regular basis. Two examples of this are the housing area in the northeast quadrant of the Arsenal and the area previously leased to Thiokol west of TA-10 and north of Redstone Road.

Each forest compartment is further broken down into forest stands to assist in planning the management and harvesting operations. Each stand is a distinct forest type that can be recognized on the ground by a forester or trained forest technician. Harvesting is generally prescribed according to compartment and on a stand level.

Figure 4.15. Forest compartment areas at Redstone Arsenal, Alabama



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4.5.6 Silvicultural Practices

The overall management system applied to the forest resources on Redstone is the volume method of regulation utilizing the seven-year cutting cycle. The system provides the opportunity to manage even-aged and uneven-aged stands that may be desirable for mission requirements. All harvest treatments of the pine stands will be a series of selective thinning operations to produce a mature high value crop stand. Just prior to rotation age, site conditions and mission requirements will be obtained to determine either a natural or artificial means of stand regeneration. Should artificial regeneration be utilized, no more than 50 ac will be cleared without there being a buffer stand of 51 ac in size.

Stand management attempts to retain optimum stocking per acre for maximum benefit over the life of the stand. This is a function of site quality, initial stocking, and stand condition. The current on-going forest stand inventory and prescriptions will provide information upon which to make management decisions for each of the stands. The major guideline is to selectively mark pine and mixed commercial timber stands to a BA of 60 to 70 sq ft/ acre, removing unhealthy trees and trees of inferior quality on a 10-year cutting cycle.

The final harvest cut of fully stocked stands will be scheduled when stands reach full maturity. Stands of non-native or off-site species and those stands which are under stocked, poorly formed, or excessively diseased, will be scheduled for final harvest as soon as feasible. Some final harvests will be completed on construction sites for buildings or new ranges as required by the Installation mission.

A silvicultural system is a comprehensive, planned program of treatments and methods applied throughout the life of a forest stand. Redstone Arsenal uses two systems with three variations. RSA's main reimbursable silvicultural system is artificial even aged systems using pine plantations (stands that have been planted with seedlings obtained from a nursery, rather than originating from seed sources on the site).

<u>Even-aged Silvicultural Systems</u>

An even-aged stand is one in which relatively small age differences exist between individual trees. The maximum difference in age permitted in an even-aged stand is usually no more than 10 years. Although, where the stand will not be harvested until it is 100 to 200 years old, larger differences up to 20% of the rotation age may be allowed.

The *artificial even-aged silvicultural system* is characterized by stands that are clear-cut, intensively site-prepared, planted with seedlings, periodically thinned, grown to rotation age, harvested, and regenerated. The system has several disadvantages as military mission damage to the plantation can occur very rapidly, there is no seed source to regenerate openings, there is a high cost of establishment, and plantations may lack biodiversity. Plant and animal species dependent upon old-growth trees normally do not do well in such an intensive, short-rotation silvicultural system. This system has application on sites where conversion from non-native or off-site species is required and an inadequate seed source is present. Where type conversion is necessary, this silvicultural system is the most logical solution. Once the stand has been

established, plantation management will be phased into the natural even-aged or uneven-aged silvicultural systems.

The *natural even-aged silvicultural system* is widely used on US Army lands in the southeastern US and is most useful in blending military training with sustained yield of multiple resources. The system may be described as forest management composed of even-aged stands originating from a seed source, thinned at periodic intervals for stand improvement, maintained by fire, and regenerated from the residual stand at rotation age. Advantages are that establishment and maintenance are relatively cheap, undesirable trees are removed at a profit, and regeneration is from a known source of high quality trees.

Uneven-aged Silvicultural System

Uneven-aged regeneration harvests are usually done at intervals of five to ten years, and every harvest has an objective to provide an opening for regeneration and to maintain an uneven-aged stand. Trees are designated for removal by the selection method either as single trees, small groups, or a combination of both. The selection method involves periodic cutting of selected trees from all merchantable classes. If possible, the slow-growing and/or poor quality trees are cut and the best trees left so that stand quality and growth will be improved. Pine regeneration will come from seed produced by the best growing and best quality trees.

Harvesting

Harvesting within silvicultural systems is called intermediate cutting and are of three types:

- A *thinning* is a harvest to reduce competition and accelerate growth of the residual stems. Commercial thinning is made in stands where revenue is derived from the sale of the thinned trees. Hand crews, prescribed fire, chemicals, or mechanical means are methods used to accomplish thinning in pre-commercial stands.
- *Improvement cut* is a method in mixed stands of desirable and undesirable trees. Undesirable trees are removed to improve quality, to remove vulnerable trees before disease and insect infestation and/or to improve wildlife habitat or aesthetics.
- *Salvage-sanitation cuts* salvages timber damaged by fire, military testing or training, insects, storms, or other catastrophic forces. Minimization of economic loss, utilization of damaged timber, and aesthetic improvement are the objectives rather than to generate income.

Regeneration

Species, site capability, weather, competing vegetation, and availability of an acceptable seed source are some of the variables that are considered when the RSA forest manager plans to regenerate a stand. In natural management, the forest manager often has little control over these variables, but must exert subtle influences through intermediate silvicultural treatments over many years to bring a stand to the point where satisfactory natural regeneration will be possible.

Even-aged regeneration harvests are planned specifically to bring about regeneration and not to

improve the stand or generate income. Characteristics of individual species such as shade tolerance, susceptibility to wind-throw, soil and moisture requirements, and seed dispersal ability are factors which determine the type of regeneration harvest to be applied within a silvicultural system. Even-aged regeneration harvests may be a clear cutting, seed tree, or shelterwood methods.

Clear-cutting is the harvesting of all merchantable trees in a stand in one operation. Generally, clear-cut areas will not exceed an average of 80 ac in any one block. Regeneration will be accomplished either naturally or artificially. Hardwood stands that have been clear-cut generally reproduce from stump and root sprouts or seeds stored in the forest floor; hardwood clear-cutting is not currently practiced at RSA. Pine stands are most often regenerated artificially by planting. Site preparation may be necessary in the form of drum chopping, raking, windrowing/piling, burning, disking, bedding, chemical application, or a combination of these treatments.

The *seed tree* method selects high quality, prolific seeding trees to be retained to provide a seed source following harvest of the rest of the stand. Ten to 15 evenly spaced dominant or co-dominant loblolly pines per acre are left as a seed source. After a stand of young trees is established, seed trees will be removed. The method is well suited to the natural regeneration of loblolly pine in situations where the seed source has good genetic integrity. Seedbed preparation such as chopping, and/or burning is usually sufficient to expose adequate mineral soil. Disking or chemicals may be necessary on sites having heavy hardwood understory or a deep root mat.

The *shelterwood* method is used on heavy seeded species such as longleaf pine (*P. palustris*), oaks, and hickories where seed dispersal from seed trees is not sufficient to provide for complete coverage of the stand. A series of preparation cuts may be necessary to remove unhealthy and defective trees and undesirable species, and to prepare the seedbed and encourage seed production. Over a period of years, shelterwood cuts will improve the vigor and productivity of remaining trees. The regeneration cut leaves 30 to 40, evenly spaced trees per acre, of the best dominant and co-dominant trees in the stand. As with the seed tree method, as soon as an adequate seedling crop is established, the overstory should be harvested.

Uneven-aged regeneration harvests (sometimes referred to as *modified shelterwood* harvests) are usually done at intervals of five to ten years, and every harvest has an objective to provide an opening for regeneration and to maintain an uneven-aged stand. Trees are designated for removal by the selection method either as single trees, small groups, or a combination of both. The selection method involves periodic cutting of selected trees from all merchantable classes. If possible, the slow-growing and/or poor quality trees are cut and the best trees left so that stand quality and growth will be improved. Pine regeneration will come from seed produced by the best growing and best quality trees.

The modified shelterwood method is the same as the shelterwood system except not all overstory trees are removed after seedling establishment. Approximately one-third to one-half of overstory trees are marked for harvest using group selection of trees in patches, ranging approximately 0.25 to two ac in size distributed throughout the stand. Created openings will take advantage of existing openings with adequate reproduction by enlarging them if necessary.

Conversion of Non-native and Off-site Stands

Redstone Arsenal will convert sites with non-native or off-site species to native species or species more suitable for a specific site. Slash pine is the only non-native pine species of any consequence growing on the Installation. The slash pine that was planted on the Installation is less than 100 ac and will be converted to loblolly pine as feasible. The area converted annually will be limited by several factors, such as the availability of funds and personnel, the number of acres needing conversion, the speed at which harvest contracts can be completed, and various other constraints. As prescriptions are prepared for each management unit, stands that require conversion will be designated as such so that they can be prioritized for conversion. These prioritizations for conversion will include all non-native and off-site stands within each compartment. The only silvicultural method will be to perform a final harvest on all or part of the stand and regenerate it to native species artificially.

Forest Product Harvest Operations

An annual harvest is sustainable and anticipated. Until the forest stand inventory and stand prescriptions are completed and analyzed, a prescription of annual harvest volumes is speculative. Based upon previous inventory volumes, informed estimates and past performance, an annual harvest of 750,000 to one MBF and 1,000 to 2,500 cords of pulpwood has historically been sustainable. Due to new endangered species requirements (e.g., northern long-eared bat), continued fragmentation of forested stands, and test area access control issues, these figures will need to be adjusted according to a new complete forest inventory.

The order of cutting will be determined by the USACE Project Forester (Sales Officer). Normally, in combined product sales, pockets of pulpwood are identified and isolated at time of marking. These may be advertised and sold as a separate item on a larger combined sale, or advertised as a separate sale. The forest stand inventory and prescriptions will identify these stands before marking, which will facilitate sales planning. Sawtimber areas are normally harvested first in mixed sales, with scattered pulpwood and top wood harvested afterward for maximum utilization of the resource. Where the contract calls for an “All Pine Trees” option, tree length harvesting, skidding, and hauling are accomplished, with product merchandising done at the consumer mill yard.

No optimum volume per sale is prescribed. In combined product sales, the cords of pulpwood per one MBF of sawtimber ratio should not exceed one to one. This provides for maximum stumpage return.

Forest Product Sale Planning

Inoperable conditions. Areas that do not contain a minimum of two cords per acre or equivalent total will not be offered as harvest areas. All areas known to contain or which might contain military or other types of metal contamination, such as shrapnel or armor-piercing bullets, will be declared as known contaminated or possibly contaminated timber. Such areas will be identified on maps or aerial photographs and ground checked with USACE District Engineer’s personnel before sales advertising. Determination of excessive contamination may be made as harvesting

4.5.7 Timber Marking and Cruising

To insure the highest quality performance and to comply with Alabama State law, only Registered Foresters will be utilized to perform contracts requiring technical forestry skills. Tree planting, timber stand improvement, and other forest practices of a similar nature will be done only by contractors or Natural Resources Program personnel that have been trained in forestry work or that have displayed the capability to complete the contract in a satisfactory manner.

Timber marking crews mark successive strips of timber approximately 50 feet wide, parallel to each other and parallel to a road, stream, fence, or other starting boundary. Merchantable trees shall be clearly marked on both sides to facilitate cutting and skidding from any direction. Acres which will not produce at least 1,500 board feet of sawtimber or five cords of pulpwood per acre should not be marked for harvest but left unmarked until the next cutting cycle.

The main objective in tree marking is to grow the maximum volumes of high grade sawtimber of the preferred species within the shortest period of time, commensurate with the high quality objectives. A list of the preferred species to leave as crop trees is found in Table 4.8. Desirable trees to leave should be straight, free of defect, free of insect and disease infestation, have a healthy crown of no more than one-half or less than one-fourth of total height, and contain small limbs. Mature trees should be left only when no other desirable or young trees are present to take their place and when it can safely be assumed that they will stand until the next cutting cycle without loss of volume or quality. Healthy trees of species not listed as preferred species may be left as crop trees in the absence of preferred species. Listed species which are not adapted to the particular site in which they are found should be harvested. Trees to be marked include those which are forked, crooked, excessively limby, diseased, infested with insects, short bodies, leaning, dead topped, or are otherwise unsound.

In addition to the above, healthy trees of desired species may be marked to allow more growing space for the crop trees. During marking operations, provisions should be made to leave $\geq$3 desirable wildlife den trees (snags) per acre. It will not usually be necessary to make provisions for leaving food or mast trees for wildlife because of the abundance of oak and hickory species. Unmerchantable dead and dying trees should be left standing for wildlife shelter, unless leaving such trees would promote the spread of insects or disease.

Timber volume sampling, or cruising, will be used to determine volumes to be harvested from large clear-cut areas, such as areas to be cleared for ranges or construction projects. Area boundary will be painted or flagged, and cruise lines laid out on a map or aerial photograph to run perpendicular to any drainage.

Variable Plot Radius Cruise (or Plot Sampling)

This is the most efficient means of cruising timber in the relatively level areas of this region. A 10 factor corrected prism will be used to determine the in trees for tally. Both diameter at breast height (DBH) class and merchantable height will be recorded. The number of points to be taken will be derived from the formula: {(Area of the Tract in Acres x percent of Cruise)/ (BA of Average Tree)} x BA Factorf of the prism = Number of Points Needed. Normally, cruising will

be based upon a10% intensity. Point sampling does not lend itself well to sparse stands.

Fixed Radius Plot Sampling

If the fixed radius plot method is used, plots will either be 0.2 acre, with a radius of 52 ft, 7.9 inches or 0.1 acre, with a radius of 37 ft, 2.8 inches. The number of plots, and spacing between plots and lines will be determined by cruise intensity, which is normally 10% and the number of acres to be cruised.

4.5.8 Reimbursable Forest Products Harvesting

Currently, the only reimbursable forest products harvested on the Installation consist of standing timber and firewood. One possible future product may be fuel wood chips as part of large clearing projects, reforestation cuts, or conversion cuts. This product will be made available on future sales where a merchantable market exists.

Reports of timber availability will be prepared in accordance with AR 420-74 and DA Pamphlet 420-7 and forwarded to the resident forester for the Mobile District of the Army Corps of Engineers for approval.

Timber sales in progress will be inspected at least once monthly by the resident forester with the USACE District Engineer Office. The Installation Forester is invited to join the resident forester on any monthly inspection. The Installation Forester will be responsible for coordination with test areas and other tenants for access to those stands within restricted areas. It may be necessary for the Installation or resident forester to escort logging contractors into highly secure areas. Items to be considered are area covered, volumes removed, erosion control needed, damage to residual timber, damage to improvements, and other things which come to the forester's attention. Monetary damages may be enforced for damage to property or timber according to the timber sale contract. Quarterly and completion reports are supplied to the Installation Forester. These reports include volume and value of products removed.

Contract clearance reports will be submitted to the USACE District Engineer or Contracting Officer after final inspection of the sale area by the Installation Forester and Resident Forester. During the inspection, the forester will go into every area harvested and view the conditions as they exist in the field. Conditions to be observed shall include but not be restricted to the following list: marked trees left standing, unmarked trees cut, unmarked trees damaged by falling trees and machinery, utilization of the tree tops, debris left in roads, eroding skid trails and roads, blocked fire trails, and stump height. The Resident Forester and Installation Forester must clear the harvest areas before the logging contractor can be released from the contract.

The Mobile District sends a monthly harvesting printout to the Installation Forester. This report shows income for the most recent month and the total to date for the FY, as well as volumes harvested by product for each contract item. A summary report is issued at the end of each FY.

Timber sold and removed from the Installation as standing or downed timber will be in accordance with AR 420-74 and AR 405-90. The Installation Forester will designate the harvest

area and provide fuel wood permits for a cost of $10 per day for authorized cutting operations. Those permit holders authorized to perform harvesting operations will be monitored by the Installation Game Warden and Installation Force Protection Officers for adherence to permit requirements.

4.5.9 Other Silvicultural Treatments

Prescribed Fire

Prescribed fire is one of the most important silvicultural tools available for use by forest managers in the management of the Installation's woodlands. The IWFMP in Section 4.15 contains detailed management information and requirements for the use of prescribed fire and wildfire suppression on the Installation. If used carefully under the proper weather conditions, prescribed fire accomplishes several silvicultural objectives. Prescribed fire can control undesirable hardwood brush, reducing competition for desirable trees and improving wildlife habitat. The prudent use of fire under prescribed conditions can simulate natural fire without detrimentally harming the resource. Other silvicultural benefits include seedbed preparation for natural regeneration, site preparation for artificial regeneration, the reduction of heavy fuel accumulation that could result in severe damage by wildfires, and the clearing of debris and undesirable vegetation from reforestation sites.

Species Conversions

The conversion or restoration of non-native or off-site pine stands to native pine stands is covered in Section 4.5.6. Sites for conversion are virtually non-existent, with the exception of bottomland sites currently planted in pine that may be converted to bottomland hardwood by removing the off-site planted loblolly. Some stands where pines have been planted may be used for wetland mitigation by conversion by natural regeneration of bottomland hardwood species. The site will naturally convert back to bottomland hardwood with adequate seed source.

Removal of Undesirable Vegetation

Undesirable vegetation includes any herbaceous or woody vegetation such as kudzu, Chinese privet, thistle, off-site/ non-native pines, and hardwood which may or is having harmful or detrimental effect on desirable vegetation. A fully integrated pest management approach using mechanical, prescribed fire, chemical treatment, or various combinations of these methods will be used to control undesirable vegetation. Chemical control of vegetation is covered in the IPMP (Section 4.9). All pesticides used will be applied in accordance with the label specifications by certified pesticide applicators and in accordance with all applicable DoD, Federal, and State of Alabama laws. Kudzu and bush honeysuckle control is implemented by chemical treatment annually.

4.5.10 Planting

Until the forest stand inventory and prescriptions data collection and report analysis is further advanced, it is not possible to forecast with any certainty the amount of planting to be done over

the next five years. Planting of trees will occur in open areas with a need for low maintenance cost and those areas where natural visual barriers are needed around restricted areas. Loblolly pine will be planted in these such areas. Mixed hardwood planting of hard and soft mast producing species may be used in some areas on hardwood specific sites. Slash pine will no longer be used for forest regeneration on the Installation. The current continuous forest stand inventory and prescriptions will be a necessity to accomplish the determination and planting of these areas.

Currently, all planting of bare root seedlings is done from 15 December to 31 March. All planting will be done by contract as there is not enough in- house personnel to handle this task. Planting contracts will specify machine planting, as this is the most cost-effective means of getting the job done. Hand planting may be used on areas that do not lend themselves to machine planting. Normally the site preparation and planting are included in one contract to provide an extra cost advantage, as contract administration is much more efficient this way. The contractor doing the preparation knows that he will also be doing the planting, and therefore is prone to do a better job, and becomes familiar with the area. Bare-root planting stock will be obtained from the most local source possible. Planting contractors will be responsible for obtaining planting stock. Consideration is currently being given to the government obtaining the tree seedlings and providing them to the contractor to plant. Due to higher survival rates, priority will be placed on purchasing containerized seedlings of loblolly pine and mixed hardwood.

The AEC is currently pursuing a centralized contract for planting on installations. This method may be used in the near future for accomplishing tree planting. Hand planting of containerized seedlings may begin as early as 1 November under the proper weather conditions.

In the last few years, seedling spacing of six by ten feet has been used in planting. The initial stocking of seedlings per acre using this spacing is 726 trees per acre. As needs and requirements dictate, spacing of seedlings may change, but the initial planting of seedlings will not exceed an average of 726 seedlings per acre for pine planting. Hardwood planting spacing will be planned on a 10 ft by 10 ft spacing or 435 trees per acre, but poor survival rates of planted hardwoods may make closer spacing necessary.

Direct seeding is not currently a viable method for regenerating pines or hardwoods in this area. Some success has occurred with direct seeding, but artificial regeneration of both pines and hardwoods will be the main planting method on the Installation. If new methods are developed which insure acceptable success with direct seeding, consideration will be given to this method.

4.5.11 Correlation of Silviculture, Wildlife Management, and Outdoor Recreation

In keeping with AR 200-1, forest management on this Installation will be accomplished under a multiple-use concept; no one resource will be treated as being mutually exclusive. Since forest management practices can be very beneficial, or detrimental, to wildlife habitat management, this impact will be considered before any action. The forest stand inventory and prescriptions in coordination with the Installation Wildlife Biologists are set up to identify critical wildlife habitat, including that specifically for T&E species. Such features as old home sites supporting good mast producing oaks and hedgerows will be retained by deleting them from site preparation

and other areas of adverse alteration. Generally, clear-cut and plant areas will not exceed an average of 30 ac in any one block. Large undifferentiated areas will be broken up by leaving one to two chain strips of unprepared land to create an edge effect. This will be specifically designed where possible to create travel lanes, link existing wildlife habitat or water sources, rather than creating an isolated feature. Any activity which will adversely alter the appearance and utility of outdoor recreation areas will be carefully planned to provide ultimate benefits, and will be discussed with FMWR and other pertinent staff elements prior to implementation. Where it is desirable, buffer strips will be left along highly visible areas and main thoroughfares to screen heavy logging and land clearing operations until stands are reestablished.

4.5.12 Goals and Objectives

(1) Periodic thinning of pine silvicultural systems per Forestry Management Component.
(2) Seed tree regeneration on approximately 120 acres by thinning of undesirable pine and mixed hardwood species in a stand adjacent to Indian Creek, with an 80’ streamside offset.
(3) Timber site improvement
    - Mechanically clear invasive and non-target understory species of approximately 150 acres on an annual basis, in accordance with the IPMP
    - Chemically treating invasive kudzu of approximately 300 acres on an annual basis, in accordance with the IPMP.
    - Conduct annual prescribed burns of approximately 2,000-4,500 acres.
(4) Implement cooperative agreement to perform timber stand inventory, updating the 2007 effort (Conservation Management Institute).

4.6 Vegetative Management Component

Vegetative management at Redstone Arsenal is accomplished through the Forest Management (Section 4.5) and Land Management (Section 4.10) components.

4.7 Migratory Birds Management Component

4.7.1 Introduction

Redstone Arsenal provides habitats and open space for a wide variety of migratory birds that migrate annually within and beyond North America (Appendix C). Regardless of how these migratory birds use Redstone Arsenal, their presence provides important ecological services and an important indicator of ecosystem health. Primary considerations with regard to migratory bird management are compliance with the MBTA and the Bald and Golden Eagle Protection Act, as amended; implementation of migratory bird management actions in accordance with EO 13186, *Responsibilities of Federal Agencies to Protect Migratory Birds*; and support, contribution and compatibility with the goals and efforts of numerous regional migratory and game bird conservation programs.

Virtually all birds that occupy Redstone Arsenal throughout the year are protected under the MBTA. The MBTA controls many actions that may negatively affect migratory birds, particularly collection and transportation of birds or bird products. Special purpose permits may be requested and issued that allow for the relocation or transport of migratory birds for management purposes. This permit allows the Installation to take management actions regarding wildlife strike hazards around airfields (Section 4.14). Other permits may be obtained for banding, scientific collection, taxidermy, special purposes and depredation activities. The EMD has a growing collection of permitted, taxidermied birds in its wildlife displays.

EO 13186, issued on January 10, 2001, requires all Federal Agencies taking actions that have, or are likely to have, a measurable negative effect on migratory bird populations to develop and implement a Memorandum of Understanding (MOU) with the USFWS. The DoD signed a MOU in 2014 that addresses natural resource management actions; installation support activities; industrial operations; construction, maintenance, renovation, or demolition of facilities that support appropriate installation activities, prevention/abatement of detrimental, environmental alterations; and conservation of migratory birds on installations.

Comprehensive bird conservation plans for migratory birds have been developed for landbirds, shorebirds and waterbirds. These conservation plans identify species and habitat conservation priorities at the national and more detailed regional scales. Plans that encompass Alabama and are applicable to Redstone Arsenal include:

- Partners in Flight, North American Landbird Conservation Plan.
- Partners in Flight, Bird Conservation Plan for the Interior Low Plateaus.
- North American Waterfowl Management Plan.
- North American Waterbird Conservation Plan.
- North American Bird Conservation Initiative.

These plans provide the framework, conservation priorities, goals, and objectives, comparable to INRMP goals and objectives for various migratory bird species and their habitats, within the manageable area of Redstone Arsenal. Consistent with these plans, and within the framework

of mission-focused conservation, the implementation of this INRMP will continue to support migratory bird conservation efforts. Redstone Arsenal's conservation of all wetlands, including forested wetlands, and restoration of native warm season grass communities all contribute valuable habitat benefits to migratory birds.

4.7.2 Population Monitoring

Migratory bird surveys and breeding bird counts provide a strong, statistically valid framework for detecting trends in migratory bird populations and assist managers in meeting their bird conservation goals. Redstone Arsenal partnered with Auburn University to provide an assessment of biodiversity, ecology, distribution, and habitat associations of the breeding avifauna of the Installation from 2006-2010. This study encompassed ten primary types of habitat on Redstone (herbaceous, floodplain forest, pine, shrub-scrub, developed, etc). A total of 128 species of birds, including 18 species of conservation concern in Alabama, were observed during this study (Best *et al*., 2010; Ortman, 2012). Habitat associations for these birds were also modeled and will be used for natural resource planning.

A Neotropical migrant songbird research study with Auburn University began in 2008 and ended in 2012 (Sterling, 2013). This study examined timber harvest conditions over 400 ac of Redstone and created a baseline for future research to investigate forest bird community shifts with timber harvest stages.

These projects, in addition to a wildlife inventory accomplished in 1999-2000 (Jones *et al.*, 2001), gives RSA natural resource managers a complete picture of avifauna population trends.

4.7.3 Habitat

Native Warm Season Grasses

Restoration of NWSG is a recent and on-going management objective at Redstone Arsenal. These NWSG areas on Redstone Arsenal will provide important habitat for numerous bird species, including species of special concern in Alabama such as the American Kestrel and Dickcissel. A short prescribed burn cycle will maintain a sparse shrub layer and promote high quality ground cover/understory habitat. Reference Appendix H for the 2017 Native Warm Season Grasses Management Plan.

South-Central Interior Mesophytic Forest Communities

Mesophytic forest communities, a predominately deciduous forest, have long been recognized as important bird habitat. The community is dominated by maples, tulip poplars, red oaks, and a highly diverse herb layer and often includes limestone outcroppings and small streams. Redstone Arsenal recognizes that mesophytic forest habitat is important for all migratory birds moving to and from their wintering grounds as well as other wildlife found in this unique system.

Forested Wetlands

Forested wetlands are among some of the most important bird habitat in the Southeast. They are diverse on Redstone Arsenal and include sinks, tupelo and cypress swamps, and riparian wetlands. Wetlands management and protection is addressed in Section 4.2. Management and silvicultural activities on Redstone Arsenal consider the ecological value of forested wetlands and are consistent with the overall goal of maintaining and protecting predominantly mature forested wetlands. Redstone Arsenal does not actively harvest bottomland hardwoods.

4.7.4 Goals and Objectives

(1) Support the conservation and management of migratory birds and their habitat:

- Integrate the objectives of the Partners in Flight Strategic Plan into Redstone's ecosystem based management activities.
- Participate in in the DoD Coordinated Bird Monitoring Plan by implementing technical recommendations for monitoring and reporting presence of migratory birds on military lands.
- Support and promote the restoration and conservation of NWSG habitats as well as bottomland hardwood forests.
- Use prescribed fire and mechanical control for midstory vegetation control and maintenance.

(2) Adhere to MBTA, Opinion M-37050, and other regulations pertaining to "take" of migratory bird species through the RSA NEPA process.

4.8 Invasive Species Management Component

Executive Order 13112, *Invasive Species,* set out guidelines for Federal agencies to locate, prevent the introduction, conduct research, educate and control the economic, ecological, and human health impacts that invasive species cause. More specifically, EO 13112 requires that each Federal agency shall take efforts to prevent the introduction of and control the spread of invasive species. This EO called for the monitoring of invasive species populations; the provision for the restoration of native species and habitat conditions in ecosystems that have been invaded; the research on invasive species and development of techniques for prevention and control of invasive species spread; and promote public education on invasive species and the means to address them.

The goals of the Invasive Species Management Program are essentially laid out in EO 13112 and DoDI 4150.07, and include preventing the introduction of non-native and invasive species at RSA through landscaping policies. Also, the EMD will take action to return areas heavily impacted by invasive species to natural, forested areas. Non-native flora are discussed in Section 2.3.4.

4.8.1 Invasive Species on Redstone Arsenal

In 2012, the ALIPC updated a list of invasive plants for the state of Alabama. The list ranks plants based on their invasive characteristics and is provided as a reference in Appendix D. This list has no regulatory authority but provides useful information to help guide agencies, private landowners, and water managers in making responsible decisions about plant use and management decisions.

To ensure invasive species are not introduced, any facility construction or other project on the Installation that involve plantings are approved based on their adherence to EO 13112, USAG-Redstone landscaping policy, Installation tree ordinance, and the most up to date “Do Not Plant” list for Redstone Arsenal (Appendix I).

<u>Kudzu</u>

Information in this section was obtained from ANR-65 (Everest *et al.,* 1999). Kudzu is a large, trifoliate- leaved, semi-woody, trailing or climbing perennial vine that belongs to the Fabaceae (legume) family. It is a fast growing vine and is able to spread in all directions, forming new plants by rooting every few feet at the nodes. Mature stands usually have a plant every one to two sq ft and may contain tens of thousands of plants per acre.

Kudzu is well adapted to Alabama and is found throughout the state. It will grow on a wide range of soil types, but does best on deep, loamy soils (as opposed to very light sands or poorly drained, heavy clay soils). It has been planted using either seed, vine cuttings, or by transplanting "crowns." Kudzu was introduced in the US in the late 19th century for use as an ornamental vine to shade porches and homes; the vine was appreciated for the fragrance of its flowers as well as its ability to grow vigorously. In the early 20th century, kudzu was promoted as an inexpensive forage item for livestock. This plant was promoted by the Federal government to combat soil erosion in the Southeast as a result of poor agricultural practices and extensive cotton production.

Kudzu

It was not long before kudzu became a nuisance by spreading quickly through the Southeast due to long growing seasons and lack of disease and insect predators. While the movement to control kudzu was slow, it was finally listed on the Federal Noxious Weed list in 1997.

An estimated seven million acres of land in the Southeast are infested with kudzu. One-quarter of a million acres cover Alabama. The infestation spreads as far north as Illinois, Pennsylvania, West Virginia, and up to Connecticut and as far west as eastern Texas and central Oklahoma. The heaviest infestations are in Alabama, Georgia, and Mississippi. A chemical control program was initiated at RSA in 1999; from that time, a range of 400-700 ac of kudzu have been treated annually.

Bush Honeysuckle

Information in this section was obtained from the USDA Forest Service Southern Research Station General Technical Report SRS–119 (Miller *et al.*, 2010). Invasive bush honeysuckle is indigenous to Asia and Western Europe and was introduced to the United States as an ornamental plant as well as a species to improve wildlife habitats.

The distribution of invasive bush honeysuckle seeds is primarily accomplished by birds and small mammals. Following a period of cold stratification, seeds germinate in areas of sparse vegetation and can tolerate moderate shade but produce more seeds in full sun. It is suspected that bush honeysuckle produces an allelopathic chemical that suppresses the growth of surrounding vegetation. Leaves appear early in the spring and remain into late fall, giving bush honeysuckle a competitive advantage over native plants.

The bush honeysuckles are tolerant of a variety of edaphic and environmental conditions. Typical habitats include disturbed successional communities, wetlands, prairie, woodland edges, and partially closed forests. Most communities found in natural areas have the potential to support a population of one of the bush honeysuckle species. These shrubs are moderately shade tolerant, taking advantage of canopy gaps created by wind throw or insect defoliation. Honeysuckle bushes are commonly found growing under trees, tall shrubs, and along fence rows that act as perch sites for birds.

Bush honeysuckle

Bush honeysuckle can be controlled mechanically and chemically. A survey of its presence on RSA was conducted in 2004, followed by the start of an intensive chemical control program. Currently, more than 700 ac of forested stands are chemically treated for the control of bush honeysuckle.

Chinese Privet

Chinese privet is a perennial shrub native to Eurasia and North Africa. Introduced in the mid 19th century, it has become a highly popular ornamental landscape plant. The information on this invasive species was largely derived from the USDA Forest Service Southern Research Station General Technical Report SRS–119 (Miller *et al.*, 2010).

This species forms dense thickets in areas of disturbed soil, including roadsides, old fields, and landscapes with abundant sunlight. It will also readily grow in the understory of forested habitats. This semi-evergreen shrub or small tree can grow up to 6.1 m in height and trunks typically occur as multiple stems with many long, leafy branches. It reproduces from seed or from root and stump sprouts.

Chinese privet

Seeds are readily eaten by

wildlife (principally birds), transported and dispersed away from existing areas of cultivation. Privet will shade and out-compete many other plant species. Once this invasive species has been established, it is very challenging to remove.

Management options include mechanical control with mowing, cutting, and hand pulling. Often, these methods are appropriate for the small, initial populations or environmentally sensitive areas where chemicals cannot be used. While repeated mowing/cutting will control the spread of Chinese privet, it will not eradicate it. If hand pulling, care should be taken to remove the entire root, as root fragments will re-sprout. Chemical control (e.g., glyphosate, triclopyr) can be used in areas of large privet thickets; the cut stump or basal bark method of chemical application may be used. A chemical, annual program for Chinese privet was started in 2007 for treatment of approximately 165 ac of pine timber stands, mixed pine-hardwood timber stands, forested stands, igloos, and other various locations. Currently, privet control is executed as funds allow.

Callery Pear (*Pyrus calleryana*)

The information on this invasive species was largely derived from Culley and Hardiman, 2007. Callery pear is a deciduous tree species native to East Asia and was introduced into the US in an effort to battle fire blight in the common pear (*Pyrus communis*) in the early 20th century. While it is currently and primarily sold as rootstock for cultivated pears (namely Bradford pear), wild populations of Callery pear now exist through the country. Wild trees grow rapidly and are comment in disturbed landscapes such as transportation corridors, parks, and restored habitats. Callery pears flower at a young age and fruit is dispersed by birds. Pear cultivars are able to tolerate a wide range of conditions, including pollution, moisture, adverse soil conditions, and disease. The wild species is currently found in more than half of the US.

Callery pear

The most effective control for this species is complete removal through mechanical and chemical means (cut and treat). Mowing is not typically useful since the species easily resprouts. Young seedlings can be pulled up by hand. A chemical control program for Callery pear was begun in 2014 for 80 ac of mid-successional habitat in the Bobcat Cave Ecologically Sensitive Area.

Ailanthus

Ailanthus

The information on this invasive species was largely derived from the USDA Forest Service Southern Research Station General Technical Report SRS–119 (Miller *et al.*, 2010). Ailanthus, also known as tree-of-heaven, is a noxious weed native to China and was introduced to North American as an ornamental in the 18th century. This tree species is adapted to a wide variety of soil conditions, making it successful in a number of different habits from urban areas to forests with a partially open canopy (is generally intolerant of shade). Ailanthus forms dense thickets, displacing native species, and is able to reproduce from both seed and root sprouts. It grows rapidly to 25-30 m and is typically short-lived (30-50 years). Seeds are easily windblown and sprouts may emerge up to 15 m away from the nearest stem.

Management options include mechanical control with cutting, girdling, and hand pulling. Cutting is considered an initial control measure, requiring herbicidal control or repetitive cutting for sprouts. Girdling can be used on larger trees when herbicide use is not feasible; resprouts are common and requires annual treatment. Hand pulling is an effective control when removing young seedlings before they produce seeds and care taken to remove the entire root. Herbicidal control can be accomplished for a variety of different scenarios of thickets and presence of nontargets, utilizing foliar spray, cut stump, basal bark, or hack and squirt methods. A chemical control program for ailanthus was begun in 2015 for 41 forested ac.

4.8.2 Goals and Objectives

(1) Reduce and eliminate exotic and invasive species from Redstone Arsenal to conserve and enhance native flora and fauna and the functional value of natural systems.

- Map and monitor non-native and exotic invasive plant/animal species at RSA via a cooperative agreement with ALNHP (2019-2021).
- Implement integrated pest management control actions on known populations of non-native and exotic infestations of invasive species including, but not limited to, those species listed in 4.8.1.
    - Chemically treat approximately 700 acres of invasive kudzu, Chines privet, and bush honeysuckled on an annual basis, in accordance with the IPMP.

4.9 Pest Management Plan

4.9.1 Introduction

The Integrated Pest Management Plan (IPMP) (USAG-Redstone, 2011a) is the framework through which the Pest Management Program is defined and accomplished on Redstone Arsenal. This plan identifies elements of the program to include health and environmental safety, pest identification, pest management, as well as pesticide storage, transportation, use, and disposal. The IPMP is to be used as a tool to reduce the reliance on pesticide usage, to enhance environmental protection, and to maximize the use of integrated pest management techniques. This document is available through the USAG-Redstone EMD.

The IPMP for Redstone Arsenal provides guidance and requirements for operating and maintaining an effective pest management program. Principles of integrated pest management are stressed in the plan. Integrated pest management consists of the judicious use of both chemical and non-chemical control techniques to achieve effective pest control with minimal environmental contamination. Adherence to the plan will ensure effective, economical, and environmentally acceptable pest control, and will maintain compliance with pertinent laws and regulations. IPMPs are governed by such laws as the Federal Insecticide, Fungicide and Rodenticide Act; EO 13112, *Invasive Species*; DoDI 4150.07, *DoD Pest Management Training and Certification Program*; EO 11987, *Exotic Organisms*; AR 200-1; and the Endangered Species Act.

Pests included in the plan include roaches, ticks, fleas, termites, ants, mosquitoes and other biting/stinging insects, spiders, beetles, millipedes, invasive plant species, weeds, and vertebrate pests such as rodents and striped skunks (*Mephitis mephitis*). These pests can interfere with the military mission, damage real property, increase maintenance costs, lower morale and expose personnel to diseases unless properly controlled. Actual pest management procedures are found in the RSA IPMP.

The IPMP applies to all activities and individuals working, residing, or otherwise doing business on Redstone Arsenal. It will be implemented to the maximum extent possible. At no time may pest management operations be performed in a manner that will cause harm to personnel or the environment. Non-chemical control efforts will be used to the maximum extent possible before pesticides are used. The IPMP will be a working document and will be continually updated to reflect actual pest management practices.

4.9.2 Integrated Pest Management

Integrated pest management (IPM) is the sensible use of chemical and non-chemical control techniques to prevent pests from exceeding a tolerable population level or damage threshold. Emphasis is placed on minimizing environmental disruption that is caused by sole reliance on pesticide applications. IPM depends on surveillance to establish the need for control and to monitor the effectiveness of management efforts. The basic principles of IPM are illustrative of the pest management philosophy used at Redstone Arsenal. Any one of the following methods may solve a specific pest problem but if long-term control is the goal, the concurrent use of

several methods is most successful.

Cultural Control. This method involves the manipulation of environmental conditions to suppress or eliminate pests. Examples include crop rotation, water management, alternate host plant destruction, sanitation, and altering irrigation times. Elimination of food and water for pests through good sanitary practices is the most important cultural control method in this plan. Modifications in human behavior that promote general cleanliness in buildings, dining facilities, break rooms, and storage areas may prevent pest populations from becoming established or from increasing in size.

Mechanical/Physical Control. This method involves the use of manual labor, physical barriers, or devices to control pests. Examples include caulking or filling voids to eliminate harborage; mechanical traps or glue boards; installation of screens or other barriers to prevent pest entry into buildings; application of heat or cold; hoeing to control weeds; and the manual removal of pests by hand or by vacuum.

Biological Control. Biological control method uses predators, parasites, or disease organisms to control pest populations. In some cases sterile adult insects may be released into the breeding population to lower reproduction. Biological control may be effective by itself, but is often used in conjunction with other types of control. This type of control is by nature very pest specific, environmentally sensitive and may not be practical or available for a given pest problem. Pesticide formulations of bacteria are readily available biological control agents for management of caterpillars on plants and mosquito larvae in aquatic breeding sites. Biological control is not exercised at RSA due to possibility of spreading nonnative and/or invasive species.

Chemical Control. Chemical control is the reduction of pest populations or prevention of pest damage by using pesticides or other materials to poison them, attract them to other devices or repel them from specific areas. The use of pesticides (e.g., insecticides, herbicides, fungicides, and rodenticides) is often the most simple and effective method of available control. However, pest resistance has reduced the effectiveness of many once commonly used compounds. In recent years, the trend has been to use pesticides that are pest or site specific with little or limited residual activity. In general, pesticides are used only after other methods of control have been attempted or considered. Chemical control is most effective when used in combination with the other methods outlined above.

4.9.3 IPM Worksheets

IPM worksheets for pest surveillance and control are found in appendices of the IPMP. Each major pest or category of pests is addressed in separate outlines. New outlines are added if additional pests at specific sites are encountered which require surveillance and/or control. Added outlines or changes in pesticide usage are sent to the AEC Pest Management Consultant for review and approval. These worksheets do not identify all the precautions and directions identified on product pesticide labels; pesticide applicators must be familiar with and follow all precautions and directions on the pesticide label of the pesticide being used.

4.9.4 IPMP Maintenance

The RSA Installation Pest Management Coordinator (IPMC) maintains this plan. Appropriate changes are made to the plan on an annual basis; it is reviewed and updated every FY to reflect all of these changes. The current Integrated Pest Management Plan is available from the Environmental Management Division.

4.9.5 Responsibilities

Responsibilities for implementing the IPMP on Redstone Arsenal are provided in the IPMP.

4.9.6 Pest Management

Insects/Animals

These are insects or other animals that are capable of transmitting organisms that cause disease, or which may themselves cause injury to people or their animals. Mosquitoes, spiders, bees, wasps, fire ants, and ticks are the prime examples of public health pests at RSA. Real property pests (termites), household pests (cockroaches), and stored products pests (moths, beetles, and rodents) also contribute to the pest management workload at RSA. Mice and rats occasionally invade buildings, requiring pest control efforts.

The Installation's pest management contract services provide pesticide application, as well as preventative treatments, on a case-by-case basis. Applications do not occur unless visual or monitoring devices prove the presence of pests. Site specific solutions for observed sources of pest food, water, harborage, and access are provided through this contract, as well as objective assessments of pest population levels.

Wild animals (e.g. skunks, raccoons, bats, red and gray foxes (*Vulpes vulpes* and *Urocyon cinereoargenteus*), stray cats and dogs) not only can become a nuisance but they may be infected with rabies. Since these animals may be found in or under buildings, the risk to public health should be recognized. Predator and beaver control is required at various times at RSA. These animals are controlled by RSA's Wildlife Resources personnel as directed by this INRMP. Control efforts for other regulated wildlife species such as deer will be coordinated with Natural Resources personnel, Game Warden, and ADCNR. Additional assistance for wildlife nuisance control can be obtained by the USDA/APHIS/WS. Local USFWS will be contacted to coordinate efforts to control federally protected species.

Vegetation

Weeds and undesirable vegetation along fence lines, road shoulders, paved surfaces (including runways), and firing ranges require control using appropriate herbicides. Herbicides are applied directly to undesirable vegetation to protect desirable vegetation and reduce contamination of natural resources. Control of unwanted plants is done mechanically (mowing, weed-eaters, etc.) as funding and schedules allow. Use of herbicides in the northwestern quadrant of the

Installation is coordinated with the IPMC and Installation Threatened and Endangered Species Program Manager due to concerns over groundwater sensitivity.

Selective vegetation control may be required for pine planting site preparation or for pine release programs of forested areas. To help control undesirable vegetation and re-vegetate with native species, prescribed burns that mimic a natural mosaic pattern as much as possible are planned. A 1994 Executive Memorandum (29 April 1994, President Clinton) directed agencies to use regionally native plants for landscaping of Federal grounds and federally funded projects. The use of native plants protects natural heritage and provides wildlife habitat. Native plant restoration may reduce the need for fertilizer, pesticides, and irrigation requirements because native plants are best suited to the local ecosystem.

Currently there are no federally listed noxious weeds listed in Alabama. There are however, at least seven state listed noxious weed species that are found on the Installation. A list of these species is provided in the IPMP. Management of invasive species is discussed in Section 4.8 of this INRMP.

Lawns, trees and shrubs on the Installation can be infested by various insect pests, resulting in damage or destruction of the plants. Integrated pest management (cultural, mechanical, chemical), along with the Installation policy to utilize native vegetation when landscaping (Section 4.10), helps combat infestations.

Control Measures.

Control measures include following and other actions as needed:

- Good maintenance practices.
- Selection of plants well suited to the site and that are locally adapted, disease/insect resistant.
- Fertilization according to recommendations from soil tests.
- Mowing/pruning or sanitation cutting to remove the unhealthy specimens with the goal of leaving only enough plants so they will occupy the site and provide the needed function of screening, wind barrier, erosion control or other function.
- Proper watering to prevent plant stress.
- Provision of light and air penetration for grasses.
- Removal and disposal of galls, cocoons, etc. or infected plants.
- Restriction of taking cuttings from infested plants.
- Disinfect pruning shears or other equipment, following maintenance.
- Replacement old plants with new ones, as needed.
- Raking to break up spore masses.
- Application fungicides, nematicides, or insecticides applicable to the disease/infestation.
- Fumigation for disease eradication, if appropriate.

At present there are no major insect or disease outbreaks that require control measures at RSA. If outbreaks occur, and chemical control is required, the Pest Management Coordinator will supervise contractor support of these services. All control activities will be coordinated with the

appropriate Federal or State agency.

There is an infestation of fire ants on the Arsenal as well as quarantine in effect for the entire state of Alabama. This means that no earth inside Alabama is to be moved to other states without being inspected and approved by USDA, APHIS, Plant Protection and Quarantine. Presently, there are no funds available for widespread control of fire ants on the Installation other than spot treatments, as needed.

There are no requirements for plant or animal quarantine on the Installation. There are no anticipated pest problems arising from shipments of household goods and material shipped to the Installation from other locations.

4.9.7 Environmental Considerations

Adequate precautions shall be taken during pesticide application to protect the public. Only certified Federal/State pesticide applicators are permitted to apply pesticides on RSA. Pesticides will not be applied outdoors when the wind speed exceeds 10 miles per hour or less if restricted by the label. Pesticide applicators shall have a means to monitor the wind speed during outdoor pesticide applications. Whenever pesticides are applied outdoors, care is taken to make sure that any spray drift is kept away from individuals, including the applicator. Residual sprays, dusts, etc. will not be applied in the immediate area of building interiors while occupied by personnel other than pesticide applicators or other personnel wearing appropriate personal protective equipment. Building occupants are instructed not to reenter a treated building until pesticide has dried and odors have dissipated. Application of non-intrusive pesticides, such as baits, is permitted in occupied buildings.

