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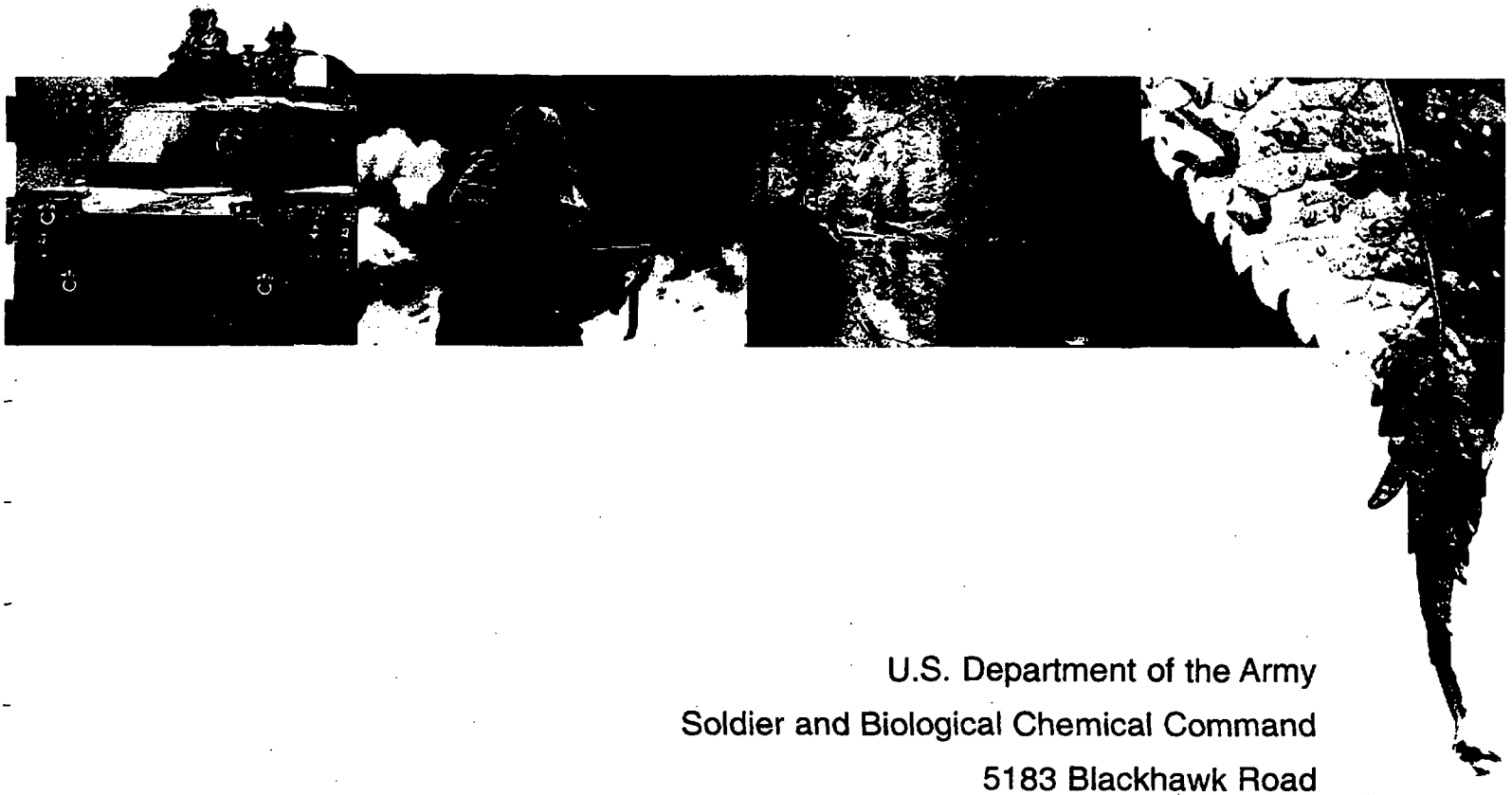
ENVIRONMENTAL REPORT

JEFFERSON PROVING GROUND

MADISON, INDIANA



U.S. Department of the Army
Soldier and Biological Chemical Command
5183 Blackhawk Road
Aberdeen Proving Ground, MD 21010-5424

June 2002

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Final

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ENVIRONMENTAL REPORT
Jefferson Proving Ground
Madison, Indiana