Sensitive areas which must be considered before conducting pest control operations are listed on each pesticide label. No pesticides will be applied directly to wetlands or water areas (lakes, river, etc.) unless use in such sites is specifically approved on the label as well as by the IPMC and Wetland Program Manager. This last statement particularly applies to wetland areas on and adjacent to the Installation. In addition to aquatic habitats, sensitive areas also include critical habitat to endangered, threatened, or rare flora or fauna species, and unique geological and other natural features. Other sensitive areas include medical treatment facilities, child development centers, playgrounds, and schools.

All migratory birds, excluding European Starlings (*Sturnus vulgaris*), Common Pigeons (*Columba livia*), and House Sparrows (*Passer domesticus*), which may periodically occur on the Installation, can only be controlled with a permit. Potential and existing T&E or sensitive plant and animal species on RSA are listed in table format in the IPMP and are further described in the Threatened and Endangered Species Management Component of this INRMP. The IPMC and Threatened and Endangered Species Program Manager will evaluate ongoing and new pest control operations to ensure compliance with the ESA and MBTA. No pest management operations are or will be conducted in habitats that are likely to have an effect on T&E or protected species (e.g., groundwater habitat buffer zone for Alabama cave shrimp in the northwestern quadrant of the Installation).

An adequate pesticide spill cleanup kit shall be maintained on RSA as part of the Emergency Response Program. Spill cleanup and notification procedures are provided in the Oil and Hazardous Substance Spill Prevention and Response Plan (USAG-Redstone, 2012b) and RSA Regulation 200-6 (USAG-Redstone, 2011b). Adequate spill cleanup kits and compliance with these plans will be required by all contractors performing pesticide operations on the Installation. Specific guidance related to pesticide spills is found on the product's Material Safety Data Sheet (MSDS) and its label. All spilled pesticides are managed under the Installation's Hazardous Waste Management Program and are reported to the EMD, the IPMC and the Installation's Hazardous Waste Coordinator.

This pest management program will comply, whenever possible, with EO 12856 of August 3, 1993, *Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements*. Controlling pests with pesticides are considered only after non-chemical control methods have been exhausted. IPM strategies that stress nonchemical control form the basic framework of this Installation's pest management program.

4.9.8 Goals and Objectives

(1) Utilize an integrated pest management approach to control unwanted pests on Redstone Arsenal to conserve and enhance native flora and fauna and the functional value of natural systems as well as minimize threats to human health and safety.

- Monitor pest presence on a programmatic level, contributing knowledge to the Installation pest management contract services team.
- Implement chemical, mechanical, and cultural control actions on known populations of pests, including non-native and/or invasive species (Section 4.8).

(2) Minimize potential for non-point source pollution and impacts to the environment, in-water species, and species vulnerable to chemicals from improper application of pesticides.

4.10 Land Management Component

The US Army policy is that management of soils for sustainment on US Army installations is accomplished by developing and implementing the soil erosion and sediment control component as a constituent of the INRMP. Redstone Arsenal currently operates under a number of plans, permits and programs which, in conjunction, form this component. The plans include Stormwater Management Plan, BMP Plan, Borrow Area Management Plan, Erosion Control Plan, Environmental Management Plan, Industrial BMP Plan, Municipal BMP Plan, and Construction BMP Plan. RSA actions also adhere to the guidelines presented in the 2009 *Alabama Handbook for Erosion Control, Sediment Control and Stormwater Management on Construction Sites and Urban Areas*, which provides guidance for preventing or minimizing the related problems of erosion, sediment and stormwater on construction sites and eroding urban areas. This handbook serves as the technical standard and guideline under ADEM Administrative Code Rule 335-6-12-.21 (Construction Best Management Practices Plans, Other Plans, Specifications, BMPs, and Technical Requirements).

4.10.1 Erosion Control

Increasing limitations caused by external and internal factors combined with increasing operational tempo, additional mission requirements, and the introduction of advanced weapon systems now, more than ever, requires long range planning to ensure testing area lands are maintained and managed for compatible uses. Constant use of the land for military research, development, test, and evaluation activities, combined with significant weather related events, can result in erosion problems that affect the quality of training and reduce the land's ability to recover naturally. Excessive soil erosion and soil sedimentation reduces the capacity of land to sustain current and future mission uses. Failure to identify and prevent excessive soil erosion and soil sedimentation can jeopardize the long-term, usable life of an installation. Neglect will:

- Allow eroded sediment to escape into adjacent streams and wetlands.
- Create impassable roads used for training and natural resources management.
- Permit eroded stream banks to encroach into military lands and threaten buildings and infrastructure.
- Force range operators to abandon unsuitable areas, causing them to exceed the training capacity of other lands which leads to new erosion problems.

The Soil Erosion and Sediment Control Plan for RSA provides guidance for operating and maintaining an effective soil erosion and sediment control program. The purpose of this plan is to address the Army Soils Policy of keeping soil erosion from water within tolerance limits as defined in soil surveys prepared by the USDA NRCS, keeping soil sediment pollutants in wetlands and waterways within compliance limits, and rehabilitating land disturbed by operations and real property management activities.

This plan describes and classifies soils on RSA, describes policy relative to soil erosion and water quality, lists RSA permits needed prior to land disturbing activities, describes installation methods/requirements for revegetation/erosion control at RSA, and provides administrative resources and contact information for erosion control. The program utilizes installation

environmental compliance managers, installation land managers, and contracted ground maintenance crews. Without control, erosion poses a severe hazard to the installation environment and could interfere with the military mission. The RSA Soil Erosion and Sediment Control Plan can be seen in its entirety at Appendix J. Adherence to the plan will ensure effective, economical, and environmentally acceptable erosion control and will maintain compliance with pertinent laws and regulation.

4.10.2 Land Use

Inventory of Land Use

Land and grounds can be defined as all lands not occupied by buildings, structures, roads, or pavements. This includes all land and water acreage for which an Installation has responsibility including outlying or satellite areas. There are three basic classifications of grounds: improved, semi-improved, and unimproved grounds. Due to severe funding shortfalls, the USAG-Redstone is currently directed by IMCOM to operate at a “red” level of service for grounds maintenance (the minimum level of service without hindering normal mission capabilities). Customers may request service above the red level but must provide funding to do so.

Improved grounds are those where intensive development and maintenance measures are performed. These are often developed areas of an Installation such as cantonment, parade grounds, drill field, athletic areas, cemeteries, housing areas, administrative area lawns, golf courses, and road shoulders. Improved grounds typically have lawn and landscape plantings that require intensive maintenance for best management. Redstone Arsenal has approximately 2,588 ac of improved grounds. At the red service level on high visibility grounds, mowing is accomplished once every two weeks. Landscaping in these areas may be accomplished annually. In areas of normal visibility, mowing at the red service level is accomplished once every three weeks; cantonment areas are typically mowed twice a year.

Semi-improved grounds are those that undergo periodic maintenance primarily for operational and aesthetic reasons (erosion, dust, and weed control; bird control; visual clear zones; and annual prescribed fire). Typical semi-improved grounds include, pistol and rifle ranges, ammunition storage areas, antennae facilities, outlying cemeteries, outlying picnic areas, jogging trails, and airfields. Redstone Arsenal has an estimated 5,157 ac of semi-improved grounds. At the red level of service, mowing is typically accomplished once every month on semi-improved grounds. Grass cutting for igloos and perimeter fences typically occurs three times a year. Mowing of test areas is on a reimbursable basis and is conducted twice annually.

Unimproved grounds are those not classified as improved or semi-improved and, at full funding levels, usually are not mowed more than once a year. Typical unimproved grounds include agricultural leases, weapons ranges, forestlands, lakes, ponds, and wetlands. Redstone Arsenal has an estimated 30,268 ac of unimproved grounds which are comprised of 14,370 ac of non-forested, unimproved grounds and 15,898 ac of managed forest. The classification and management of RSA’s forestlands are described in detail in Section 4.5 (Forestry Management) of this document. Plantings within this category are limited to control of soil erosion and reseeding required on agricultural outleases. Mowing is normally performed to

prevent development of fire hazards, usually once or twice annually. Eroded areas are bare because of excessive use, soil removal, poor soil or they are maintained bare to facilitate the Army's mission. Planted species will be selected on a case by case basis to provide for optimal erosion control with the intent to meet the Installation's objective of using native flora.

4.10.3 Vegetation Management

Vegetation management is conducted across RSA in various forms and degrees to carry foot traffic, maintain and improve aesthetic appearance, and prevent soil erosion. Trees, shrubs, vines, grasses, and legumes are utilized on improved grounds, semi- improved grounds and unimproved grounds to accomplish these goals. EO 13112 restricts the introduction of non-native and invasive species at RSA through landscaping actions. It is the policy of the USAG–Redstone to require at least 75% of all landscape plantings are accomplished with native flora, when it does not interfere with the military mission.

Trees, shrubs, hedges, plants, and grasses on improved grounds are replaced upon occurrence of death, irreparable damage or unsightly appearance of existing vegetation. Natural Resources personnel may provide recommendations for any corrective measures deemed necessary. Requests for vegetation management by building tenants are submitted through the Job Order Request System (Section 3.3). The planting of trees, shrubs, grasses and other vegetation are accomplished by means of government contracts and natural resource staff to implement the a self-help program and execute the Installation Grounds Maintenance Contract.

At the red service level for grounds maintenance, no period lawn treatment (fertilizer, liming, aeration, weed control, etc.) occurs. Soil testing and fertilizer application often occurs by natural resource program managers in creation and maintenance of wildlife openings as well as by agricultural area lessees.

Cultural pruning improves the quality, appearance and/or health of the plant and should optimally be performed in the winter, spring, or summer depending on species. At this time, however the grounds maintenance contract provides pruning for safety reasons only.

Irrigation of improved grounds is necessary during the growing seasons to maintain healthy turf and other landscape plantings. Irrigation systems exist on the golf course and on the grounds of various tenant organizations (e.g., Sparkman Center, if funded) however the US Army Garrison-Redstone does not install, repair, or maintain any irrigation system on the Installation under the Grounds Maintenance Contract.

4.10.4 Site Preparation

Site preparation and planting activities occurs during the early portion of the growing season. When possible, sites are accessible by conventional equipment and graded to accomplish this goal where needed. Sites are maintained for proper drainage and erosion control. Where erosion has impeded seeding or other planting activities, topsoil is replenished as necessary.

A wide assortment of species and varieties of plants may be used to establish vegetative cover, in accordance with the Installation tree and landscaping policies. Plants which have been used for this purpose on the Installation are listed, but not limited to the below subsections.

Perennial Grasses. Southern perennial grasses grow best during warm summer months and are relatively dormant during the remainder of the year. In the southern states, Bermuda grass and fescue are widely used turf grass. At Redstone Arsenal, these grasses are used for erosion control and as lawn/turf type plantings in improved areas, recreational/parade fields, and the airfield. These grasses are not used in wildlife food/cover plots nor in unimproved grounds.

Temporary or Annual Grasses. Annual rye grass is a cool-season bunch grass, widely adapted for temporary or emergency plantings for erosion control or as a companion or cover crop. Planting is by seed only, usually during the fall or early spring. Cereal grains are fall or early spring planted species, widely used for erosion control for emergency cover crops where applied mulches are impractical, and for supplementary wildlife feeds. Sorghum is a warm season, spring or summer-planted crop used in agriculture for forage and grain. The species in its many forms may be used for erosion control and emergency cover crop where applied mulches are impractical. For agricultural purposes, the crop is normally planted in rows, but when used as planted mulch, it is planted with a grain drill, as for cereal grains. Sudan grass is a spring or summer planted bunch grass, widely used for erosion control and emergency cover crops where applied mulches are impractical. Permanent grasses may then be planted into the dead vegetative residue after sudan grass has matured.

Native Warm Season Grasses. Information on NWSG is found in Appendix H.

Miscellaneous Legumes and Ground Covers. Legumes are valuable supplements to grasses for erosion control, and are usually used in mixtures with grasses. Vines and other ground covers are also useful usually as a substitute for grasses on special problem sites.

There are many species of clovers commonly used in mixtures with the perennial grasses. White clover has value in mixtures of cool season grasses for erosion control on unimproved grounds and embankments. These are not normally of value in improved lawns nor athletic fields. Both species are perennial but are short lived and rely on seed for continuing persistence in the planted mixture. Hop clovers, bur clovers and other clover species are frequent natural mixtures in southern pastures and grasslands. All are objectionable in lawns and athletic fields but are of some value for erosion control on unimproved grounds. They are low–growing, annual plants that produce abundant seed supplies. Sweet clovers are winter annual or biennial species used principally for a temporary cover crop or pasture, or to build up the soil preparatory to permanent planting. Sweet clovers are generally useful on military installations, except as a part of an agricultural leasing program.

Weeds in agricultural lease areas are controlled by the lessee and in mowed areas under the Grounds Maintenance Contract. Other problem areas are controlled via work orders or separate contracts. Control measures will be applied according to the site conditions and the species present. Detailed information on pest and disease control at Redstone Arsenal is provided in the IPMP and Section 4.9 of this INRMP.

4.10.5 Goals and Objectives

(1) Monitor improved and semi improved grounds annually to prevent land erosion and vegetative disease and insect control.

- Implement described corrective action as problems occur.

(2) Support adherence to USAG–Redstone policy for at least 75% of landscape plantings to be accomplished with native flora, when it does not interfere with the military mission. Assist tenants by recommending appropriate species.

- Enforce compliance with the “Do Not Plant List” that is created and maintained by natural resources personnel in EMD (Appendix I).

(3) Minimize potential for non-point source pollution from improper applications of fertilizer or pesticides.

(4) Implement native warm season grasses management plan for erosion control and grounds maintenance.

4.11 Agricultural Outleasing Plan

4.11.1 Introduction

Agricultural land on the Installation has been leased since shortly after World War II. The first leases were based primarily on cash returns and the lessees were allowed to use the land for any crop without land use restrictions. Relatively large tracts of land were leased, and frequently only a small part of the leased land was used. In 1949, it was decided that the use of available cropland should be confined to the production of small grains, hay, and pasture. It was also decided that the major consideration should relate to maintenance and improvement of the land. Leased areas have since been improved and most leased parcels currently display an excellent appearance during all seasons of the year.

Since the beginning of the leasing program, many land parcels have been added to and withdrawn from the program, depending on mission development. The problem of coordinating on-going agricultural use with the required military mission has been minor. Often agricultural lessees have been permitted to utilize the areas required for military construction to within a few days prior to the actual commencement of construction.

4.11.2 Description of Leased Areas

The Department of Wildlife and Fisheries, Forest and Wildlife Research Center and the Mississippi Cooperative Extension Service, Soil Testing Laboratory at Mississippi State University completed vegetative surveys and soil analysis on all agricultural units in 2000. This report can be obtained from the RSA Agricultural Outlease Program Manager. Soil testing continues to be performed on a three year cycle on all agricultural units. Vegetative species composition has remained constant without significant change through 2017.

The overall condition of the range within leased units is fair to good. Over grazing is not evident at this time; if future problems arise, lessees will be required to transfer their livestock from one pasture to another within a lease unit and restore range vegetation.

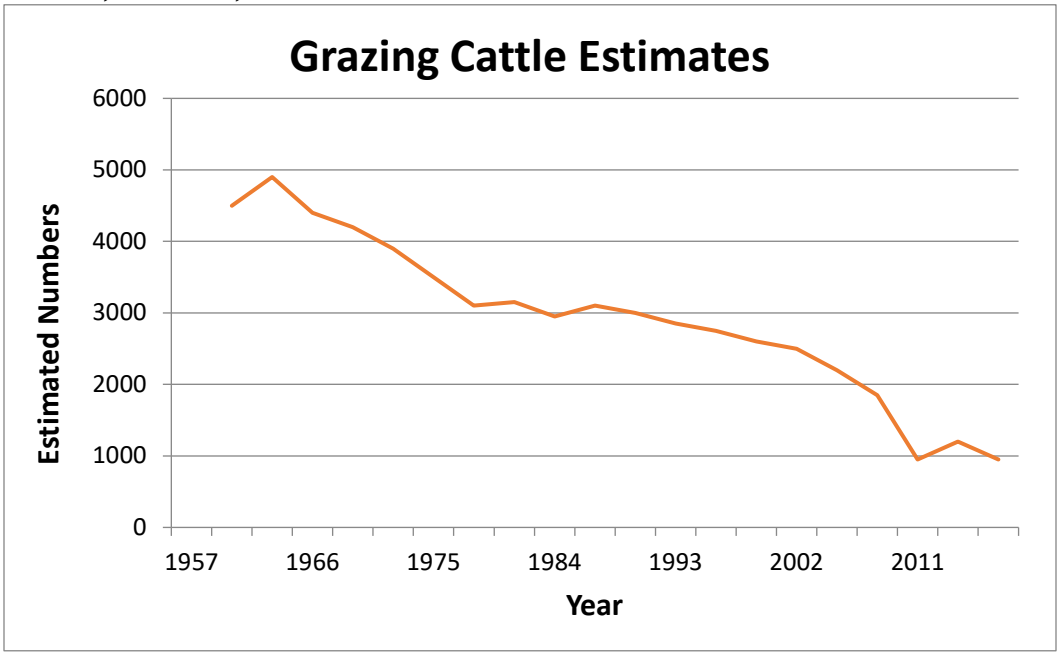
The growing season for pasture grasses is approximately nine months. The average carrying capacity for this type of pasture (improved ground) is approximately two livestock units per acre per month, contingent upon rainfall amounts. Normal carrying capacity is usually extended, when necessary, by means of supplemental feedings. Water supplies for units leased for grazing purposes is provided through the Installation water system at a rate of charge to the lessees.

4.11.3 Agricultural and Grazing Program

Accurate records regarding number and kind of livestock historically grazed on leased areas are not available. Estimates pertaining to livestock grazed at RSA since 1957 are available and should only be considered such. An average of 700 sheep were grazed on agricultural leases from 1957-1959 and have not been present since that time. Figure 4.16 depicts estimated

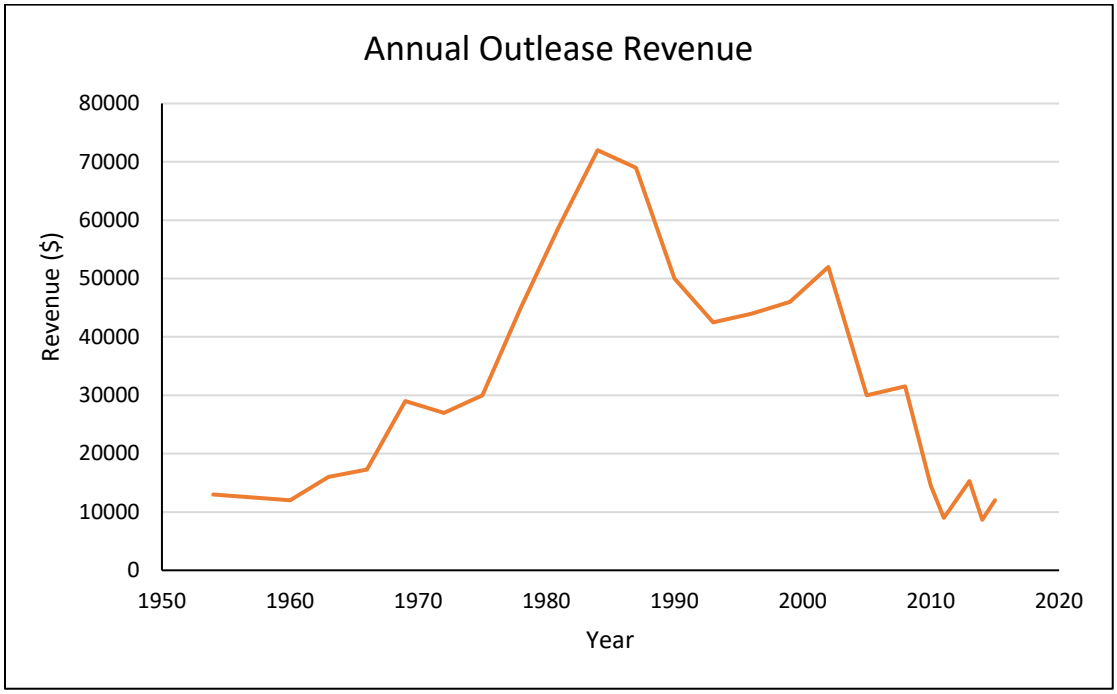
numbers of cattle grazed on agricultural leases from 1957-2014. The amount of cattle grazing over time has decreased significantly due to the loss of agricultural outlease land to mission and construction projects.

Figure 4.16. Estimated number of cattle grazed on agricultural leases at Redstone Arsenal, Alabama, 1957-2014



The direct benefits from the program come from rental cash paid to the Federal government. From 1954 through 2007, the amount of annual cash revenue has decreased due to the loss of agricultural outlease land to mission construction projects. The estimated value of the services received from agricultural leases is the total worth of all work performed by the lessee on the land at no cost to the Installation. These services are in the form of mowing, seeding eroded areas, clearing, seeding pastures, maintenance of drainage ways, fertilization, and weed control. Based on interviews with farmers and agro-businessmen, it was determined that the value of these services in 2008 was $100.00 per acre. The total value to the Installation in 2008 was estimated at $191,000 on 2,119 ac of agricultural lease land. Figure 4.17 depicts total annual amounts of cash paid to the Installation from agricultural outlease rentals from 1954 to 2014. Revenue per acre has ranged from $1.91 to $14.12 over the last 40 years.

Figure 4.17. Annual revenue on agricultural leases at Redstone Arsenal, Alabama, 1954-2014



4.11.4 Location of Outleased Tracts

Figure 4.18 shows the 2017 current use and location of outleases. Natural Resources personnel review outleases yearly and make recommendations concerning which areas to add or delete from the program based on Master Planning and mission needs.

Because of RSA mission changes, establishment of additional programs, and the cyclic nature of cattle production, a tendency to reduce acreage in the outlease program has developed. It is expected that these tendencies will continue during the life of this INRMP.

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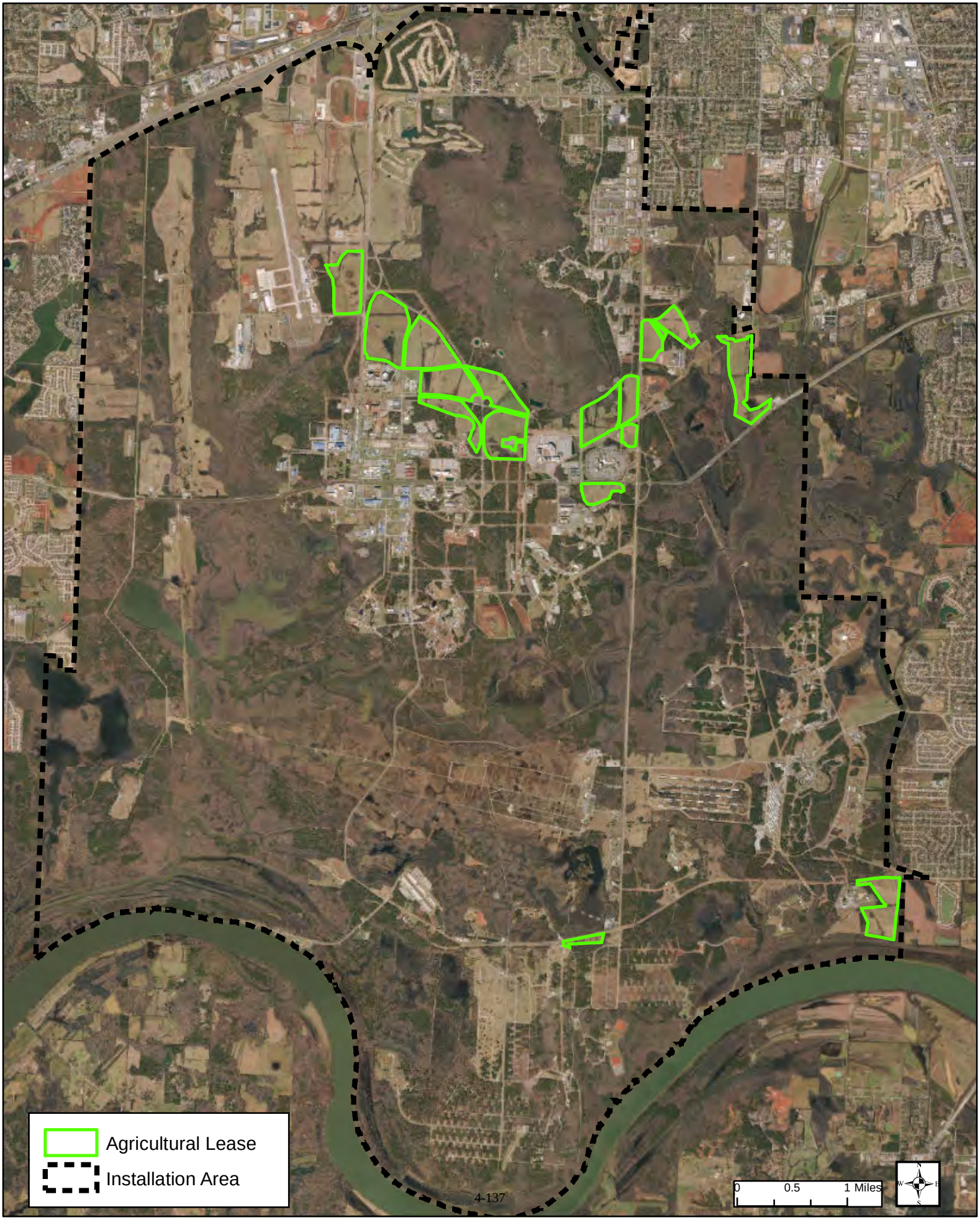
Figure 4.18. Agricultural Leases on Redstone Arsenal



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4.11.5 Program Management

Agricultural outleases are managed through the Mobile District, US Army Corps of Engineers. Reports of Availability (ROAs) are prepared by the EMD Agricultural Program Manager (APM) when lease units expire. Completed ROAs are provided to the Mobile District for publication of Special Public Notice. During the term of the lease the Agricultural Program Manager, along with the USACE, makes semi-annual inspections to insure compliance with the Land Use Regulations provided in the lease documents. Currently, 10 agricultural units totaling 1,015 ac are leased.

Provisions within leases ensure proper land management practices are implemented. Land Use Regulations are revised, as necessary, to meet specifications particular to each area. When determined to be in the best interest of the Government, these regulations may be revised by written agreement between the lessee and the USACE. Any changes or alterations to these regulations must be approved in writing by the CNR Branch. The lessee shall conduct all farming operations in accordance with the Land Use Regulations, conservation plans, and the RSA IPMP.

The lessee shall comply with the provisions of the Land Use Regulation by furnishing all equipment, labor, supplies and pay all expenses necessary and occurring after lease agreement. The lessee's compliance with the Land Use Regulation constitutes a portion of the compensation for use of the leased land, and failure to comply therewith will be regarded as a delinquency, the same as failure to pay cash rental. It is the responsibility of the lessee to provide the APM advance notice of his operations such as mowing, fencing, and application of herbicides. The lessee will provide semiannual compliance reports detailing the accomplishment of all maintenance, protection, and restoration actions specified in the Land Use Regulation to the Agricultural Program Manager in the CNR Branch of EMD.

Land preparation that involves soil disturbances such as disking, harrowing, plowing or other means of tilling up the soil is strictly prohibited. All soil applications will be implemented utilizing broadcast or no-till drill procedures.

The leased unit may be used for the production of hay crops with previously established grass and legume species such as fescue, clover, timothy, alfalfa, Bermuda grass and small grain species such as wheat, rye, oats, barley, triticale, provided that the certain small grain species are utilized exclusively for the production of hay. Row crop production, the production of seed or any use of a combine is strictly prohibited.

Any and all land utilized for the production of hay using annual crops shall be re- vegetated to an acceptable grass species at least 3 months prior to lease expiration. All re-vegetation plans and approvals shall be prepared and in accordance with the lease, at least 6 months prior to lease expiration.

Fertilizer shall be applied on all arable land prior to 15 May of each year. Fertilizer requirements shall be at the discretion of the lessee but a minimum 200 pounds of 13-13-13 (nitrogen-phosphorus-potassium) must be applied annually. Liquid nitrogen may be used in combination

with applications of herbicides to control noxious weeds. If liquid nitrogen is used in this manner, granular fertilizer must be applied prior to 15 September to conform to the minimum requirements stated above. Lime shall be applied on all arable land prior to 1 March of the first year of the lease. One lime application shall be sufficient for the term of the five year lease. Soil aeration will occur at the discretion of the farmer each year.

The lessee may restore vegetation to the arable land by reseeding. The APM must approve plans for restoration in writing prior to commencement of work. Plans shall include species to be seeded, ground preparation, analysis and quantities of fertilizer and/or liming products to be used, agricultural chemicals to be used, areas to be restored, and dates of work.

All arable land utilized for hay production will be cut twice a year to reduce unsightly vegetation growth. Each mowing shall include mowing within two feet of fences, utility poles, guy-wires, and other stationary objects located within or adjacent to the arable land. Each mowing shall also include mowing of all utility right-of-ways within the boundary of the leased units. The government will maintain the right of way for all utilities through the non-arable portions of all leased units.

The lessee shall maintain the premises in good condition and free from excessive weed growth, trash, brush in pastures, washes, gullies and other erosion which is detrimental to the value of the premises for agricultural purposes. The lessee shall maintain drainage ways within the leased land by removing debris and vegetation from ditches and culverts as necessary to sustain uninterrupted water flow.

Noxious weeds, such as thistle, will be controlled on each unit through the application of approved herbicides annually. Herbicides, which have been approved for use on Redstone Arsenal for these purposes are 2,4-D and Grazon P+D. Rates and time of application will be by label direction and shall be applied by a certified applicator. Copies of applicator certification and dates of application will be provided to the APM three days in advance in order for written approval of herbicide application to be obtained. Failure to provide three days advance notice and gain written approval is a violation of the lease and will result in disapproval of the application. Applications of chemicals on government lands without approval of the APM will result in a $500.00 fine per occurrence and be grounds for revocation due to noncompliance with lease terms. A completed DD-Form 1532 will be provided to the APM or IPMC within three days after completion of approved herbicide application.

The lessee shall not use any chemicals other than those specified above without obtaining prior written approval from the IPMC through the APM. The lessee shall submit a monthly Pest Management Report to the IPMC through the APM, following the month of any pesticide operation. The APM must receive the report no later than the 15th of the month following pesticide usage.

Buildings, parking lots, and other improvements, together with the right of ingress and egress thereto, are excluded from the lease. The lessee and the government for military mission requirements, hunting and fishing activities, and natural resources management may use the

leased land concurrently. Military training of personnel and wheeled vehicles may be expected to occur at least once a month on each unit.

4.11.6 Requirements

Fences

All fence materials used in the construction of fences on or within individual agricultural units on Redstone Arsenal must comply with current Army specifications.

Two chemicals, Round-Up (glyphosate) and 2,4-D, may be applied according to label direction to assist in keeping the fence lines clean, provided the chemicals are applied by a certified applicator. Chemical applications may not occur in areas designated as wetlands or in areas designated as sensitive (e.g., Northwestern area of the Installation, main roadway fences along Rideout and Patton Roads) by the APM. DD-Form 1532 must be completed and submitted to the APM or IPMC within three days of completion of chemical application.

All fence wires and posts damaged by the removal of trees and brush must be replaced to government specifications within 24 hours of identification. All trees, limbs, and underbrush must be removed from arable lands and placed along wood lines or other locations such that it will not interfere with mowing, haying, and/or fertilizing on arable lands.

All unit boundary fences will be kept in neat and good condition. Any fence posts found to be broken or leaning shall be replaced with new posts of similar composition or up righted and approved by the Agricultural Program Manager. All barbed wire shall be strung tight between posts and when found to be sagging or broken shall be immediately tightened or replaced to government specifications. Farm gates shall be in good condition and remain properly hung (*i.e.*, gate is level during opening and closing) at all times. Gates and support posts found to be broken or deteriorated shall be repaired or replaced immediately.

Livestock

Redstone Arsenal regulations prohibit livestock on roads, training areas, test ranges, airfield runways, and other areas where they pose a safety hazard. The lessee shall be responsible for confining his livestock to those portions of the leased land to be grazed and shall install and maintain in good condition any additional fencing necessary for this purpose. The lessee shall re-confine stray animals and make any necessary fence repairs immediately after having been notified. Any animal or group of animals straying repeatedly from the leased land shall be removed from Redstone Arsenal at the expense of the lessee.

All cattle permitted by lease agreement to graze upon Redstone Arsenal shall be the responsibility of the lessee to maintain a disease free herd in accordance with USDA regulations and shall provide the APM with certification from an accredited veterinarian after any eradication of contagious infectious disease such as tuberculosis or brucellosis.

As a measure to prevent the possible spread of infectious diseases, the lessee will be responsible

for periodically checking for sick, injured, or dead animals. The lessee shall tend to sick or injured animals within 3 hours of notification and dispose by burial or hauling to an approved landfill off post dead animals within 24 hours after having been notified.

All livestock on the leased land shall be branded in accordance with the laws of Alabama or tagged in accordance with an identification system approved by the APM. Tags used in lieu of branding shall be colored plastic material, and shall be securely attached to the ear or around the neck of the animal.

Other

Grazing of perennial forage crops of less than two inches average height is defined as overgrazing and such practice is prohibited. In the event of damage to an established perennial grazing crop by overgrazing, the lessee shall make comparable restoration in the form of removal of cattle from the overgrazed site, application of additional fertilizer and/or reseeding following the directions provided in the Land Use Regulation.

Hay bales, feeders or other attractants of cattle shall not be placed closer than 200 ft from any roadway, drainage way or cemetery, unless approved in writing by the APM. The lessee shall furnish, install, and maintain his stock water facilities. The lessee shall install meters and shall pay for water in accordance with the conditions set forth in the agricultural lease.

The lessee shall notify the Agricultural Program Manager immediately and no later than 24 hours of discovery of any potential or suspected environmental contaminants or conditions identified on the lease or adjoining property. The lessee shall manage any and all hazardous materials or waste (e.g., oil, gasoline, diesel fuel, pesticides, and batteries) brought onto government property in accordance with applicable State and Federal regulations. The lessee shall notify the APM immediately of any release of environmental contaminants.

4.11.7 Goals and Objectives

(1) Maintain the Agricultural Outlease Program to insure continued direct and indirect benefits to the government are achieved.

- Conduct semiannual compliance inspections. Maintain all lease paperwork and records for operations.
- Conduct soil and vegetative surveys on all units.
- Provide immediate response to all emergency calls received.

(2) Manage agricultural program in compliance with other natural resource laws and regulations.

- Prohibit use of invasive vegetative species.
- Minimize potential for non-point source pollution from improper applications of fertilizer or pesticides.
- Implement erosion control processes to minimize habitat destruction in grazed areas.

4.12 GIS Management, Data Integration, Access, and Reporting Component

4.12.1 General

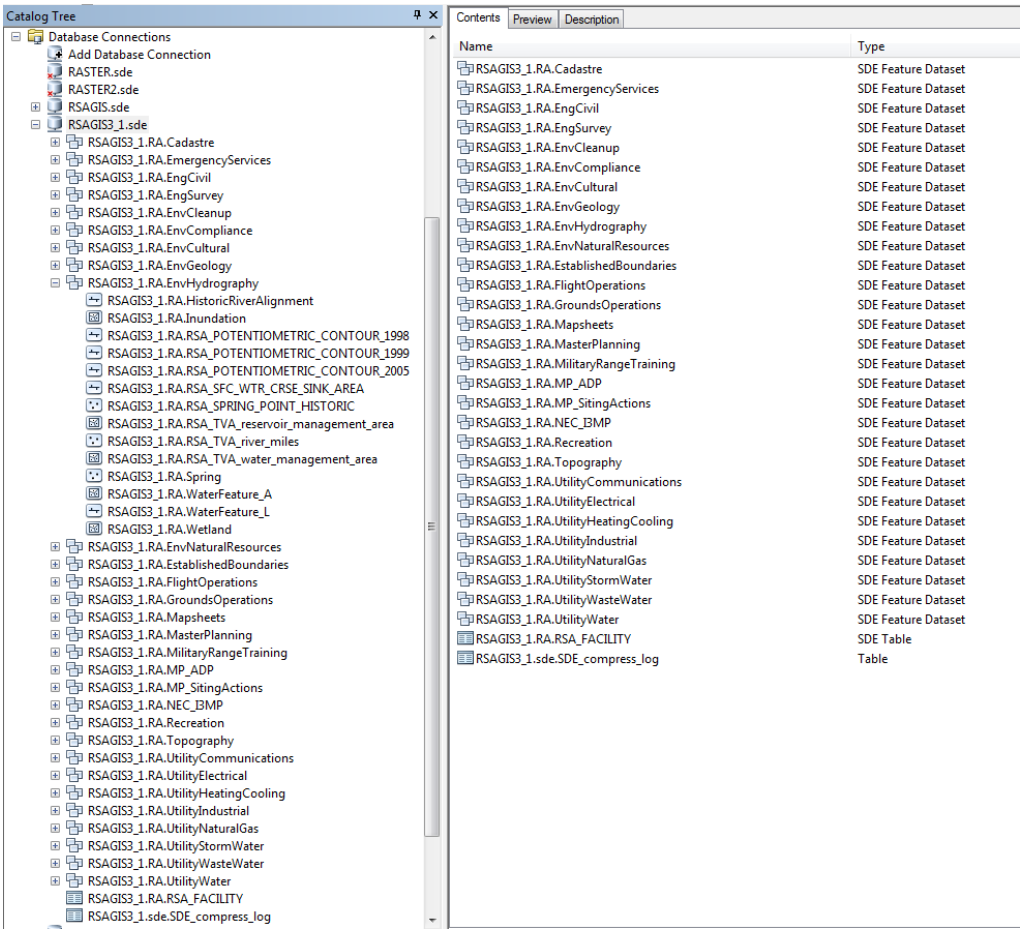
Mapping and spatial analysis are integral components of natural resources management that are fulfilled through the use of GIS data and software. Data provide documentation for the location and attributes of resources while software contains the tools necessary for the management, display, and analysis of these data. A major goal of any GIS is the development of rigorous organization and accuracy standards. These standards provide for a sound base dataset needed for rigorous analysis used in managing natural resources.

4.12.2 Spatial Data Standard for Facilities, Infrastructure, and Environment

The US Army has set forth a policy of GIS data standardization, quality control, and reporting in document AR 115-11, *Geospatial Information and Services*. The Installation Geographic Information and Services (IGI&S) program is the means by which AR 115-11 is implemented. The SDSFIE is the set ("family") of layer/field naming and database architecture standards that the IGI&S program implements. Originally written by the USACE, the latest version (SDSFIE 3.1) of these standards is now managed by the Defense Installation Spatial Data Infrastructure Group.

The SDSFIE is defined as a broad set of GIS standards created by the US Army and now being implemented throughout the DoD. The SDSFIE uses a standard data storage template with a hierarchical file schema. The most general level, the Entity Set (*i.e.*, environmental hazards), defines 29 groups that cover the spectrum of occupational fields. Each entity set contains multiple Entity Classes which logically group geographical feature types or Entity Types (*i.e.*, EnvCleanup). The smallest class of data, the Entity Type (*i.e.*, environmentalRemediationSite_A), can be graphically depicted on maps. Figure 4.19 depicts an example of the hierarchical format taken from ArcGIS at RSA. These standardized structures make data development uniform between offices and across installations, providing a level of quality control inherent to the data structure.

Figure 4.19. Hierarchical structure of an SDSFIE Geodatabase at Redstone Arsenal, Alabama



A second process to ensure data integrity and promote data sharing is the production of standardized metadata. This record of data development is essential for communicating the proper use of the data so that it is not applied out of context. SDSFIE dictates database architecture with nominal guidance on how to populate the metadata. US AEC managers of v3.0 have developed Quality Assurance Plans (QAP) for each layer, to set minimum metadata requirements.

The third process, implemented by SDSFIE to ensure data quality, is a hierarchical quality control procedure. It specifies who is responsible for data production from initiation to final approval. Most data are produced by a GIS technician who is skilled at GIS data creation, manipulation, and management, but in general, has no authority to choose the source data or modify any data without approval. The person who has control of choosing a data source and initiating data modification is the Subject Matter Expert (SME). The SME is located within the division responsible for the data layer and is the person who is most familiar with the physical location and attributes of the spatial features. The SME is the first person in the chain-of-approval once the data and metadata are completed. The Data Steward is the next person in line after the SME and is generally the Division or Departmental Chief supervising the SME. The duty of the Data Steward is to manage the status of all the data layers within their organization by

obtaining routine feedback from their SMEs. They also provide a vehicle for SME continuity upon personnel transition.

Data is maintained locally at the Directorate level. However, periodically data must be transferred to the US Army for final approval and integration with a US Army enterprise database. The IGI&S Coordinator, who organizes all the Garrison GIS activities, delivers completed GIS data to the Command Level Authority, who is typically the Garrison Commander, for final approval. Finally, the data are forwarded up through regional and national levels for approval and is appended to the US Army GIS database. From this database these data can be accessed online from an interactive mapping website called the Army Mapper.

4.12.3 Redstone Arsenal GIS Data Use and Development

The RSA Environmental Management Division uses GIS mapping capabilities for daily decisions as well as long term planning of natural resources management and its integration with the Army Mission. This work is driven by laws such as the NEPA, ESA, and CWA. For NEPA compliance, all impacts to Federal land from a proposed project and its alternatives must be considered before the project can be implemented. These impacts are frequently to natural resources such as endangered species, wetlands, and timber, so detailed databases and maps are required to assess the impacts on them. A list of SDSFIE data layers that the DPW maintains is provided as Appendix K.

The branches and offices within the Environmental Division keep GIS databases of these resources including threatened and endangered plant and animal inventories, hydrograph data such as streams and wetlands, cultural resource data, and environmental compliance data. The CNR Branch, which includes Fish and Wildlife, Forestry, and Cultural Resources Programs, maintains numerous GIS data layers including hunting areas, food plots, threatened and endangered species, wetlands, forest stand inventories, fire breaks, prescribed burning areas, archaeological sites, and cemeteries. The EMD Compliance Branch has developed GIS data for solid waste management buildings with asbestos-containing materials and sites of above and underground storage tanks. The EMD Restoration Branch maintains data layers for RCRA sites and areas with potential for Unexploded Ordnance (UXO)/Munitions and Explosives of Concern (MEC).

Along with these data the DPW also stores ancillary data that can affect a project such as infrastructure, boundaries, and geodetic reference points. Data for the Army’s training mission such as training area boundaries, live-fire ranges, and training impact areas are maintained by DPW with input from DOO.

Analyses of these data range from creating maps for a visual spatial analysis to multistep GIS algorithms to custom software extensions. Much of the work done with GIS is producing static maps containing standard GIS layers, but may require new data or custom statistics to be produced for project specific features. The custom extensions are usually only used to run analyses for long-term planning. One custom package is the Range Manager’s Tool Kit, which includes the Surface Danger Zones (SDZ) tool. This tool creates a database that can store parameters for creating particular SDZs and will flag violations if the SDZ breaches a boundary

or poses a danger for a facility.

All of the aforementioned types of GIS analysis require accurate, updated datasets and the ability to share current data and communicate data updates with users. Currently the EMD maintains a server where finalized data, intermediate working data, and all supporting files are stored. The finalized SDSFIE compliant data are stored in an enterprise GIS database (ArcSDE) with SQL Server as the management system; data are constantly being updated and developed.

To keep up with the increasing use and complexity of GIS data and to make it available to a wider audience, several projects are being implemented. A website is being planned to discuss the use of GIS on Redstone Arsenal, to communicate local and US Army GIS policies, to communicate upgrades to GIS technology and software, and to communicate data updates to local users. ArcSDE has been in use for the past ten years at RSA; it is used to streamline the dissemination and updating of data as a part of the ArcGIS Server, making GIS services available over a wider network. GIS software users will be able to access data from a GIS data service, which is a source of GIS data that is served to customers over the internet where it can be utilized directly by the user's computer software.

4.12.4 Goals and Objectives

(1) Utilize the RSA ArcSDE to manage natural resources by inputting, tracking, and manipulating data such as ecologically sensitive area boundaries and components, timber marking, wetland delineations, and so on.

- Update program data on a semi-annual basis, or as needed.
- Communicate with the other branches of DPW, as well as Redstone tenant organizations, the availability of such program data.

4.13 Outdoor Recreation Component

4.13.1 Introduction

Redstone Arsenal supports outdoor recreation as guided by AR 200-1 and the Sikes Act. The program is compatible with national defense and security requirements and is part of multiple use management. The Commanding General, Redstone Arsenal, is directly responsible for operations and maintenance of RSA, including implementing and enforcement of the Outdoor Recreation (OR) Program. This involves the cooperation of many different organizations both on Redstone Arsenal as well as outside agencies.

The outdoor recreation program is administered jointly by the DFMWR, DPW-EMD, and DOO. Implementation and oversight of the OR Program is coordinated by DFMWR using available personnel, contracts, interagency agreements, and local Installation expertise as available. The preparation and implementation of the biological management of all species and natural resources portion of the OR Program are the responsibility of the CNR Branch of EMD. DFMWR is responsible for the movement of persons, special events, and organizational elements of outdoor recreation at RSA. Test areas and training range managers coordinate with and inform DFMWR and DPW of military training requirements and objectives as it relates to the implementation of short and long-term range development plans and upcoming training activities that may affect outdoor recreation resources.

The objectives of the outdoor recreation program at RSA are:

- To support the military mission by providing Redstone Arsenal personnel with recreational opportunities to enhance quality of life.
- To provide outdoor recreation opportunities that do not conflict with the requirements of Redstone Arsenal’s mission.
- To promote conservation and wise use of renewable natural resources.
- To protect the natural environment.
- To promote a healthy awareness and understanding of the natural environment.

The activities included in the OR Program provide a framework to allow for suitable natural resources areas of Redstone Arsenal to be managed for outdoor recreational opportunities. Conservation of outdoor recreation resources are considered in all programs, site feasibility studies, and project planning and design. All actions and activities covered in this program will be carried out in accordance with all applicable Redstone Arsenal, US Army, DoD, Federal, State, and local laws and regulations; specifically AR 200-1.

4.13.2 Existing Outdoor Recreation Resources

With nearly 30,000 ac of commercial woodland and unimproved grounds, Redstone Arsenal has an abundant outdoor recreation resource base varying from forested upland habitats to forested wetland habitats and open water resources.

RSA natural resources management relies on an ecosystem-based management philosophy,

correlating forest management, wildlife management, and outdoor recreation. This strategy blends multiple-use needs and provides a consistent framework to managing military installations, while ensuring the integrity of the ecosystem. Ecosystem-based management is the current management philosophy being endorsed by the DoD and other Federal agencies and is explained in more detail in Section 1.8 of this INRMP.

4.13.3 Outdoor Recreation Program

Outdoor Recreation programs on Redstone provide opportunities to participate in, and enjoy, the great outdoors by offering several outdoor activities. The Installation has and currently provides multiple-use outdoor recreation opportunities such as a nationally recognized disk golf course, a 36-hole golf course, picnic areas, nature education areas, running, hiking and biking trails, camping areas, as well as canoeing, boating, fishing, and hunting opportunities. Additional information regarding FMWR benefits and activities can be viewed at http://www.redstonemwr.com. Redstone boasts a well-developed outdoor recreation program that increases available opportunities and maximizes its production of quality outdoor recreation.

4.13.4 Administration

As mandated by AR 200-1, whenever practical, US Army lands with suitable natural resources are to be managed to allow for outdoor recreation opportunities. Outdoor recreation on Army lands is addressed by laws and regulations including the Sikes Act, DoDI 4715.03, AR 215-1 (*Military Morale, Welfare, and Recreation Programs and Nonappropriated Fund Instrumentalities*), RSA Regulation 200-3 (Appendix F), and various others.

Administrative responsibilities are discussed in detail in Section 1.0 of this INRMP. The USFWS provides technical advice to Redstone Arsenal for the management of its natural and outdoor recreation resources, particularly endangered species and migratory birds. AR 200-1, Chapter 4, provides cooperative guidance to be followed by Redstone Arsenal with the USFWS regarding endangered species management on Army installations. The State of Alabama, functioning through the Director, ADCNR, provides limited technical advice and assistance if funds are available and priority warrants. ADCNR provides permit and license information and guides to hunting, fishing and camping in the state.

4.13.5 Goals and Objectives

(1) Manage the Outdoor Recreation Program in a sustainable manner consistent with AR 200-1 and AR 215-1

(2) Prohibit use of off-road vehicles for recreational purposes on Redstone Arsenal. Discourage pedestrian and bike use of trails through ecologically sensitive areas; provide alternative location options.

4.14 Wildlife Aircraft Strike Hazard Plan

4.14.1 Wildlife Aircraft Strike Hazard Plan (WASH) Plan for Redstone Army Airfield

The RAAF was established during World War II to test incendiary devices. In the mid-1950s, the Redstone AAF began to serve military and commercial flights until Huntsville Airport was constructed. Current, the RAAF supports the Aviation Flight Test Directorate, AMCOM, FMWR Flying Activity, MSFC activity, and other tenant units.

As with any airfield, the RAAF has the potential for small animals such as rabbits, skunks, small birds, and waterfowl, including geese, to be present in the vicinity of runways, taxiways, and run-up areas. This Airfield has also documented larger animals (e.g., deer, turkey, coyotes) on or near the runway and taxiways. In light of this reality and in accordance with IMCOM requirements and operating procedures, including but not limited to AR 200-1, AR 385-10 (*Army Safety Program*), and DA Pamphlet 385-10, a WASH Plan for the RAAF was drafted and approved in 2015 (Appendix L). This plan prescribes comprehensive procedures for implementing a wildlife hazard management plan. Control measures in this WASH Plan are both passive and active, however no lethal control is executed at this time.

4.14.2 Goals and Objectives

(1) Protect the health and safety of Installation tenants and aircraft from the threats of wildlife animal hazards and general nuisance situations.

- Continue implementing WASH Program. Maintain the existing wildlife damage management/control program.
- Complete wildlife hazard assessment at Redstone Army Airfield.
- Monitor habitat modifications at Redstone Army Airfield.

4.15 Wildland Fire Management Plan

As with all other DoD components, Redstone Arsenal is tasked with managing fuel loads, providing adequate planning for wildand fire management, and implementing prescribed burn programs where appropriate. This management reduces wildfire potential and functions as an ecosystem-based management tool. Suppression of forest and grass fires is the responsibility of the Installation Fire Department, assisted by the Installation Forester and Grounds Maintenance Contract personnel.

All wooded areas are inspected periodically by the Fire Chief, Installation Forester, and Natural Resources personnel. Firebreaks are constructed and maintained where necessary for the control of wildfire. Frequently, due to new or different locations or types of RDT&E tests performed on ranges, special inspections of woodland areas will be performed to insure adequacy of existing firebreaks or provisions of new breaks. Fire reports are analyzed annually by the Fire Marshal to determine how the fire protection program can be improved.

Prescribed fires are a management tool used to reduce forest fuels that could generate a high intensity fire and destroy natural resources. Prescribed burning operations that utilize fire as predetermined by area locations and fire intensities to reduce hazards of wildfire will be accomplished on an annual basis. Annual prescribed fires are required by this INRMP to protect and maintain forest resources, restore native ecosystems, reduce fuel loads, and discourage the reproduction and growth of invasive species. Annual prescribed burning is also conducted to reduce the risk of wildfire from training related activities. Fuel reduction fires are generally conducted during the dormant season when temperatures are low and the weather is more predictable. Dormant season burns also minimizes damage to desirable vegetation. All prescribed fires are conducted in accordance with the Integrated Wildland Fire Management Plan (IWFMP), which can be provided upon request by the EMD. The Installation annually burns between 2,000 and 4,500 ac to meet natural resources and mission requirements.

The Annual Prescribed Burn Plan for Redstone Arsenal during FY 2016 is found at Appendix G. Prior to prescribed burn operations, the Installation Forester obtains authorization with a State Burn Permit and local clearance for the control of air pollution. All necessary firebreaks are prepared before fire is started and proper personnel, tools and equipment will be present for controlling the fire. Burn personnel will inspect fuel conditions during the planning phase for the burn and obtain local weather information from the local National Oceanic and Atmospheric Association station. Goals include the prevention of head fires, crown scorching, burning of hardwood stands, and burning of uneven aged pine stands that contain pine saplings and younger trees susceptible to damage by fire.

4.15.1 Goals and Objectives

(1) Take active role in managing wildland fire by executing annual prescribed burning program in managed timber stands as well as test areas and range lands.

4.16 Training of Natural Resources Personnel

Army Regulation 200-1 requires that INRMPS be implemented by "ensuring that sufficient numbers of professionally trained natural resources management personnel are available to perform the tasks required by the INRMP." The Sikes Act similarly states that the Secretary of the Army must ensure sufficient numbers of professional trained natural resources management personnel be available to carry out the preparation and implementation of the INRMP.

Continuing education is necessary for natural resources professionals to stay current with new developments, skills, and technologies in their fields. This field requires that personnel comply with laws, obtain and maintain professional certifications, and maintain membership in natural resources associations. The Army is authorized, but not required, to pay for training resulting in continuing education units and associated expenses so long as the training directly benefits the Army. Personnel in the USAG-Redstone DPW are required to maintain an Individual Development Plan (IDP) which projects training needs on a multi-year basis. These IDPs are the means to gain local Garrison approval for funding and attending training.

In July 2015, the Secretary of the Army updated the Army policy on hosting and attending conferences in an effort to ensure compliance with DoD policies and optimize the use of scarce resources. This policy supports the Joint Travel Regulation's definition of a conference: "A meeting, retreat, seminar, symposium or event that involves attendee travel. Also applies to training activities that are conferences under 5 CFR 410.404." If a conference is needed to obtain training, personnel are required to provide justification and request approval by the IMCOM Commander. The Army has determined that formal classroom training is not a conference and therefore is exempt from the 2015 policy.

4.16.1 Wildland Fire Personnel Training

The DoD adopted the National Wildfire Coordination Group's (NWCG) Federal Wildland Fire Policy to govern all wildland fire activities carried out by DoD personnel. This policy requires all personnel involved in prescribed fire and/or wildfire activities meet certain training and physical qualifications. Some military installations have already implemented this requirement with most making it mandatory for new hires and positions and voluntary for current employees. Redstone Arsenal's requirements for personnel qualifications will be reviewed and the IWFMP will contain complete information on personnel qualifications.

4.16.2 Pesticide Applicator Training

Federal personnel applying any pesticide on Federal land need DoD certification in accordance with AR 200-1. Only Federal employees under hiring programs with duties as pesticide applicators can participate in the on-the-job training program. During this time, the new employee works under the direct supervision of a certified pesticide applicator, until they are qualified (one year on-the-job experience) and satisfactorily complete the DoD Pest Management Certification Course and can work independently. Certification is required for the IPMC in the appropriate categories of work, which occur on the Installation.

Civilian contractors applying any pesticide on RSA property require an Alabama certification in the category or applicable subcategories of work performed. All of the contractor's pest management staff who apply pesticides must be certified as pesticide applicators. Non-certified contractor employees are prohibited from applying pesticides.

Individuals who evaluate the quality of work of pest control contracts should also be trained in the pest management category or categories of work being performed. Direct supervision is defined in DoDI 4150.7 as supervision that includes being at the specific location where pest management work is conducted; providing instruction and control; and maintaining a line-of-sight view of the work performed. Certain circumstances may temporarily remove the line-of-sight view of the application of pesticide from the supervisor such as topographic, vegetation, or structural constraints. Under these temporary circumstances, the supervisor shall be responsible for the actions of the pesticide applicators.

Training and certification will be conducted at government expense for DoD personnel. Certified Pest Control personnel shall be recertified in accordance with Alabama or DoD requirements as specified above. Employed pesticide applicators must be certified and the quality assurance evaluator must be trained in the following categories when appropriate. Certification and training is required when performing pest control operations that involve restricted-use or state-limited use pesticides, to supervise other employees conducting pest control involving restricted-use or state-limited use pesticides, or to evaluate contractor performance relating to pest control within the categories of pest control including forest, ornamental and turf, aquatic, right-of-way, industrial institutional, structural, health related. The IPMP provides clarification of the Alabama statutes that address the status of state employees who apply pesticides with respect to certification, licensing, and required categories and sub-categories.

Personnel involved in pesticide applications on a regular or seasonal basis, especially when mixing formulations is required, are encouraged to attend local pest management classes, workshops, seminars, etc. The time and labor expended in this type of training is easily recouped through improved efficiency in pest management. Local pest management training may include on-site training in addition to any off site recertification training, such as the DoD course or State recertification requirements. Other personnel who deal directly with pest control operations, but who may not need to be certified, are also encouraged to attend local seminars to better understand pest management needs.

4.16.3 Goals and Objectives

(1) Sustain the natural resources workforce at USAG-Redstone by supporting training and continuing education.

- Maintain approved IDPs

4.17 Coastal/Marine Management Component

Coastal and marine management is not applicable to Redstone Arsenal.

4.18 Floodplain Management Component

EO 11988, *Floodplain Management*, requires all Federal agencies to provide leadership and take action to reduce the risk of flood loss; minimize the impacts of floods on human safety, health, and welfare; and restore and preserve the natural and beneficial values of floodplains when acquiring, managing, or disposing of Federal lands. Redstone Arsenal's planners consult the National Flood Insurance Program maps distributed by the Federal Emergency Management Agency and available through the Arsenal's GIS, to determine if the proposed action occurs in a floodplain.

Redstone Arsenal utilizes 44 CFR 9.5 in implementation of EO 11988, with project review and stormwater management programs. The erosion and sediment programs of the State and local issuing authorities review all development and prevent construction of structures from within critical floodplains. Figure 2.4 represents the 100-yr and 500-yr flood zones at Redstone Arsenal. The following steps are taken to minimize impacts to floodplains:

- Through NEPA and project review, DPW personnel (e.g., Master Planning Division and the CNR Branch of EMD) decide which projects are located in a 100-yr floodplain. Available alternatives to relocate or prevent life, health and safety issues that are potentially located in that floodplain are investigated.
- Agencies, where possible, shall use natural systems, ecosystem processes, and nature-based approaches in the development of alternatives for all actions to which EO 11988 applies.
- Require responsible and sponsoring agencies to circulate a FONPA in cases where potential exists to damage floodplain capacity, facilitate future development within 100-yr floodplains, or where a 100-yr flood event would present potential damage to new construction or equipment.
- Redstone Arsenal staff and contract personnel will determine the boundaries of the floodplain in accordance with the floodplain maps.
- Pertinent associated material, including aerial images and maps (topographical, etc.) are assembled for floodplains management.

4.18.1 Goals and Objectives

(1) Adhere to EO 11988 and examine alternatives to development within the 100-year floodplain at Redstone Arsenal.

4.19 Other Leases

Coverage of other leases in this INRMP is not applicable to Redstone Arsenal.

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5.0 Implementation

Over the course of its implementation, the INRMP will:

- Ensure compliance with environmental laws.
- Enable Redstone Arsenal to make progress towards achieving a sustainable natural resources base and a realistic training environment.
- Establish appropriate stewardship policies that serve to protect both natural and cultural resources.
- Provide a continuity of direction and effort that can accommodate changes in personnel and leadership.
- Promote cost-effectiveness through better planning and coordination.
- Make use of innovative strategies to accomplish specific management objectives.
- Promote good public relations by demonstrating the Installation's commitment to stewardship, as well as a multiple-use concept for the general public.

5.1 Plan Implementation and Review

The CNR Branch develops annual work plans based on the requirements and funding of all program elements that comprise the INRMP. Detailed natural resources management prescriptions that drive the major actions/projects will be developed annually. Work plans developed for each FY will include a listing of projects, funding requirements, supporting common levels of service (CLS), and manpower data to complete the action. These work plans will be used to track progress on INRMP implementation, budget expenses, request budget allotments for the next fiscal year, and coordinate needed manpower requirements for labor intensive projects.

Natural Resources managers and personnel will meet on a quarterly basis to review plan implementation and discuss any necessary adjustments. These reviews shall use the Natural Resources Conservation Metrics described in Enclosure 5 of DoDI 4715.03. External tri-partite stakeholders (USFWS and the State fish and wildlife agency) shall be invited to participate. This in-process review will serve to prioritize projects; resolve conflicts between program areas; coordinate implementation of specific provisions of the INRMP; identify common objectives so some projects may be completed by several partners; and identify the need for work plan updates. A list of prioritized projects will be developed at the beginning of each FY and reviewed and updated each quarter for the remainder of that year. The list will include a brief description of the project; cost estimate; timeline for completion; designation as “in-house” or “contract;” the most likely funding mechanism; and a point of contact for each project. After prioritization, those projects for which funding and other resources are available will be started in accordance with the developed timeline. Additional projects which require funding will incorporated into appropriate funding streams as permissible. IMCOM will utilize the Army Environmental Database Environmental Quality (AEDB-EQ) database to model annual funding. Project-specific funding requests will be prioritized on the Garrison level.

5.2 Achieving No Net Loss

The implementation of proposed projects described in this INRMP, as well as future revisions and updates to reflect emerging natural resources planning needs, assist Redstone Arsenal resource managers in achieving "no net loss" of the capability of military lands to support the Installation's mission. To implement this plan and ensure minimal impacts or conflicts with military training, frequent and close coordination between the CNR Branch and range/test area manager personnel is necessary. Range and test area coordinators schedule and manage training land use and they need to be aware of management actions within the training areas. These actions include, but are not limited to, timber harvest, fire lane maintenance, plant/animal surveys, and wetland delineations. In addition, it is important that the natural resources staff remain aware of when and where field training is occurring so work can be adjusted around those activities when necessary.

5.3 Outside Assistance

The magnitude and complexity of the management requirements are such that outside assistance is necessary. This assistance can vary but usually takes the form of a partnership which may include funding, facilities, GIS support, or simply an agreement on how two agencies will work with each other to achieve common goals. Many cooperators are involved including the GSA, USACE, ADCNR, USFWS, universities, and contractors.

5.4 Programming and Budgeting Priorities

5.4.1 Environmental Program Requirements

Funds for Natural Resource Programs, other than Forestry, are acquired from the annual budget modeling system, derived from the AEDB-EQ survey database and CLS reporting criteria that reflects site specific resources such as Installation size, T&E species, wetland acreage, etc. Annual funding for these programs has decreased over time, with funding shortfalls across the Army. After annual funds are distributed by IMCOM, individual project prioritizations are made on the Garrison level.

Recurring natural resources conservation management requirements are typically costs of sustaining an effective program and may include, but are not limited to, manpower, training, supplies, permits, reporting and recordkeeping, maintenance of equipment, and compliance self-assessments. The USAG-Redstone EMD gives priority to these recurring costs.

Non-recurring natural resources management requirements are classified and prioritized as follows:

a. Current Compliance. Installation projects/activities to support programs out of compliance (e.g., enforcement actions against the program), consent orders, meeting requirements with all federal and state laws and regulations, military mission sustainment, and projects/activities that will be out of compliance if not implemented in the current program year. Project/activity examples include, but are not limited to,

environmental analyses, planning documents, mitigation required by permit, planning-level surveys, and wetland delineations. At RSA, specific examples are INRMP review/revision, environmental impact analyses, and planning level surveys for at-risk species and ecologically significant communities.

b. Maintenance Requirements. Projects/activities needed to meet a deadline established beyond the current program year and maintain compliance. Examples include conservation, GIS mapping and data management to comply with federal and state laws and regulations; leadership initiative efforts; wetlands enhancement to minimize loss or offset degradation; and conservation recommendations pursuant to ESA. At RSA, a specific example is the series of hydrogeological assessments of an ecologically sensitive area that will contribute to a future biological assessment.

c. Enhancement Actions Beyond Compliance. Projects/activities to enhance conservation resources or integrity of the installation mission but are not specifically required by law or regulation and are not of an immediate nature. Examples include community outreach events, educational/public awareness projects, and volunteer/partnership program management. At RSA, specific examples are Earth Day, National Public Lands Day, and the Path to Nature.

5.4.2 Reimbursable Funds

The available acreage for agricultural outleases is decreasing due to mission development at RSA (Section 4.11). D irect revenue from this program (FY16 revenue approximately $15,000) has historically contributed funding to INRMP implementation, specifically wildlife resource management. With the continued decrease in these reiumbursable funds, resource managers at Redstone Arsenal may struggle to implement many components of the INRMP.

Redstone Arsenal receives, on average, $110,000 annually to fund the operation of the Forest Management Program. These Forestry Reimbursable Funds are received through AEC. The funds are derived from proceeds of forest product sales from all Army installations. Redstone Arsenal produced approximately $120,000 in FY16 to fund the account, and will produce approximately $168,000 in FY17. Rough estimates of funds through FY21 are provided in Table 5.1. By law, the funds can only be used for reimbursement of expenses directly related to the economic production of timber products and their harvest. Budget figure requirements for the implementation of the Forest Management Plan are provided in Table 5.2.

Table 5.1. Estimated Value of Harvest Products, Redstone Arsenal, Alabama, FY 2017-2021

Product	FY17	FY18	FY19	FY20	FY21
Pine Pulpwood	$77,000	$75,000	$77,000	$80,000	$82,000
Pine Sawtimber	$27,000	$25,000	$26,000	$27,000	$27,000
Hardwood Sawtimber	$17,000	$12,000	$13,000	$14,000	$14,000
Hardwood Pulpwood	$45,000	$41,000	$42,000	$43,000	$45,000
Firewood	$2,000	$2,000	$2,000	$2,000	$2,000
Total	$168,000	$155,000	$160,000	$166,000	$170,000

Table 5.2. Forest Management Plan Budget, Redstone Arsenal, Alabama, FY 2017-2021

Items	FY17	FY18	FY19	FY20	FY21
Equipment	$51,000	$52,200	$52,200	$53,000	$53,000
Fire Protection	$57,000	$60,000	$60,000	$61,000	$61,000
Management	$87,550	$90,000	$93,000	$95,700	$98,500
Access Roads	$9,000	$8,000	$8,000	$6,000	$6,000
Reforestation	$50,000	$40,000	$30,000	$30,000	$30,000
Support	$10,000	$6,000	$9,000	$10,000	$10,000
Total Requirement	$264,550	$256,200	$252,200	$255,700	$258,500

Fish and wildlife funds are obtained from the sale of hunting and fishing permits (Section 4.4). These funds are designated as Army account 21X5095. In 2016, $21,130 was generated from hunting/fishing/trapping permit sales at Redstone.

5.4.3 Other Funds

Other funds that may become available to complete projects are the DoD Forestry Reserve Account, Legacy, construction project mitigation funds, USDA (Pest Management Board) funds, DoD "Sustainable Forests, Protecting Our Future" funds, end of FY funds (subject to availability), grants, and other funding sources.

5.4.4 Summary of INRMP Implementation Costs

All requirements set forth in this INRMP requiring the expenditure of the RSA's funds are expressly subject to the availability of appropriations and the requirements of the Anti-Deficiency Act (31 U.S.C. Section 1341). No obligation undertaken by RSA under the terms of

this INRMP will require or be interpreted to require a commitment to expend funds no obligated for a particular purpose.

In FY17, the approximate cost of fully implementing the INRMP is $836,924 (Table 5.3). Some variability is expected and this estimate does not take into account the reimbursable funds generated from the hunting/fishing, agricultural, and forestry programs. Actual funding levels and annual budgets will always be predicated on availability of funds from IMCOM. The annual costs of INRMP implementation will be tracked in this document over the next five year period.

Table 5.3. Costs of INRMP Implementation, Redstone Arsenal, Alabama

Requirements	**FY17**	**FY18**	**FY19**	**FY20**	**FY21**
T&E Species Management	$416,363	$424,690	$433,184	$441,848	$450,685
Natural Resources (Non-T&E) Management	$257,035	$262,176	$267,419	$272,767	$278,222
Natural Resources Program Support	$163,526	$166,797	$170,133	$173,536	$177,007
Total	$836,924	$853,663	$870,736	$888,151	$905,914

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Appendix A
Acronyms

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ABWG	Alabama Bat Working Group
amsl	above mean sea level
APZ	Accident Potential Zone
ac	acre
APM	Agricultural Program Manager
AL	Alabama
ADCNR	Alabama Department of Conservation and Natural Resources
ADEM	Alabama Department of Environmental Management
ALIPC	Alabama Invasive Plant Council
ALNHP	Alabama Natural Heritage Program
APHIS	Animal and Plant Health Inspection Service
AEC	Army Environmental Command
AEDB-EQ	Army Environmental Database Environmental Quality
AMC	Army Materiel Command
AR	Army Regulation
AMCOM	Aviation and Missile Command
BA	basal area
BMP	best management practice
BO	Biological Opinion
Ca	calcium
cm	centimeter
CWA	Clean Water Act
CCAR	Climate Change Adaption Roadmap
CFR	Code of Federal Regulations
CLS	common levels of service
CWCS	Comprehensive Wildlife Conservation Strategy
CEQ	Council on Environmental Quality
CR	County Road
cfs	cubic feet per second
cu ft	cubic foot
cms	cubic meter per second
CNR	Cultural and Natural Resources
dm	decimeter
DA	Department of Army
DoD	Department of Defense
DoJ	Department of Justice
DBH	diameter at breast height
DDT	dichlorodiphenyltrichloroethane
DPW	Director of Public Works
DES	Directorate of Operations
DFMWR	Directorate of Family and Morale, Welfare and Recreation
DWFF	Division of Wildlife and Freshwater Fisheries
DoDI	DoD Instruction

DoDM	DoD Manual
ESA	Endangered Species Act
EUL	Enhanced Use Lease
EMD	Environmental Management Division
EMS	Environmental Management System
EPA	Environmental Protection Agency
EO	Executive Order
ERDC	Engineer Research and Development Center
°F	Fahrenheit
FONPA	Finding of No Practicable Alternative
FTX	field training exercise
FY	Fiscal Year
ft	foot
FMC	Forestry Management Component
GIS	Geographic Information System
GSA	Geological Survey of Alabama
HPW	hardwood pulpwood
HST	hardwood sawtimber
HSB	Huntsville Spring Branch
in	inches
IDP	Individual Development Plan
IC	Installation Compliance
IGI&S	Installation Geographic Information and Services
IMCOM	Installation Management Command
IPMC	Installation Pest Management Coordinator
IR	Installation Restoration
IWGW	Installation-wide Groundwater
ICRMP	Integrated Cultural Resources Management Plan
INRMP	Integrated Natural Resources Management Plan
IPM	integrated pest management
IPMP	Integrated Pest Management Plan
ITAM	Integrated Training Area Management
IWFMP	Integrated Wildland Fire Management Plan
I	Interstate
km	kilometer
LEED	Leadership in Energy and Environmental Design
Mn	magnesium
MSFC	Marshall Space Flight Center
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
m	meters
MBTA	Migratory Bird Treaty Act
mph	mile per hour

MHPI	Military Housing Privatization Initiative
MMRP	Military Munitions Response Program
mm	millimeter
MEC	munitions and explosives of concern
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act
NRHP	National Register of Historic Places
NWI	National Wetlands Inventory
NWCG	National Wildfire Coordination Group
NWSG	native warm season grass
NRCS	Natural Resources Conservation Service
NRFL	non-reimbursable forestland
OR	Outdoor Recreation
PIF	Partners in Flight
PPW	pine pulpwood
PST	pine sawtimber
PCB	polychlorinated biphenyl
K	potassium
PAL	Privatization of Army Lodging
PAO	Public Affairs Office
QAP	Quality Assurance Plans
RPMP	Real Property Master Plan
RAAF	Redstone Army Airfield
RSA	Redstone Arsenal
RCL	Redstone Communities, LLC
RFL	reimbursable forestland
ROAs	Report of Availability
RDT&E	research, development, test and evaluation
RCI	Residential Communities Initiative
RCRA	Resource Conservation and Recovery Act
SVOCs	semi-volatile organic compounds
SAIA	Sikes Act Improvement Act
Na	sodium
SDSFIE	Spatial Data Standards for Facilities, Infrastructure, and Environment
sq ft	square foot
SOP	standard operating procedure
SWG	State and Tribal Wildlife Grants
SCWP	State Comprehensive Wildlife Plan
SR	State Road
SMZ	streamside management zone
SME	Subject Matter Expert
SDZ	surface danger zone
TWW	Teaming with Wildlife

TM	Technical Manual
TVA	Tennessee Valley Authority
TA	Test Area
TNC	The Nature Conservancy
MBF	thousand board feet
T&E	Threatened and Endangered
TCE	trichloroethene
UXO	unexploded ordnance
UFC	Unified Facilities Criteria
USC	United States Code
USAG	US Army Garrison
USACE	US Corps of Engineers
USDA	US Department of Agriculture
USFWS	US Fish and Wildlife Service
USGS	US Geological Survey
VOC	volatile organic compound
VA	vulnerability assessment
WNS	White-nose syndrome
WNWR	Wheeler National Wildlife Refuge
WASH	Wildlife Aircraft Strike Hazard Plan
WS	Wildlife Services

Appendix B
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Appendix C
Birds of Redstone Arsenal

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BIRDS
OF
REDSTONE ARSENAL

Redstone Arsenal is located in the Tennessee River Valley between the cities of Decatur and Huntsville, Alabama, and was established in 1941 as part of the military mobilization leading up to US involvement in World War II. The Installation's 38,100 acres provides a great diversity of habitats including forested wetlands, upland hardwoods, deep river channels, tributary creeks, swamps, backwater embayments, pine uplands, and agricultural fields. This diversity provides for an amazing variety of birdlife and makes the refuge fertile grounds for enjoying the great activity of bird watching.

How to use your checklist

The bird checklist is designed to be informative and simple to use. It is arranged in the order established by the American Ornithologists' Union. This list was developed with the assistance of Tennessee Valley Audubon members R.B. "Willie" Williams and the late Mark Brown and was officially created for Wheeler National Wildlife Refuge. Symbols which appear in this checklist represent the following:

Seasonal Appearance

Sp	Spring	March - May
S	Summer	June - August
F	Fall	September - November
W	Winter	December - February

Seasonal Abundance

a - abundant: a common species which is very numerous
c - common: certain to be seen in suitable habitat
f - fairly common: occurs annually
u - uncommon: present but not certain to be seen
r - rare: seen at intervals of 2 to 5 years
v - vagrant: less than ten valid records in last decade
x - accidental: less than three valid records
h - historical: species occurring formerly
***** - may nest on the installation
I - Introduced species

This checklist includes 296 species of birds and is based on local observations by biologists and birders. If you should find a species not on this list, please notify the Environmental Management Division. We appreciate your help in updating our records. To report unusual sightings or for further information, contact:

Environmental Management Division
US Army Garrison-Redstone
4488 Martin Road
Redstone Arsenal, AL 35898
(256) 876-6122

	Sp	S	F	W
WATERFOWL				
___ Black-bellied Whistling-Duck	-	x	x	-
___ Greater White-fronted Goose	r	-	f	f
___ Snow Goose	u	-	c	a
___ Ross' Goose	-	-	f	f
___ Canada Goose*	f	u	a	a
___ Brant	-	-	x	x
___ Barnacle Goose	-	-	x	x
___ Mute Swan (I)	-	x	x	-
___ Tundra Swan	r	-	r	r
___ Wood Duck*	c	c	c	c
___ Gadwall	c	v	c	a
___ Eurasian Wigeon	-	-	v	v
___ American Wigeon	c	-	a	a
___ American Black Duck*	f	u	c	c
___ Mallard*	c	f	a	a
___ Blue-winged Teal*	c	r	c	r
___ Northern Shoveler	c	v	c	c
___ Northern Pintail	u	v	c	c
___ Green-winged Teal	c	-	c	c
___ Canvasback	f	-	c	c
___ Redhead	f	-	c	u
___ Ring-necked Duck	c	-	c	c
___ Greater Scaup	r	-	r	r
___ Lesser Scaup	c	-	c	c
___ Harlequin Duck	-	-	-	x
___ Surf Scoter	-	-	x	-
___ White-winged Scoter	v	-	v	v
___ Black Scoter	-	-	-	x
___ Long-tailed Duck	v	-	v	v
___ Bufflehead	c	-	c	c
___ Common Goldeneye	c	-	c	c
___ Hooded Merganser*	f	u	c	c
___ Common Merganser	r	-	r	r
___ Red-breasted Merganser	f	-	f	u
___ Ruddy Duck	c	-	c	c
GALLINACEOUS BIRDS				
___ Wild Turkey*	u	u	u	u
___ Northern Bobwhite*	f	f	f	f
LOONS				
___ Red-throated Loon	v	-	-	v
___ Common Loon	f	v	f	c
GREBES				
___ Pied-billed Grebe*	c	u	c	a
___ Horned Grebe	f	-	f	c
PELICANS				
___ American White Pelican	r	-	f	r
CORMORANTS				
___ Double-crested Cormorant	c	u	c	c
ANHINGA				
___ Anhinga	h	h	h	-
HERONS				
___ American Bittern	u	-	u	-
___ Least Bittern*	r	r	r	-
___ Great Blue Heron*	c	u	a	a
___ Great Egret	f	u	f	f
___ Snowy Egret	r	r	r	-
___ Little Blue Heron	f	f	u	-
___ Tricolored Heron	r	r	-	-
___ Cattle Egret	c	c	f	x
___ Green Heron*	c	c	f	x
___ Black-cr. Night-Heron	u	u	f	u
___ Yellow-cr. Night-Heron*	f	f	u	-
IBISES and ALLIES				
___ White Ibis	v	r	u	-
___ Glossy Ibis	-	-	v	-
___ Wood Stork	h	h	h	-

	Sp	S	F	W
VULTURES				
___ Black Vulture*	u	u	u	u
___ Turkey Vulture*	u	u	u	u
HAWKS AND ALLIES				
___ Osprey*	u	f	u	u
___ Mississippi Kite	r	r	r	-
___ Bald Eagle	u	-	u	u
___ Northern Harrier	u	-	f	c
___ Sharp-shinned Hawk*	f	r	f	f
___ Cooper's Hawk*	u	r	u	u
___ Red-shouldered Hawk*	f	u	f	u
___ Broad-winged Hawk*	f	u	c	-
___ Swainson's Hawk	-	-	-	x
___ Red-tailed Hawk*	c	u	c	a
___ Rough-legged Hawk	-	-	v	v
___ Golden Eagle	-	-	v	v
___ American Kestrel*	f	r	c	c
___ Merlin	r	-	r	v
___ Peregrine Falcon	r	-	u	r
RAILS AND ALLIES				
___ Yellow Rail	x	-	x	-
___ King Rail	h	h	h	h
___ Virginia Rail	r	-	r	-
___ Sora	u	-	u	-
___ Purple Gallinule	v	v	-	-
___ Common Moorhen	v	v	v	-
___ American Coot*	a	u	a	a
CRANES				
___ Sandhill Crane	-	-	f	f
___ Whooping Crane	-	-	-	u
SHOREBIRDS				
___ Black-bellied Plover	r	-	u	-
___ American Golden-Plover	u	-	u	-
___ Semipalmated Plover	c	-	c	-
___ Piping Plover	x	-	x	-
___ Killdeer*	a	c	a	a
___ Black-necked Stilt	v	-	v	-
___ American Avocet	-	-	f	-
___ Greater Yellowlegs	c	u	c	f
___ Lesser Yellowlegs	c	u	c	u
___ Solitary Sandpiper	f	u	f	-
___ Willet	v	-	v	-
___ Spotted Sandpiper*	c	u	c	v
___ Upland Sandpiper	r	-	r	-
___ Whimbrel	v	-	v	-
___ Hudsonian Godwit	v	-	v	-
___ Marbled Godwit	v	-	-	-
___ Ruddy Turnstone	r	-	r	-
___ Red Knot	-	-	v	-
___ Sanderling	r	-	u	-
___ Semipalmated Sandpiper	c	u	c	-
___ Western Sandpiper	f	-	c	r
___ Least Sandpiper	c	u	c	c
___ White-rumped Sandpiper	u	r	v	-
___ Baird's Sandpiper	r	-	r	-
___ Pectoral Sandpiper	c	r	c	-
___ Dunlin	f	-	f	u
___ Stilt Sandpiper	u	-	u	-
___ Buff-breasted Sandpiper	r	-	u	-
___ Short-billed Dowitcher	f	-	f	-
___ Long-billed Dowitcher	u	-	u	-
___ Wilson's Snipe	c	r	c	c
___ American Woodcock*	u	u	u	u
___ Wilson's Phalarope	r	-	u	-
GULLS AND TERNS				
___ Laughing Gull	r	r	r	r
___ Franklin's Gull	v	v	v	v
___ Bonaparte's Gull	c	-	f	c
___ Ring-billed Gull	a	u	a	a
___ Herring Gull	f	r	c	c
___ Glaucous Gull	-	-	-	x
___ Caspian Tern	u	r	u	-

Sp	S	F	W
___ Common Tern	u	-	u	-
___ Forster's Tern	c	r	c	u
___ Least Tern	r	r	-	-
___ Black Tern	f	u	c	-
PIGEONS AND DOVES				
___ Rock Pigeon* (I)	a	a	a	a
___ Eurasian Collared-Dove (I)	u	u	u	u
___ Mourning Dove*	a	a	a	a
___ Passenger Pigeon	Extinct			
___ Common Ground-Dove	v	v	v	v
PARAKEETS				
___ Carolina Parakeet	Extinct			
CUCKOOS				
___ Black-billed Cuckoo	u	-	u	-
___ Yellow-billed Cuckoo*	c	c	c	-
OWLS				
___ Barn Owl*	r	r	r	r
___ Eastern Screech-Owl*	c	c	c	c
___ Great Horned Owl*	f	f	f	f
___ Barred Owl*	u	u	u	u
___ Short-eared Owl	v	-	v	r
NIGHTJARS				
___ Common Nighthawk*	c	c	c	-
___ Chuck-will's-widow*	c	c	u	-
___ Whip-poor-will	u	-	u	-
SWIFTS				
___ Chimney Swift*	c	c	a	-
HUMMINGBIRDS				
___ Ruby-throated Hummingbird*	c	c	c	-
KINGFISHERS				
___ Belted Kingfisher*	f	u	c	c
WOODPECKERS				
___ Red-headed Woodpecker*	u	u	u	u
___ Red-bellied Woodpecker*	c	c	c	c
___ Yellow-bellied Sapsucker	f	-	c	c
___ Downy Woodpecker*	c	c	c	c
___ Hairy Woodpecker*	f	f	f	f
___ Northern Flicker*	c	c	c	c
___ Pileated Woodpecker*	f	f	f	f
FLYCATCHERS				
___ Olive-sided Flycatcher	r	-	r	-
___ Eastern Wood-Pewee*	c	f	c	-
___ Yellow-bellied Flycatcher	v	-	v	-
___ Acadian Flycatcher*	u	u	u	-
___ Alder Flycatcher	v	-	v	-
___ Willow Flycatcher*	v	r	v	-
___ Least Flycatcher	r	-	r	-
___ Eastern Phoebe*	c	c	c	c
___ Ash-throated Flycatcher	-	-	x	-
___ Great Crested Flycatcher*	c	c	u	-
___ Eastern Kingbird*	c	c	c	-
SHRIKES				
___ Loggerhead Shrike*	f	f	f	f
VIREOS				
___ White-eyed Vireo*	c	f	c	-
___ Yellow-throated Vireo*	f	u	f	-
___ Blue-headed Vireo	u	-	u	u
___ Warbling Vireo	v	-	v	-
___ Philadelphia Vireo	u	-	u	-
___ Red-eyed Vireo*	c	f	c	-
JAYS AND CROWS				
___ Blue Jay*	c	c	c	c
___ American Crow*	f	f	f	a

	Sp	S	F	W
LARKS				
___ Horned Lark*	c	f	c	a
MARTINS AND SWALLOWS				
___ Purple Martin*	c	c	v	-
___ Tree Swallow*	c	r	c	-
___ N. Rough-winged Swallow*	c	f	c	x
___ Bank Swallow	c	-	c	-
___ Cliff Swallow*	f	c	f	-
___ Barn Swallow*	c	c	c	x
CHICKADEES AND TITMICE				
___ Carolina Chickadee*	c	c	c	c
___ Tufted Titmouse*	c	c	c	c
NUTHATCHES				
___ Red-breasted Nuthatch	u	-	u	u
___ White-breasted Nuthatch*	u	u	u	u
___ Brown-headed Nuthatch	v	-	v	v
CREEPERS				
___ Brown Creeper	u	-	f	c
WRENS				
___ Carolina Wren*	c	c	c	c
___ Bewick's Wren	h	h	h	h
___ House Wren	f	r	c	r
___ Winter Wren	u	-	u	f
___ Sedge Wren	u	-	f	x
___ Marsh Wren	u	-	u	r
KINGLETS AND GNATCATCHERS				
___ Golden-crowned Kinglet	f	-	c	c
___ Ruby-crowned Kinglet	c	-	c	c
___ Blue-gray Gnatcatcher*	c	f	c	v
THRUSHES				
___ Eastern Bluebird*	c	c	c	c
___ Veery	f	-	u	-
___ Gray-cheeked Thrush	u	-	u	-
___ Swainson's Thrush	f	-	u	-
___ Hermit Thrush	f	-	u	f
___ Wood Thrush*	c	c	c	-
___ American Robin*	a	c	c	a
MIMIC THRUSHES				
___ Gray Catbird*	c	c	c	r
___ Northern Mockingbird*	c	c	c	c
___ Brown Thrasher*	c	c	c	c
STARLING				
___ European Starling* (I)	a	a	a	a
PIPITS				
___ American Pipit	f	-	c	c
WAXWINGS				
___ Cedar Waxwing	c	v	c	a
WARBLERS				
___ Blue-winged Warbler	u	r	f	-
___ Golden-winged Warbler	u	-	u	-
___ Tennessee Warbler	c	-	c	-
___ Orange-crowned Warbler	f	-	f	f
___ Nashville Warbler	u	-	u	-
___ Northern Parula*	c	u	c	-
___ Yellow Warbler*	c	u	c	-
___ Chestnut-sided Warbler	f	-	f	-
___ Magnolia Warbler	f	-	c	-
___ Cape May Warbler	f	-	u	-
___ Black-throated Blue Warbler	v	-	v	-
___ Yellow-rumped Warbler	a	-	a	a
___ Black-throated Green Warbler	f	-	f	-
___ Blackburnian Warbler	f	-	f	-
___ Yellow-throated Warbler*	f	u	f	-
___ Pine Warbler*	c	c	c	c
___ Prairie Warbler*	f	u	f	-

	Sp	S	F	W
___ Palm Warbler	c	-	c	f
___ Bay-breasted Warbler	c	-	c	-
___ Blackpoll Warbler	c	-	x	-
___ Cerulean Warbler	u	r	u	-
___ Black-and-white Warbler*	f	r	c	-
___ American Redstart*	c	u	c	-
___ Prothonotary Warbler*	c	c	c	-
___ Worm-eating Warbler*	f	u	f	-
___ Swainson's Warbler*	r	r	r	-
___ Ovenbird*	f	u	c	-
___ Northern Waterthrush	f	-	u	v
___ Louisiana Waterthrush	u	r	u	-
___ Kentucky Warbler*	f	f	c	-
___ Connecticut Warblerv	-	v	-	
___ Mourning Warbler	v	-	v	-
___ Common Yellowthroat*	a	f	c	r
___ Hooded Warbler*	f	f	c	-
___ Wilson's Warbler	r	-	u	-
___ Canada Warbler	u	-	u	-
___ Yellow-breasted Chat*	c	c	c	-
TANAGERS				
___ Summer Tanager*	c	c	c	-
___ Scarlet Tanager*	c	u	f	-
SPARROWS				
___ Eastern Towhee*	c	c	c	c
___ Bachman's Sparrow	v	v	-	-
___ American Tree Sparrow	-	-	-	v
___ Chipping Sparrow*	c	u	c	u
___ Field Sparrow*	c	c	c	a
___ Vesper Sparrow	f	-	f	r
___ Lark Sparrow*	r	r	r	-
___ Savannah Sparrow	c	-	c	c
___ Grasshopper Sparrow*	u	u	u	-
___ Henslow's Sparrow	h	-	h	h
___ Le Conte's Sparrow	-	-	-	r
___ Nelson's Sharp-tailed Sparrow	v	-	-	-
___ Fox Sparrow	f	-	f	c
___ Song Sparrow*	c	u	c	a
___ Lincoln's Sparrow	u	-	u	-
___ Swamp Sparrow	c	-	c	a
___ White-throated Sparrow	a	-	a	a
___ White-crowned Sparrow	u	-	f	f
___ Dark-eyed Junco	f	-	c	c
___ Lapland Longspur	-	-	-	f
GROSBEAKS				
___ Northern Cardinal*	a	a	a	a
___ Rose-breasted Grosbeak	c	-	c	-
___ Blue Grosbeak*	c	c	c	-
___ Indigo Bunting*	a	c	a	x
___ Dickcissel*	c	c	u	x
BLACKBIRDS AND ALLIES				
___ Bobolink	c	-	u	-
___ Red-winged Blackbird*	c	c	a	a
___ Eastern Meadowlark*	c	c	c	c
___ Western Meadowlark	-	-	v	v
___ Yellow-headed Blackbird	v	-	v	v
___ Rusty Blackbird	u	-	c	c
___ Brewer's Blackbird	u	-	u	r
___ Common Grackle*	c	c	a	a
___ Brown-headed Cowbird*	c	c	a	a
___ Orchard Oriole*	c	c	u	-
___ Baltimore Oriole*	f	u	f	-
FINCHES				
___ Purple Finch	u	-	u	u
___ House Finch* (I)	a	a	a	a
___ Red Crossbill	-	-	-	x
___ Pine Siskin	u	-	u	f
___ American Goldfinch*	f	u	c	c
___ Evening Grosbeak	r	-	r	r
OLD WORLD SPARROWS				
___ House Sparrow* (I)	a	a	a	a

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Appendix D
Alabama Invasive Plant Council
Invasive Plant List

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Alabama Invasive Plant Council

"Rescuing and Preserving Our Natural Heritage"

P.O. Box 2033, Auburn, AL 36831-2033

www.se-eppc.org/alabama/

Approved by ALIPC Board of Directors Jan 31, 2007

The Purpose and Objectives for Listing and Categorizing Invasive Plants in Alabama

The intent of this list is to:

1. Rank plants based on their invasive characteristics;

2. Foster early detection of invasive plants so that landowners, managers, and stewards can implement a rapid response action to prevent them from becoming established and spreading;

3. Educate the general public, land based and water-use resource managers, landowners, and plant growers in an effort to eliminate the use of invasive plants in landscaping, restoration, and enhancement projects.

This list has no regulatory authority but provides useful information to help guide agencies, private landowners, and water managers in making responsible decisions about plant use and management decisions. The Council acknowledges that most introduced species are harmless. However, it also realizes that many species do escape cultivation, pasturage, landscaping, and water gardens and have the potential to spread and become ecological disasters.

Alabama Invasive Plant Council

Criteria for Evaluating Plant Species for Invasiveness in Alabama

Category 1:

1) The plant species or sub-species or variety is non-native to Alabama.
2) The plant has the potential for rapid growth, high seed or propagule production and dispersal, and establishment in natural communities or in managed areas where it is not desired.
3) The plant is able or known to be able to out-compete other species in plant communities or cropping systems thereby impacting native plant biodiversity, ecosystem functions, or crop productivity.
4) The plant persists in free living infestations (without cultivation) within Alabama.
5) The plant is widespread and occurs in two or more invasive regions, which are
    1. Plateaus and Piedmont
    2. Mountains
    3. Middle Coastal Plain
    4. Black Belt
    5. Lower Coastal Plain
6) It occurs in dense stands of numerous individuals in frequent infestations.

Category 2:

7) The plant meets criteria 1-4.
8) The plant occurs within one or more cultural uses and one or two invasive regions
9) It occurs as scattered individuals or widely scattered dense infestations.

Watch list A:

10) The plant meets criteria 1-3.
11) a. The plant has recently appeared as free living populations within Alabama, or
    b. The plant is invasive in nearby states but its status in Alabama is unknown or unclear, and it has the potential, based on its biology and its colonization history in the Southeast and elsewhere, to become invasive in Alabama.

Watch list B:

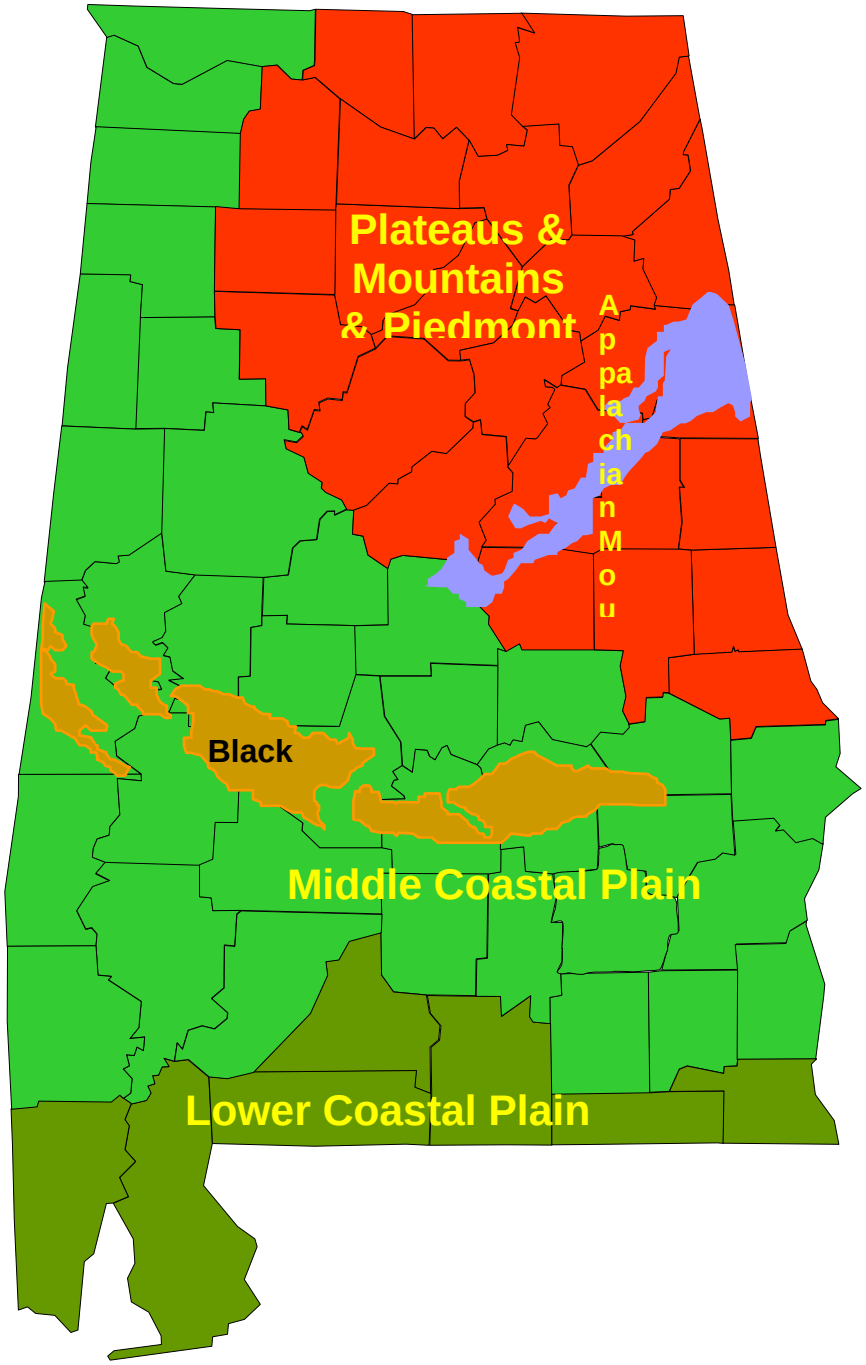
12) The plant meets criteria 1-3.
13) The plant is grown in Alabama.
14) The plant has a documented history of invasiveness in other areas of the Southeast and/or is listed by the Global Invasive Species Program as a world-class invasive plant for habitats similar to those in the Southeast.

Watch list C:

15) The plant meets criteria 14 only.

Alabama Invasive Region Map Attached updated 1/31/07

Alabama Invasive Regions



Alabama Invasive Plant Council's 2007
List of Alabama's Invasive Plants by Land-Use and Water-Use Sectors

O= ornamental C= crop W= Watch 1= Extensive and dense infestations in AL or severe invasive in an adjacent state 2= Scattered and localized infestations in AL		Urban and Interface	Managed Forests	Natural Areas and Parks	Wildlife Habitat/ Food Plots	Rights-of-Way	Aquatic-Wetland / Riparian	Pastures/ Orchards	Rowcrops/ Nurseries
TREES									
tree-of-heaven	*Ailanthus altissima*	2,O	1	1		1			
silktree	*Albizia julibrissin*	2,O	2	1		1			
camphor tree	*Cinnamomum camphora*	2	2	2					
chinaberrytree	*Melia azedarach*	2,O	W	2		2			
princesstree	*Paulownia tomentosa*	1,O	2	2					
trifoliate orange, hardy orange	*Poncirus trifoliata*	2,O	W	2				2	
callery pear "Bradford" *	*Pyrus calleryana*	2,O	W	2		O			
tallowtree	***Triadica sebifera***	2,O	1	1	1		1		
tungoil tree	*Vernicia fordii*	W	2	2		W			
SHRUBS									
thorny olive	*Elaeagnus pungens*	2,O	2	2	2,C	2,O			
autumn olive	*Elaeagnus umbellata*	W,O	2	1	C				
glossy privet	*Ligustrum lucidum*	W,O	2	2		2			
Chinese privet	***Ligustrum sinense***	1,O	1	1	1	1	2	1	W
Bell's honeysuckle	*Lonicera X bella*	W,O	2	2	C	2			
Amur honeysuckle	*Lonicera maackii*	W,O	W	1	C				
multiflora rose	***Rosa multiflora***	2,O	W	1	1	2		1	
tropical soda apple	***Solanum viarum***		W	2	W	W		1	
VINES									
sweet autumn virginsbower	Clematis terniflora	2,O	W	2		2	W		
Chinese yam	*Dioscorea oppositifolia*	2,O	2	1		2	2		
English ivy	*Hedera helix*	1,O	2	1					
Japanese honeysuckle	*Lonicera japonica*	1,O	1	1	C	2	1		
Japanese climbing fern	***Lygodium japonicum***	2	1	1	2		1		
kudzu	***Pueraria montana* var. *lobata***	1	1	1	1,C	1		1	
Chinese wisteria	*Wisteria sinensis*	1,O	2	1		1			
GRASSES, GRASS-LIKES, AND CANES									
giant reed	*Arundo donax*	W,O		W		2	W		
cogongrass	***Imperata cylindrica***	W	1	1	1	1	1	1	W
Nepalese browntop, Japanese stiltgrass	*Microstegium vimineum*	2	1	1		1	1		
torpedo grass	*Panicum repens*	1		2		2	2	1	
golden bamboo	*Phyllostachys aurea*	2,O	2	2		1			
Johnsongrass	*Sorghum halepense*	2	2	2	1	1		1,C	1
FORBS (Broadleaf Plants)									
nodding plumeless thistle, musk thistle	*Carduus nutans*			2		1		1	
elephant ears, coco yam	*Colocasia esculenta*	2,O					2		
tropical spiderwort, benghal dayflower	*Commelina benghalensis*		W			W	W		2
hairy crabweed, mulberry weed	*Fatoua villosa*	2							2
shrubby lespedeza	*Lespedeza bicolor*		2	2	C	2,C			
Chinese lespedeza	*Lespedeza cuneata*	2	2	2	C	2,C		2,C	
purple loosestrife*	*Lythrum salicaria*			2			2		

Alabama Invasive Plant Council's 2007
List of Alabama's Invasive Plants by Land-Use and Water-Use Sectors

O= ornamental C= crop W= Watch	1= Extensive and dense infestations in AL or severe invasive in an adjacent state 2= Scattered and localized infestations in AL	Urban and Interface	Managed Forests	Natural Areas and Parks	Wildlife Habitat/ Food Plots	Rights-of-Way	Aquatic-Wetland / Riparian	Pastures/ Orchards	Rowcrops/ Nurseries
Asiatic dewflower, wartremoving herb	*Murdannia keisak*				W		2		
chamber bitter	*Phyllanthus urinaria*	1		W	W	W	W	2	W
sicklepod, Java-bean	*Senna obtusifolia*	2	1	2	1	2			1
blessed milkthistle	*Silybum marianum*			2				2	
AQUATIC and WETLAND PLANTS									
alligatorweed	***Alternanthera philoxeroides***	W		1	1		1		1
common water hyacinth	*Eichhornia crassipes*	W					1		
hydrilla, waterthyme	***Hydrilla verticillata***	W					1		
parrot feather watermilfoil	*Myriophyllum aquaticum*	W					1		
Eurasian water milfoil, spike watermilfoil	***Myriophyllum spicatum***	W					1		
Cuban bulrush*	*Oxycaryum cubense*						1		
common reed* (grass)	*Phragmites australis*	W					1		
water lettuce	*Pistia stratiotes*	W					1		
giant salvinia, kariba-weed	*Salvinia molesta*	W					1		
Watch list A: Recently appearing in Alabama as free living infestations									
garlic mustard (forb)	*Alliaria petiolata*	W	W	W		W			
porcelain berry, Amur peppervine (vine)	*Ampelopsis brevipedunculata*	W		W		W			
hen's eyes, coralberry (forb)	*Ardisia crenata*	W	W	W					
bushkiller (vine)	*Cayratia japonica*	W							2
Oriental bittersweet (vine)	*Celastrus orbiculatus*	W,O	2	W					
Canada thistle (forb)	*Cirsium arvense*			2		2		W	
bull thistle (forb)	*Cirsium vulgare*					W		W	
water yam (vine)	*Dioscorea alata*	W,O		W			W		
air yam (vine)	*Dioscorea bulbifera*	W,O		W			W		
Japanese privet (shrub)	*Ligustrum japonicum*	W,O	2	W		W	W		
Morrow's honeysuckle (shrub)	*Lonicera morrowii*	W,O	W	W		W			
Beale's barberry (shrub)	*Mahonia bealei*	2,O	W	W	C,W				
nandina, sacred bamboo* (shrub)	*Nandina domestica*	W,O	W	2			W		
Japanese knotweed (shrub)	*Polygonum cuspidatum*		W	W		W			
Macartney rose (shrub)	*Rosa bracteata*	W	W	W				2	
Cherokee rose (shrub)	*Rosa laevigata*	W	W	W		W			
Watch list B: Invasive in adjacent states or planted in Alabama									
Chinese silvergrass, silverplume grass* (grass)	*Miscanthus sinensis*	O	W	W					
wetland nightshade, scrambling nightshade (shrub)	*Solanum tampicense*			W			W		
Bold indicates Alabama's Worst 10,	*** Invasiveness may vary by subspecies and variety**								

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Appendix E
Species of Concern
at Redstone Arsenal

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SPECIES OF CONCERN AT REDSTONE ARSENAL

Scientific Name	Common Name	Federal Status	State Status	State Priority
Plants				
Apios priceana	Price's potato bean	LT	S2	
Clematis morefieldii	Morefield's leather flower	LE	S2	
Eriogonum longifolium var harperi	Harper's umbrella plant	FPC/SAR	S1	
Hottonia inflata	Featherfoil		S2	
Leavenworthia uniflora	Michaux's gladecress		S2	
Ophioglossum engelmannii	Limestone adder's-tongue		S2	
Panax quinquefolius	American ginseng		SP	
Silphium brachiatum	Cumberland rosinweed	FPC/SAR	S2	
Trillium pusillum var alabamicum	Alabama least trillium	FPC/SAR	S2	P2
Birds				
Ammodramus henslowii	Henslow's Sparrow	MBTA/PIF	SP/S2	P1
Ammodramus savannarum	Grasshopper Sparrow	MBTA/PIF	S3	P3
Aquila chrysaetos	Golden Eagle	BGEPA/PIF	SNR	P2
Caprimulgus vociferus	Eastern Whip-poor-will	MBTA/PIF	S3	P3
Falco columbarius	Merlin	MBTA	SP	P3
Falco peregrinus	Peregrine Falcon	Former LE/MBTA	SP/S3	P3
Grus americana	Whooping Crane	Experimental		
Haliaeetus leucocephalus	Bald Eagle	Former LE/BGEPA	SP	P3
Ixobrychus exilis	Least Bittern	MBTA/PIF	SP/S2	P2
Peucaea aestivalis	Bachman's Sparrow	MBTA/PIF	SP/S3	P2
Protonotaria citrea	Prothonotary Warbler	MBTA/PIF	SP	P3
Setophaga cerulea	Cerulean Warbler	MBTA/PIF	SP/S1	P1
Spiza americana	Dickcissel	MBTA/PIF	S2	P3
Vermivora chrysoptera	Golden-winged Warbler	PL/MBTA/PIF		
Vermivora cyanoptera	Blue-winged Warbler	MBTA/PIF	S3	P3
Mammals				
Myotis austroriparius	Southeastern myotis		SP/S2	P2
Myotis grisescens	Gray bat	LE	SP/S2	P1
Myotis lucifugus	Little Brown bat		S3	P2
Myotis septentrionalis	Northern Long-eared bat	LT	S2	P1
Myotis sodalis	Indiana bat	LE	SP/S2	P1
Neotoma magister	Allegheny woodrat		S3	P2
Perimyotis subflavus	Tricolored bat	PL	S3	P2
Reptiles and Amphibians				
Alligator mississippiensis	American alligator	LT	SP	
Aneides aeneus	Green salamander	PL/FPC	SP/S3	P2
Plestiodon inexpectatus	Southeastern five-lined skink		SP/S3	P2
Fish				
Etheostoma tuscumbia	Tuscumbia darter	PL/FPC/SAR	SP/S2	P2
Typhlichthys subterraneus	Southern cavefish		SP/S3	P3

Scientific Name	Common Name	Federal Status	State Status	State Priority
Invertebrates				
Cumberlandia monodonta	Spectaclecase	LE	S1	P1
Danaus plexippus	Monarch butterfly	PL		
Elimia nassula	Round-rib elimia	PL	S1	P1
Elimia perstriata	Engraved elimia	PL	S1	P1
Epioblasma triquetra	Snuffbox mussel	LE	SP/S1	P1
Fusconaia cor	Shiny pigtoe	LE	SP/S1	P1
Fusconaia subrotunda	Longsolid	PL	PSM/S1	P1
Lampsilis abrupta	Pink mucket	LE	SP/S1	P1
Orconectes australis	Southern cave crayfish		S3	P3
Palaemonias alabamae	Alabama cave shrimp	LE	SP/S1	P1
Plethobasus cyphyus	Sheepnose	LE	SP/S1	P1
Pleurobema oviforme	Tennessee clubshell	PL	PSM/S1	P1
Pleurobema plenum	Rough pigtoe	LE	SP/S1	P1
Pleurobema rubrum	Pink pigtoe	PL	S2	P1
Pleurocera pyrenella	Skirted hornsnail	PL	S2	P2
Pleuronaia barnesiana	Tennessee pigtoe	PL	PSM/S1	P2

Designation Definitions

Federal Designation:

LE: Federally listed endangered species under the Endangered Species Act

LT: Federally listed threatened species under the Endangered Species Act

PC: Proposed Candidate for the Endangered Species Act

FPC: Form Proposed Candidate for the Endangered Species Act

PL: Petitioned for Listing under the Endangered Species Act

BGEPA: Bald and Golden Eagle Protection Act

MBTA: Migratory Bird Treaty Act

DoD Designation:

PIF: Partners in Flight - Species identified by DoD Partners in Flight as a priority species.

SAR: Army Species at Risk - Species identrified as imperiled whos proactive conservation may prevent effects to mission.

State of Alabama Designation:

Regulatory:

SP: State Protected - Species protected by Regulation 220-2-.92 (Nongame Species Regulation), 220-2-.98 (Invertebrate Species Regulation), 220-2-.26(4) (Protection of Sturgeon), 220-2-.94 (Prohibition of Taking or Possessing Paddlefish), 220-2-.97 (Alligator Protection Regulation), or Ginseng Regulation Article 10

PSM: Partial Status Mussels - All mussel species not listed as a protected species under the Invertebrate Species Regulation are partially protected by Regulations 220-2-.104 and 220-2-.52.

Alabama Copmrehensive Wildlife Conservation Strategy:

P1: Highest Conservation Concern = Species critically imperiled and at rik of extinction/extirpation because of extreme rarity; restricted distribution; decreasing population trend/population viability problems; and specialized habitat needs/habitat vulnerability due to natural/human-caused factors.

P2: High Conservation Concern = Species imperiled because of three of four of the following: rarity; very limited, disjunct, or peripheral distribution; decreasing population trend/population viability problems; and specialized habitat needs/habitat vulnerability due to natural/human-caused factors.

P3: Moderate Conservation Concern = Species with conservation problems because of insufficient data **or** because of two of four of the following: small populations; limited, disjunct, or peripheral distribution; decreasing population trend/population viability problems; and specialized habitat needs/habitat vulnerability due to natural/human-caused factors.

Alabama Natural Heritage/NatureServe Methodology:

S1: Critically Imperiled = Very high risk of extirpation in the jurisdiction due to very restricted range, very few populations or occurrences, very steep declines, severe threats, or other factors.

S2: Imperiled = High risk of extirpation in the jursdiction due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors.

S3: Vulnerable = Moderate risk of extirpation in the jursdiction due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors.

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Appendix F
Redstone Arsenal
Regulation 200-3

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Redstone Arsenal
Policy 200-3

Natural Resources

Redstone Arsenal Hunting, Fishing, and Trapping Policy

US Army Garrison - Redstone Arsenal
Redstone Arsenal, AL 35898

Date: 17 AUG 2018

UNCLASSIFIED

US Army Garrison
Redstone Arsenal, AL 35898

Redstone Arsenal Policy 200-3

Natural Resources Management Program:
Hunting, Fishing, and Trapping Policy

Official:

Kelsey A. Smith
COL, AV
Garrison Commander

HISTORY. This publication supersedes Redstone Arsenal Policy 200-3, 9 December 2014.

SUMMARY. This policy establishes the hunting, fishing, and trapping plan for Redstone Arsenal (RSA). It establishes policy, procedures, and responsibilities for all activities to ensure compliance with federal, state, and RSA laws and regulations.

APPLICABILITY. This policy applies to all organizational elements, including tenant activities, on the installation.

PROPONENT AND EXCEPTION AUTHORITY. The proponent of this policy is the Chief, Environmental Management Division, Directorate of Public Works, US Army Garrison-Redstone (USAG-RSA). The proponent has the authority to approve exceptions to this policy that are consistent with federal or state law or regulation.

MANAGEMENT CONTROL PROCESS. This policy does not contain management control provisions in accordance with Army Regulation 11-2. This Policy will be reviewed and published annually prior to the start of the fall hunting season on or about 1 SEP.

SUGGESTED IMPROVEMENTS. Users are invited to send comments and suggested improvements on DA Form 2028 (Recommended Changes to Publications and Blank Forms) to USAG-RSA, Directorate of Public Works, Environmental Management Division, (IMRE-PWE), Redstone Arsenal, AL 35898.

DISTRIBUTION. This publication is approved for public release; distribution is unlimited.

CONTENTS (Listed by paragraph number)

1. PURPOSE.

a. This policy establishes policy, assigns responsibilities, and prescribes procedures for hunting, fishing, and trapping on RSA.

b. Seasons, hours, legal game, daily bag limits, hunting ages, and possession limits for all game and fish are set by federal and state laws and regulations.

c. All federal and state laws on hunting, fishing, and trapping apply to RSA. This policy, as well as special notices, rules, and procedures are posted at the Outdoor Recreation Branch, also apply to RSA.

d. Installation hunting, fishing, and trapping activities may be closed, as necessary, in support of installation activities, training, or security requirements.

2. RESPONSIBILITIES.

a. The USAG-RSA Commander manages and directs hunting, fishing, and trapping on RSA. Any exceptions or special requests to this policy must receive approval from the Garrison Commander.

b. The Directorate of Operations, with USAG-RSA Conservation Officers as its authorized agents, is the proponent for enforcement of all hunting, fishing, and trapping regulations as well as aiding in control of nuisance wildlife and conducting studies related to wildlife and habitat management in conjunction with the RSA Garrison Wildlife Biologists. All activities related to nuisance wildlife control, depravation hunts or scientific studies are exempt from all hunting and fishing permits and license requirements. The Directorate of Operations will:

(1) Function as the central organization for collecting and reporting of hunting area availability.

(2) Create a weekly hunting area availability report using a weekly standing data call. All Redstone organizations identified with missions using hunting areas will provide input identifying such areas necessary to close on a day by day basis for one week ahead of the report effective date.

(3) Disseminate the weekly hunting report to the Safety Office, Directorate of Public Works (DPW), Directorate of Operations and MWR Outdoor Recreation.

(4) Take reports for daily changes in hunting availability due to mission requirements that could not be predicted in the weekly report. Coordinate these daily changes with Outdoor Recreation.

(5) Register weapons.

c. The Directorate of Family and Morale, Welfare and Recreation, with the Outdoor Recreation Branch as its authorized agent, administers the hunting, fishing, and trapping programs to include:

(1) Maintaining HuntTrac/TeleTrac call in hunting area assignment system.

(2) Sale of RSA hunting permits.

(3) Control access of hunters, trappers, and fishermen.

(4) Post hunting areas in HuntTrac.

(5) Provide RSA Hunting and Fishing Policy / upon request

(6) Conducting annual hunter safety orientations for all Redstone hunters prior to the beginning of each annual hunting season. Orientations may be requested periodically throughout the season upon request for new hunters unable to attend pre-season orientations.

(7) Implementing "on-the-spot" changes to the size, numbers and sex of deer taken during the hunt, as directed by the USAG-RSA Wildlife Biologists.

(8) In conjunction with the Directorate of Operations, collecting weekly reports from DPW, DPW approved reporting contractors, and Redstone tenant organizations to prepare for utilization of restricted areas for hunting and fishing when they become available.

d. DPW is responsible for:

(1) Establishing responsible points of contact for reporting hunting areas needed to be closed for mission requirements NLT 45 days prior to the beginning of hunting season. This report will meet established hunting requirements and schedule and will be made available to the Directorate of Operations.

(2) In coordination with Contracting Officers Representatives and Contracting Officers, establish a process for selected larger contractors working over the entire installation and who control their own work schedules to be able to report their work requirements in hunting areas directly to the Directorate of Operations.

(3) Reporting changes to the availability of hunting areas due to DPW mission requirements to the Directorate of Operations, as soon as a change is identified.

e. DPW, Environmental Management Division is responsible for:

(1) Conducting all fish and game management activities, to include the upkeep of food plots, wildlife clearings and designating fishing areas on RSA.

(2) Coordinating with federal and state officials to set the dates of game harvest within the boundaries of RSA.

(3) Setting hunting quotas, creel limits and restrictions as necessary for proper management of all species according to accepted wildlife science and ecological principles.

(4) Designating trapping areas, allowable species, and trapping quota.

(5) Biologist will maintain harvest data.

(6) Controlling nuisance wildlife under current state and federal permits. These actions are exempt from all RSA hunting, fishing, and trapping permit and license requirements, including those duties performed by the US Department of Agriculture Wildlife Services.

(7) Conducting studies related to wildlife and habitat management. These actions will be exempt from all RSA hunting, fishing, and trapping permit and license requirements.

f. All Redstone tenant organizations controlling hunting lands on RSA for mission activities are responsible for:

(1) Establishing a single point of contact responsible for reporting to the USAG-R

Directorate of Operationson hunting area availability and utilization, and meeting established reporting schedules.

(2) Make available for hunting purposes all hunting areas not directly and immediately required for mission.

(3) Reporting unexpected changes to the availability of hunting areas for recreation to Directorate of Operations as soon as a change is identified, to ensure that workers and hunters are safely in and out of the affected areas respectively.

g. All authorized hunting, fishing, and trapping persons, to include guests and family members, on RSA will know and abide by federal and state laws and this policy. When a person receives a RSA Hunting/Fishing/Trapping Permit, he/she will sign a statement on the permit to indicate that he/she has received a copy of this policy and will abide by the rules herein.

h. Party leaders/sponsors are responsible for the conduct and safety of their guests/Family members. Penalties assessed for violations committed by guests/Family members will also be assessed against their party leader

3. PROCEDURES.

a. Eligibility to hunt, fish and trap on RSA, including the Wheeler National Wildlife Refuge portion.

(1) Military personnel and their dependents may hunt, fish, and trap on RSA. Military personnel include: Active duty, Retired, Military Dependents 18 years of age or older with a valid identification card, reserve and national guard components while on Active Duty training status, but not while on weekend drill status, and Allied Forces assigned for duty with
US Forces when authorized US Army support.

(2) Civilian employees and their dependent Families may fish, trap, and participate in all authorized hunts, except waterfowl hunts. These individuals are limited to: Civilian employees of the United States Government assigned to RSA (as identified by RSA identification badges or Civilian Access Control (CAC) Cards), dependent Family members of eligible Civilians, and retired Civilian employees of RSA.

(3) Full-time RSA contractor employees, RSA subcontractor employees, and agricultural lessees (whose name appears on the lease) who have a RSA personnel identification badge may hunt (not waterfowl), fish and trap. These eligible employees may sponsor their dependents' participation in these activities. However, the employee must accompany his/her dependents during their participation, and supervise no more than 2 eligible dependents at one time. This is not intended to and does not authorize

participation of part-time and on-call contractor employees or part-time and on-call sub-contractor employees. This is also not intended to authorize participation by employees of agricultural lessees. All persons as indicated in this category will maintain a current statement of verification for their employment/lessee standing (RSA Form 200-3CH).

(4) Dependent Family Members.

(a) Military. Dependent Family members of eligible military personnel (paragraph 3.a.1) include spouses, children 17 years or age or younger, and those children 18 through 22 years who present a current student identification card and proof of age. Two Family members of military personnel may hunt when accompanied by their sponsor (maximum party of three people). Eligible dependents who are 18 years of age or older may participate during authorized hunts without being accompanied by their sponsor but are not entitled to bring guests or other minor (under 18 years of age) siblings.

(b) Civilian/Contractors/Subcontractors/Agricultural Lessees. Dependent Family members of eligible Civilians/contractors/subcontractors/agricultural lessees (Para 3.a.2 and Para 3.a.3) include spouses, children 17 years of age or younger, and those children 18 through 22 years who present a current student ID card and proof of age. A maximum of two of these Family members may hunt only when accompanied by their sponsor (maximum party of three people).

(5) Guests (defined as those who are not already eligible hunters on RSA):

(a) Military personnel may take two guests hunting (maximum hunting party of three people).

(b) Guests must be accompanied by their sponsor at all times and must remain within the assigned hunting area with their sponsor.

(c) Military personnel with guests not otherwise authorized to access RSA will escort their guests at all times while hunting on RSA.

(d) Civilian employees, contractors, subcontractors, and agricultural lessees are not authorized to have guests.

b. Licenses and Permits.

(1) Eligible personnel can obtain hunting and trapping permits at the Outdoor Recreation Branch, Building 5139.

(2) All persons 16 years or older who hunt or trap on RSA will have in their possession a valid state of Alabama hunting, fishing and/or trapping license, as well as any special

license, stamp or permit required by federal or state law. Additionally, an appropriate RSA Permit (Form 278-1) and hunter orientation (Form 278-4) are required, and valid shotgun/muzzleloader weapons permit.

(3) All hunters must possess a state approved hunter education certification (certified in any state or Europe) before being allowed the privilege of hunting on RSA. The only exception is for youth under the age of 16 participating in state-sponsored youth hunting activities.

(4) Outdoor Recreation Branch will issue RSA permits to persons 65 years or older, free of charge, if they present proof of age and a state approved hunter education certification.

c. Standards for Youth Hunts. The USAG-RSA allows children between the ages of 9-15 to participate in youth hunts.

d. Hunting.

(1) Hunting is authorized in designated areas only. There will be no hunting of any kind on Tuesdays or Wednesdays, except during selected holidays. A master chart of all hunting areas, the number of hunters allowed in each, and the type hunting allowed in each area will be available at the Outdoor Recreation facility.

(2) All persons who apply to hunt must have the following: Alabama State Hunting License, any state's Hunter Education Certificate or a valid Hunter Education Certificate from Europe, RSA Hunter Safety Orientation (Form 278-4), RSA Hunting Permit (Form 278-1) and a RSA weapon permit.

(3) Personnel should request assignment to hunting areas by calling in to the HuntTrac/TeleTrac system. Information on using the system will be passed out with your hunting permit, available at the Outdoor Recreation Branch, Building 5139. Requests will begin being processed on the day prior to the hunt at the designated times.

(4) Hunting areas will be assigned as they are called in to the HuntTrac system for each day. Active Duty may begin calling in on the HuntTrac system between 1700 (5PM) and 1800 (6PM) for the next day; all others may begin calling after 1800.

(5) Hunters will have a copy of the Hunter Vehicle Control Card, RSA Form 251, displayed on the dash of all vehicles in the hunting party in a manner such that the information can be read by enforcement personnel. Contractor personnel must also display RSA Form 200-3CH (Contractor Employment Certification Form), in the same manner as the RSA Form 251. Hunters must call to clear the hunting areas prior to the designated check-in times

(6) Outdoor Recreation may schedule special hunts prior to or during the regular hunting seasons. Dates for these special hunts will be announced at the Outdoor Recreation Branch.

(7) A hunter with authorized access to that portion of Wheeler National Wildlife Refuge which lies within RSA boundaries will hunt only in that portion of the refuge identified on the current RSA hunting and fishing map, with the same area designation, and the addition of the letter "R," e.g. hunters authorized to hunt in hunting area 55 are also authorized to hunt in area 55R if the refuge is open for hunting that day. It is the hunter's responsibility to confirm that the refuge is open on the day of the hunt. RSA hunters are only authorized to hunt deer and raccoon on portions of Wheeler National Wildlife Refuge that fall within RSA.

(8) ONLY after contacting a Conservation Officer or Outdoor Recreation will a hunter enter another open hunting area in search of wounded game,. Under no circumstance will hunters conduct "Hot Pursuit" into an adjacent, Restricted or closed hunting area without permission.

(9) Hunters must report all wildlife taken at the end of each hunting trip on the hunting harvest form. Bucks must have at least a 15" outside spread or a 15" beam length of at least one antler from base to tip. Donating a deer to another individual, the hunter must complete a donation certificate with name, address, phone number, hunting license number, and date of harvest. This requirement is for turkey and deer only.

(10) Hunters on RSA will not drive deer or participate in deer drives; enter any portion of Wheeler National Wildlife Refuge except when authorized; hunt in any area other than the area assigned; construct or use permanent blinds or tree stands; use dogs to hunt deer; leave areas at the end of the day's hunt without removing decoys, blinds, and portable stands; enter places designated on RSA hunting and fishing map as restricted areas (colored orange), unless authorized; destroy evidence of sex of deer or turkey; use or possess buckshot of any size; or discharge a weapon in the direction of a roadway.

(11) Hunters on RSA will not block any paved or unpaved roadway, gate, access drive, or building entrance; operate vehicles off existing roadways (Note: fire breaks are not roadways); litter; destroy, tamper with, or remove any property of the US Government, its contractors or lessees, including fences, gates, and signs; carry flame producing devices in areas where they are banned; loan, transfer, or alter a license, permit, vehicle control card (RSA Form 251), identification card, RSA identification badge, or Hunter Safety Orientation card; possess on their person, or in any vehicle, any weapon or ammunition, other than that authorized for the type game being hunted (Note: firearms transported in a vehicle must be unloaded and in a sealed case, separate from ammunition.); use, possess, or be under the influence of alcoholic beverages or other drugs or controlled substances, while hunting or otherwise on RSA property; or drive a vehicle on any food plot. There will be NO off-road

vehicle use allowed. This includes bicycles. Four-wheelers/ATVs are not authorized for use on RSA; their use in ANY capacity is prohibited. NOTE: ATV use is only for those engaged in official government duties/operations.

e. Weapons and Ammunition.

(1) The only firearms authorized for hunting on RSA are pellet guns (22 caliber or smaller), shoulder-fired shotguns and muzzleloaders of 40 caliber or larger. Shotguns must be incapable of or otherwise plugged to reduce shell carrying capacity of two in the magazine and one in the chamber.

(2) Weapons will be registered at the Directorate of Operations – Division of Law Enforcement, Building 3623.

(3) All hunters using shotguns and muzzleloaders will observe a 300-foot minimum distance from buildings, permanent structures, and RSA boundaries. Under no circumstances will hunters fire a weapon from or across any road.

(4) Deer hunters may use shotguns, 10 gauge through 20 gauge, or muzzleloaders, 40 caliber or larger, all of which must fire a single projectile/slug. Redstone Arsenal allows hunters to use the same type of weapons to deer hunt Wheeler Refuge lands that are authorized for deer hunting on RSA. Weapons and ammunition must comply with applicable state laws.

(5) Waterfowl hunters must comply with all Federal and Alabama state hunting regulations.

(6) Small game hunters may use 10 gauge or smaller shotguns using standard No. 4 shot or smaller. Raccoon hunters must use a No. 6 shot or smaller per state law. Air guns are acceptable for use to hunt squirrels only.

The only authorized projectile for use and/or have in possession while possessing an air gun is pellets; BB's are not authorized and their use and/or possession constitute illegal ammunition while possessing or transporting an air gun. Redstone regulates air guns equally with regard to shotguns and muzzleloaders and their transportation on RSA. All sighting devices shall comply with state law.

(7) Archery equipment authorized for hunting on RSA include compound bows, long bows, recurve bows, and crossbows. All archery equipment must be in compliance with Alabama state law specifications.

(8) Bow and crossbow hunters will not have in their possession any arrows that are not in compliance with the state of Alabama regulations.

(9) Small game bow hunters will not have in their possession arrows fitted with heads other than conventional field, target, or blunt tips of barbless design, except for closed season groundhog hunting.

(10) All scopes and sighting devices used on any weapon, including archery equipment, must be in compliance with state law.

(11) Raccoon hunters authorized for hunting on Wheeler Refuge lands shall use and/or possess only shot shells containing steel, or other approved non-toxic shot in a size compliant with state law.

(12) All other weapons and ammunition are prohibited for hunting purposes. The USAG-RSA Wildlife Biologists, USAG, Conservation Officers, and employees of the US Department of Agriculture Wildlife Services may use any means available and applicable by law in the performance of their official duties.

f. Turkey.

(1) Season: Spring season only.

(2) Bag Limit: Gobblers Only. One per day. Seasonal quota and limits established by the USAG-RSA Wildlife Biologists on an annual basis. The Outdoor Recreation Branch will post this information at the Outdoor Recreation facility.

(3) Authorized Hunters: All registered hunters, as previously defined.

(4) Required Safety Garments: Turkey hunters are required to wear a cap/hat of international orange while stalk hunting or walking to and from stands. Nothing in this policy is intended to prevent turkey hunters from removing orange hats while on "a stand" (sitting or standing in the same location for extended periods of time).

(5) Legal Weapons and Ammunition: Shotguns (including muzzle-loading shotguns), 10 gauge or smaller, using standard No. 2 shot or smaller; long bows and compound bows (no crossbows) shall be in compliance with state regulations.

(6) Assignment of Hunting Areas: Requests for assignment of hunting areas will be called in to the HuntTrac system the day before the hunt or as specified. There will be no turkey hunting on Wheeler National Wildlife Refuge.

(7) Prohibited Methods and Devices: In accordance with Alabama state law.

(8) Hunting Times: Turkey hunting is allowed only during the period between sunrise and 1200. Afternoon hunting is not allowed.

(9) Any person hunting turkey shall maintain and have in his/her possession an "Antlered Buck and Turkey Harvest Record," in accordance with Alabama state law. All turkey harvested must be recorded completely on the harvest record before the turkey is moved or field dressed.

(10) Each harvested turkey must be brought to the Outdoor Recreation Branch to be weighed, examined, registered, and recorded.

g. Deer.

(1) Season: As per Alabama state law.

(2) Bag Limit: Quotas/limits and buck harvest criteria shall be set by the USAG-RSA Wildlife Biologists on an annual basis, in conjunction with applicable Alabama state law. The Outdoor Recreation Branch will post this information at the Outdoor Recreation facility.

(3) Authorized Hunters: All registered hunters, as previously defined.

(4) Required Safety Garments: A cap and vest consisting of a minimum of 500 square inches of hunter safety orange is required. Your hunter's orange may be removed once you are elevated 12 feet in the tree. Prior to coming down the tree you must have your hunter's orange on as per Alabama state law.

(5) Legal Weapons and Ammunition: As per paragraph 3.e "Weapons and Ammunition," above.

(6) Assignment of Hunting Areas: As per paragraph 3.d "Hunting," above.

(7) Prohibited Methods and Devices: Deer decoys are not authorized for use on RSA. All other game decoys as per Alabama state law. Hunters will not place cameras on Redstone Arsenal. Use of bait is prohibited. Bait is considered anything used to attract wildlife in consumable form. Minerals, grains, plant matter and consumable (to include syrups/liquids) commercial attractants placed by a person(s) are considered bait. Piled salt or salt blocks are also prohibited.

(8) Hunting Times: Hunting may begin 30 minutes before official sunrise and must end 60 minutes after official sunset. Holiday hours are from 30 minutes before official sunrise until 1200.

(9) Any person hunting deer shall maintain and have in his/her possession an "Antlered Buck and Turkey Harvest Record," in accordance with Alabama state law. All antlered bucks harvested must be recorded completely on the harvest record before the deer is moved or field dressed.

(10) Each deer harvested must be brought to Outdoor Recreation Branch to be

weighed, registered, and examined by an MWR staff member or a Conservation Officer prior to the hunter(s) leaving post. A receipt will be issued to the hunter to retain as proof that the deer has been checked-in. Female deer will be brought to the check station whole or field dressed with the "milk sac" intact for examination. Field Dressing of male deer is at the hunter's discretion.

(11) Hunters will dispose of unwanted or non-edible animal remains processed at the Outdoor Recreation Branch's check station in an appropriate manner off-installation. RSA only allows Active Duty Military living on the installation to dispose of unwanted or non-edible animal remains in wooded areas, at a minimum distance of 1,000 feet from any roadways or buildings.

h. Beaver, Groundhog, and Coyote.

(1) No closed season; daylight hours only.

(2) No bag limit.

(3) Legal Weapons and Ammunition: Shotguns 10 gauge or smaller using No. 2 shot or smaller or slugs; muzzleloaders of 40 caliber or larger; long bow, crossbow, and compound bows. Coyotes may be hunted with buckshot no larger than 00 buck during times when there is no deer or turkey season open.

i. Raccoon.

(1) Season: As per Alabama state law.

(2) Bag Limit: As per Alabama state law.

(3) Authorized Hunters: All registered hunters, as previously defined.

(4) A request must completed in person and approved by the staff at Outdoor Recreation based on the range report. All game harvested must be reported at the game building on the log sheet.

(5) Parties will have no more than four dogs in the field at one time.

(6) The party leader, who will carry No. 6 shot or smaller shells, is the only person authorized to be in possession of a shotgun. All other weapons, whether carried in the field or left in vehicles, are prohibited. You may not use or possess lead shot on Wheeler Refuge.

(7) Redstone allows hunters to carry and use lights to hunt raccoon only.

(8) Trees will not be cut.

j. Additional Game Species.

(1) These include Mourning Dove, Bobwhite Quail, waterfowl (ducks and geese only), squirrel, rabbit, and opossum.

(2) Season: As per Alabama state law.

(3) Bag Limit: As per Alabama state law or as designated by the USAG-RSA Wildlife Biologists. A hunter who attains his bag limit must immediately terminate hunting and check out of the area via HuntTrac.

(4) Authorized Hunters: All registered hunters, as previously defined.

(5) Personnel may hunt these additional game species from 30 minutes before official sunrise to sunset only or as specified by Alabama DCNR rules and regulations.

(6) Hunters may use dogs to hunt Bobwhite Quail, Mourning Dove, rabbits, raccoons, squirrel, and waterfowl. Hunters using dogs will have owner contact information on the collar of every dog used on RSA and make every effort to maintain custody/control of their dog(s) while on RSA. Hunters that cannot retrieve all dog(s) at the end of the day's hunt, must notify either the RSA Police Desk prior to leaving the installation at 256-876-2222 or Central Dispatch at 256-544-4356 that a dog(s) couldn't be retrieved and leave contact information (name & cell phone #) with the official taking their call. If notified by an installation official that their dog has been found, the hunter will respond immediately to retrieve the dog. Hunters failing to report an un-retrieved dog or who fail to immediately return and pick up a found or located dog, may be subject to suspension of hunting privileges, lose the ability to use dogs in the future or both.

k. Non-Game Species. May be taken during the regular hunting season, as per Alabama state law, include: feral dogs, feral hogs, feral cats, coyotes, skunks, groundhogs, and beavers.

l. Protected Species. All species of wildlife, including birds, mammals, reptiles, and amphibians not expressly listed above as "game species" and allowable "non-game species" are protected and their take while hunting, trapping, and fishing is prohibited.

m. Fishing.

(1). Fishing is authorized only in designated areas. A master chart showing the location of authorized fishing areas is posted at the Outdoor Recreation Branch. Eligibility is as specified in paragraph 3.

(2) Persons wanting to fish should first check in with the Outdoor Recreation Branch to ensure the desired fishing areas are available and sign-up in person to be assigned to fishing at Bradford Sinks. Bradford Sinks is available only on the weekends and holidays that range control releases it for recreational purposes.

(3) Game fish, to include daily limits, possession limits and size limits, are designated per Alabama state law.

(a) The use of firearms is strictly prohibited.

(b) Eligibility and application procedures are as specified in paragraph 3.

(4) Only an Alabama state license is required to fish.

(5) Redstone only allows boats with electric motors in Bradford Sinks.

(6) Littering is strictly prohibited.

n. Dog Training.

(1) The USAG-RSA Wildlife Biologists and Outdoor Recreation Branch must approve all dog training. Anyone training or hunting with dog(s) must comply with Section j. Part (6) of this policy.

(2) No dog training will occur during turkey season or in the months of May and June.

(3) Any licensed dog trainer or hunter may train their own dog(s) during the closed season, except as noted in paragraph 3.n(2). Licenses and permits are required. Trainers may use starter pistols loaded with blanks, not live ammunition, for training purposes.

(4) Training of hunting dogs for the hunting of raccoon, opossum, and rabbit is permitted during the closed season, except as noted in paragraph 3.n(2), by licensed hunters, provided that under no circumstances will anyone take, kill, or have in his/her possession any raccoon, opossum, or rabbit, or possess any device or gun that could aid in the capturing or killing.

o. Scouting.

(1) The scouting of areas is permitted during daylight hours only. Hunters desiring to scout will process through the Outdoor Recreation Branch and obtain approval.

(2) While scouting, the use or possession of weapons or any type of call is prohibited.

(3) Scouting for deer is not permitted once the bow deer season begins.

p. Trapping.

(1) Trapping is permitted only in designated areas. A master list of areas cleared for trapping and the species and numbers that may be taken will be posted at the Outdoor Recreation Facility.

(2) Eligibility is as specified in paragraph 3.

(3) An eligible person wanting to establish a trap line on RSA will submit a written request to a USAG-RSA Wildlife Biologist and Outdoor Recreation Branch. Traps will not be put out without written approval from a USAG-RSA Wildlife Biologist and Outdoor Recreation Branch.

(4) Any person trapping will provide the staff of the Outdoor Recreation Branch with a map showing the location of all traps and will immediately notify the Outdoor Recreation Branch staff when traps are removed.

(5) Trappers will submit a weekly, written trapping report to the USAG-RSA Wildlife Biologist. The report will list all animals by species trapped during that reported week.

(6) Personnel will check their traps daily. Trappers will immediately release any wildlife not authorized to be trapped.

(7) Trappers will permanently mark each trap with the owner's identification.

(8) Use of suspended bait is prohibited.

(9) Trapping in any portion of Wheeler National Wildlife Refuge is prohibited without written permission from the refuge manager.

(10) Trappers must carry and use choke sticks while checking traps. Trappers may use a pellet rifle to dispatch trapped animals.

(11) Trappers who wish to trap and hunt at the same time must gain authorization from Outdoor Recreation Branch to carry weapons (as defined in paragraph 3e) provided:

(a) The individual processes through the Outdoor Recreation Branch to check area availability.

(b) Trappers must check through Outdoor Recreation before entering different hunting areas.

q. Safety.

(1) The staff of the Outdoor Recreation Branch will refuse permission to hunt, trap, or fish to anyone they suspect of using, possessing, or being under the influence of alcoholic beverages, other drugs, or controlled substances. Conservation Officer(s) will cancel the permission to hunt, trap, or fish to anyone they suspect of using, possessing or being under the influence of alcoholic beverages, other drugs, or controlled substances in the field.

(a) USAG-RSA Conservation Officers are authorized to close any or all hunting areas for safety, enforcement, management, or mission purposes.

(b) No child under the age of 9 will carry or use a weapon. Sponsors of youth hunters are expected to instruct participants on firearm safety.

(2) A cap and vest consisting of a minimum of 500 square inches of hunter safety orange is required for all hunters during deer gun season. Hunter safety orange is not required for any other hunting season with the exception of Spring Turkey Season (as defined in paragraph 3f), but is encouraged at all times. Hunter safety orange garments must be in good condition and readily visible to other hunters. The staff of the Outdoor Recreation Branch may request proof that all hunters are so equipped before issuing authorization to hunt.

(3) Non Hunters requesting to participate in recreational activities during the Deer and Turkey Season will check in with Outdoor Rec to determine if hunting activities are ongoing in the area in which the Non-Hunter recreationalist is planning to utilize.

(4) Boats launched from or on RSA will conform to all federal and state regulations regarding equipment, lighting, operation, and registration. Hunters desiring to use boats to access a hunting area, must launch from within RSA, place dash placard in the vehicle at the launch and also put a note on the bow of the boat with the info required on a dash placard. Each occupant will wear a Coast Guard approved, personal flotation device.

(5) No person while hunting, fishing, or trapping will attempt to operate, remove or otherwise attempt to move or touch any item of equipment not belonging to that person. Items include, but are not limited to, missile and rocket fragments or whole portions thereof. Unexploded ordnance (UXO) is defined as any military ammunition, device, component, or container that failed to function as designed or has been discarded.

(6) Leave UXO or any suspicious item alone, mark its location without touching the item and notify the authorities by dialing 911.

(7) Personnel will not enter closed hunting or fishing areas. Buildings and other structures will not be entered without specific permission.

(8) Hunters using any type of tree stand must utilize a safety belt or full body harness that is capable of supporting the hunter's weight. The safety belt/harness shall be attached to the hunter and to the tree at all times while the hunter is elevated to any degree off the ground, including ascending or descending.

(9) No hunter shall drive, drill, screw or otherwise insert any metal object such as, but not limited to, spikes, bolts, nails, or the various types of tree steps, into a tree. No hunter shall hunt from a tree that has been "spiked" or otherwise prepared in any of the listed methods regardless of who actually prepared the tree. Hunters may not use or construct permanent stands and all tree stands shall be removed from the tree at the end of the day. An exception may be granted for authorized stands/blinds for handicapped/special needs hunters.

r. Enforcement.

(1) USAG-RSA Conservation Officers are tasked with the responsibility to ensure hunters are complying with federal, state, and RSA laws and regulations. Conservation Officers will be patrolling those areas assigned to hunters and those hunters not complying may be cited.

(2) All persons having knowledge of or involved in a shooting incident will report that incident to the military police and the Outdoor Recreation Branch personnel immediately. A shooting incident occurs when an individual discharges a weapon in an unsafe manner and injures or endangers himself or others. Individuals will be suspended immediately if they commit an unsafe act and will remain in that status until the USAG-RSA Commander directs reinstatement of privileges. Hunters having knowledge of in-progress hunting violations or violations less than 90 days old, will report such violations to Conservation Officers. Failure to report may result in a suspension of hunting privileges per the discretion of the Garrison Commander.

s. Violation and Penalties.

(1) Persons who violate federal or state laws will be referred to the appropriate authority for prosecution.

(2) Persons who violate this policy and/or federal and state law will have their hunting, fishing, and trapping privileges on RSA suspended or revoked, depending on the offense. Party leaders/sponsors will suffer such penalties as may be assessed against their guests/Family members. The following subparagraphs contain violations and the penalties assessed:

Violation	Administrative Penalty
Discharging a firearm from a vehicle or from/across a named road	Permanent Revocation
Driving Under the Influence or possession of illegal substance	Permanent Revocation
Hunting while under the influence of intoxicants	Permanent Revocation
Hunting with unauthorized weapon or ammunition	Permanent Revocation
Unauthorized trapping	Permanent Revocation
Taking or attempting to take game illegally/hunting out of season	Permanent Revocation
Hunting with or over bait	Permanent Revocation
Failure to obey law enforcement officer/submit to legal search or inspection	Permanent Revocation
Making a false statement to obtain permit and/or area assignment	Permanent Revocation
Hunting in an off limits or restricted area, impact area, cantonment area	Permanent Revocation
Unauthorized use of permit or automated system	Permanent Revocation
Illegal use of artificial light for locating game or hunting	Permanent Revocation
Criminal trespassing on Federal property	Permanent Revocation
Collection of historical artifacts	Permanent Revocation
Illegal take of state or federally protected species	Permanent Revocation
Carrying a concealed weapon while hunting	Permanent Revocation
Failure to check in big game or turkey harvest	3 Year Suspension
Drive hunting/Participating in a drive hunting deer	3 Year Suspension
Transporting loaded weapon in vehicle	3 Year Suspension
Unauthorized photography/Placing camera(s)	3 Year Suspension
Hunting in area closed to hunting	3 Year Suspension
Failure to register weapon(s) on the installation with Directorate of Operations	2 Year Suspension
Participating in outdoor recreation activities without area assignment	2 Year Suspension

Participating in outdoor recreation activities without valid permit/license	2 Year Suspension
Shooting before or after legal shooting hours	2 Year Suspension
Firing a weapon within 300 feet of an occupied building	2 Year Suspension
Harvesting a deer not meeting required antler restrictions	2 Year Suspension
Possessing under sized fish or fish in slot limit	2 Year Suspension
Exceeding bag/creel limit	1 Year Suspension
Outdoor recreation activities outside assigned area	1 Year Suspension
Bypassing roadblock, cable or gate in a vehicle	1 Year Suspension
Target practicing or discharging firearms in an unauthorized area	1 Year Suspension
Hunting with firearm capable of holding more than 3 rounds total	1 Year Suspension
Exceeding authorized natural resource collection limits	1 Year Suspension
Transporting uncased weapon in vehicle	6 Month Suspension
Unauthorized use of any all-terrain vehicle	6 Month Suspension
Allowing minors (under 15) to hunt unattended	90 Day Suspension
Unauthorized use of firebreaks or unauthorized roads	90 Day Suspension
Littering or dumping	60 Day Suspension
Failure to have required PFD in boat	60 Day Suspension
Failure to wear required safety garments and/or equipment	60 Day Suspension
Failure to utilize a safety harness while hunting in a tree stand	60 Day Suspension
Failure to complete check out procedures	30 Day Suspension
Failure to operate a boat in a safe manner	30 Day Suspension
Parking in an unauthorized area	30 Day Suspension
Failure to display area assignment parking permit in vehicle window	30 Day Suspension
Failure to report small game harvest	30 Day Suspension
Unsportsmanlike or disruptive conduct	30 Day Suspension
Fishing with unauthorized bait	30 Day Suspension

(h) Other suspensions as determined by the USAG-RSA Commander:
An individual alleged to have committed an unsafe act that results in a shooting incident will be placed under suspension of privileges immediately and remain in that status until the USAG-RSA Commander directs that privileges be restored.

APPENDIX A

ACRONYMS

ATV	All Terrain Vehicle
CAC	Civilian Access Control
DA	Department of the Army
DoO	Directorate of Operations
DFMWR	Directorate of Family and Morale, Welfare and Recreation
DPW	Directorate of Public Works
EMD	Environmental Management Division
IMRE-PWE	IMCOM Redstone Public Works Environmental
PFD	Personal Floatation Device
RSA	Redstone Arsenal
RTC	Redstone Test Center
TA	Test Area
USAG	United States Army Garrison
USAG-RSA	United States Army Garrison-Redstone Arsenal
USDA	United States Department of Agriculture
UXO	Unexploded Ordnance

APPENDIX B

HUNTING & FISHING MAP

AVAILABLE ON THE PDF VERSION OF THIS REG

RELEASE AND HOLD HARMLESS AGREEMENT

I,_____ , am voluntarily participating in hunting and/or fishing and/or trapping activities on Redstone Arsenal. I understand and acknowledge that these activities are inherently dangerous activities. I agree that I am assuming the risk of all personal injuries, death, and property damage that may occur as a result of taking part in these activities. These include such injuries or damage as may be caused by:

(INITIAL BELOW TO ACKNOWLEDGE)

_____ - Hazards incident to hunting/fishing/trapping on Redstone Arsenal; to include, but not limited to UXO, various wires/rocket parts and chemicals.

_____- The negligent acts of others.

_____ - Any dangerous condition, known or unknown, that exists in the military training areas.

_____ - Any other negligent act of Redstone Arsenal or its directorates.

I, on behalf of myself, my personal representatives, and my heirs voluntarily agree to release, waive, and hold harmless the United States Army, Redstone Arsenal, its agents, officers, and employees for any and all claims arising from participating in any hunting or fishing or trapping activity.

I certify on this date_____, that I/my child and/or guest(s) will follow all federal, state and installation laws, regulations and policies.

Signature:Hunter/Angler/Trapper_____

If participant is a minor child, in addition to initialing above, a parent or legal guardian must sign.

I,_____ , parent/legal guardian of the above child, do consent to his/her participation in hunting and fishing activities and will abide by the above indemnity agreement.

Signature of Parent/Guardian_____

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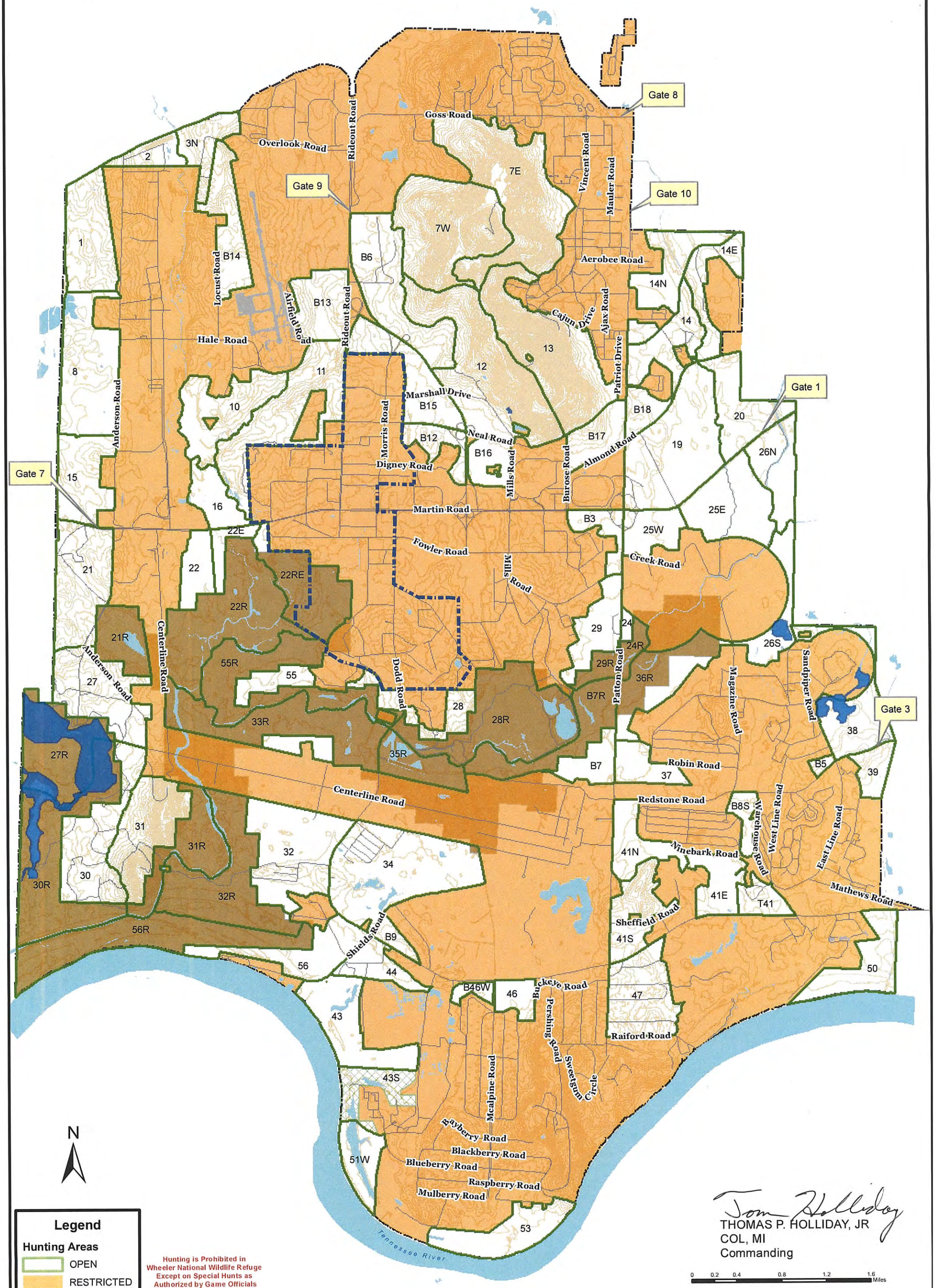
REDSTONE ARSENAL
HUNTING & FISHING
MAP
2017/2018



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Appendix G
Burn Plans

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PRESCRIBED BURNING PROGRAM PLAN
Garrison Redstone during FY 16

PURPOSE: Hazard reduction, wildlife habitat improvements, TSI, site preparation for reforestation, control tree diseases, improvement for utilization by troops and TOE missions.

TIMING OF BURNS: The prescribed burns will normally be conducted during the winter months (Dec-Mar). Other special burns may be required during the growing season to provide desired vegetation control or hazard reduction.

AREA LOCATIONS: See enclosed maps.

DESCRIPTION OF AREAS:

Burn Area	**Acres**	**Description**	**Justification**	**Sensitive Items**
112 and 122	198.14	Mature pine stands and open areas in hunting areas 1 and 2	Habitat improvement and hazard reduction	I565, western boundary off post, and bldgs 6112, 6113 6115, 6119, 6118, and 6122 (smoke)
131 and 151	584.5	Open areas of TA-3	Hazard reduction from testing activities	Bldgs 6210-11, 6213, 6218, 6301, 6218, SED Bldgs, and I-565 (smoke)
222	127.2	Mature pine stands in hunting area B2 north of Neal and west of Patton Roads	Hazard reduction and habitat improvement	Bldgs 3400, 3423, 3444, 3463, 3470, 3489, 3500, 3559, 3613, 3614, 3616-19, 3639, 3641, 3644, 3651-54, 3661, Gray, Neal, and Patton Rds (smoke)
212	155.46	Mature pine north of Toftoy and west of Rideout Roads	Hazard reduction and habitat improvement	Bldg 4189, 4194, and 4189 Toftoy, Marshall, and Rideout Roads (smoke)
142	292.91	Mixed forest stand south and east of Indian creek in hunting area 11.	Hazard reduction and habitat improvement	Bldgs in the northwest corner of MSFC. SED complex (smoke)
321, 532, and 542	116.93	Mature pine/native grass stands in hunting area 19	Hazard reduction and habitat improvement	Bldgs 5123, 5124, 5129, 5131, Archery targets, Patton and Martin Roads (smoke)
232 and 312	48.21	Mature Pine stands north of Hansen road just inside old gate 5	Hazard reduction, and habitat improvement	Off installation and Patton Road (smoke)

Burn Area	**Acres**	**Description**	**Justification**	**Sensitive Items**
421 and 451	76.91	Native grass planting areas along Redstone Road	Hazard reduction and habitat maintenance for native grass	Bldg 7319, 7351, and Redstone Road (smoke)
442	25.24	Mature pine stand north of Redstone and west of West Line Road	Habitat improvement and hazard reduction	FBI Hazardous Devices Complex, and Redstone and West Line Road (smoke)
412	113.1	Mature pine stands in Hunting Area 24 on Corkern Range	Hazard reduction and habitat improvement	Bldg 5389, Patton Road (smoke)
432	92.71	Mature pine stands within the FBI Hazardous Devices School	Hazard reduction and habitat improvement	All buildings within the HDS and MISC. Matthews, Warehouse, and Redstone Roads (smoke)
242 and 512	39.86	Mature pine stands and pine plantations in hunting area B12 and B13	Hazard reduction and Habitat improvement	Toftoy thruway, Martin Road, and Digney Road, Bldgs 4459, 4454, 4496, 4497 (smoke)
5102	230.4	Mature pine stands within NASA Test Stands	Habitat improvement and hazard reduction	Bldgs 4657, 4659, 4656, 4655. All bldgs inside NASA Test Stands (smoke)
522	41.36	Recently thinned pine plantations around the intersection of Martin and Toftoy.	Hazard reduction and habitat improvement	Von Braun Complex, Martin Road, Toftoy Thruway, Mills Road Child Development Center (smoke)
552, 562, and 572	120.96	Mature pine stands in hunting area 29	Hazard reduction and habitat improvement	Bldg 5560 (complex), Patton and Mills Rds (smoke)
581 and 631	1503.5	Open range lands on TA-1	Hazard reduction from missile firings	Remote cameras, set out targets, facilities outside burn area, RSA 63, and NASA Test Stands (smoke)

592 and 5112	482.85	Mature pine/hardwood stands in hunting area 28 and 55 on TA-1	Hazard reduction and habitat improvement	NASA Test Stands (smoke)
621	177.15	Open range lands on TA-6	Hazard reduction and habitat improvement	Bldgs 6301, 6307, 6309; Martin road, Anderson road, Off installation (smoke)
Burn Area	**Acres**	**Description**	**Justification**	**Sensitive Items**
652	23.25	Recently thinned pine plantations north of the Hazard Site on TA-1	Hazard reduction and habitat improvement	RTC Hazard Test Site and Anderson Road (smoke)
861 and 711	60.93	Native grass planting and open field at Bradford Sinks	Hazard reduction and habitat maintenance for native grass	RTC Hazard Test Site and Southern Anderson road (smoke)
612	422.23	Mature pine stands south of Martin and west of Anderson Roads	Habitat improvement, hazard reduction, and habitat research	Off western boundary of installation, south Anderson, west Martin, Gate 7 (smoke)
722	109.70	Mature hardwood stand on Bradford Mountain	Hazard reduction and habitat improvement	All buildings within the Hazard Site at TA-1 (smoke)
162	206.4	Mature pine stands in hunting area 15 west of TA-3	Hazard reduction and habitat improvement	Bldg 6230 and gate 7; Martin Road, Anderson and Zeirdt(smoke)
642	47.86	Recently thinned pine stands south of Martin Road west of TA-6	Hazard Reduction and Habitat Improvement	All TA-6 bldgs, Bomb Pad, and Martin Road (smoke)
732	65.91	Mature pine stand southwest of RTC Hazard Test Site	Hazard reduction, habitat improvement	Bldgs 6701 and 6701A. South Anderson road, Off installation west (smoke)
812	7.33	Mature hardwood stand in TA-2	Hazard and pest reduction	Bldgs 7853, 7853G, 7855-56, all other buildings within TA-2, and Patton road (smoke)
821	49.04	Open range lands in hunting areas 46 and 47	Open range lands for hazard reduction and site preparation for tree planting	Bldg 8762, power poles, Patton, Buxton, and Raiford Roads (smoke)
832 and 842	512.14	Mixed forested and open stands in TA-5 north	Hazard reduction, habitat improvement	All test stands, igloos, and buildings north of

				Blackberry Road within Test Area 5
852	87.53	Mixed forest stand south of TA-5 security fence in hunting area	Hazard reduction, habitat improvement	All building, igloos and test in the southern portion of Test Area 5.
862	319.74	Mature pine stands within the berry road igloo area west of McAlpine Road	Hazard reduction, and habitat improvement	All igloos and McAlpine road (smoke)
Burn Area	**Acres**	**Description**	**Justification**	**Sensitive Items**
872 and 882	108.3	Mature pine stands in TA-4, restricted areas along the south of Buxton road in hunting area 44	Hazard reduction, and habitat improvement	Bldg 8006 and TA-4 buildings; McKinley Range, and Buxton and Shields Road (smoke)
911	43.31	Open native grass planting in hunting area 41	Hazard reduction and habitat improvement	Buxton Road, climatic test branch buildings, tower site, and FBI HDS buildings near Buxton road (smoke).
922	69.06	Mature pine stand within the tower site fence	Hazard reduction and habitat improvement	Buxton and Warehouse Roads, tower site buildings and 7408 (smoke).
932	126.25	Mature pine stand bounded by Warehouse, Buxton and Matthews Roads.	Hazard reduction and habitat improvement	Buildings in MISC, E3, and FBI HDS. Buxton, Matthews, and Warehouse Roads (smoke)
942	50.07	First-thinned pine stands in FBI Hazardous Devices School	Hazard reduction and habitat improvement	Power poles and all buildings within Hazardous Devices School; Redstone Road (smoke)
952	84.77	Recently thinned plantations within the MISC area in the southwest corner of the installation	Hazard Reduction and Habitat Improvement	All bldgs within MISC area, FBI Hazardous Devices School, and Redstone Road (smoke)
921	4.4	Early successional example habitat at Path to Nature educational trail	Hazard reduction, habitat improvement, community education	Bldg 8930, Mississippian mud hut, civilian rec area (smoke)

962	59.88	Recently thinned plantations south of Buxton Road in Hunting Area 48.	Hazard Reduction and habitat improvement	All bldgs within the climatic test branch just north of Buxton Road (smoke)
972 and 982	116.85	Mature pine stands south of Buxton and east of Patton Roads.	Hazard Reduction and habitat improvement	Any hazardous storage igloos, Bldg 7804 and Buxton Road (smoke)
Total	7002.95			

PRE-BURN REQUIREMENTS:

1. 10-15 foot wide clean firelanes will be plowed around the perimeter of sensitive items and burn areas before burn implementation.
2. Backpack and mobile equipment with water will be available to restrict or suppress fire around power poles and other small isolated sensitive items.
3. Minimum 5 man burning crew will be available for burn operations.
4. Weather and fuel conditions will meet Prescribed Burn Plan for each burn area.
5. Coordination will be conducted with area residents and other potential personnel with activities in the area.
6. 24 hours prior to planned burn operations notification will be sent out electronically to all personnel on Redstone Arsenal.

DAY OF BURN OPERATIONS REQUIREMENTS:

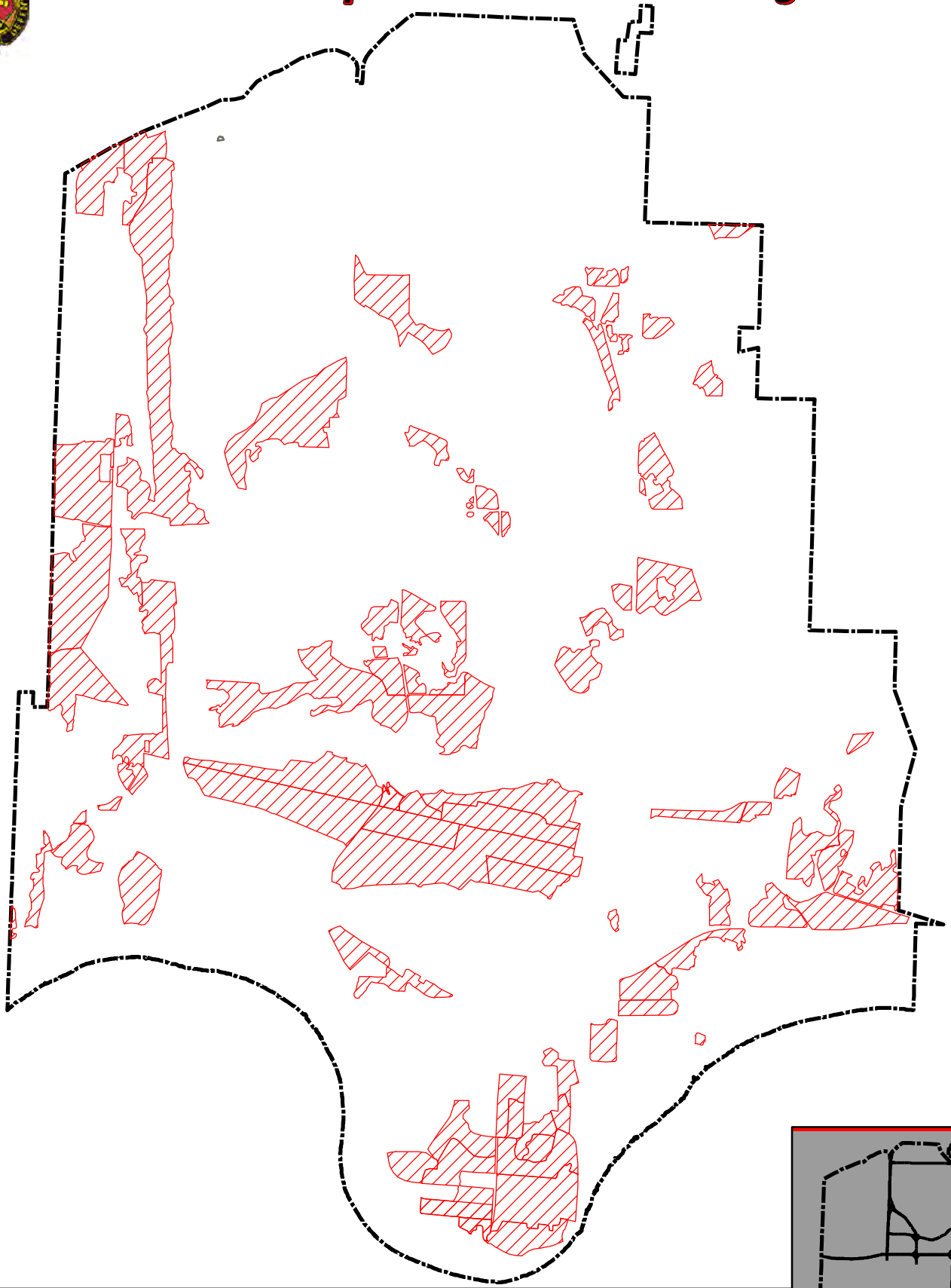
1. Weather and fuel conditions will meet Prescribed Burn Plan for burn area. (Weather conditions before, during and after burn will be monitored)
2. Burn permit will be acquired from Alabama Forestry Commission for areas to burn.
3. Burn notification will be given to:
   ADEM-Air Quality
   AMCOM Emergency Operations
   Installation Fire and Emergency Services
   Provost Marshal Office
   Redstone 911 Center
   Madison County 911 Center
   NASA
   Garrison Redstone Environmental Office
   Public Affairs
   Outdoor Recreation Services

4. Burning operations briefing with burn crew will be conducted before the burn.
5. Backfires initiated at approximately 1000.
6. All sensitive areas will be burned away from and monitored until burn is complete.
7. Burn and weather conditions will be monitored to determine appropriate action.
8. Setting fires should decrease after 1400 and final containment operations should begin with personnel made available for any fires that continue through the evening and night time. (Containment operations will include tree snag cutting, eliminating any firebrand source that has potential of starting new fires, ensuring a safe wide buffer exists around the perimeter of the burn area)
9. Notify Fire and Emergency Services of status of burn before departing burn area.

EVALUATION: As noted in the Prescribed Burn Plan for each burn the following items will be evaluated:

1. Structural and facility damage determination
2. Timber damage assessment
3. Objective accomplishment assessment
4. Public reaction

FY 2016 Proposed Prescribed Burning



0 3,310 6,620 13,240 19,860 26,480 Feet

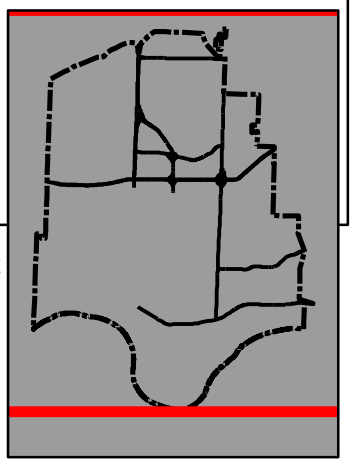
scale 1"= 1.25 mile

Legend

2016 Proposed Burning

Installation Area - 38,125 ac

Map Prepared by: Greg Hicks
4488 Martin Road, A317
Redstone Arsenal, AL 35898
11/3/2015



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Appendix H
Native Warm Season Grasses
Management Plan

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Native Warm-Season Grass Management on Redstone Arsenal, Alabama

January 2017

Cultural and Natural Resources Branch,

Environmental Management Division, USAG - Redstone Arsenal

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NATIVE WARM-SEASON GRASS MANAGEMENT ON REDSTONE ARSENAL, AL

INTRODUCTION

Historically, the southeastern United States included tracts of native grasslands and savannas, as well as openings and grass understory in mature hardwood and pine forests. These habitats were preserved by natural fire events, beaver activity, wind events, and geography (soil structure/type). In Alabama, these different habitats are referred to as **glades, barrens, prairies, prairie barrens, wet pine savannas, bogs, and xeric limestone prairies**, all of which are dependent on topography, aspect, soil types, and historical fire regime (20, 68). The Black Belt was the largest and most extensive grassland system in Alabama, covering at least 17,700 acres in the west central part of the state. Over the last century, most of these areas have been replaced with nonnative grasses, agricultural crops, forest cover (due to suspension of fire regime), and urban/suburban development (7, 11, 16, 34, 35, 44, 62, 64, 66). Because of this habitat loss, many wildlife species, including about **70% of grassland and shrubland birds that depend on grasslands and other types of early successional habitat are experiencing long-term population declines** (14 are federally listed as endangered or threatened and at least19 others are at risk), including at least a **65% decline in Northern Bobwhite** (*Colinus virginianus*) populations (17, 39, 47, 56). The decreases are so noticeable and well documented that numerous state and federal programs (ex. Farm Bill), were established to increase targeted wildlife species though restoration of grasslands and other early successional habitat (15, 22, 49). Even if we do not have completely accurate details about the pre-history amounts of grasslands and early successional habitats in the east, the degree and number of species in decline that depend on those habitats warrant attempts at restoring them. Looking forward by identifying desirable goals in terms of maintaining viable populations of declining migratory birds and other wildlife can lead us to the appropriate amount of habitat needed today. For example, in Alabama's Comprehensive Wildlife Conservation Strategy (68) various early successional habitats, the species dependent on them, and needed research (ex. implement inventory and monitoring programs for distribution of key species) and conservation actions (ex. increase prescribed burning to encourage maintenance of grasslands) are identified to promote management and conservation.

REDSTONE ARSENAL

Redstone Arsenal (RSA) is part of the **Tennessee River Migratory Bird Focus Group** which lies in the Central Hardwoods Bird Conservation Region created by the North American Bird Conservation Initiative (20). The primary goal of this public-private Focus Group is to improve habitat for **priority grassland bird species** such as Dickcissels (*Spiza Americana*), Grasshopper Sparrows (*Ammodramus savannarum*), Field Sparrows (*Spizella pusilla*), Prairie Warblers (*Dendroica discolor*), Northern Bobwhite, Loggerhead Shrikes (*Lanis ludovicianus*), and Eastern Meadowlarks (*Sturnella magna*) (see Table 1). In addition, Department of Defense (DoD) is a contributing member of Partners in Flight, a national cooperative effort created in response to declines in North American land bird species. Restoring native warm-season grass (NWSG) areas is one path for reaching population restoration goals because birds in the grassland and grass-shrubland species suites use these areas for nesting and brood-rearing. In addition to ensuring compliance with the Sikes Act, the Migratory Bird Treaty Act, and Section 3 of Executive Order 13186, regional partnerships designed to improve habitat for declining species may prevent the need for future listings under the Endangered Species Act. RSA chose to participate in this group by planting approximately 100 acres of NWSG in 2008 to improve migratory bird habitat in the region and help promote the DoD as a leader in regional conservation. Approximately 100 additional acres were planted in 2009 to supplement the initial planting and contribute to meeting the ecosystem management goals of RSA. **Ecosystem management** is one of the main goals of the Natural Resources Program on RSA and this often is accomplished through conservation of important habitats or targeted habitat manipulation (65). Therefore, RSA NWSG plantings are managed for wildlife use and are not managed for grazing, haying, or other monetary goals.

Funding for the original NWSG areas was provided to enhance habitat for migratory birds, but also are beneficial to many types of wildlife. RSA has a number of priority bird species that utilize early successional habitat, as found in the 2008-2010 breeding bird survey (5). These species were separately identified by North American Bird Conservation Initiative, Partners in Flight, and Alabama Department of Conservation and Natural Resources (ALDCNR) as species of high priority for research, conservation, and management due to their regional and/or nationwide population declines (see Table 1).

Grassland Nesting or Utilizing Species Known[1] on RSA and Their Habitat Preferences

Species	Grass Height			Avoids grasslands with woody vegetation [2]	Regional Priority Species
	Short	Med.	Tall		
Northern Harrier			X	X	Y
American Kestrel	X	X			
Common Barn Owl	X	X	X	X	
Loggerhead Shrike	X	X	X	X	Y
Horned Lark	X			X	Y
Bobolink		X		X	Y
Eastern Meadowlark		X			Y
Savannah Sparrow	X	X		X	Y
Grasshopper Sparrow	X			X	Y
Field Sparrow	X	X	X		
Bachman's Sparrow	X	X	X	X	Y[3]
Fox Sparrow		X	X		
Golden-winged Warbler	X	X	X		Y[3]
Blue-winged Warbler		X	X		Y[3]
Prairie Warbler		X	X		Y[3]
Eastern Kingbird	X	X	X		Y
Yellow-breasted Chat	X	X	X		Y
Dickcissel		X	X		Y
Eastern Towhee		X	X		Y
Orchard Oriole		X	X		Y
Brown Thrasher	X	X	X		
Indigo Bunting	X	X	X		
Painted Bunting		X	X		Y[3]
Northern Bobwhite	X	X	X		Y
American Goldfinch	X	X	X		
Killdeer	X				

[1] Priority species identified during the 2008 – 2010 breeding bird survey. Other grassland species may be present on RSA.

[2] While species avoid areas with woody vegetation, most can tolerate some woody vegetation within areas dominated by grassland. [3] Species also of Continental concern

Table 1. Grassland Nesting or Utilizing Species Known on Redstone Arsenal, Alabama

Some species receive more attention than others. For example, Northern Bobwhite declines have been a concern for decades and numerous private and research organizations were formed to study and help landowners manage this important game species (ex. Quail Unlimited, Southeast Quail Study Group, Northern Bobwhite Conservation Initiative). A more recent species of concern, the Golden-winged Warbler (*Vermivora chrysoptera*) is currently petitioned for listing under the Endangered Species Act due to its rapid and extensive population declines.

DoD has the aforementioned interest and responsibility to manage and protect all wildlife, especially species of concern, and properly managing early successional habitats is one avenue to promote game species management as well as priority species conservation. Eastern cottontails (*Sylviagus floridanus*), white-tailed deer (*Odocoileus virginianus*), and Eastern Wild Turkey (*Meleagris galopavo*) all utilize grassland habitat when available. Eastern cottontails use even very small grasslands (< 2 acres) for nesting, foraging, and shelter and prefer some interspersed shrubs, thickets, or brush piles

for cover (1,14, 24, 37, 46). White-tailed deer use any size grasslands to forage for forbs in spring and fruits in summer and use the erect grasses for cover during fawning and winter bedding (12). Eastern Wild Turkey prefer larger fields with scattered shrubs or thickets for nesting and will use grasslands for brooding, especially for poult bugging opportunities (36, 41, 51, 57).

In 2002, ALDCNR has identified imperiled wildlife in their Alabama Wildlife Volumes 1 – 4 (54), many of which are identified as depending on or utilizing grassland habitats during their life history. These grassland species include some of the birds listed in Table 1, but also mammals and reptiles. Imperiled reptiles which utilize grassland habitat whose distribution includes RSA include prairie kingsnake (*Lampropeltis calligaster*), eastern kingsnake (*Lampropeltis getula getula)*, and northern pinesnake (*Pituophis melanoleucus melanoleucus*). Imperiled mammals which utilize grassland habitat that are known or are likely to be on RSA include little brown myotis (*Myotis lucifugus*), southeastern myotis (*Myotis austroriparius*), eastern harvest mouse (*Reithrodontomys humulis*), oldfield mouse (*Peromyscus polionotus*), prairie vole (*Microtus ochrogaster*), northern short-tailed shrew (*Blarina brevicauda*), southern short-tailed shrew (*Blarina carolinensis*), least shrew (*Cryptotis parva*), southeastern shrew (*Sorex longirostris*, and long-tailed weasel (*Mustela frenata*). While each species has specific spatial, temporal, and structural early successional habitat requirements, all can benefit from NWSG management (see Table 2).

Habitat Component	Habitat Requirements
General	-Grasslands, crop/grassland/forb mixed communities, prairies, meadows, hayfields, grazed pastures and rangelands, reverted agricultural fields, idle pastures and old fields, utility and roadway right-of-ways and other strip habitats, and other open herbaceous habitats.
Food	-Insects and other invertebrates -Fruits, seeds and cultivated crops: wild berries, weed seeds, exotic grass seeds, seeds of sedges, corn, oats, wheat, barley, other small grain crops - Native grasses seeds: big bluestem, little bluestem, switchgrass, Indiangrass, side-oats grama.
Interspersion – grassland obligate species	-Mixture of short, medium, and tall grass areas in large, unbroken grassland blocks with less than 5% woody vegetation cover. -Native grasses provide optimal conditions, but some introduced cool-season grasses may also provide suitable habitats for many grassland birds.
Interspersion – species requiring woody vegetation	-Grassland communities adjacent to woodlands, savannas, wetlands, shrubland, old field communities, overgrown fencerows and shelterbelts. -Individual bird species requirements must be considered in determining woody vegetation requirements.
Minimum Habitat Size	-Minimum size of suitable nesting and breeding habitat required to support a breeding population. Depending on species habitat objectives, minimum habitat size may range from as little as 2 acres to as more than 500 acres. -For grassland bird management, at least 40 acres of grassland should be available unless adjacent to larger blocks of early successional habitat .

Table 2. Grassland Species Habitat Requirements Summary

NWSG VALUE

NWSG areas are one type of early successional habitat important for many species of migratory birds and other wildlife because their clumpy growth form provides **structural cover** for nesting and brood rearing and their seed production, along with associated forbs and soft mast shrubs, provides ample **foraging** opportunity (15, 21, 43). NWSG bunchy growth form creates openings through which birds and small mammals can safely **travel, forage, and nest**. Native forbs, such as partridge pea (*Chamaecrista fasciculata*), clovers (*Dalea* sp.), and annual sunflowers, that germinate between bunches provide additional cover and forage (10, 58). NWSG also provides structural cover in the winter for birds, white-tailed deer, and Eastern cottontail rabbits because their stems remain upright. Some areas of woody growth such as blackberries (*Rubus* sp.), plum (*Prunus* sp.), or sumac (*Rhus* sp.) provide cover for shrub nesting birds such as

Dicksissels and Field Sparrows (23). In general, the more diverse vegetation found in a grassland community, the greater the wildlife value (9, 53). In contrast, nonnative grasses in open pastures for livestock forage and hay production have been shown to provide little wildlife benefit (3, 6, 55).

NWSG ESTABLISHMENT

Site Preparation

Establishment of NWSG is a slow process, whether the areas are **planted** or whether **the seed bank is released**, taking a few years to see desirable results. NWSG planted for wildlife management should be very sparse the first year because most of the growth is root development. Even without proper soil amendments or rainfall, NWSG areas should be established by the third year if properly managed.

Control of nonnative grasses, such as tall fescue and bermudagrass, is critical for NWSG establishment. Burning is not usually effective on its own if nonnative grasses are thoroughly established, so typically some combination of burning and herbicide treatment is needed for effective competition control. Burning in late winter and allowing cool-season grass regrowth before herbicide application in the spring results in more effective control than without burning (50, 67). Nonnative warm-season grasses often are more difficult to control than cool-season grasses. A late spring burn followed by an imazapyr and glyphosate application after 5 to 8 cm of grass regrowth and again one month later effectively controls bermudagrass (4). Using imazapyr just before or at onset of flowering is also successful (6). Bahiagrass is one of the most difficult nonnative grasses to control during NWSG conversion with some studies never achieving complete control (4). In general, if just applying herbicide, fall application of glyphosate or imazapic is more effective than spring application (32). It should be recognized that all herbicides have drawbacks due to their level of specificity so site specific objectives must be considered. For example, imazapyr will not affect blackberries or legumes, but may kill NWSG (6, 26).

While NWSG are adapted to their native soil, establishment can benefit from **seedbed preparation**. pH adjustment and fertilizer, especially if planting for hay or pasture, can produce optimum NWSG growth. If drilling, the seedbed should be free of dead vegetation, usually by prescribed burning, so germination and seedling survival are optimal. Top-sown seed should not be cultipacked or disked afterwards because seed would be covered too deep.

NWSG Planting

Planting: NWSG seeds can be planted with a no-till drill or by top-sowing (with spreader or by hand). Planting requirements differ by species, but using a calibrated no-till drill will accommodate all. This method is recommended due to its proven success for NWSG mixes, which are more diverse and therefore more beneficial to wildlife than planting single species. Conversely, if hay production and/or livestock forage is the priority grassland management objective then monocultures of switchgrass could be planted with a clover seed box on a grain drill. NWSG seed should not be planted deeper than ¼ inch (at least 30% should be obvious on top of the planting furrow (31).

Timing: Timing of NWSG planting is extremely important due to the slow establishment rate. Recommended planting season is mid-April through May or just before the soil temperature reaches 58° F (31). This allows time for germination and seedling growth before summer heat and dry periods.

Seed quality: Seed quality of NWSG mixtures should be of prime consideration because purity and germination rate is usually low. It is therefore important to determine the pure live seed (PLS) so that proper seeding rate can be calculated. Cold stratification of the seeds or purchasing pre-treated seed can alleviate this concern.

Seeding Rate: When planting NWSG for wildlife management, seeding rate should be 20-50% coverage with high percentages of bare ground and forbs. Past experiences with cool-season plantings initially influenced managers and landowners to plant NWSG too thick, with rates up to 8-10 lbs PLS. This results in very dense grass areas with few forbs and little bare ground, actually decreasing wildlife densities (18). Instead, managers have realized that 3-4 lbs PLS is more appropriate so that adequate early successional vegetation diversity can be accomplished and managed for wildlife (29). If using a no-till drill, rate should be approximately 3-4 lbs PLS per acre. If stand is top-sown, PLS rate should be 6-8 lbs

PLS per acre to accommodate for a decreased germination rate. Table 3 shows example seeding mixtures for different objectives.

Example Calculation: To determine the amount of bulk seed to be planted, first consult the seed tag for the percent PLS, which is (germination x purity), divided by 100. The bulk pounds to plant is then (the desired seeding rate in PLS pounds divided by the percent PLS) x 100. For example, let's say a big bluestem seed lot has a germination of 80% with an additional 5% "hard or dormant" seed. The total germination is then 85%. The seed tag shows a purity of 60%. Therefore, the percent of PLS in the bag is 51% (0.85 x 0.60 = 0.51). You want to plant 3 PLS pounds per acre. The amount of bulk seed to set the drill to deliver is then 3 divided by 0.51 = about 5.9 bulk pounds per acre.

Seeding mixture (lbs PLS per acre)	**Objectives**
Wildlife – tall grass mixture	
1.0 lb big bluestem	Nesting cover
1.0 lb indiangrass	Brooding cover
0.5 lb little bluestem	Winter cover
0.5 lb switchgrass	
0.5 lb native forbs	
Wildlife – short grass mixture	
2.0 lb little bluestem	Nesting cover
0.5 lb sideoats grama	Brooding cover
0.5 lb indiangrass	
0.5 lb native forbs	
Forage Stand	
2.0 big bluestem	Cattle forage
2.0 little bluestem	
2.0 indiangrass	
2.0 switchgrass	
2.0 Eastern gamagrasss	

Table 3: Example NWSG Seeding Mixtures for Wildlife Management or Forage

Seedbank Release

Concerns: There are certain areas of concern when trying to manipulate a seedbank. One is **historic land use** of the area to be converted. Areas forested more than 50 years often have an extremely diverse and desirable seedbank. Seedbanks in former pastures always will be dominated by nonnative grasses and forbs. Agriculture fields will have little or no seedbank, especially those continuously treated with herbicides. The latter two land uses probably will require planting NWSG to establish early successional habitat beneficial to wildlife. Another concern when attempting seedbank release is **perception**. The very species that are beneficial to wildlife are the ones that are discouraged in pastures and agriculture fields (e.x. blackberries, goldenrod, native grasses). High quality early successional habitat often looks unkempt and unmanaged, creating a negative perception. Lastly, conversion of areas to NWSG areas takes **time and effort**, with high intensity effort occurring the first few years of establishment. When seedbank release is the method of establishment, clear objectives and commitment are needed, but dramatic increases in wildlife populations can be expected (55)

Control: Control of nonnative vegetation is more important with native seedbank release attempts than with planting of NWSG. Full-broadcast applications of the appropriate herbicide are needed to control competition followed by burning and/or disking to release the native seedbank (30). See Establishment section above for more information. Seedbank content should be evaluated at least 1 year after release to determine if there are desirable species present. If there are native plants present and if nonnative plants are manageable with herbicides, management can continue as if the areas were planted (periodic prescribed fire and/or disking if NWSG stands are too thick).

NWSG MANAGEMENT

Management of NWSG open structure and control of competitors are crucial to successful establishment and management of the areas, but can be difficult. **Percent grass coverage should be approximately 50%** in a NWSG area properly managed for wildlife such as foraging Eastern Wild Turkey polts and Northern Bobwhite broods (18, 29). If not managed properly, NWSG fields may become grass dominated over time (18, 53). There also is a constant battle with remnant nonnative grasses and woody encroachment. Disturbance is vital for preventing excessive succession; primary management techniques include prescribed fire, disking, and herbicide application. Secondary, less effective methods, with less desirable outcomes for wildlife, include bushhogging, haying, and grazing (18, 48). **Timing and frequency of management techniques** are highly influential on amount of bare ground, vegetation composition and even invertebrate availability so an adaptive planning is essential for successful wildlife habitat management.

Prescribed fire: Prescribed fire is the most effective method for managing NWSG because it reduces litter buildup, sets back succession, increases nutrient availability, and stimulates herbaceous growth (8, 26, 40, 45, 69). However, timing and frequency of burns greatly influences returning vegetation. Late winter and early spring (January – March) prescribed burns typically stimulate nonnative cool-season grasses which compete with native vegetation and decrease habitat suitability (3, 19). Burning in late spring (March- early April) favors NWSG over cool-season grasses (26, 38, 63). Burning late in the dormant season or early growing season stimulates NWSG and forbs, allows extended use of winter cover, and is prior to nesting season (8, 23). Use of fire in late summer or early fall thins overly dense grass, stimulates forb production, and reduces woody succession (by depleting energy reserves in root systems), but can affect nesting or young wildlife (27). Annual prescribed fire will result in a grass and forb dominated system, while 2-3 year and 3-4 year rotations will favor greater forb and shrub components in increasing amounts (31).

Disking: Disking is an alternative management technique to prescribed burning, but offers the additional benefit of breaking up thick stands of NWSG to create a more open structure at ground level (18, 26, 28). Disking sets back succession, increases open space at ground level, facilitates litter decomposition, and stimulates the seedbank (8, 31, 59). Again, timing is an important consideration for reaching desirable management goals. Disking in the dormant season (before April) promotes desirable forbs, while disking in the growing season is likely to promote nonnative grasses found in the seedbank such as johnsongrass (*Sorghum halepense*) or crabgrass (*Digitaria* sp.) (25,61). If NWSG has become too dense, a heavy offset disk is more effective than a tandem disk at breaking them up and even then, multiple passes may be necessary (often 4 passes) (32). If the NWSG area is very overgrown with woody vegetation, mowing or burning may be required prior to disking.

Herbicides: Herbicide application can be used to selectively reduce NWSG density or to control undesirable vegetation, but should not be the main management technique utilized. Strip spraying with a grass-selective herbicide in late spring can decrease grass density, create additional open space at ground level, and stimulate the seedbank (6, 26, 31). This should be accomplished before NWSG are 12 inches tall so that they do not create a thatch layer which prevents germination from the seedbank (32). Spot spraying can manage nonnative grasses or unwanted woody vegetation; the problem species will dictate herbicide to use. Spot spraying allows the manager to keep desirable woody vegetation (e.x. plum (*Prunus serotina*), persimmon (*Diospyros virginiana*), black cherry (*Prunus americana*)), but control undesirable woody vegetation (sweetgum (*Liquidamber styraciflua*), green ash (*Fraxinus pennsylvanica*), American elm (*Ulmus americana*)).

Mowing: Mowing (without burning or disking immediately after) **is not a recommended practice** for managing NWSG because it increases the litter layer, inhibits mobility for wildlife, inhibits the seedbank germination, reduces vegetation diversity, and reduces availability of seeds and invertebrates for foraging broods (10, 32, 40, 52). Unfortunately, it is a common landowner management practice in grasslands (18). An additional issue is that when landowners bushhog, they traditionally do so at the worst times of the year for wildlife management. Mowing in the summer destroys nest and nestlings, kills young white-tailed deer and eastern cottontails (*Sylvilagus floridanus*), and removes reproductive cover. Mowing in fall destroys winter protective cover, often a limiting factor for wildlife. In addition, instead of reducing woody competition, mowing stimulates sprouting (27, 42). Mowing is so detrimental to NWSG areas it is considered a violation of Wildlife Habitat Incentive program (WHIP), Environmental Quality Incentives program (EQIP) and/or Conservation Security Program (CSP) contracts. However, mowing strips during summer in areas

of mainly blackberry or goldenrods (*Solidago* sp.) can benefit some ground-nesting birds and promote NWSG growth (33). If required, areas can be bushhogged just prior to disking for stand thinning.

Haying: NWSG can result in high quality forage for cattle and can occur with wildlife management as a secondary goal if the proper grass species are planted and appropriate management timing is used. For example, big and little bluestem (for diversity) can be planted with indiangrass (a valued cattle forage) and hayed in July to avoid the May and June nesting species. Waiting until early fall can result in lower quality hay and can inhibit next year's growth of NWSG by depleting carbohydrate reserves. It should not be cut lower than 4-5 inches and only once per year (31).

Grazing: Grazing NWSG during the summer and allowing cool-season grass pasture to rest can reduce the need for hay and if rotated properly also can allow some benefit to wildlife. Most NWSG should not be grazed until they reach 30 inches (30). Grazing NWSG after early fall can inhibit next year's growth by depleting carbohydrate reserves (31).

NWSG MANAGEMENT ON RSA

According to the 2015 Integrated Natural Resources Management Plan (65), RSA natural resource management goals include to "Manage natural resources to maintain or restore ecological processes important to species interactions and ecosystem health. Integrate landscape dynamics into natural resource management planning and decision making. Protect interactions among ecosystems to preserve or restore ecosystem connectivity and habitat mosaics." Incorporating different types of habitats in a juxtaposition that is beneficial to target wildlife species is a tool for promoting biological diversity through our adaptive ecosystem management approach. NWSG areas can complement other habitat types and provide additional habitat resources to wildlife to make an area more suitable for survival and reproduction. Most of the areas chosen for NWSG plantings on RSA are adjacent to multiple habitat types and therefore balance the landscape in terms of resource availability. For example, the NWSG areas on Eastline Road are adjacent to hardwood forest, planted pines, wetlands, woody early successional habitat, and food plots of various types. This arrangement provides wildlife such as white-tailed deer or Bobwhite Quail all needed resources within a relatively small area. This arrangement also can lead to improved survival and increased populations over time.

There are approximately 200 acres of NWSG areas planted on RSA (See Appendix A). The areas have all been managed differently due to various reasons, including but not limited to, location, lack of adequate burning conditions, lack of adequate personnel to conduct management, lack of management knowledge, lack of time, or lack of interest. This is evident from the 2012 NWSG assessment, where approximately half of the areas were surveyed and then compared to planted hay fields for % cover native plants, % cover nonnative plants, and % cover bare ground (2). The RSA NWSG areas have on average greater % cover native plants, greater plant diversity, and less % cover nonnative plants than the hay fields. However, they have the same percentage of bare ground as the hay fields (27%) and do not yet differ in bird diversity. These results indicate that the plantings were successful (i.e. there was good initial control of nonnative grasses and good germination of planted NWSG seeds), but that we need to adjust our management of the areas. Reasons include: hardwood encroachment, overly think NWSG, or nonnative grasses present in great densities.

Because each of the NWSG areas has been managed differently (see Table 4), their future management needs also are different (see Table 5). Management needs should be assessed and altered as required each year. For example, the Redstone site is our healthiest NWSG site (greatest plant diversity, least non-native plants, appropriate amount of bare ground), but is nearing maximum vegetation density useful to wildlife. We will continue to annually burn the area, but may run disk strips if we see the area is continuously too dense. There also are requirements for maintaining native grasslands by and on Wheeler National Wildlife Refuge (WNWR) property where trees are cut for test area operations (13). These requirements have not been met or maintained in the past, but a current proposal for clearing trees on 4 acres on Test Area 1 (TA-1) will be included in future NWSG management plans (TA-1/WNWR). In addition, it is required that areas planted in NWSG destroyed for development or dedicated for other uses must be replaced elsewhere on RSA. As an example, approximately 5 acres of the Almond Road NWSG site has been converted to a wildlife food plot to accommodate easier hunting of white-tailed deer for the Directorate of Family, Morale Welfare and Recreation (FMWR) hunting program. A replacement 5 acres of early successional habitat maintained with a dominant NWSG component will be established on Hale Road in 2015 as part of a 20 acre wetland water quality protection project that also will meet the mission requirements of the Airfield.

NWSG Area	Acres	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18
Bradfords 1	24	Planted	Burned		Burned		Burned	Burned				Burn
Bradford Sinks 2	23.5		Planted		Burned		Burned	Burned				Burn
Buxton	41	Planted	Burned		Burned	Burned		Burned				Burn
Almond	31*	Planted									Mow/Spray	Burn
Redstone	67		Planted	Burned	Burned	Burned	Burned	Burned			Mow	Burn
Eastline W	11		Planted	Burned	Burned	Burned	Burned	Burned				Burn
Hale Road	21								Planted		Mow/Spray	Plant
P2N	7										Planted	
TA-1 Field	30											Plant
Anderson Rd Shortleaf	18											Burn/Plant
Dodd Shortleaf	12											Burn/Plant
Total	**253.50**											

*approximately 5 acres removed for food plot in FY12

Table 4: Past Management of NWSG Areas at Redstone Arsenal, Alabama

*hardwood (HW)

Table 5: Future Management of NWSG Areas at Redstone Arsenal, Alabama

NWSG Area	Immediate Issues	FY17			FY18		FY19	FY20	FY21
		Fall	Winter	Spring	Fall	Spring			
Bradford Sinks 1	HW* encroachment/dense			Mow	HW Control (herbicide)	Burn			Burn
Bradford Sinks 2	HW encroachment/dense			Mow	HW Control (herbicide)	Burn			Burn
Buxton						Burn			
Almond	HW encroachment/nonnative grass			Mow	HW Control (herbicide)	Burn			Burn
Redstone	None			Mow		Burn	Burn		Burn
Eastline W	None			Mow			Burn		Burn
TA-1/Wheeler	New early successional habitat (4 acres) due to tree clearing mission requirements			Mow	HW Control (herbicide)		Burn		Burn
Hale Road	None			Mow/Spray		Plant			Burn
P2N	HW* encroachment	Bushhog	Bushog	Plow/Spray/Plant		Mow	Burn		Burn
Ta-1 Field	Monoculture grass habitat					Burn/Plant			Burn
Anderson RD Shortleaf	Monoculture grass habitat			Mow		Burn/Plant			Burn
Dodd Rd Shortleaf	Monoculture grass habitat			Mow		Burn/Plant			Burn

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Appendix I
Installation Landscaping

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Installation Landscaping

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US Army Garrison-Redstone Arsenal
Installation Landscaping Policy

29 November 2018

TO: All US Army Garrison-Redstone employees, directorates, divisions, offices, and customer organizations operating on Redstone Arsenal and supported by the Garrison

FROM: Environmental Management Division

SUBJECT: Installation Landscaping Policy

POLICY: All landscaping activities, to include construction and maintenance projects, taking place on Redstone Arsenal that require planting/removal or maintenance of any trees/shrubs or vegetative plant material, will be coordinated through the US Army Garrison (USAG) - Redstone, Directorate of Public Works, to the Natural Resources (NR) Branch of the Environmental Management Division (EMD) IMRE- PWE-N for final approval.

DISCUSSION:

a. Department of Defense Instruction (DoDI) 4715.3 requires that environmentally and economically beneficial landscaping practices shall be used on all DoD lands consistent with the 1994 Presidential Memorandum titled as such. Installations shall, to the extent practicable, conserve and protect water resources, use locally adapted native plants, avoid using invasive species, and minimize the use of pesticides and supplemental watering.

b. The NR Branch of the EMD has developed a native plant species list that will, to the extent practicable, be recognized and used when landscaping on the installation. Additionally, the branch has developed a “Do Not Plant List” of species deemed noxious or invasive by state and/or federal authorities. Such species shall NOT be utilized in landscaping on RSA. A minimum use of 75% native plants will, to the extent practicable, be required for planting activities. Acceptable and prohibitive plant lists shall be provided upon request during construction and operation missions at Redstone Arsenal; NR personnel will be available to provide technical assistance related to landscaping activities.

c. Pursuant to the development of sustainable landscaped installations on Redstone Arsenal, landscape design specifications shall incorporate a minimum 5 year planning criteria. Plant selection, placement, and spacing installations shall consider the full growth geometry of plant species. The long term sustainment and reduction of maintenance requirements shall be the priority of landscape system designs. The NR Branch reserves the right to reject or modify landscape designs based on this criteria.

d. This policy shall pertain to all organizations/tenants of Team Redstone. Any action that may involve landscaping or tree planting, including project planning and development for

construction or operations shall be reviewed by natural resource personnel via the Job Order Request system.

PURPOSE: This policy provides a point of contact for reviewing landscaping activities on the installation to ensure adherence to sound landscaping guidance, maintenance of enhanced facilities with cost effectiveness, and sustainable landscaping practices.

Redstone Arsenal

Do Not Plant List

Updated FY18

US Army Garrison - Redstone is committed to the protection of our natural environment and the promotion of sustainable landscaping utilizing native plants. This commitment is required to meet the standards set in numerous legislation including Executive Order (EO) 13112, EO 13148, EO 13514, 60 Federal Register (FR) 154 the Sikes Act, The Federal Noxious Weed Act, and Army Regulation (AR) 200-1.

EO 13112 *Invasive Species* (amended by EO 13751). Requires each Federal agency to the extent practicable and permitted by law to identify such actions and not authorize, fund, or carry out actions that it believes are likely to cause or promote the introduction, establishment, or spread of invasive species.

EO 13148 *Greening the Government through Leadership in Environmental Management.* Requires federal agencies to integrate accountability into day-to-day decision-making and long-term planning processes and strive to promote the sustainable management of Federal facility lands through the implementation of cost-effective, environmentally sound landscaping practices, and programs to reduce adverse impacts to the natural environment.

EO 13514 *Federal Leadership in Environmental, Energy and Economic Performance*. Requires federal leadership in environmental, energy, and economic performance, including protection of water resources through efficiency, implementing integrated pest management; and other appropriate landscape management practices.

60 FR 154 provides guiding principles and definitions to assist with planning sustainable landscaping practices on federally owned properties. Lists and defines 5 guiding principles that are meant to improve and expand upon current principles of landscape design, implementation and management.

Sikes Act. To promote effectual planning, development, maintenance, and coordination of wildlife, fish, and game conservation and rehabilitation in military reservations.

Federal Noxious Weed Act. Federal land-managing agencies required to establish integrated management systems to control or contain undesirable plants.

AR 200-1 *Environmental Protection and Enhancement*. Implements Federal environmental laws and DOD policies for preserving, protecting, conserving and restoring the quality of the environment. Requires mission activities to be conducted in a manner that precludes the introduction or spread of invasive species.

INVASIVE PLANTS AND NOXIOUS WEEDS THAT CANNOT BE USED IN RSA LANDSCAPING

List derived from Alabama Invasive Plant Council/South East Exotic Pest Plant Council

http://www.se-eppc.org/alabama/

Plants are ranked based on their invasive characteristics, see below for criteria used.

Common Name	Scientific Name	Invasive Rank	Suggested Native Alternatives
TREES			
Tree Of Heaven	*Ailanthus altissima*	1	Black Locust, Black Walnut, Sumac, Hoptree, White and Blue Ash
Silktree/Mimosa	*Albizia julibrissin*	1	Redbud, Fringetree, Indigo Bush, Flowering Dogwood, Washington Hawthorne
Camphor Tree	*Cinnamomum camphora*	2	Magnolia grandiflora, Ilex sp., Pinus sp.
Chinese parasoltree	*Firmiana simplex*		
Chinaberrytree	*Melia azedarach*	2	Devil's Walkingstick
Princess Tree	*Paulownia tomentosa*	2	Northern Catalpa, Red Buckeye, Sweetbay Magnolia, Rusty Blackhaw, Redbud, Flowering Dogwood
Trifoliate Orange	*Poncirus trifoliata*	2	Fragrant Sumac, Mockorange, Spicebush
Callery Pear "Bradford pear"	*Pyrus calleryana*	2	Allegheny and Downy Serviceberry, Hawthorne, Mexican and Chicksaw Plum, Rusty Blackhaw
Tallowtree	*Triadica sebifera*	1	Sourwood
Tungoil Tree	*Vernicia fordii*	2	Red Maple, Horsechestnut, River Birch, American Hornbeam
SHRUBS			
Coralberry, Hen's eyes	*Ardisia crenata*	WA	Shrub Yellowroot, Blueberry, White Spirea, Fragrant Sumac, Rosebay Rhododendron
Japanese Barberry	*Berberis thunbergii*	2	Ninebark, Witch Alder, Winterberry, Pasture and Virginia Rose, Small-leaf Arrowwood, Southern Bush Honeysuckle
Oriental Bittersweet	*Celastrus orbiculatus*	2	American Bittersweet, Strawberrybush
Thorny Olive	*Elaeagnus pungens*	2	Spicebush, Rusty Blackhaw, Yaupon, Highbush Blueberry
Autumn Olive	*Elaeagnus umbellata*	1	Spicebush, Sunburst and Shrubby St. John's Wort,
Burningbush	*Euonymus alatus*	1	Strawberry Bush, Virginia Sweetspire, Dwarf Witch Alder, Highbush Blueberry, Fragrant Sumac, Winged Sumac
Chinese holly	*Ilex cornuta*	WA	
Lantana	*Lantana camara*	2	
Shrubby Lespedeza	*Lespedeza bicolor*	2	White Wild Indigo, Wild Blue Indigo, Carolina Bushpea
Glossy Privet	*Ligustrum lucidum*	2	Mountian Laurel, Devilwood, Possumhaw Viburnum

Japanese Privet	*Ligustrum japonicum*	2	Mountian Laurel, Inkberry, Yaupon
Chinese Privet	*Ligustrum sinense*	1	Devilwood, Inkberry, Yaupon
European Privet	*Ligustrum vulgare*	2	Possumhaw Viburnum, Yaupon
Bell's Honeysuckle	*Lonicera bella*	2	Winterberry, American Beautyberry, Mapleleaf and Rusty Blackhaw Viburnum, Flame and Sweet Azaleas
Sweet breath of spring	*Lonicera fragrantissima*	2	
Morrow's Honeysuckle	*Lonicera morrowii*	WA	Spicebush, Fringe Tree, Trumpet Honeysuckle, Southern Bush Honeysuckle
Amur Honeysuckle	*Lonicera maackii*	1	Witch Hazel
Beale's Barberry	*Mahonia bealei*	2	Possumhaw Viburnum, Silky Dogwood, Strawberry Bush, American Beautyberry, American Holly,
Nandina/Sacred Bamboo	*Nandina domestica*	2	Golden & Shrubby St. John’s-wort, Yellowroot, Leucothoe
Macartney Rose	*Rosa bracteata*	2	Pasture Rose, Virginia Rose
Cherokee Rose	*Rosa laevigata*	WA	Pasture Rose, Virginia Rose
Multiflora Rose	*Rosa multiflora*	1	Pasture Rose, Virginia Rose
Wetland Nightshade	*Solanum tampicense*	WB	Lyre-leaf Sage, Cutleaf Coneflower, Phlox sp.
Tropical Soda Apple	*Solanum viarum*	1	Bottlebrush Buckeye, Red Buckeye, Pepperbush, Beaked Hazelnut

VINES

Porcelain Berry	*Ampelopsis brevipedunculata*	WA	Passionflower, Virginia Creeper, Vitis, Pepper Vine
Bushkiller	*Cayratia japonica*	WA	Pepper Vine, Supplejack, Virginia Creeper, Climbing Rose
Oriental Bittersweet	*Celastrus orbiculatus*	2	American Bittersweet, Strawberrybush
Sweet Autumn, Virginsbower	*Clematis terniflora*	2	Leatherflower, Virgin's Bower
Water Yam	*Dioscorea alata*	WA	Pickerel Weed, Green Corn Lily, Common Large Skullcap, Broadleaf Arrowhead
Air Yam	*Dioscorea bulbifera*	WA	Pepper Vine, Supplejack, Virginia Creeper, Climbing Rose
Chinese Yam	*Dioscorea oppositifolia*	1	Pepper Vine, Supplejack, Virginia Creeper, Climbing Rose
Wintercreeper	*Euonymus fortunei*	2	Crossvine, Pussytoes, Lyre-leaf Sage, Christmas Fern
English Ivy	*Hedera helix*	1	Supplejack, Crossvine, Partridgeberry, Wintergreen, Pachysandra
Japanese Honeysuckle	*Lonicera japonica*	1	Spicebush, Fringe Tree, Trumpet Honeysuckle, Carolina Jasmine,
Japanese Climbing fern	*Lygodium japonicum*	1	Pepper Vine, Supplejack, Virginia Creeper, Climbing Rose
Kudzu	*Pueraria montana*	1	Pepper Vine, Supplejack, Virginia Creeper, Climbing Rose
Common Periwinkle	*Vinca minor*	WB	Phlox, Partridgeberry, Crested Wood Fern
Chinese Wisteria	*Wisteria sinensis*	1	American Wisteria

GRASSES, GRASS-LIKES, AND CANES			
Giant Reed	*Arundo donax*	2	River Cane, Big Bluestem, Indian Grass
Cogongrass	*Imperata cylindrica*	1	Switchgrass, Sideoats Grama
Japanese Stiltgrass, Nepalese browntop	*Microstegium vimineum*	1	Pink Muhly Grass, Pennsylvania and Texas Sedge
Chinese silvergrass, silverplume grass	*Miscanthus sinensis*	WB	Little Bluestem, Indian Grass, Switchgrass, Splitbeard Bluestem, Pink Muhly Grass
Torpedo Grass	*Panicum repens*	1	Little Bluestem, Indian Grass, Switchgrass, Splitbeard Bluestem, Pink Muhly Grass
Golden Bamboo	*Phyllostachys aurea*	1	Little Bluestem, Indian Grass, Switchgrass, Splitbeard Bluestem, Pink Muhly Grass
Japanese Knotweed	*Polygonum cuspidatum*	WA	Culver's Root, Pepperbush, Virginia Sweetspire
Johnsongrass	*Sorghum halepense*	1	Little Bluestem, Indian Grass, Switchgrass, Splitbeard Bluestem, Pink Muhly Grass
FORBS (Broadleaf Plants)			
Japanese chaff flower	*Achyranthes japonica*	WA	
Garlic Mustard	*Alliaria petiolata*	WA	Doll's-eye Baneberry, Asclepias sp., Bastard Toadflax, Prairie Verbena
Common Wormwood	*Artemisia vulgaris*	2	Asclepias sp., Hypericum sp., Pycnanthemum sp.
Musk thistle, nodding plumeless thistle	*Carduus nutans*	1	Eupatorium sp., Helenium sp., Helianthus sp.
Canada Thistle	*Cirsium arvense*	2	Eupatorium sp., Helenium sp., Helianthus sp.
Bull Thistle	*Cirsium vulgare*	WA	Eupatorium sp., Helenium sp., Helianthus sp.
Elephant Ears, wild taro	*Colocasia esculenta*	2	Running Serviceberry, New Jersey Tea, Bundleflower, Dwarf Huckleberry
Tropical Spiderwort	*Commelina benghalensis*	2	Virginia Spiderwort
Hairy crabweed, mulberry weed	*Fatoua villosa*	2	Pennsylvania and Texas Sedge, Pink Muhly Grass
Chinese Lespedeza	*Lespedeza cuneata*	2	White Wild Indigo, Wild Blue Indigo, Carolina Bushpea
Purple Loosestrife	*Lythrum salicaria*	2	Liatris sp., Cardinal Flower, Blue Mistflower, Asclepias sp.
Asiatic Dewflower	*Murdannia keisak*	2	Pickerel Weed, Green Corn Lily, Common Large Skullcap, Broadleaf Arrowhead
Chamber Bitter	*Phyllanthus urinaria*	1	Cinnamon Fern, Spleenwort, Crested Wood Fern
Rue-leaved saxifrage	*Saxifraga tridactylites*	WA	
Sicklepod	*Senna obtusifolia*	1	
Blessed Milkthistle	*Silybum marianum*	2	Eupatorium sp., Helenium sp., Helianthus sp.

AQUATIC and WETLAND PLANTS			
Alligatorweed	*Alternanthera philoxeroides*	1	Pickerel Weed, Green Corn Lily, Common Large Skullcap, Broadleaf Arrowhead
Water Hyacinth	*Eichhornia crassipes*	1	Pickerel Weed
Hydrilla, waterthyme	*Hydrilla verticillata*	1	
parrot feather watermilfoil	*Myriophyllum aquaticum*	1	
Eurasian watermilfoil, spike watermilfoil	*Myriophyllum spicatum*	1	
Cuban Bulrush	*Oxycaryum cubense*	1	Pink Muhly Grass, Pennsylvania and Texas Sedge, Scouring Rush Horsetail
Common Reed	*Phragmites australis*	1	Little Bluestem, Indian Grass, Switchgrass, Splitbeard Bluestem, River Cane
Water Lettuce	*Pistia stratiotes*	1	Pickerel Weed, Green Corn Lily, Common Large Skullcap, Broadleaf Arrowhead
Giant salvinia, kariba-weed	*Salvinia molesta*	1	

Criteria for Evaluating Plant Species for Invasiveness in Alabama found in

Urban and Interface, Aquatic-Wetland/Riparian, Natural Areas/Parks, Rights-of-Way, Pastures/Orchards
Rowcrops/Nurseries, Managed Forests, Wildlife Habitat/Food Plots

Category 1:

1) The plant species or sub-species or variety is non-native to Alabama.

not desired.

3) The plant is able or known to be able to out-compete other species in plant communities or cropping systems thereby impacting native plant biodiversity, ecosystem functions, or crop productivity.

4) The plant persists in free living infestations (without cultivation) within Alabama.

5) The plant is widespread and occurs in two or more invasive regions, which are

a. Plateaus and Piedmont

b. Mountains

c. Middle Coastal Plain

d. Black Belt

e. Lower Coastal Plain

6) It occurs in dense stands of numerous individuals in frequent infestations.

Category 2:

7) The plant meets criteria 1-4.

8) The plant occurs within one or more cultural uses and one or two invasive regions

9) It occurs as scattered individuals or widely scattered dense infestations.

Watch list A:

10) The plant meets criteria 1-3.

11) The plant has recently appeared as free living populations within Alabama or the plant is invasive in nearby states but its status in Alabama is unknown or unclear, and it has the potential, based on its biology and its colonization history in the Southeast and elsewhere, to become invasive in Alabama.

Watch list B:

12) The plant meets criteria 1-3.

13) The plant is grown in Alabama.

14) The plant has a documented history of invasiveness in other areas of the Southeast and/or is listed by the Global Invasive Species Program as a world-class invasive plant for habitats similar to those in the Southeast.

Appendix J
Erosion Control Plan

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Soil Erosion and Sediment Control Plan

For

U.S. Army Garrison

Redstone Arsenal, Alabama

Table of Contents

Executive Summary

Redstone Arsenal (RSA) consists of approximately 38,100 acres located in north central Alabama. The U.S. Army Garrison-Redstone is the host activity headquartered at Redstone Arsenal. The command maintains over 14 million square feet of administrative and Research Development Test and Evaluation (RDT&E) building space, 200 lane miles of roads, eight major test ranges, an airfield, a railhead with two spurs, two barge docks, and six access control points on the installation. Activities at RSA include research, development, engineering, testing, procurement, production and logistics support of operational missile and rocket systems. In addition, the Garrison supports more than 70 major tenant organizations.

The Soil Erosion and Sediment Control Plan for RSA describes and classifies soils on RSA, describes RSA policy relative to soil erosion and water quality, lists RSA permits needed prior to land disturbing activities, describes installation methods/requirements for revegetation/erosion control at RSA, and provides administrative resources and contact information for erosion control. This program utilizes installation environmental compliance managers, installation land managers, and a grounds maintenance crew operating under contract. Without control, erosion poses a severe hazard to the installation environment and could interfere with the military mission.

This plan is supplemental to the Natural Resource Management Plan (INRMP) for U.S. Army Garrison, Redstone Arsenal, Alabama.

Introduction

I. Program Objective

This plan provides guidance for operating and maintaining an effective soil erosion and sediment control (SESC) program. The purpose of the SESC Plan is to address the Army Soils Policy of keeping soil erosion from water within tolerance limits as defined in soil surveys prepared by the U.S. Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS), keeping soil sediment pollutants in wetlands and waterways within compliance limits, and rehabilitating land disturbed by operations and real property management activities. The Army Soils Policy is found in AR200-1, para 4-3d(1)(s) and 3d(3). The primary goals of this plan are to describe and classify soils on RSA, describe RSA policy relative to soil erosion and water quality, list RSA permits needed prior to land disturbing activities, describe installation methods/requirements for revegetation/erosion control at RSA, and provide administrative resources/contact information for erosion control. Adherence to the plan will ensure effective, economical, and environmentally acceptable erosion control practices to maintain compliance with pertinent laws and regulations.

a. Installation Description

Redstone Arsenal is located in Madison County in north central Alabama. The Arsenal is approximately 10 miles long and 6 miles wide, with a total area of approximately 38,100 acres. It is bounded on the east, north and west by the City of Huntsville and on the south by the Tennessee River. In 2010, Huntsville was estimated to have a population of approximately 180,000 and is the fourth largest city in Alabama. Within one hundred miles of the Arsenal are Nashville, TN, Birmingham, AL, and Chattanooga, TN.

Approximately 2,900 acres owned by TVA and 4,100 acres of Wheeler National Wildlife Refuge are in the southern half of the Arsenal. Of this acreage, approximately 1,250 acres are under water at all times. Management of the refuge is directed chiefly to provide a wintering ground for migrant waterfowl and provide protection to thousands of other birds.

b. Land Use and Layout of Facilities

The majority of installation activities and most base improvements are facilities located in the northern and central portions of RSA. The land use regions on RSA are: administrative areas, housing and community support facilities, airfield, test areas, training facilities, production facilities, operational maintenance, research and development, storage, and recreational areas. These are described in detail in the INRMP. Areas other than those listed are relatively undeveloped except by undeveloped roads and trails passable by four-wheeled drive vehicles. These open spaces include Ward, Weeden and Madkin mountains.

c. Inventory of Land Use

There are three categories of grounds on RSA. These are: improved, requiring intensive maintenance; semi-improved, requiring periodic maintenance; and unimproved. There are commercial forest stands on RSA. Land management can be summarized as follows: forest management – 15,656 acres, agricultural outleasing – 1,015 acres, apiary outleasing – 1 acre, grounds maintenance – 3,605 acres and fish and wildlife management – 26,439 acres. A full description of the lands in the grounds categories is in the INRMP for Redstone Arsenal.

d. Erosion Defined

Soil erosion is the process by which the land surface is worn away by the action of wind, water, and gravity. Erosion can be a natural process such as the wind and water giving the earth's surface its natural shape or erosion can be accelerated by the actions of people. Soil erosion is a three-step process involving soil particle detachment, transportation, and deposition. Soil detachment happens when energy either by wind, water, or physical/mechanical processes is applied to soil particles. After a soil particle is detached it is then easily transported by either wind or water. In the case of water driven erosion, transportation happens when the particle is suspended in the water column and moved down gradient. Deposition occurs when the energy used to move the soil particle drops sufficiently to allow it to settle into a stream bed, on a floodplain, or at the base of a slope. The easiest way prevent erosion is soil particle detachment (Web).

e. Watershed Soil Functions

Soils are a key link between upland and lowland portions of watersheds. From a watershed management perspective soils have at least four functions.

1. Regulate watershed hydrology: Soils regulate the balance between infiltration and runoff. All water that falls on the watershed either runs off the landscape or soaks into the soil. As water soaks into the soil it recharges aquifers where it then slowly recharges surface springs, lakes, and streams. If water does not infiltrate and move through the soil slowly it can cause surface erosion as runoff depending on vegetation and topography.
2. Regulate nutrients in the environment: Soils are the primary source for plant nutrients. The organic matter in soils is a major source of nitrogen, phosphorous, sulfur, and other micronutrients. Soil organisms help break down this organic matter into nutrient forms available to plants.
3. Regulate water quality: Soils improve water quality by filtering out significant quantities of nonpoint source pollution before they are carried into groundwater or discharged into streams as runoff.
4. Provide habitat for life: Soil is home to plant roots, burrowing animals and millions of organism such as fungi, bacteria, algae, protozoa, insects, spiders, worms, etc. These organisms are important components in the ecosystems that maintain healthy watersheds (Web).

A map of watersheds on RSA can be seen in Attachment A. The map is a model which shows watersheds derived from different pour points on major creeks, branches, and channels located on RSA. Pour points are outlets on the surface at which water flows out of an area.

II. Soils Description and Classification

According to the 2002 US Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Soil Survey of Redstone Arsenal, a total of 43 map units representing 19 different soil series are mapped within the Installation's grounds. These map units and soil series can be seen on the detailed NRCS soil maps in Attachment B as well as on Table 1 with acreages associated at RSA. The predominant soil type at Redstone Arsenal consists of a deep, well-drained to moderately well-drained, silt loam to silty clay loam. These soils typically possess a loamy surface horizon underlain by a loamy to clayey subsoil layer with lenses of silty and/or sandy clay. Rock fragments generally occur throughout the clayey material. The soil colors range from a brownish-red in the northern portion to a brownish-gray in the southern portion of Redstone Arsenal. Darker gray soils are found in areas of topographic lows. Soil depths range from very shallow on the mountains to much deeper along the larger tributaries of the Tennessee River, where broad floodplain areas have been formed by the river and its tributaries (US Army Missile Command 1994).

The locations of different RSA soil map units can be seen in Attachment B with acreages, percentages of total RSA land area, and soil names listed on Table 1. The table below also includes NRCS soil erosion ratings and erosion factor T for each soil map unit. Ratings in the hazard of off-road or off-trail erosion column on the table below are based on the slope and on soil erodibility factor K. The soil erodibility factor K indicates the susceptibility of a soil to sheet and rill erosion by water. The soil loss is caused by sheet or rill erosion in off-road or off-trail areas where 50 to 75 percent of the surface has been exposed by logging, grazing, mining, or other kinds of disturbance. The hazard is described as slight, moderate, severe, or very severe. A rating of slight indicates that erosion is unlikely under ordinary climatic conditions; moderate indicates that some erosion is likely and that erosion-control measures may be needed; severe indicates erosion is very likely and that erosion-control measures including revegetation of bare areas is advised; and very severe indicates erosion is expected, loss of soil productivity and off site damage is likely, and erosion-control measures are costly and generally impractical (Soil Survey.) As can be seen on the table the majority of off road or off trail erosion hazards are in the slight category with only four different soil series being in the moderate category. An erosion hazard off-road or off trail map with soil rating polygons is shown in Attachment C.

Erosion factor T is also included on the table below. Erosion Factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop production over a sustained period. T factors are integer values from 1 through 5 tons per acre per year (Soil Survey). The factor of 1 ton per acre per year is for shallow or otherwise fragile soils and 5 tons per acre per year is for deep

soils that are least subject to damage by erosion. A map including RSA T factors can be seen in Attachment D. Areas in red on the map with low T factors correspond to elevated areas on RSA such as Weeden-Madkin Mountains, Lehman's Bluff, and Bell Bluff. These low T factor areas are not prime farmland areas as defined by the NRCS due to the slope of these areas. The majority of other non-sloping areas on RSA have a T factor of either 4 or 5 as can be seen on the table below and the T factor map.

Table 1: RSA Soils and Erosion Potential

Map symbol and soil name	Acres	Percent of Total RSA Land Area	Hazard of off-road or off-trail erosion	Erosion factor (T)
ChA: Chennby	680	1.8	Slight Slope/ erodibility	5
CoB2: Colbert	349	0.9	Slight Slope/ erodibility	3
CoC2: Colbert	258	0.7	Slight Slope/ erodibility	3
CsD: Colbert	215	0.6	Moderate Slope/ erodibility	3
DeA: Decatur	35	< 0.1	Slight Slope/ erodibility	5
DeB2: Decatur	2,454	6.4	Slight Slope/ erodibility	5
DeB3: Decatur	301	0.8	Slight Slope/ erodibility	5
DeC2: Decatur	80	0.2	Slight Slope/ erodibility	5

DeC3: Decatur	920	2.4	Slight Slope/ erodibility	5
EgA: Egam	471	1.2	Slight Slope/ erodibility	5
EmA: Emory	2,127	5.6	Slight Slope/ erodibility	5
EtA: Etowah	278	0.7	Slight Slope/ erodibility	5
EtB2: Etowah	1,118	2.9	Slight Slope/ erodibility	5
EwB2: Etowah	519	1.4	Slight Slope/ erodibility	5
F1B2: Fullerton	37	< 0.1	Slight Slope/ erodibility	5
FlC2: Fullerton	255	0.7	Slight Slope/ erodibility	5
F1D2: Fullerton	26	< 0.1	Moderate Slope/ erodibility	5
HaB2: Hartsells	117	0.3	Slight Slope/ erodibility	2
HeE: Hector Rock Outcrop	258	0.7	Severe Slope/ erodibility Not Rated	1 Not Rated

HoA: Hollywood	50	0.1	Slight Slope/ erodibility	3
KeA: Ketona	2,234	5.8	Slight Slope/ erodibility	3
KrA: Ketona	311	0.8	Slight Slope/ erodibility	3
KrA: Chenneby			Slight Slope/ erodibility	5
KtA: Ketona	5,879	15.4	Slight Slope/ erodibility	3
KtA: Chenneby			Slight Slope/ erodibility	5
LcA: Locust	341	0.9	Slight Slope/ erodibility	4
LcB2: Locust	438	1.1	Slight Slope/ erodibility	4
LoA: Locust	1,586	4.1	Slight Slope/ erodibility	4
LoB2: Locust	201	0..5	Slight Slope/ erodibility	4
MnB2: Minvale	92	0.2	Slight Slope/ erodibility	5

MnC2: Minvale	481	1.3	Slight Slope/ erodibility	5
MnD2: Minvale	92	0.2	Moderate Slope/ erodibility	5
PeD3: Paleudults Guillies	252	0.7	Slight Slope/ erodibility Not Rated	5 Not Rated
Pt: Pits Dumps	49	0.1	Not Rated Not Rated	Not Rated Not Rated
PuD: Paledults Udarents	1,963	5.1	Slight Slope/ erodibility Not Rated	5 Not Rated
RgE: Rock Outcrop Gladdice	1,895	5.0	Not Rated Moderate Slope/ erodibility	Not Rated 2
SeA: Staser	159	0.4	Slight Slope/ erodibility	5
SoA: Swafford	1,097	2.9	Slight Slope/ erodibility	4
TuA: Tupelo Ketona	1,071	2.8	Slight Slope/ erodibility Slight Slope/ erodibility	5 3

Udb: Urban land Decatur Emory	4,962	13.0	 Not Rated Slight Slope/ erodibility Slight Slope/ erodibility	 Not Rated 5 5
W: Water	762	2.0	Not Rated	Not Rated
WaB2: Waynes-boro	2,395	6.3	Slight Slope/ erodibility	5
WaC2: Waynes-boro	541	1.4	Slight Slope/ erodibility	5
WaC3: Waynes-boro	462	1.2	Slight Slope/ erodibility	5
WoA: Wolfever	354	0.9	Slight Slope/ erodibility	5

III. RSA Permits, Plans, and Policy Relative to Soil Erosion and Water Quality

The RSA operates under a National Pollutant Discharge Elimination System (NPDES) individual storm water permit for its stormwater/industrial wastewater discharges. The permit was issued by the Alabama Department of Environmental Management (ADEM) in March of 2014. The permit covers 54 Discharge Monitoring Sites that are monitored on a monthly, quarterly, semi-annual, and annual basis. The intent of the permit is to prevent or minimize the potential for the release of pollutants to waters of the state from material storage areas, process and material handling areas, and fueling stations. The permit is issued through the Water Division at the Alabama Department of Environmental Management in accordance with the Clean Water Act.

In addition, RSA is responsible for maintaining a Best Management Practices (BMP) Plan for the installation in accordance with Part IV.A of the RSA NPDES individual storm water permit. The BMP's in the plan are employed to prevent storm water from coming into contact with potential pollutant sources. The plan includes sediment and erosion control practices as baseline practices applicable to prevent or minimize the potential for the release of pollutants into waters of the State from material storage areas, process and material handling areas, and fueling stations. The plan also requires monthly inspections for specific facilities listed in the plan.

RSA also operates under the ADEM Water Division NPDES Phase II General Permit. The permit was issued January 2011 and authorizes discharges of storm water from small municipal separate storm sewer systems (MS4s) as defined in 40 CFR Part 122.26(b)(16). The general permit requires RSA to submit and comply with a Municipal Storm Water Management Plan for municipal discharges from regulated MS4s.

The purpose of the RSA Municipal Storm Water Management Plan is to reduce the discharge of pollutants from MS4s to the maximum extent practicable, protect water quality, and to satisfy the appropriate requirements of the Clean Water Act in accordance with the ADEM Water Division NPDES Phase II General Permit. The management plan identifies construction site municipal runoff control and post-construction management in new development and redevelopment as minimum control measures that are expected to result in significant reductions in pollutants discharged from RSA MS4's.

The RSA Municipal Storm Water Management Plan requires:

- the Storm Water Program Manager in the Environmental Management Division (EMD) to be notified of new projects before construction starts using the "National Environmental Policy Act (NEPA) Project Tracking Database". The NEPA database provides basic engineering information for review of construction projects.

- all construction projects disturbing one or more acres on RSA to have coverage under the Alabama Department of Environmental Management (ADEM) Construction General Permit

- the contractor completing the work under the Garrison Department of Public Works to officially notify the ADEM of the project by submitting a Notice of Intent for coverage under the Construction General Permit, along with the necessary fees required by the ADEM to review the plan.

- all construction sites to install erosion and sediment controls prior to land disturbing activities, performing required inspections and/or monitoring, and preparing and implementing a Construction Best Management Plan required by the General Permit.

- regular inspections to be performed in accordance with ADEM Admin. Code. R. 335-6-12, regular inspections will be performed by a Qualified Credentialed Inspector (QCI) trained through the Qualified Credentialed Inspection Program (QCIP)

-selected post-construction sites to be inspected to ensure post-construction best management plans are adequate

IV. State and Local Permits Needed at RSA Prior to Land Disturbing Activities

ADEM Construction General Permit – Required for all construction projects disturbing one or more acres on RSA. A construction BMP plan must be developed and implemented that outlines the Best Management Practices and procedures that will be used to effectively prevent pollutants from leaving the project site and entering in the municipal run-off.

Clean Water Act Section 404 Permit– Required for construction projects on RSA that will result in the discharge of dredged material (i.e., materials excavated from waters) or fill material (i.e. materials placed in waters such that dry land replaces water-or a portion thereof-or the water's bottom elevation changes) into a water of the United States.

RSA Dig Permit – The RSA Garrison Directorate of Public Works requires that a digging permit be obtained for all digging operations that take place on RSA property. The proponent for digging is to call 256-876-2801 to request a permit before digging commences. The procedures for obtaining a dig permit can be found in Garrison Policy No. 420-2.

V. Revegetation and Erosion Control Methods/Requirements

This chapter contains the requirements for revegetation/erosion control and associated activities on Redstone Arsenal. Final revegetation shall result in at least 90% ground cover. If an ADEM Construction General Permit has been obtained for a construction site the permit can only be termination when final stabilization has been achieved on all portions of the site.

Appropriate revegetation and erosion control methods consists of proper site preparation. Adequate site preparation is essential to successful establishment of vegetation on a site. Proper site preparation provides an environment within the physiological tolerance of the plants, thereby allowing successful plant establishment. To best prevent erosion, plan the area to be disturbed to fit the site topography. Proper site preparation should consist of installing erosion controls prior to disturbing the land.

Site preparation includes both physical and chemical treatments. Site preparation should cause minimal disturbance to existing desirable and undesirable vegetation at the site to best prevent erosion.

Revegetation and erosion control projects shall be done as described in accordance with this section and the Alabama Handbook for Erosion Control, Sediment Control, and

Stormwater Management on Construction Sites and Urban Areas. Erosion projects involving channels of 500 feet of greater total linear footage shall be coordinated with the Environmental Management Division to determine whether a permit is required.

a. Revegetation

1. Heavily compacted soils shall be ripped.

Soil compaction often results from use of heavy machinery on a site. As a result, ripping is necessary for severely compacted soils. Deep ripping shatters soils compacted during construction activities. Shallow ripping breaks up impervious soil layers below the normal tillage depth and improves water infiltration, drainage and root penetration.

Ripping only needs to be done where soils have been compacted, such as on new construction sites. The following ripping guidelines should be followed.

- Ripping should always be done on the contour.
- Soils should be relatively dry prior to ripping so that the seams do not reseal.
- The ripper tines should be adjusted so that the distance between the tines is adequate to accomplish the task.

2. Shaping/grading shall be done to allow natural swales and drainage away from buildings. Slopes shall not be greater than 3:1 (horizontal:vertical). Natural Resources personnel shall be notified of slopes greater than 3:1 and their approval received for revegetation of slopes.

Shaping/grading should be done to reduce slope steepness, smooth roughed areas, blend the area with surrounding terrain, and provide natural swales to receive and convey drainage gradually. Steep and/or irregular slopes should be avoided. Addition of topsoil may be necessary in some cases to better shape and contour the site, especially if a large quantity of original soil has eroded away. Distribution of topsoil should follow the contour. Grades should be contoured and shaped to minimize disruption of natural drainage patterns and minimize slope and steepness. Whenever possible, slopes should be graded so they do not exceed 3:1. Shaping/grading should be done immediately prior to seedbed preparation.

Techniques for improving steep, long, and/or rough slopes include the following:

- Slope rounding – This is the preferred method for slopes on the installation that cannot be graded to 33% slope or less. If possible, contour furrowing should be done. With slope rounding, a dozer blades the top and bottom of the slope and deep-rigs the slope surface, resulting in a rounded top and toe of slope which increases slope stability. This technique is most efficient if done from top to bottom of slope and/or along contour.
- Bench grading – A broad stair step effect is created between the sloping portion of a cut or fill. Bench grading should be used on 25-33% slopes that are 300 feet or longer and for 50% slopes or steeper where access to the area for future activities may be necessary.

- Stair step grading – This technique should be used for steep slopes that cannot be rounded and where high runoff and erosion potential exists. With stair step grading, micro terrace systems are made by cutting 24 to 35 inches deep in soft materials and not more than 39 inches in rocky materials. Use of this method should be limited as sloughing may occur with water infiltration.
- Contour furrowing – This method of grading utilizes an implement towed behind tractor disks to make furrows parallel to the ground. This grading method is limited to steep slopes on which tractors can safely operate. Contour furrowing should be done in conjunction with slope rounding when possible.

3. Initial tilling shall be done to a depth of 6-8 inches and oriented to the contour of the site.

The graded surface must be tilled after grading/shaping to improve soil structure. Initial tilling (either disking or harrowing) breaks up surface clods, turns under stubble and relieves surface compaction. Initial tilling should be done to a depth of 6-8 inches and oriented to the contour of the site.

Disk tilling is useful on sites having an established cover of vegetation. Both disk tilling and chisel plowing are effective on compacted sites. Disk harrowing is effective where soils have not been compacted.

4. Amendments shall be added after initial tilling to correct deficiencies indicated by soil testing. Where there are no deficiencies, a general 16-16-16 fertilizer shall be used. Soil pH shall be adjusted as necessary to range between 6.6 and 6.8.

Soil deficiencies are frequently the limiting factor in successful vegetation establishment. Soils should be tested to determine deficiencies of nitrogen, phosphorus, potash (potassium), calcium, magnesium, sulfur, iron, boron, copper or zinc. A general fertilizer 16-16-16 should be used where there are no deficiencies.

Soil pH should also be tested since it can limit nutrient availability. If soil pH does not range between 6.6 - 6.8, amendments are necessary. Lime should be added to correct acid soils; the amount of lime required will vary with the type of lime used. Calcium sulfate (gypsum) should be added to alkaline soils.

Amendments should be applied with either a tractor or truck drawn spreader on large areas. Hand held broadcast spreaders should be used on small areas.

5. Secondary tilling shall be done to a depth of 3 - 6 inches to incorporate soil amendments.

Secondary tillage is necessary to incorporate amendments into the soil and to work the soil to a shallow depth. Secondary tillage also further pulverizes any clods and firms the seedbed. Secondary tillage should be done to a depth of 3 - 6 inches. Methods of secondary tilling are disk harrowing, roller harrowing and packing, and tooth-type

harrowing. Roller harrowing and packing is the preferred method to be used at Redstone arsenal as it is effective for preparing a seedbed for range debris.

6. Areas with slopes less than or equal to 3:1 shall be seeded to grass. Areas approved by Natural Resource personnel may be seeded to wildflowers. After seeding, seed must be covered and firmed into the soil. Slopes of 3:1 or greater shall be sodded or hydroseeded. Species used shall be as described below.

Planting times may vary with climate, type of planting, moisture needs of the species planted, frost heave, anticipated erosion problems during plant establishment and soil dryness necessary to allow equipment access to the site. Fall and spring are the best planting times at Redstone, with fall being the preferred time. Spring planting can be delayed due to wet soils. Summer plantings should be limited to special cases and well necessitate watering.

There are 3 basic methods of planting to establish vegetation on a site: seeding, sodding, and hand planting seedlings.

i. <u>Planting Methods</u>

Seeding should be the predominant planting method at Redstone. Proper seedbed preparation as described above is critical to vegetation establishment from seed. Three seeding methods apply to Redstone - broadcast seeding, drill seeding, and hydro seeding. For broadcast and drill seeding, seed must be covered and firmed into the soil. Hydro seeding must be followed by hydro mulching.

<u>Broadcast Seeding</u>

Broadcast seeding should only be done on Redstone for small areas (5-10 acres) or areas on which a culti-packer cannot be used. Although broadcast seeding is often preferred on large areas it is not successful unless followed by scarification and firming to cover the seed and eliminate air pockets in the soil.

With broadcast seeding, seed is spread manually or blown onto the soil surface. Seed is held in a hopper and can be applied by tractor, truck or hand. Aerial application is not permissible on Redstone. Fillers such as cotton seed hulls should be mixed with the seed for lower seeding rates or even distribution of small sized seed.

<u>Drill Seeding</u>

Drill seeding is the superior seeding method and should be used at Redstone wherever conditions permit. Drill seeding utilizes a seedbox with spout attachments through which seed fall onto the soil. Not only does drill seeding require less seed than broadcasting, but also can be adjusted to place seed at specific depths to promote successful germination.

The preferred equipment to be used at Redstone for drill seeding is the seeder culti-packer. This seeder has a seedbox mounted between two culti-packers, or rollers.

The front roller breaks up clods and creates furrows into which the seed fall. The rear roller covers the seed, compacts the soil around them and creates furrows which direct moisture to the seed. The culti-packer is capable of planting in rough terrain as long as it can be safely operated.

Hydro seeding

Hydro seeding is to be used on steep slopes which do not allow other seeding operations. Hydro seeding employs a water tank with a pump and discharge nozzle. A mix of seed in a slurry is agitated and sprayed on a site at a range of 20 - 200 feet.

Hydro seeding can be done in conjunction with fertilizing, but must be followed by hydro mulching to insure seed germination. Seed should never be applied with the mulch as they are not likely to make necessary soil contact.

Sodding

Sodding is to be done at Redstone where immediate erosion control or aesthetic concerns are high priorities. Turf strips should be 1 inch thick or thicker, depending on species. Sod used must be free of weeds, annual plants, and fire ants.

Sod must be laid soon after preparation. Because sod storage time is limited, sod should be delivered as close to the time of sodding as possible. In addition, debris such as rocks and sticks must be removed from the site.

Sod strips should be placed so the ends are adjacent without gaps. Any gaps that do occur must be filled with soil or sod pieces. After placement, sod should be tamped to eliminate air spaces.

On steep slopes (greater than 49%) or in drainage channels sod should be staked on 2 - 3 foot centers to prevent slippage. Erosion control netting may also be used for sod anchoring. After placement sod must be watered to insure growth. Watering frequency will depend on existing precipitation patterns.

Hand Planting Seedlings

Hand planting seedlings should be used to promote vegetative cover on extremely harsh sites where establishment by seed would be difficult and/or a fast developing ground cover is necessary. Sites requiring this method of vegetation establishment for erosion control have not been identified on Redstone at this time.

When and if needed, hand planting on the installation should utilize containerized stock. An adequate size hole must be dug to accommodate the root plug. After planting, the soil must be firmed around the seedling to eliminate any air spaces. Hand planting is more costly than seeding but has a high probability of success. Time of planting is very limited by climate to insure seedling survival.

Trees/Shrubs

Trees shall be planted in holes twice the width of the root ball and one and a half times as deep. Shrubs shall be planted in holes that are a total of 12 inches wider and 6 inches deeper than the size of the container.

ii. Species Selection

Seeding

Seed species should be the same as current species in the area for small erosion areas. For larger areas the following applies: large sunny areas should be seeded to Bermuda; large shady areas should be seeded to fescue. **Seeding rates are 15 lb/ac for Bermuda, 35 lb/ac for fescue**. Eroded areas on golf course fairways, greens and roughs must be reseeded in accordance with golf course requirements and as recommended by the golf course manager.

Wildflower Seeding

Wildflowers are to be seeded in areas designated by the Installation Ecologist and the Installation Land Manager. Wildflowers are used to vegetate land, decrease mowing needs to a maximum of once a year, and beautify areas. Wildflower seed mix shall be approved by the Installation Ecologist. **An example wildflower species mix is listed in Table 2**. The wildflower mix should be planted at a rate of 20 pounds/acre. Roundup must first be applied to areas with existing vegetation 3 - 4 weeks prior to planting. Wildflower seeding should be done with a seeder culti-packer on areas with slopes of less than 3:1. Broadcast seeding may be done in small areas less than an acre in size. Hydro seeding wildflowers may be done on steep slopes such as overpass embankments.

Table 2: Wildflower Seed Mix

% by Weight	Scientific Name	Common Name
0.2	Achillea millefolium	white yarrow
0.81	Aquilegia canadensis	eastern columbine
9.77	Centaurea cyanus	dwarf cornflower
0.81	Cerastium biebersternii	snow-in summer
1.07	Chrysanthemum leucanthemum	ox-eye daisy
3.26	Cichorium intybus	chicory
6.51	Coreopsis lanceolata	dwarf lance-leaved coreopsis
0.81	Coreopsis tinctoria	dwarf plains coreopsis

9.77	Delphinium ajacis	rocket larkspur
6.51	Echinacea purpurea	purple coneflower
13.02	Eschscholzia californica	California poppy
6.51	Gaillardia pulchella	annual gaillardia
1.63	Ipomopsis rubra	gilia
3.26	Liatris spicata	gayfeather
9.77	Linm perenne lewisii	blue flax
1.63	Lotus corniculatus	bird's-foot trefoil
9.77	Lupinus perennis	perennial lupine
1.07	Monarda citriodora	lemon mint
0.81	Myosotis sylvatica	forget-me-not
0.54	Oenothera speciosa	showy evening primrose
1.07	Rudbeckia hirta	black-eyed Susan
6.51	Salvia coccinea	scarlet sage
3.26	Silene pendula	nodding catchfly
1.63	Viola cornuta	Johnny jump-up

*Available from Applewood Seed Co., Arcada, CO.

Sodding

Bermuda sod shall be used on the installation.

Hand Planting

Species for hand planting shall be determined on a case by case basis. There are no projects requiring hand planting at the present time.

7. Seeded areas shall be mulched on the contour with hay or straw. Crimping of mulch is preferred. Hydroseeded areas shall be hydromulched. Erosion nets/mats shall be used where slopes are 3:1 or greater in conjunction with other surface stabilization devices.

Mulching must be done after planting to aid in plant establishment and growth. Mulches not only reduce further wind and water erosion but also help retain soil moisture

and can be used for temperature control. There are 3 basic types of mulch: plant residues; erosion nets/mats; and hydro mulches.

Plant Residues (hay/straw)

This is the most common, most economical and preferred mulch type to be used on Redstone where slopes are less than or equal to 3:1. Materials used should not be musty, moldy or decayed and must be weed free.

Straw/hay mulches should be applied on the contour and crimped. If straw/hay mulches are used on slopes steeper than 3:1 a tackifier must be used to hold the material in place.

Erosion Nets/Mats

Erosion nets/mats are useful for erosion control and soil moisture retention on steep slopes. Their use on the installation should be limited to small areas with slopes having high potential runoff erosion problems, especially concentrated flows.

There are a wide variety of erosion nets/mats commercially available. Those used on Redstone must include some type of fiber and be photo- or bio- degradable. Application of erosion mats should be done according to specific product instructions. In general, all require securing in place with pins or staples.

Hydro mulching

Hydro mulching is the preferred mulching method for steep slopes subject to sheet flow on the installation. Hydro mulching is a relatively fast and inexpensive method for controlling erosion, holding seed in place, and conserving moisture during plant establishment. Hydro mulching is mandatory for slopes that have been hydroseeded. Hydro mulches must have tackifiers as part of the mulch to insure adhesion to the soil surface.

b. Mechanical Soil Stabilization

Mechanical soil stabilization shall be limited to sites where vegetative growth would pose additional problems or is undesirable.

Mechanical soil stabilization refers to soil stabilization without the use of vegetation. The most common materials used are gravel or stones. Examples of areas where mechanical stabilization may be required are unpaved truck loading areas or dirt access trails into pasture land.

c. Drainage

Drainage areas shall be properly shaped, lined and/or planted as described in this section in conjunction with the Alabama Handbook for Erosion Control, Sediment Control, and Stormwater Management on Construction Sites and Urban Areas. Areas of major water discharge, such as at the mouth of culverts, shall be

designed with outlet protection. Details for different drainage situations and appropriate drainage linings are described below.

Good surface drainage provides for the collection and discharge of excess water from land and structural surfaces in order to prevent storm damage/flooding, landslides, and maintain desirable vegetation. Surface drainage conveyances include streams, ditches and diversion channels. Poorly designed or inadequate drainage conveyances can increase erosion problems on the installation.

Providing and maintaining adequate surface drainage may be classified under three general areas: protection of slopes and other graded areas; roadway protection; and channel protection. Methods used to protect slopes/graded areas and roadways involve a point of discharge that is also susceptible to erosion. Such discharge points on the installation must be provided with energy dissipating structures such as rip-rap to prevent further erosion from occurring.

1. Protection of Slopes/Graded Areas

The following methods should be used appropriately to correct/prevent erosion problems on slopes and graded areas on the installation.

Diversion Dikes

Diversion dikes may be either temporary or permanent. A temporary diversion dike is a ridge of soil made at the top of a cut or fill slope to divert surface flow from small areas to prevent runoff on the slopes. These are to be used during construction on the installation. Temporary diversion dikes should be a minimum of 1.5 feet high, 2 feet wide and have a maximum slope of 2:1. Runoff from temporary diversion dikes should be diverted to a stabilized area or a slope protection structure.

A permanent diversion dike is a ridge of non-erodible material. These should be used on roads where erosion can or has occurred as a result of roadway drainage flowing off the road. Permanent diversion dikes require non-erodible discharge outlets, such as pipe drops, with energy dissipating structures such as rip-rap.

Interceptor Ditches

Interceptor ditches are permanent structures located on slopes that divert water drainage away from the slope of the cut. These are usually necessary on slopes having greater than a 3:1 ratio. Interceptor ditches should be designed to capture water discharge from above the slope cut and discharge it to a non-erodible area or into an energy dissipating structure. Pipe drops may also serve as an outlet for interceptor ditches. Interceptor ditches must also be protected from erosion with either a flexible or rigid lining (See section on Channel Protection).

Down Drains

Down drains (also known as slope drains) are temporary or permanent conduits which convey drainage from slopes to stable points of discharge below. Since the discharge area may also be susceptible to erosion, discharge areas should be protected with an energy dissipating structure. There are 3 basic types of down drains: flexible down drains; pipe drops; and chutes (flumes).

Flexible down drains are usually temporary. These are flexible conduits made of heavy duty fabric or other similar material. Flexible down drains should be placed on firm foundations and anchored in place. The point or discharge for flexible down drains must be a stabilized outlet.

Pipe drops may be either temporary or permanent pipes placed on cut or fill slopes as outlets for diversion dikes or interceptor ditches. The discharge area for pipe drops must be into an energy dissipating structure.

Chutes (flumes) are permanent, high velocity open channels for conveying water to lower levels without erosion. Chutes must be placed on a firm foundation. A rigid lining such as concrete should be used. The chute outlet must discharge into an energy dissipating structure.

Diversions

Diversions are temporary or permanent structures consisting of channels or ditches and a ridge constructed across sloping surfaces on the contour to intercept and divert surface runoff before water volume and velocity increase to the point that erosion occurs. The collected water is conveyed laterally along the diversion at a low velocity and discharged into a protected area or outlet.

A filter strip of close growing grass must be maintained above the channel for all permanent diversions. Filter strip width must measure half the width of the channel plus 15 feet. If permanent diversions are located below areas producing large amounts of sediment, measures must be taken to prevent accumulation of sediment in the channel. Measures taken may be either the establishment of vegetative cover, or the implementation of surface stabilization devices such as the installation of geosynthetic erosion mats or rip-rap.

2. Roadway Protection

The following methods should be utilized to correct/prevent erosion damage to roads and roadsides on the installation.

Interceptor Dikes

Interceptor dikes are temporary structures which are designed to intercept and convey water at construction sites at non-erosive velocities to adequate stable outlets. Interceptor dikes may be designed to also serve as crossings for construction traffic. These dikes are temporary ridges of compacted soil constructed at right angles to the slope or graded right-of-way. Minimum ridge height and width is 1.5 feet and 2.0 feet

respectively. The maximum side slope is 2:1. Discharge must be to a stabilized undisturbed area, a slope protection area (down drain, etc.), or some other energy dissipating structure.

Drainage Dips

Drainage dips may be either temporary or permanent structures which are constructed across graded right-of ways in order to reduce erosion by intercepting storm runoff and diverting it to an area where it can be disposed of with minimal erosion. Dips are installed below outcurves, above incurves, and through fills and wherever else is needed. Drainage dips are only appropriate on roads having less than 10% grade, a minimum 50 foot uphill approach, and a minimum of 15 feet on the slope leaving the dip. In-slope drainage should be conveyed to the downhill side of the road to retain water until it reaches the bottom of the dip. Dips must dissipate to an energy dissipating structure either directly or indirectly by means of a chute.

Side Ditches

Side ditches adjoin the road shoulder and are meant to prevent uncontrolled runoff on roads. Erosion on side ditches is probably the most common erosion problem, or potential problem, on the installation. Side ditches can be lined or unlined. The ditches must have the capability to provide the capacity required for runoff, resist erosion, and prevent sedimentation. Side ditches should have a flat bottom of two feet or more. Ditches should always be U-shaped, especially if the roadside area does not permit construction of a 2 foot flat ditch bottom. Protection of side ditch sides is discussed in the section titled Channel Protection.

Culverts

Culverts are conduits used to conduct drainage water under roads, canals, or other embankments. These conduits are usually corrugated metal or reinforced pipe. Open-top culverts are box-like frames installed flush with road surfaces and are used only on very low volume traffic, unpaved roads.

Proper culvert design is crucial to erosion prevention. Factors to consider to correct/prevent culvert failure and associated erosion problems are culvert alignment, culvert grade, culvert capacity, debris control, and energy dissipation. The following guidelines to correct/prevent erosion should be followed on the installation.

Culverts must be aligned to provide water with a direct entrance and exit and thereby reduce the probability of erosion at these points. Culverts must be aligned with the channel grade so as to avoid erosion or sedimentation at the point of exit.

Culvert grade should be at least one or two percent more than that of the channel or waterway. In general, a 10% grade will prevent deposition of material which eventually leads to erosion problems at the side walls of the culvert.

The importance of culvert debris control cannot be overemphasized. With average annual precipitation of 55 inches per year, lands at Redstone are susceptible to further erosion caused by re-channelization of water as a result of debris accumulation in

the direct path of water flow. Debris barriers should be selected and used on the installation depending on expected debris at the site, e.g. logs, limbs, refuse, silt, etc.

Energy dissipation is probably the most needed corrective and preventive measure for culvert erosion on the installation. All too often ditch erosion is the result of drainage from flat areas without definite channels. Such areas should be evaluated for use of drop inlets which reduce the discharge velocity from culverts by lowering the culvert flow line gradient. Energy dissipation structures should also be used at culvert outlets. These include rip-rap and discharge aprons. Without these structures, culvert sidewalls suffer serious erosion damage.

3. Channel Protection

There are three major types of channel protection that should be used either separately or in combination: vegetative lining; flexible lining, and rigid lining.

Vegetative Linings

The majority of drainage channels on the installation can be protected by vegetative lining if the channel is properly sloped and prepared. Vegetative lining not only reduces erosion along channels and provides filtration of sediment, but also is aesthetically pleasing. The most common vegetation lining is grass, but wildflowers can be used under certain conditions.

Vegetation can be used as the sole means of channel protection if the slopes are less than 3:1. Vegetation on steep slopes (3:1 or greater) requires reinforcement with a flexible lining such as geosynthetic erosion mats (refer to following section, Flexible Linings).

Grass should be established on channel slopes by seeding and using methods described in the Revegetation section of this guide. Either Bermuda grass or fescue should be used based on site conditions (sun or shade, respectively) and surrounding vegetation. Bermuda sod may be used in areas requiring immediate channel protection. Mulches or erosion control netting should be used to provide temporary erosion control until vegetation is established on slopes greater than 3:1.

Wildflowers may be used instead of grass on channel sides with slopes of 3:1 or less to beautify highly visible areas and to reduce mowing costs. Channels protected with wildflowers should have grass or other protective materials on the channel bottom. Channel protection with wildflowers must be coordinated with the installation ecologist and/or installation land manager.

The wildflower seed mix is specified in Table 2 of the Revegetation section of the guide. Wildflower seeding must be protected with mulch or erosion mats.

Flexible Linings

Channel sides having slopes of 3:1 or greater should be protected with permanent flexible linings. Flexible linings are three-dimensional structures which are not biodegradable. These are materials such as rip-rap, gabions, and geosynthetic erosion

control products. Flexible linings are preferable to rigid linings since they are able to conform to changes in channels shape and yet maintain overall channel integrity.

Geosynthetic erosion control products, such as Enkamat, are the preferred type of flexible lining as they are less expensive, permit water flow both in and out and have a more natural appearance. Vegetation should normally be used in conjunction with erosion control mats but in some cases rip-rap or gravel may be required.

Rigid Linings

Rigid linings are nonflexible materials such as concrete or asphalt which are used to line channels. Because of their low roughness, rigid linings provide maximum flow capacity. As a result, increased runoff rate could cause erosion problems further downstream.

Rigid linings should not be used on the installation except to provide for areas of high flow velocity and/or quantity. If used, the immediate downstream area must provide for energy dissipation and protection of sidewalls as discussed in previous sections.

VI. Erosion Prevention

Erosion is usually easier and less costly to prevent rather than to correct. Good erosion control starts with good sediment control. Following is a list of things that can be done to prevent minor erosion problems on the installation.

- Do not drive or park on off road surfaces, especially if the ground is wet. Off road vehicle traffic kills vegetation and results in bare ground that is vulnerable to erosion.

- Make sure mower blades are high enough that the ground will not be scalped. Scalping kills/removes vegetation and results in serious erosion problems on slopes.

- Put splash blocks under downspouts to prevent gully formation.

- Minimize vegetation removal around fence lines, telephone poles, and other mowing obstacles. Such bare areas, which are frequently on a grade, serve as an initiation point for erosion.

- Do not throw grass clippings or other materials in ditches. Objects thrown in ditches redirect or impede water flow and re-channelization results in erosion problems at sidewalls and channel banks.

Seven basic principles of erosion and sediment control are listed below:

1. Plan the development to fit the particular topography
   -select a site suitable for construction rather than modifying a site to the construction activity).
2. Minimize the extent and duration of area to be exposed

-clear only the area to be developed immediately

3. Apply erosion control practices to prevent on-site damages before exposing the soil. When erosion is not adequately controlled, sediment control is more difficult and expensive.
4. Keep runoff velocities Low and Retain sediment on site.
   -keep slope lengths short and gradients low
   -preserve natural vegetative cover
   - convey runoff to stabilized outlet and/or build storm water detention structures
5. Apply perimeter control practices to protect disturbed areas from storm water runoff coming onto the site and to prevent damage to downslope areas from storm water runoff and sediment leaving the site.
6. Stabilize disturbed areas as soon as possible
   - preserve existing vegetation
   - construction sequencing (phasing)
   - just-in-time clearing
   - stabilize as you go
7. Implement a thorough maintenance and follow-up program
   - repair, replace, improve, and keep records (Thompson Engineering)

VII. Administration

a. Contracts

Erosion control on RSA is generally performed under the stand alone grounds maintenance contract currently held by Wolf Creek. Construction and repair/maintenance contractors are responsible for erosion as a result of their work.

b. Job Order/Work Order Requests

Erosion Problems can be reported through the submission of a job order request to the Directorate of Public Works at https://garrison.redstone.army.mil/dpw/index_frames.asp. Work orders involving revegetation/erosion control will be reviewed and approved by Natural Resource personnel. Approved Work Orders will be forwarded to the COR. A minor service order (MSO) can also be input to report an erosion problem by calling 256-876-2801.

c. Construction Activities

All plans/scopes of work for construction activities shall be reviewed and approved by Environmental Management Division personnel prior to contract award. Revegetation/erosion control activities shall be done as described in the Revegetation and Erosion Control Methods/Requirements section.

d. Outleases

There are currently 15 agricultural outleases for a total of approximately 1,400 acres on RSA. Leases are supplied with RSA Land Use Regulations with agricultural outleases. Leases are responsible for correcting erosion problems resulting from their use of the land. RSA is responsible for correcting/preventing any naturally occurring erosion.

e. Test Areas

Test Areas are restricted access areas owned by the government but operated by RTTC. RSA is responsible for naturally occurring problems in these areas. Due to the restricted access, erosion monitoring and control projects are coordinated with RTTC personnel.

f. Marshall Space Flight Center

MSFC is required to report any major ground disturbance to RSA and is responsible for land maintenance of their area.

g. Resources

1. Annual Program Cost

The annual cost of erosion control on RSA is estimated at approximately $240,000. This figure is based on projects submitted for the previous year. The current ADEM permit review fee for coverage under the Construction General Permit program is $1,155 for a construction site.

2. Staffing

The following personnel are involved with the erosion control program on RSA: Installation Forester; Stormwater Program Manager, grounds service contractor; and the DPW Systems Analyst inspectors for ground maintenance.

3. Materials

All erosion and sediment control materials are furnished by the grounds services contractor when assigned erosion control projects. Materials for erosion projects involving construction are provided through the Job Order Contract (JOC) contractor and any sub-contractors that may be used.

VIII. Coordination

Any erosion projects requiring permits will be coordinated with the appropriate agencies through the Stormwater Program Manager in the Garrison Environmental Office. The Installation Forester will do any necessary preliminary coordination with tenants for non-construction erosion projects. Coordination for actual project performance between the contractor and a tenant will be done by the COR.

IX. Services Provided to Tenant Activities

Erosion control services are provided for personnel and buildings of all tenant activities on RSA by the ground services contractor for naturally occurring erosion problems.

X. Plan Maintenance

Maintenance of the Soil Erosion and Sediment Control Plan shall be provided by the Environmental Management Division. Pen and ink changes will be made, when necessary. The Plan will be officially updated every five years when the RSA Integrated Natural Resources Management Plan (INRMP) is updated.

XI. Points of Contact

Greg Hicks, Installation Forester.....256-313-3258

Ramzi Makkouk, Stormwater Program Manager……..…..256-955-8501

XII. References

1. Federal and State Laws

Clean Water Act

Federal Insecticide, Fungicide, and Rodenticide Act

Marine Protection, Research, and Sanctuaries Act

Occupational Safety and Health Act

Executive Order 11514, Protection and Enhancement of Environmental Quality

Executive Order 11988, Floodplain Management

Executive Order 11990, Protection of Wetlands

DoD Directive 4150.7, DoD Pest Management Program

2. Army Regulations

AR200-1, Environmental Protection and Enhancement

AR 420-74, Natural Resources - Land, Forest, and Wildlife Management

32 CFR Part 651, Environmental Analysis of Army Actions, Final Rule

3. RSA Permits and Plans

ADEM NPDES Permit – Redstone Industrial NPDES Permit (Permit No. AL0000019)

ADEM Water Division Phase II General Permit (Permit No. ALR040033)

US Army Garrison Municipal Storm Water Management Plan, July 2012

US Army Garrison Best Management Practices Plan, December 2011

4. Technical Manuals

TM 5-630, Natural Resources, Land Management, July 1982.

TM 5-633, Natural Resources, Fish and Wildlife Management, February 1982

TM 5-830-2, Establishment of Herbaceous Ground Cover, September, 1983

5. Other References

Amimoto, Perry Y. 1981. Erosion and Sediment Control Handbook. Dept. of Conservation, Resources Agency, State of California. 198 p.

Long, Stephen G. James K. Burrell, Nancy M. Laurenson, and James H. Nyenhuis. 1984. Manual of Revegetation Techniques. U.S.D.A. For. Serv. Equipment Development Center, Missoula, MT. 145 p.

Slick, Bernard M. and Curtis, Willie R. 1985. A guide for the use of organic material as mulches in relamation of coal minesoils in teh Eastern United States. Gen. Tech. Rep. NE-98. Broomall, Pa. U.S.D.A. For. Ser., Northeastern Forest Experiment Station. 144 p.

Soil Survey of U.S. Army Redstone Arsenal, Madison County, Alabama. Publication. N.p.: United States Department of Agriculture Natural Resources Conservation Service, n.d. Print.

Thompson Engineering. "Pollution Prevention Principles." *Stormwater Management Training Manual Qualified Credentialed Inspector Program*. September-December 2013 ed. 2013. 4.3-4.7. Print

US Army Aviation and Missile Command. April 1999. Final Real Property Master Plan Land Use Analysis for Redstone Arsenal. US Army Missile Command. 1994. Final

Environmental Assessment for Redstone Arsenal Master Plan Implementation, Redstone Arsenal, Alabama

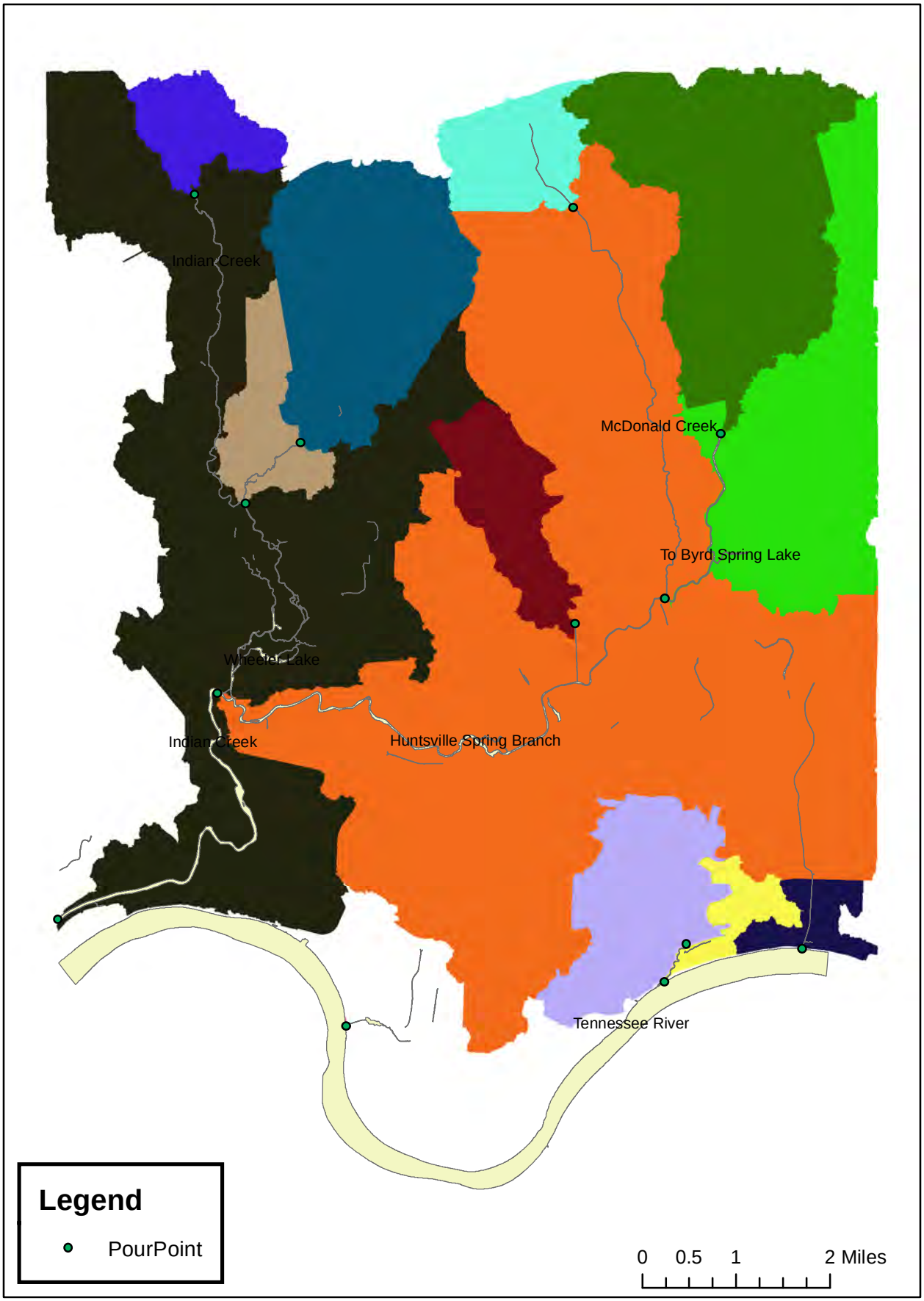
U.S.D.A. Forest Service. 1979. User guide to soils. U.S.D.A. For. Serv. Gen. Tech. Rep. INT-68, 80 p. Intermt. For. and Range Exp. Stn., Ogden, UT.

U.S.D.A. Forest Service. 1079. User Guide to vegetation. U.S.D.A. For. Ser. Gen. Tech. Rep. INT-64, 85 p. Intermt. For. and Range Exp. Stn., Ogden, UT.

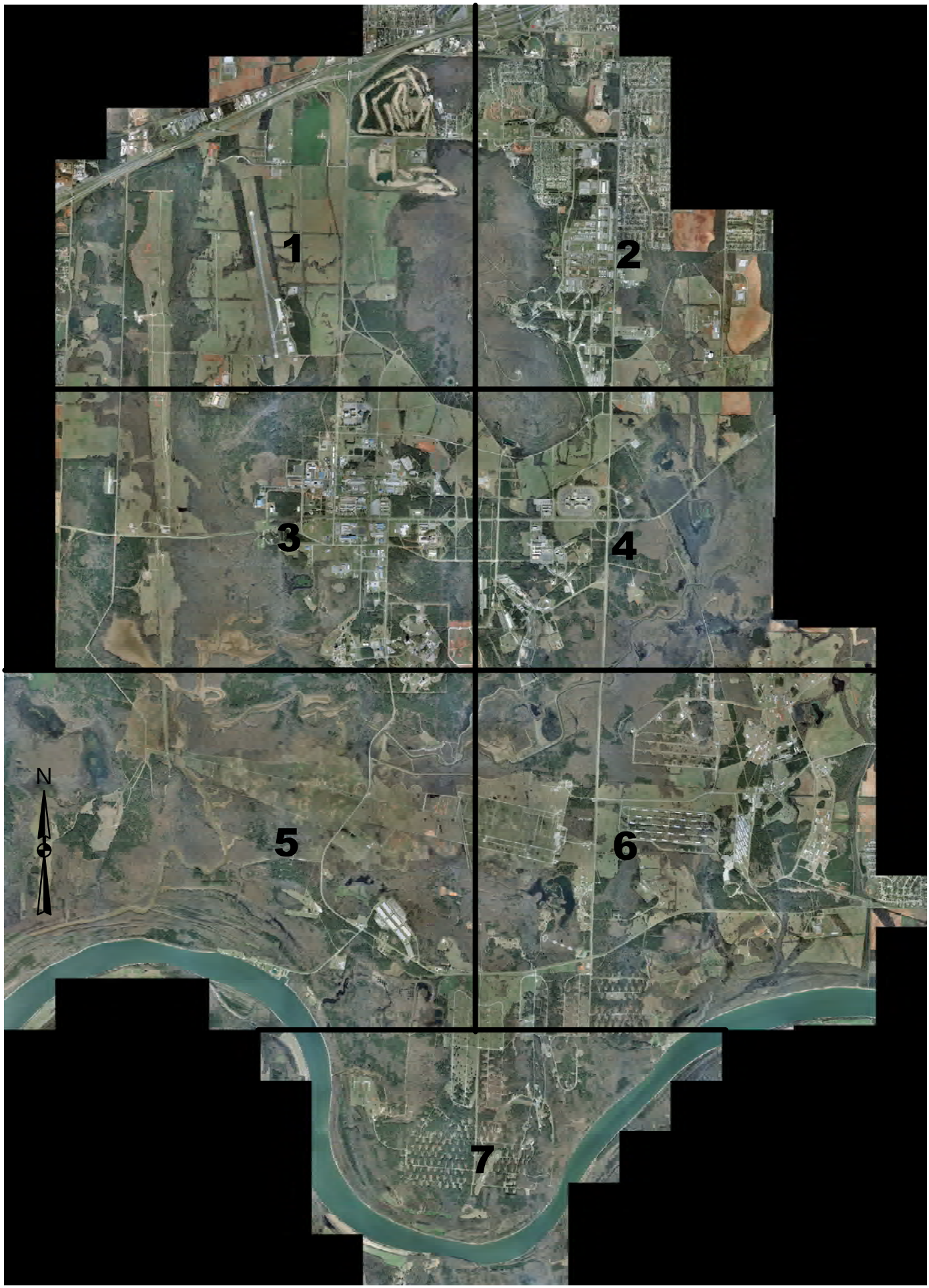
Web. 14 Apr. 2015. <https://cals.arizona.edu/watershedsteward/resources/docs/guide/(6)Soils.pdf>.

ATTACHMENT A
Watersheds of RSA using Channel Drains as Pour Points

Watersheds of RSA using Channel Drains as Pour Points

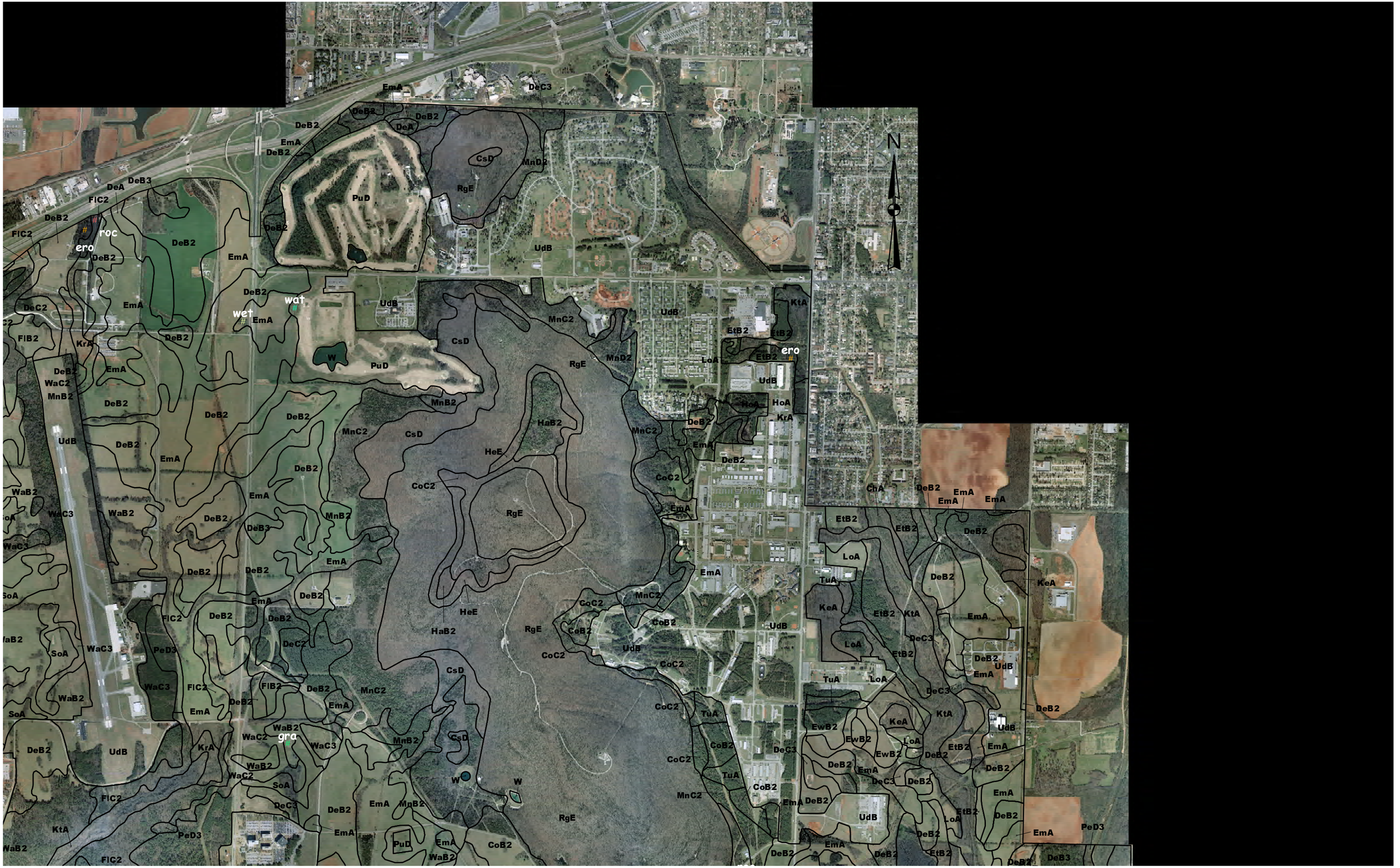


ATTACHMENT B
NRCS Soil Maps

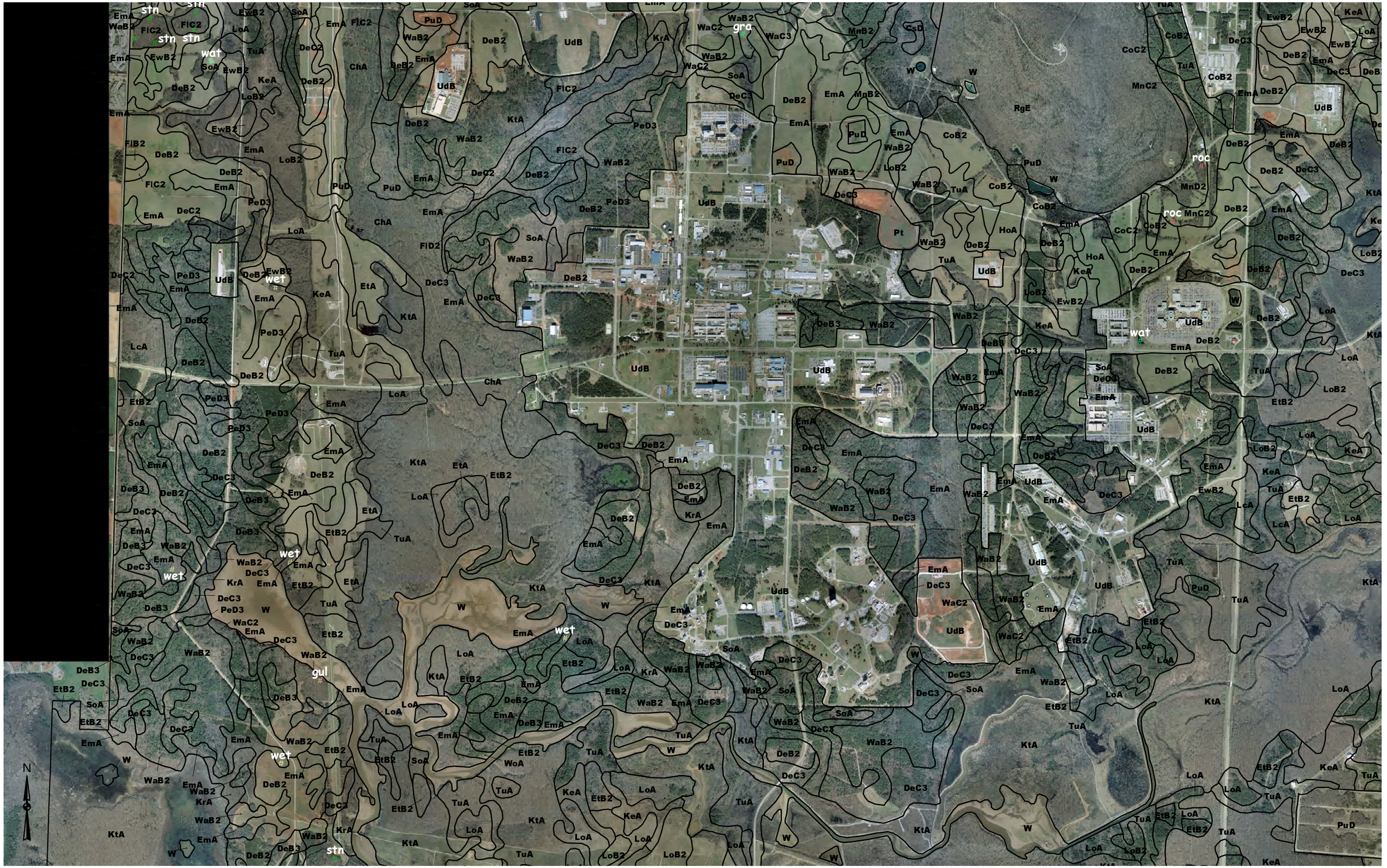


Index To Map Sheets Soil Survey of Redstone Arsenal, Madison County, Alabama

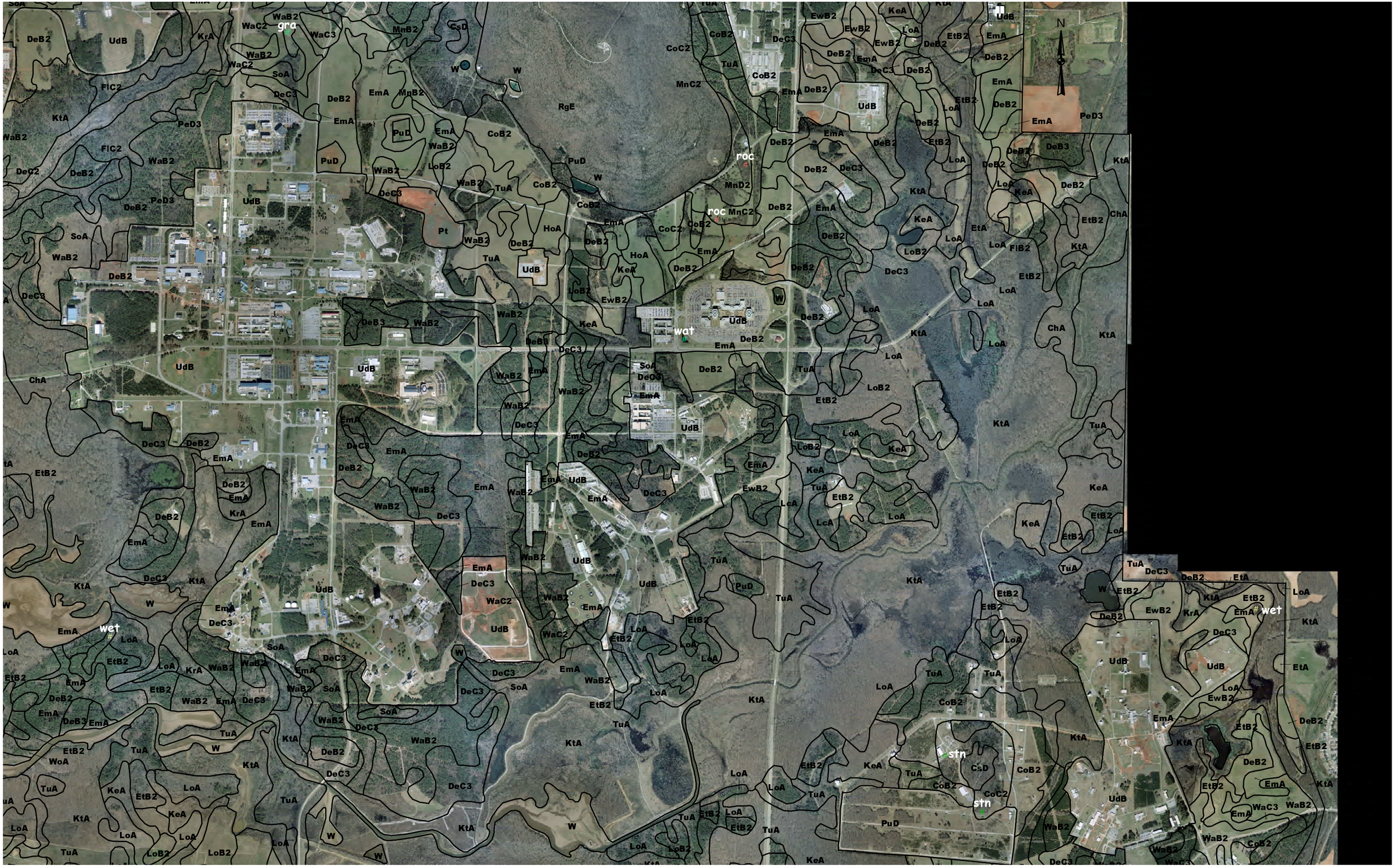
Soil Survey of Redstone Arsenal, Madison County, Alabama 1:24,000 Map Sheet 1



Soil Survey of Redstone Arsenal, Madison County, Alabama 1:24,000 Map Sheet 2



Soil Survey of Redstone Arsenal, Madison County, Alabama 1:24,000 Map Sheet 3



1 0 1 2 Miles

Soil Survey of Redstone Arsenal, Madison County, Alabama 1:24,000 Map Sheet 4

1 0 1 2 Miles

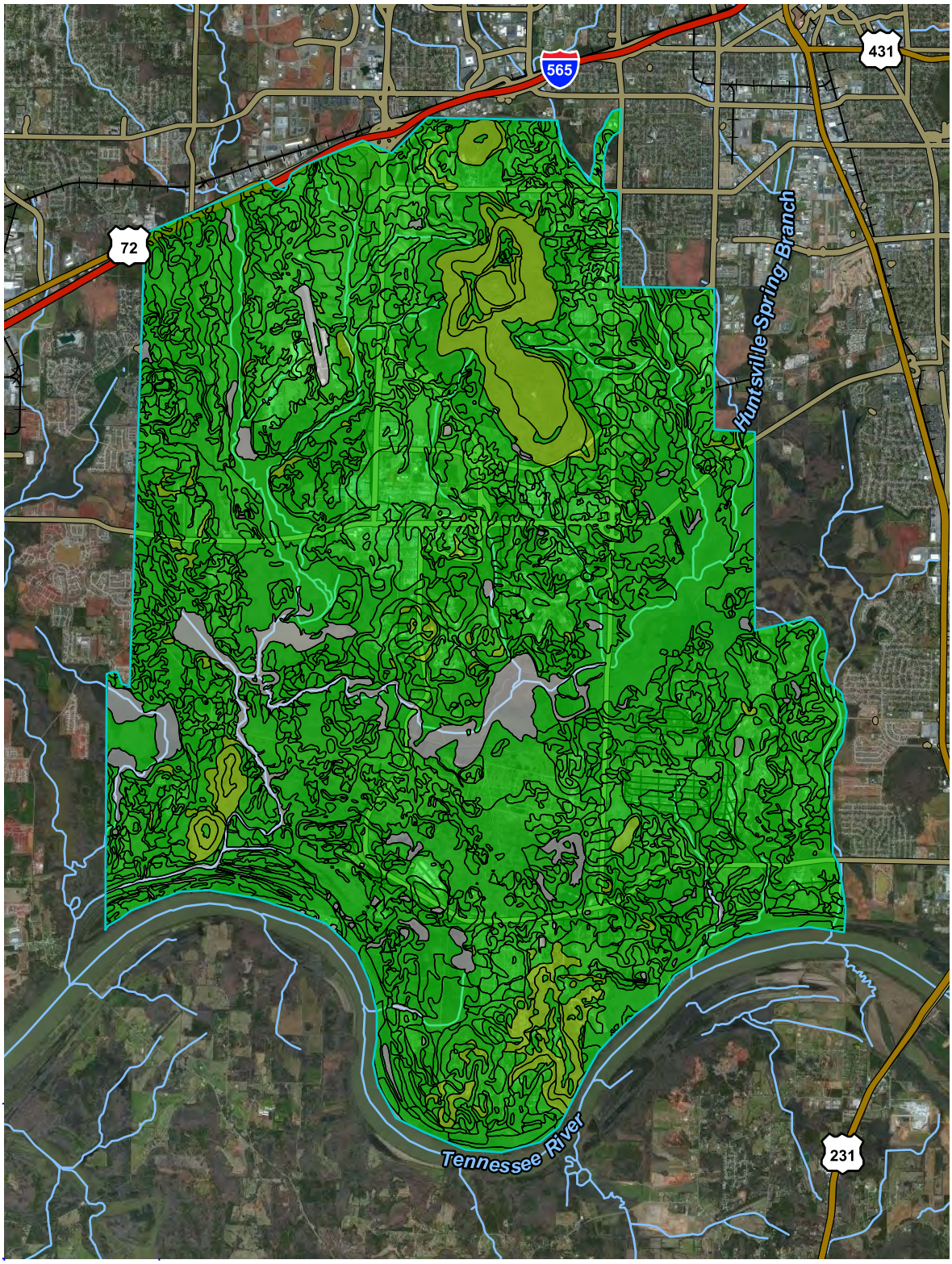
Soil Survey of Redstone Arsenal, Madison County, Alabama 1:24,000 Map Sheet 5

Soil Survey of Redstone Arsenal, Madison County, Alabama 1:24,000 Map Sheet 6

Soil Survey of Redstone Arsenal 1:24,000 Map Sheet 7

ATTACHMENT C
NRCS Soil Erosion Hazards
Off-Road, Off Trail

86° 44' 30" W
86° 33' 58" W
34° 43' 36" N
34° 32' 5" N



Map Scale: 1:104,000 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 1500 3000 6000 9000

Feet
0 5000 10000 20000 30000

Map projection: Web Mercator Corner coordinates: WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- Very severe
- Severe
- Moderate
- Slight
- Not rated or not available

Soil Rating Lines
- Very severe
- Severe
- Moderate
- Slight
- Not rated or not available

Soil Rating Points
- Very severe
- Severe
- Moderate
- Slight
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Madison County, Alabama
Survey Area Data: Version 6, Sep 16, 2014

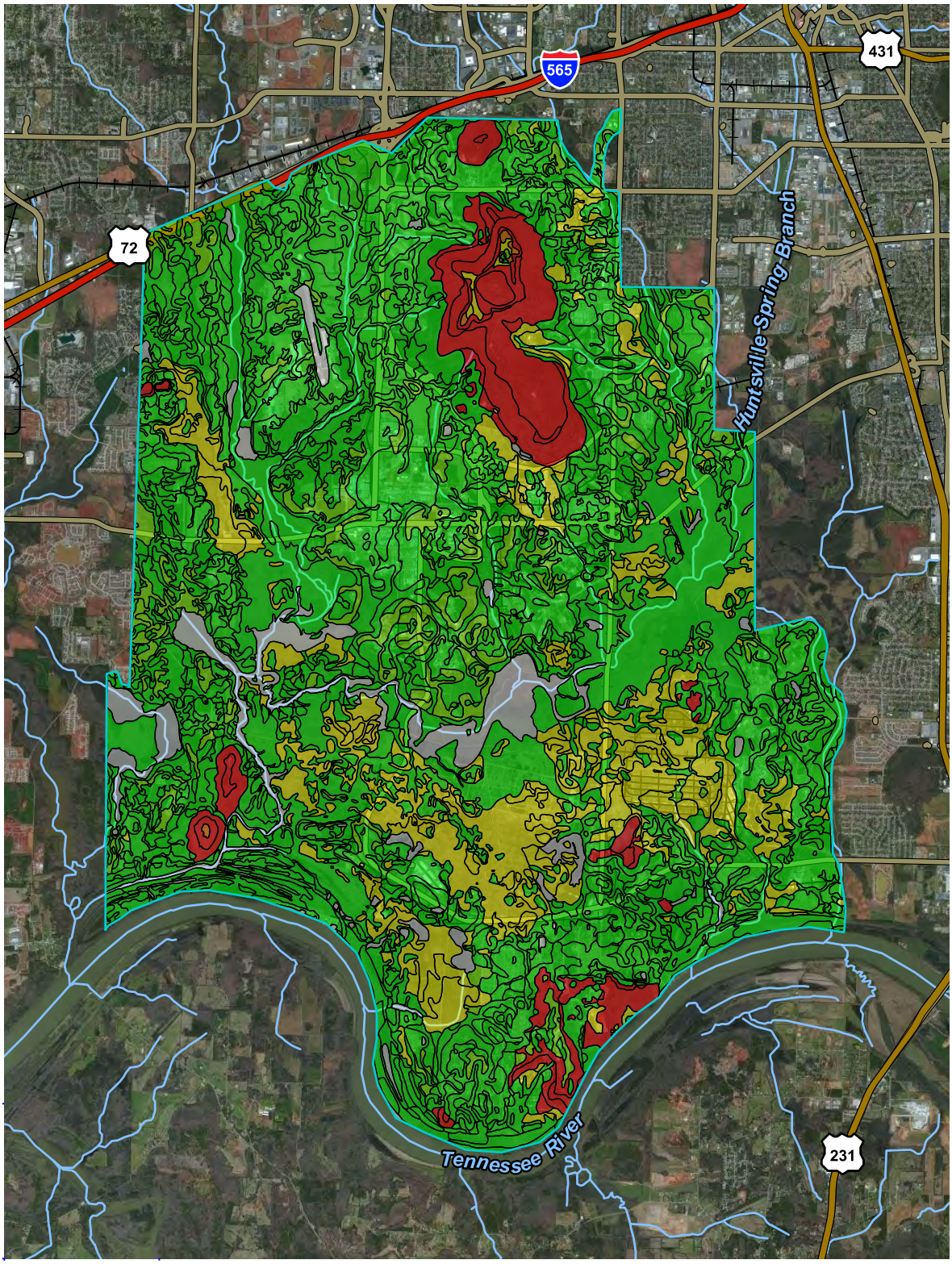
Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 17, 2011—Jun 30, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

ATTACHMENT D
NRCS Soil Erosion "T" Factors

86° 44' 30" W
86° 33' 58" W
34° 43' 36" N
34° 32' 5" N



Map Scale: 1:104,000 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 1500 3000 6000 9000

Feet
0 5000 10000 20000 30000

Map projection: Web Mercator Corner coordinates: WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- 1
- 2
- 3
- 4
- 5
- Not rated or not available

Soil Rating Lines
- 1
- 2
- 3
- 4
- 5
- Not rated or not available

Soil Rating Points
- 1
- 2
- 3
- 4
- 5
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

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Appendix K
SDSFIE Layers

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Cadastre
EmergencyServices
EngCivil
EngSurvey
EnvCleanup
EnvCompliance
EnvCultural
EnvGeology
EnvHydrography
EnvNaturalResources
EstablishedBoundaries
FlightOperations
GroundsOperations
Mapsheets
MasterPlanning
MilitaryRangeTraining
MP_ADP
MP_SitingActions
NEC_I3MP
Recreation
Topography
UtilityCommunications
UtilityElectrical
UtilityHeatingCooling
UtilityIndustrial
UtilityNaturalGas
UtilityStormWater
UtilityWasteWater
UtilityWater

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Appendix L
Wildlife Aircraft Safety Hazard Plan

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REDSTONE ARSENAL Pamphlet 385-90-1

Safety Management Program

Wildlife Aircraft Strike Hazard (WASH) Plan

0 2 APR 2015

US Army Garrison – Redstone
Redstone Army Airfield
Redstone Arsenal, AL 35898-5000

US Army Garrison – Redstone
Redstone Arsenal, AL 35898-5000

REDSTONE ARSENAL Pamphlet 385-90-1

Safety Management Program:
Wildlife Aircraft Strike Hazard (WASH) Plan

Official:

WILLIAM L. MARKS II 0 2 APR 2015
COL, LG
Garrison Commander

HISTORY. The establishment of this publication was directed by IMCOM Suppl 1 to AR 95-2, dated 1 Feb 2013.

SUMMARY. This document prescribes comprehensive procedures for the Redstone Army Airfield Wildlife Hazard Management plan. It incorporates provisions of IMCOM Suppl 1 to AR 95-2 using IMCOM Pamphlet 385-90-1, Wildlife Aircraft Strike Hazard (WASH) Template, dated 19 Aug 13.

APPLICABILITY. This publication applies to all organizational elements, including tenant activities, on the installation.

PROPONENT AND EXCEPTION AUTHORITY. The proponent of this publication is the Chief, Airfield Division, Directorate of Plans, Training Mobilization, & Security, US Army Garrison-Redstone (DPTMS) IMRE-PLA. The proponent has the authority to approve exceptions to this publication that are consistent with federal or state law or regulation.

MANAGEMENT CONTROL PROCESS. This pamphlet does not contain management control provisions in accordance with Army Regulation 11-2.

SUGGESTED IMPROVEMENTS. Users are invited to send comments and suggested improvements on DA Form 2028 (Recommended Changes to Publications and Blank Forms) to USAG-RSA, DPTMS, Airfield Division, (IMRE-PLA), Redstone Arsenal, AL 35898.

DISTRIBUTION. This publication is approved for public release; distribution is unlimited.

Table of Contents

Appendix List

Chapter 1. Wildlife Aircraft Strike Hazard (WASH) Plan

1-1. Purpose: This plan sets forth procedures and responsibilities designed to minimize the number of bird/wildlife strikes at Redstone Army Airfield (RAAF) with an integrated wildlife management approach.

1-2. Conditions of Execution: This plan is based on hazards posed by both resident and seasonal wildlife populations, therefore portions will be implemented on a continuous basis while others implemented as needed during seasonal changes.

1-3. Concept of Operations:

a. Establish a Wildlife Hazard Working Group (WHWG) and designate responsibilities to its members.

b. Establish procedures for reporting hazardous wildlife activity and altering or discontinuing flying operations. Reporting will be a collective effort between all aircrews and ground personnel operating in the airfield environment.

c. Establish procedures to identify hazardous conditions and to aid supervisors and aircrews in disseminating information, issuing alerts, and altering or discontinuing flying operations when required.

d. Develop active and passive techniques of dispersing wildlife from the airfield and decreasing airfield attractiveness to wildlife.

e. Establish procedures to eliminate or reduce environmental conditions that attract wildlife to the airfield/heliport.

f. Identify organizations with authority to initiate or terminate wildlife watch conditions.

Chapter 2. Organizational Tasks

2-1. General: A cooperative effort between all installation agencies will help ensure airfield vegetation, fencing and drainage are managed to minimize wildlife attractants.

2-2. Garrison Commander (GC):

a. Establishes methods and procedures outlined by this plan.

b. Chairs the Wildlife Hazard Working Group (WHWG) meetings. Meetings maybe incorporated into the Airfield Operations Board (AOB).

c. Reviews recommendations from the WHWG.

d. Appoints the Wildlife Detection And Dispersal Team (WDDT).

2-3. Directorate of Public Works (DPW):

a. **Operations and Maintenance Division:**

(1) Advises WHWG of physical modifications.

(2) Corrects physical conditions that increase WASH potential.

(3) Maintains physical conditions of the airfield and surrounding areas based on guidance of AR 95-2, TM 5-630 and the recommendations of the WHWG.

b. **Environmental Management Division (EMD):**

(1) Advises Airfield Manager and WHWG on wildlife biology and behavior, habitat requirements or modifications or management schemes to make informed decisions and minimize aircraft-wildlife strikes.

(2) Conducts wildlife hazard assessment to identify local wildlife species along with numbers, locations, movement, daily and seasonal occurrences. Develop recommendations to reduce the wildlife hazards.

(3) Helps to acquire all necessary state/federal permits for harassment of nuisance wildlife and provides permits to the airfield manager.

(4) Identify remains of dead wildlife and ensure proper disposal of remains pursuant to permits.

2-4. Public Affairs Office: Public Affairs Office participates as required and upon request will provide a public information program designed to inform post personnel, family members, and the general public on the hazards and costs of uncontrolled wildlife activity on the airfield and the measures being taken to minimize them.

2-5. Directorate of Plans Training, Mobilization and Security (DPTMS):

a. **Chief, Airfield Division / Airfield Manager:**

(1) Declares a wildlife watch condition (WWC) or delegates authority to do so.

(2) Disseminates airfield wildlife hazard warnings.

(3) Provides guidance to airfield personnel for reporting WWC and wildlife strikes to aircraft.

(4) Issues specific guidance to Base Operations personnel on procedures to be followed under each WWC.

(5) Should make operational changes to avoid areas and times of known hazardous wildlife concentrations, mission permitting.

(6) Determines when and where WDDT members can respond.

(7) Coordinates with DPW (EMD) on actions to modify habitat and trap/remove wildlife.

b. **Airfield Operations Officer**: The Airfield Operations Officer may be responsible for the operation of the WASH plan if directed by the airfield manager:

(1) May declare or adjust WWC as necessary.

(2) Acquire, maintain and coordinate with DPW EMD on all dispersal equipment. See Appendix G for a description of some dispersal equipment.

(3) Monitors the training of all members of the WDDT on all dispersal equipment.

c. **Airfield Safety Officer (AFSO)**: The airfield safety program manager may be responsible for the management of the WASH plan if directed by the airfield manager:

(1) Monitors compliance with the WASH plan.

(2) Assembles and disseminates wildlife data to WHWG and aviation units via the Airfield Safety Council and/or the Airfield Operations Board to include information on how each unit may obtain predictive wildlife hazard information using the United States Air Force Bird Avoidance Model; see Appendix F.

(3) Monitors wildlife activity and strike statistics and advises the Chief, Airfield Division when additional meetings are deemed necessary.

(4) Establishes a WASH education program to include films, posters and information on local wildlife hazards and reporting procedures in coordination with DPW EMD.

(5) Coordinates with Airfield Services, Base Operations or aircrews for collecting non-fleshy remains after strikes.

(6) Establishes and maintains a continuity folder with trend data and other pertinent wildlife data and information to assure continuity of knowledge with personnel turnover.

(7) Monitors the current WWC posted to the Redstone Army Airfield Automation System (AAAS).

d. **Air Traffic Control Facility (ATC)**:

(1) Reports observed wildlife activity to base operations and pilots.

(2) Issues wildlife watch condition advisories to aircrews when conditions are reported as Moderate or Severe.

(3) Recommends missed approaches or delayed takeoffs when possible wildlife hazards appear on ATC radar.

(4) Under WWC "SEVERE", ATC will ensure that pilots understand the condition and are provided the option to delay, divert or continue the proposed operation into the hazardous area.

(5) Recommends appropriate operational changes or options to pilots/aviation units to avoid areas of known hazardous wildlife concentrations, mission permitting.

(6) Upon request from the pilot in command, considers the following during periods of increased wildlife activity:

(a) Raise pattern altitude.

(b) Change pattern direction to avoid bird concentrations.

(c) Avoid takeoffs/landings at dawn/dusk ± 1 hour.

(d) Limit or prohibit formation takeoffs and landings.

(e) Depart pattern in trail; rejoin 3000 feet above ground level.

(f) Raise altitude en route to low level or training areas.

(g) Split formation during recovery.

(h) Make full stop landings.

e. **Base Operations/Airfield Services**:

(1) Observes, reports, and disperses wildlife on or near the airfield as necessary during daily airfield inspections and checks.

(2) May declare or adjust WWC as necessary.

(3) Posts the current WWC to the AAAS.

(4) Reports all wildlife strike incidents To Airfield Manager and Airfield Safety Officer.

(5) Maintains wildlife dispersal equipment and wildlife identification books.

(6) Recover wildlife remains after a strike incident and notify DPW EMD Wildlife Biologist personnel for pick-up and identification.

(7) Receive reports of wildlife aircraft strike mishaps from aircrews or other witnesses and submit to the AFSO to enter the data online at the US Combat Readiness Safety Center through (Report-It).

(8) Maintain daily records of wildlife activity and harassment (responses of birds/wildlife to control activities and number of wildlife dispersed).

(9) Create and maintain a map using large scale airfield diagram or equivalent to indentify high risk areas.

f. **Wildlife Detection and Dispersal Team (WDDT):**

(1) The GC selects the WDDT and includes personnel authorized to employ non-lethal control techniques in accordance with federal and state permits. The DPW EMD Wildlife Biologist will assist with training for the WDDT. The Members will have documented training on the following initial and recurring (annual) training:

(a) Species identification

(b) Wildlife active/passive control techniques

(c) WASH equipment safety

(d) WWC identification, reporting and downgrading

(e) Safe handling and disposal of wildlife

(2) The WDDT will be activated when wildlife on the airfield creates hazardous conditions. WDDT personnel will have immediate access to necessary wildlife dispersal equipment.

(3) The following offices will be permanent members of the WDDT:

(a) Chief, Airfield Division/Airfield Manager

(b) Airfield Safety Officer

(c) Airfield Operations Officer

(d) DPW Environmental Management Division Chief

(e) Airfield Base Operations personnel

(4) The WDDT will follow procedures outlined in section 5 of this plan.

2-6. Wildlife Hazard Working Group (WHWG): The Wildlife Hazard Working Group is organized to implement and monitor the WASH Program.

a. Authority: The GC or a designated representative will be the WHWG chairman, responsible for the WASH program and is the approval authority for all WHWG recommendations. The AFSO will act as the WHWG coordinator and monitors the effectiveness of the plan. The WASH plan will also be included in the Integrated Natural Resource Management Plan (INRMP) with DPW EMD involvement.

(1) The WHWG members will consist of the following personnel:

(a) Chairman: Garrison Commander (or designated representative)

(b) Directorate of Plans, Training, Mobilization and Security

(c) Chief, Airfield Division/Airfield Manager

(d) Garrison Safety Office

(e) Airfield Safety Officer

(f) Airfield Operations Officer

(g) Airfield Air Traffic Control facility representative

(h) DPW Operations and Maintenance representative

(i) DPW Environmental Management Division representative

(j) Aviation Safety Officers from each of the tenant flying organizations

(2) WHWG meetings will be part of the AOB when required but will meet no less than twice a year. Minutes for the WHWG will be prepared and distributed with the AOB minutes.

b. WHWG Functions:

(1) Execute and update the WASH program.

(2) Monitor compliance with the WASH plan.

(3) Collect, compile and review trend data on wildlife strikes, wildlife watch condition changes and wildlife dispersal activities on or near the airfield/heliport.

(4) Identify and recommend actions to reduce the wildlife hazards.

(5) Recommended changes in operational procedures and airfield environment.

(6) Prepare informational programs and safety briefings for aircrews as required.

(7) Recommend modifications to the program to improve effectiveness.

Chapter 3. Participants Outside Of Airfield Management

3-1. Tennant Flying Organizations: Should assign a primary/alternate WASH POC to represent the organization during Garrison WHWG and develop a unit level WASH program that includes the following minimum elements:

a. Annual aircrew briefing to report airfield wildlife strikes and hazardous conditions.

b. Posting current airfield wildlife condition status and activity data reported by airfield management.

c. Ensure current wildlife activity data is available and briefed for each planned phase of flight.

d. Ensure an adequate supply of WASH report forms and wildlife activity maps are readily available for aircrews (combined with the Hazards map).

e. Seasonal wildlife hazards awareness.

3-2. Aircrews:

a. Should consider and incorporate wildlife hazards into the mission planning and briefing process. See Appendix F.

b. Notify other aircrews and Redstone Army Airfield Base Operations about wildlife sightings.

Chapter 4. WASH Operations

4-1. WASH Planning:

a. The Redstone AAF wildlife hazard assessment (WHA) will provide the foundation from which a more complete and site-specific understanding of potential wildlife hazards. The WHA for RAAF will be conducted by the DPW EMD Wildlife Biologist and is in its planning stages.

b. AAF Description (See airport diagram in Appendix D):

(1) Redstone Arsenal topography is gently rolling elevations primarily in the range of 600-650 feet mean sea level (MSL). Runway elevation at the RAAF ranges approximately from 654-685 (MSL). The terrain generally slopes southward towards the Tennessee River, which is greater than 5 miles south of the RAAF.

(2) No permanent water areas are present on the RAAF.

(3) The majority of the RAAF's 426 acres is developed land surrounded by approximately 28,300 linear feet of security fencing.

(4) Redstone Army Airfield runways are approximately 0.5 miles east of Indian Creek, 0.4 miles north of springs that contribute flow to the tributaries of Indian Creek and approximately 250-1,000 feet from wet weather conveyances to the northeast and west. Storm water flows to all directions and drains primarily towards unnamed tributaries of Indian Creek where topographic relief is greatest.

(5) Currently, the trees and landscaping present on the RAAF include limited growth of eastern red cedar (*Juniperus virginiana*) and other small landscaping vegetation at or within close proximity to inhabited buildings.

(6) Undeveloped land on the RAAF is minor. Native vegetation in the vicinity of the RAAF, outside the security fence, is characterized by mixed mesophytic forests dominated by oaks and hickory, with pine interspersed throughout. Managed timber stands of loblolly pine (*Pinus taeda*) are also located within the vicinity of the RAAF, outside the security fence.

(7) The Redstone Arsenal C&D Landfill is located approximately 3.2 miles SE of the RAAF.

(8) Biofiltration areas are typically located adjacent to large hardstand areas however they are not characterized by standing water and managed to prevent wildlife attraction. These areas are required by the Endangered Species Act as part of a management plan to protect the quality of groundwater for the federally endangered Alabama cave shrimp (*Palaemonias alabamae*).

(9) Redstone Links (golf course) is located approximately 2 miles NE of Redstone AAF.

(10) An unnamed tributary of Indian Creek is located to the south of RAAF. This wetland complex contains Tuscumbia Darter (Etheostoma tuscumbia), a protected species. This area is managed by the DPW EMD Cultural and Natural Resources Branch IAW the AR 200-1, the Sikes Act, the Redstone Arsenal INRMP and other applicable environmental laws and regulations.

(11) There is no designated critical habitat on Redstone Arsenal; however many habitats are present on the Installation, as well as Wheeler National Wildlife Refuge which is located within 2 miles of the RAAF, that support protected species. Members of the WDDT will be educated in identifying protected species and take proactive steps to prevent harm to those species during wildlife management activities.

4-2. WASH Plan Execution:

a. The WHA for RAAF will be conducted by the DPW EMD Wildlife Biologist and is currently in its planning stages. Findings developed from the completed WHA will be later incorporated into the WASH plan to allow full execution by identifying wildlife attractants, modifying and managing wildlife habitat, establishing a Wildlife Watch Warning System, and disseminating wildlife watch conditions (WWC) to ground agencies and aircrews.

b. Wildlife Watch Conditions will be used to establish the Wildlife Warning System. The airfield manager, airfield safety manager or operations officer can declare a wildlife watch condition indicating Low, Moderate or Severe conditions during normal flight operations based on ground observations, pilot reports, radar observations, etc. See Appendix B for WWC definitions.

c. The DPTMS Airfield Division will work in concert with the DPW Operations and Maintenance Division to procure funding for the maintenance of RAAF turf as prescribed in AR 95-2 and TM 5-630. Grass and vegetation height on the airfield should be maintained between 6 to 12 inches in an effort to discourage flocking avian species thus reducing bird/aircraft strike hazards.

d. Bare areas located within the infield of RAAF have been eliminated and seeded with grass. This practice will continue. On-going construction projects will be required to include reseeding of bare areas during land disturbance activities and after project completion in an effort to minimize ideal wildlife roosting and loafing sites.

e. Established ditches will be properly maintained with steep sides and trimmed vegetation in order to prevent standing water on or near RAAF. Any culverts passing under or through the security fence will be regularly inspected for wildlife use and entrance to the airfield. Fencing, gates, or other deterrents will be installed to discourage this behavior.

f. Security fencing will be checked monthly for wildlife breaches, unsecure gates, overgrowth of vegetation on or near the fence, and any other wildlife/security issues. A 25 foot external boundary area will be maintained free of trees or tall brush outside the entire security fence perimeter.

g. Perch, Roost, and Nest Sites such as isolated trees, airfield structures, runway markers, poles, equipment and others will be monitored, managed, and/or removed to prevent birds using them as perches, roosting, and/or nesting sites. The RAAF Manager and/or Safety Officer will provide information to all airfield tenants about the hazards of wildlife using their building post to aircraft as well as information on approved measures to reduce wildlife usage. Current perch, roost, and nesting sites on the RAAF include the limited and patchy growth of landscape trees near inhabited buildings; utility poles; overhead electrical lines; fence lines; and aircraft hangars.

h. Waste Management: All organic wastes will be stored in enclosed containers until collected and removed. Construction containers as well as public trash containers will be covered to limit access by birds and other wildlife.

i. Wildlife Attractants: All personnel will be prohibited from building structures, erecting nesting platforms or boxes, feeding birds, improperly disposing of wastes, or otherwise encouraging birds or other hazardous wildlife in areas of the installation that may threaten flight operations.

j. See additional passive WASH control methods in Appendix H.

Chapter 5. Wildlife Detection Dispersal Team Procedures (WDDT)

5-1. General Dispersal Guidelines.

a. WDDT will actively patrol as-needed and use appropriate active deterrence methods. See Appendix G for WASH dispersal/depredation equipment and methods available.

b. The ATC tower will be notified prior to conducting any wildlife dispersal procedures on the airfield.

c. Vehicle horns and sirens will first be used in attempting to disperse wildlife from aircraft movement areas. Bioacoustics devices or sound cannons may be required if these procedures prove unsuccessful.

d. Pyrotechnic devices such as screamers, whistle bangers, and cracker shells may be used in conjunction with vehicle harassment.

e. If portable propane sound cannons are used on the airfield, they will be relocated periodically to prevent habituation.

f. At this time, Redstone Airfield management does not intend to utilize lethal force. The WASH will be updated accordingly if the use of lethal force becomes necessary.

5-2. Approval Authority for the Use of Weapons: The Garrison Commander is the approval authority for the use of weapons to remove wildlife from RAAF. Lethal methods for depredation will be carried out IAW local, state and federal laws if necessary.

5-3. Procedures for the Use of Pyrotechnics:

a. The ATC tower will be contacted to receive proper clearances prior to discharging pyrotechnics. If aircraft operations are imminent, the WWC will be raised prior to initiating dispersal operations.

b. The Airfield Manager and/or AFSO will be informed prior to discharging pyrotechnics on the flightline.

c. Ear, eye and hand protection will be used as necessary.

d. **WARNING: Pyrotechnics should not be loaded or fired from inside a vehicle.**

Chapter 6. Wildlife Strike Reporting

6-1. Reporting Wildlife Aircraft Strikes:

a. All known or suspected wildlife strikes should be reported to the control tower as soon as possible. Base Operations, Airfield Services, or DPW EMD Wildlife Biologist will attempt to recover any reported wildlife remains located within the airfield.

b. Aircrews will preserve any wildlife remains discovered during post flight inspection (including feather, hair, tissue and/or blood) and notify Base Operations personnel for collection instructions.

c. The FAA Form 5200-7, Bird/Wildlife Strike Report (Appendix I), should be completed by the aircrew or any witnesses and forwarded to Base Operations for reporting purposes to the applicable agencies.

d. Any aircraft damage resulting from a wildlife strike will be reported to the owning organization for reporting and investigation as necessary IAW DA Pam 385-40.

Chapter 7. Recordkeeping.

a. Base Operations will maintain a daily activity log to document wildlife sightings and WDDT activities.

b. Airfield Safety Officer should develop a quarterly summary of the wildlife data collected by the WHWG to be briefed at the airfield operations board and safety council meetings.

Appendix A. Acronyms and Abbreviations

AAF	Army Airfield
AFSO	Airfield Safety Officer
ASO	Aviation Safety Officer
AGL	Above Ground Level
AHAS	Avian Hazard Advisory System
AHP	Army Heliport
AOB	Airfield Operations Board
AR	Army Regulation
ATC	Air Traffic Control
ATIS	Automatic Terminal Information Service
AWOS	Automated Weather Observing System
BAM	Bird Avoidance Model
CCTV	Closed Circuit Television
DOD	Department of Defense
DPTMS	Directorate of Plans, Training, Mobilization and Security
DPW	Directorate of Public Works
DSN	Defense Switch Network
FAA	Federal Aviation Administration
FAAO	Federal Aviation Administration Order
FOD	Foreign Object Damage
ILS	Instrument Landing System
IMCOM	Installation Management Command
INRMP	Integrated Natural Resources Management Plan
IPM	Integrated Pest Management
NEPA	National Environmental Policy Act
NOTAM	Notice to Airmen
MOA	Military Operations Area
MSL	Mean Sea Level
PA	Public Affairs
TA	Trans Alert
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
WASH	Wildlife Aircraft Strike Hazard
WDDT	Wildlife Detection and Dispersal Team
WHA	Wildlife Hazard Assessment
WHWG	Wildlife Hazard Working Group
WHMP	Wildlife Hazard Management Plans
WWC	Wildlife Watch Condition

REFERENCES

AC 150/5200 33B	FAA Advisory Circulars Hazard Wildlife Attractants on or near Airports
AR 95-2	Airspace, Airfields/Heliports, Flight Activities, Air Traffic Control, and Navigational Aids
AR 200-1	Environmental Protection and Enhancement
AR 385-10	Army Safety Program
DA Pam 385-10	Army Safety Program
DA Pam 385-40	Army Accident Investigations and Reporting
DA Pam 385-90	Army Aviation Accident Prevention Program
DoDI 4715.03	Natural Resources Conservation Program
DoDI 4150.07	DOD Pest Management Program
Exec Order 13514	Federal Leadership in Environmental, Energy, and Economic Performance
FM 5-19	Composite Risk Management
IMCOM Pam 385-90-1	Wildlife Aircraft Strike hazard (WASH) Template
IMCOM Sup1 to AR 95-2	Airspace, Airfields/Heliports, Flight Activities, Air Traffic Control and Navigational Aids
UFC 3-260-01	Airfield and Heliport Planning and Design

Appendix B. Explanation of Terms in WASH Plan

a. Active Bird Dispersal.

Harassment techniques employed to disperse wildlife from airfield and surrounding areas. Methods may include chase, pyrotechnics, or bioacoustics.

b. WASH.

Wildlife aircraft strike hazard. Is a general term to describe wildlife hazards and wildlife hazard prevention programs.

c. Wildlife Hazard Working Group (WHWG).

Local committee concerned with the control of wildlife hazards to aviation. Executes and makes recommendations to the WASH program.

d. Wildlife Watch Condition (WWC).

A bird hazard alert condition used to warn aircrew of bird activity.

e. WWC LOW.

A WWC that indicates only sparse concentrations of wildlife are on the airfield in a location that represents little or no hazard to flight operations.

f. WWC MODERATE.

A WWC that indicates moderate concentrations of wildlife are on the airfield in a location that represent a probable hazard to flight operations.

g. WWC SEVERE.

A WWC indicating heavy concentrations of wildlife on or immediately adjacent to the runway, which presents an immediate hazard to base operations; or any concentration of wildlife that presents a danger to aircraft.

h. Bioacoustics.

Tape recordings of distressed bird and predator calls used to disperse birds off of runways and airfield areas.

i. Wildlife Strike.

Any documented collision between wildlife and aircraft which may or may not result in damage.

j. Depredation.

Technique used to remove problem wildlife permanently from the airfield and hangars when other scare tactics are ineffective. Depredation permits are required for most species.

k. Models/decoys.

Various static devices used to disperse birds from airfield areas. Many include scarecrows, decoys, Mylar® tape and eye spots.

l. Propane cannons.

Stationary non-projectile sound producing device used to disperse birds from airfield areas.

m. Pyrotechnics.

Noise-producing devices fired from pistol or shotgun. Used by the WDDT to scare wildlife away from runways and airfield areas. Pyrotechnics are Class 1.4 explosives.

n. Wildlife Detection and Dispersal Team (WDDT).

A roving airfield patrol, which reports WWCs, disperses problem wildlife via chase, bioacoustics, pyrotechnic, or other approved methods.

Appendix C. Wildlife Management Techniques and Recommendations

a. Techniques and recommendations: Bird control and dispersal will primarily be accomplished by airfield operations personnel or the agency responsible for performing airfield inspections/checks. A variety of dispersal and control measures may also be available to other personnel (environmental, security, crash, fire, rescue, deployed duty officers, etc.) to use on an as-needed basis. These measures will be readily available at any time when birds or other wildlife threaten airfield operations. Pyrotechnic equipment will be properly stored.

b. Active harassment.

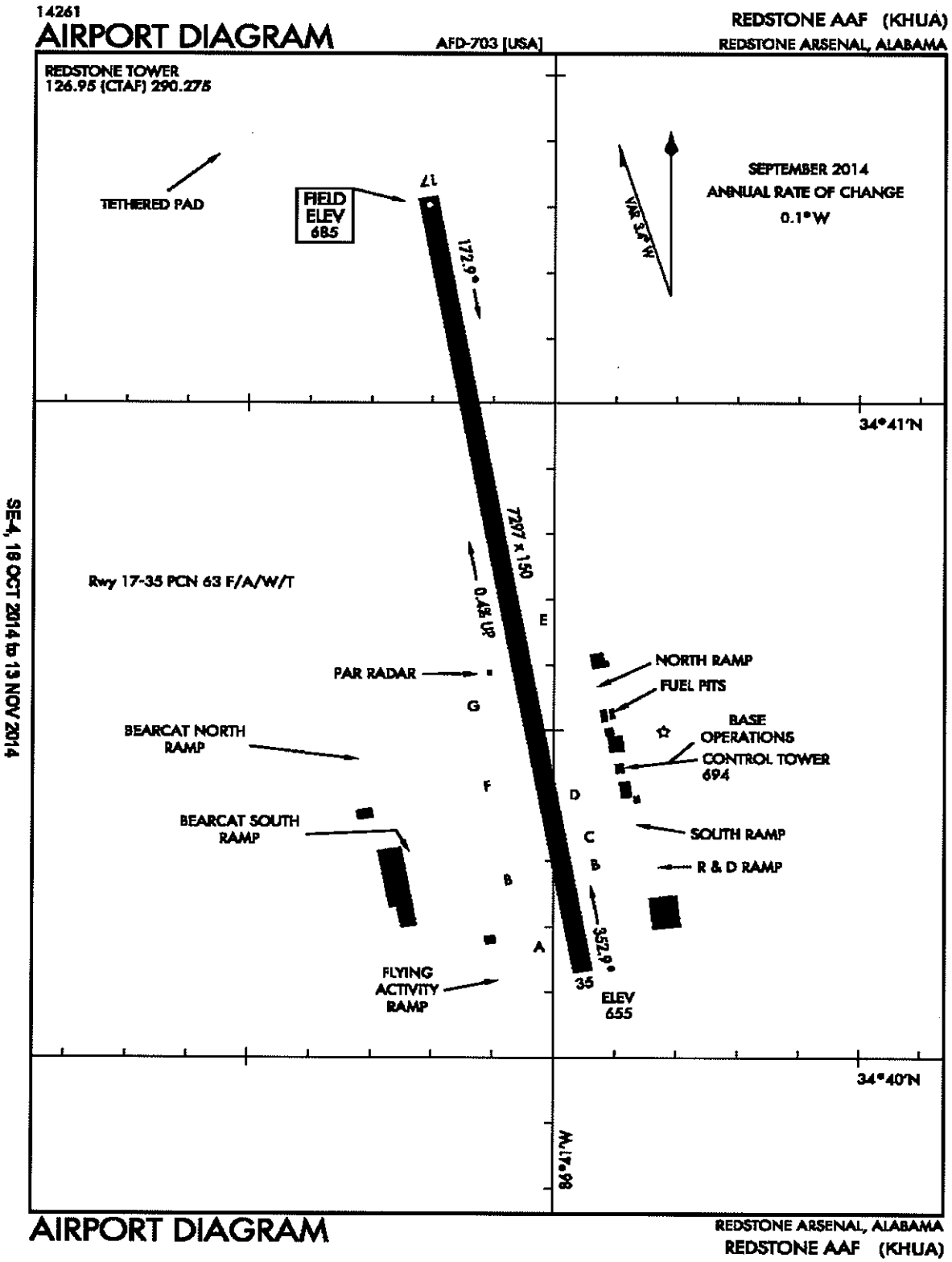
(1) The RAAF will have enough harassment tools to effectively control and harass wildlife on the airfield.

(2) The RAAF anticipates that a combination of human presence, bioacoustics, and pyrotechnics will be enough to prevent birds from landing and feeding.

(3) Bioacoustics with species-specific calls will be used.

(4) Additional harassment techniques such as networks of remotely-triggered gas cannons, radio-controlled model aircraft or others may be used as effective supplements to other dispersal techniques.

Appendix D. Redstone AAF (KHUA)



Appendix E. Local Wildlife Species

Species identified by the WHA will be included in this Appendix. Existing, current knowledge of the common wildlife found at Redstone Arsenal, routine observations by aircrews, and bird surveys at RAAF allows for the following wildlife summary:

a. Avian.

Common avian inhabitants at the RAAF likely include European Starlings (*Sturnus vulgaris*), American Crows (*Corvus brachyrhynchos*), Eastern meadowlarks (*Sturnella magna*), Mourning Doves (*Zenaida macroura*), Red-tailed Hawks (*Buteo jamaicensis*), House Sparrows (*Passer domesticus*), and Killdeer (*Charadrius vociferus*). Owls have also been observed using hangars for roosting. The RAAF will continue to monitor avian use, record avian observations, and actively harass birds under acquired federal and state permits as necessary. Turf maintenance to prevent seed production; bioacoustics; ditch and grounds maintenance to prevent standing water; and measures to deter roosting and perching will be the primary methods of control.

b. Mammals.

Common mammal inhabitants at the RAAF likely include white-tailed deer (*Odocoileus virginianus*), coyotes (*Canis latrans*), gray fox (*Urocyon cinereoargenteus*), raccoons (*Procyon lotor*), armadillos (*Dasypus novemcinctus*), and striped skunks (*Mephitis mephitis*). Small terrestrial mammals (e.g., rodents) are not typically considered a direct threat to aviation but do serve as an attractant to larger predators. Small aerial mammals (e.g., bats) may be considered of lower risk than birds or large mammals to aviation; however, efforts will be made to reduce their use of the airfield. The RAAF will continue to monitor mammal use, record mammal observations, and actively harass mammals under acquired federal and state permits as necessary. Turf maintenance to reduce habitat attraction; fence maintenance to prevent entrance; ditch and grounds maintenance to prevent standing water; measures to deter roosting; and active harassment as previously detailed will be the primary methods of control. If necessary, aircraft flight schedules during times of increased activity (e.g., dusk) may be adjusted to reduce the potential for damaging incidents.

c. Threatened and Endangered Species.

Federally threatened and endangered species and sensitive species protected by the Endangered Species Act, Migratory Bird Treaty Act, Bald and Golden Eagle Protection Act and/or other applicable laws or regulations that may occur in the RAAF area include, but are not limited to, the gray bat (*Myotis grisescens*), Indiana bat (*Myotis sodalis*), Bald Eagle (*Haliaeetus leucocephalus*), and Whooping Crane (*Grus americana*).

Appendix F. USAF Low-Level Bird Avoidance Model (BAM)

a. The BAM is a predictive model using geographic information system (GIS) technology as a key tool for analysis and correlation of bird habitat, migration, and breeding characteristics, combined with key environmental and man-made geospatial data. The value for each cell (or pixel) of the model is equivalent to the sum of the mean bird mass (in ounces), for all bird species present during a particular daily time period, for one of 26 two-week periods in a year. Avian Hazard Advisory System (AHAS) is the dynamic version of the BAM and is available online http://www.usahas.com/. Coverage includes the entire continental United States and Alaska.

b. The bird species data set was derived from discrete geographic information for observations of 60 key WASH bird species, over a 30-year period. Species data was acquired from several key datasets, including the Audubon Societies' Christmas Bird Count, the US Geological Survey's North American Breeding Bird Survey, bird migration patterns for the contiguous US, and additional data specific to particular bird species.

c. The risk levels describe three predicted risk classes — Low, Moderate and Severe, which are based upon the bird mass in ounces per square kilometer. In other words, the risk levels represent the amount of birds (bird mass) in a kilometer squared spatial area. The "Moderate Zone" indicates a risk ratio that is 57-708 times the risk of the "Low Zone", while the "Severe Zone" indicates a risk ratio that is 2,503-38,647 times the risk of the "Low Zone".

d. The model uses the best available data for historical modeling of bird migratory patterns to provide the user with an effective decision making tool. Because birds are dynamic creatures whose migratory behavior is affected by weather events in any given year, the model cannot be said to predict the exact movement of bird species through space and time beyond the biweekly timeframe. Spatial zones indicating a severe risk according to the model should not be ignored and should be avoided. It is not suggested that pilots fly within the "Severe Zone" unless it is absolutely mission essential.

Appendix G. Active WASH Dispersal Equipment

A variety of methods and equipment to utilize for dispersing wildlife may be used at RAAF to control wildlife and have been previously defined. The WDDT will be trained in the use of dispersal equipment at RAAF/approved landing sites annually. Equipment to be used includes, but is not limited to, Static deterrent devices (e.g., scarecrows, silhouettes, effigies); propane cannons; bioacoustics; pyrotechnics; wildlife identification books; safety equipment (e.g., gloves, safety glasses, ear protection, fire extinguishers, procedures for emergency/accident reporting); wildlife strike collection kits; and binoculars.

Appendix H. Passive WASH Control Methods

a. Manage turf height between 6 to 12 inches to prevent seed production, control broad leafed weeds (chemical application for weed control must be reviewed and approved by DPW EMD prior to any use) and minimize maintenance costs.

b. Plant bare or erodible areas with grass mixtures that is designed for areas that receive no supplemental fertilization or irrigation, does not involve invasive or weedy species, promotes native ecosystems and land sustainability, and does not conflict with the military mission at the airfield will be used.

c. Remove/minimize habitat diversity and edge effect. Control woody vegetation on the airfield to promote the most uniform vegetative condition as possible.

d. Remove animal carcasses from the airfield/heliport to avoid attracting scavengers. Coordinate with DPW EMD for identification if necessary..

e. Remove dead vegetation such as brush piles, grass clippings, mulch to prevent wildlife cover use.

f. Practice integrated pest management to control potential food sources (rodents, invertebrates) for larger predators as well as invasive or weedy vegetative species on the RAAF grounds. Coordinate actions with DPW EMD Pest Management Coordinator.

g. Maintain drainage features to prevent standing water on the RAAF grounds. Regularly inspect ditches to keep them clear. Maintain ditch sides as steeply as possible (minimum slope ratio of five to one) to discourage birds and emergent vegetation. Improve drainage as necessary to inhibit even temporary ponds or puddles.

h. Eliminate or manage perching, nesting, and/or roosting sites on fences, poles, trees, and buildings/hangars.

i. Maintain perimeter fence and gates.

j. Several environmental restoration sites have been identified within the RAAF boundaries. Any intrusive work that occurs within these sites must be coordinated with the Installation Restoration Program prior to project implementation.

Appendix I. FAA Form 5200-7, Bird/Other Wildlife Strike Report

Form Approved OMB NO. 2120-0018

U.S. Department of Transportation
Federal Aviation Administration

BIRD/OTHER WILDLIFE STRIKE REPORT

1. Name of Operator	2. Aircraft Make/Model	3. Engine Make/Model

4. Aircraft Registration	5. Date of Incident	6. Local Time of Incident
	____/____/____ Month Day Year	☐ Dawn ☐ Dusk ____ HR ____ MIN ☐ Day ☐ Night ☐ AM ☐ PM

7. Airport Name	8. Runway Used	9. Location if En Route *(Nearest Town/Reference & State)*

10. Height *(AGL)*	11. Speed *(IAS)*

12. Phase of Flight

- ☐ A. Parked
- ☐ B. Taxi
- ☐ C. Take-off Run
- ☐ D. Climb
- ☐ E. En Route
- ☐ F. Descent
- ☐ G. Approach
- ☐ H. Landing Roll

13. Part(s) of Aircraft Struck or Damaged

	Struck	Damaged		Struck	Damaged
A. Radome	☐	☐	H. Propeller	☐	☐
B. Windshield	☐	☐	I. Wing/Rotor	☐	☐
C. Nose	☐	☐	J. Fuselage	☐	☐
D. Engine No. 1	☐	☐	K. Landing Gear	☐	☐
E. Engine No. 2	☐	☐	L. Tail	☐	☐
F. Engine No. 3	☐	☐	M. Lights	☐	☐
G. Engine No. 4	☐	☐	N. Other:	☐	☐

(Specify, if "N. Other" is checked)

14. Effect on Flight

- ☐ None
- ☐ Aborted Take-Off
- ☐ Precautionary Landing
- ☐ Engines Shut Down
- ☐ Other: *(Specify)*

15. Sky Condition

- ☐ No Cloud
- ☐ Some Cloud
- ☐ Overcast

16. Precipitation

- ☐ Fog
- ☐ Rain
- ☐ Snow
- ☐ None

17. Bird/Other Wildlife Species

18. Number or birds seen and/or struck

Number of Birds	Seen	Struck
1	☐	☐
2-10	☐	☐
11-100	☐	☐
more than 100	☐	☐

19. Size of Bird(s)

- ☐ Small
- ☐ Medium
- ☐ Large

20. Pilot Warned of Birds ☐ Yes ☐ No

21. Remarks *(Describe damage, injuries and other pertinent information)*

DAMAGE / COST INFORMATION

22. Aircraft time out of service:	23. Estimated cost of repairs or replacement *(U.S. $)*:	24. Estimated other cost *(U.S. $) (e.g. loss of revenue, fuel, hotels)*:
_____ hours	$	$

Reported by *(Optional)*	Title	Date

Paperwork Reduction Act Statement: The information collected on this form is necessary to allow the Federal Aviation Administration to assess the magnitude and severity of the wildlife-aircraft strike problem in the U.S. The information is used in determining the best management practices for reducing the hazard to aviation safety caused by wildlife-aircraft strikes. We estimate that it will take approximately 5 minutes to complete the form. If you wish to make any comments concerning the accuracy of this burden estimate and any suggestions for reducing this burden, send those comments to the Federal Aviation Administration, Management Staff, ARP-10, 800 Independence Avenue, SW, Washington, DC 20591. The information collected is voluntary. Please note that an agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. The OMB control number associated with this collection is 2120-0045.

FAA Form 5200-7 (3-97) Supersedes Previous Edition

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