U.S. Department of the Army
Soldier and Biological Chemical Command
5183 Blackhawk Road
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ACRONYMS

°C	degrees Celsius
°F	degrees Fahrenheit
ACHP	Advisory Council on Historic Preservation
ADA	Americans with Disabilities Act
ALARA	as low as reasonably achievable
ANG	Air National Guard
AR	Army Regulation
ARPA	Archeological Resources Protection Act
BGS	below ground surface
BLM	Bureau of Land Management
BRAC	Base Realignment and Closure Act of 1988
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CERFA	Community Environmental Response Facilitation Act of 1992
CFR	*Code of Federal Regulations*
cfs	cubic feet per second
cm	centimeter
cm/sec	centimeters per second
COC	chemical of concern
DCGL	derived concentration guideline limit
DOD	U.S. Department of Defense
DP	Decommissioning Plan
DU	depleted uranium
E	Endangered
EA	Environmental Assessment
EIS	Environmental Impact Statement
EO	Executive Order
EPA	U.S. Environmental Protection Agency
ER	Environmental Report
FE	Federally Endangered
FMP	Fire Management Plan
FONSI	Finding of No Significant Impact
FS	Feasibility Study
FT	Federally Threatened
ft	foot or feet
ft^3	cubic feet
FWS	U.S. Fish and Wildlife Service
GPR	ground-penetrating radar
HE	High Explosives
IANG	Indiana Air National Guard
IDEM	Indiana Department of Environmental Management
IDNR	Indiana Department of Natural Resources
in.	inches
INSC	Indiana Special Concern
IRP	Installation Restoration Program
IWI	Index of Watershed Indicators
JPG	Jefferson Proving Ground
kg	kilogram

km	kilometer
km^2	square kilometers
KSNPC	Kentucky State Nature Preserves Commission
KYE	Kentucky Endangered
KYSC	Kentucky Special Concern
m	meter
m^3	cubic meters
m^3/sec	cubic meters per second
MIDCOR	Madison-Jefferson County Industrial Development Corporation
mm	millimeter
MMI	Modified Mercalli Intensity
MOA	Memorandum of Agreement
mrem/yr	millirem per year
MW	monitoring well
MWH	Montgomery Watson Harza
NA	not applicable
NAGPRA	Native American Graves Protection and Repatriation Act
NaI	sodium iodide
NCDC	National Climatic Data Center
NCSHPO	National Conference of State Historic Preservation Officers
NE	Northeast
NFA	No Further Action
NHPA	National Historic Preservation Act
NMSS	Office of Nuclear Material Safety and Safeguards
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
NRHP	National Register of Historic Places
NW	Northwest
NWR	National Wildlife Refuge
NWS	National Weather Service
%	percent
pCi/g	picocuries per gram
pCi/L	picocuries per liter
ppb	parts per billion
R	Rare
RAB	Restoration Advisory Board
RESRAD	Residual Radiation
RI/FS	Remedial Investigation and Feasibility Study
Rust E&I	Rust Environment and Infrastructure
S	South
SAIC	Science Applications International Corporation
SARA	Superfund Amendments and Reauthorization Act of 1986
SBCCOM	Soldier and Biological Chemical Command
SEG	Scientific Ecology Group
SHPO	State Historic Preservation Officer
SRP	Standard Review Plan
STOLS	surface-towed ordnance locator system
STV	Save the Valley
SVOC	semivolatile organic compound
T	Threatened
TEDE	Total Effective Dose Equivalent

U	uranium
USACE	United States Army Corps of Engineers
USACHPPM	United States Army Center for Health Promotion and Preventive Medicine
USAEC	United States Army Environmental Center
USAF	U.S. Air Force
USATSDR	U.S. Agency for Toxic Substances and Disease Registry
USDA	U.S. Department of Agriculture
USDHHS	U.S. Department of Health and Human Services
USGS	United States Geological Survey
UXO	unexploded ordnance
VOC	volatile organic compound
WHO	World Health Organization
WL	watch list
µCi	microcurie
µm	micrometer
µR/hr	microroentgen per hour

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1.0 INTRODUCTION

This Environmental Report (ER) was prepared in support of the U.S. Army's Proposed Action to terminate its Nuclear Regulatory Commission (NRC) license at the Jefferson Proving Ground (JPG), located in Madison, Indiana. The strategy and program for management of JPG, in general, and the depleted uranium (DU) impact area, in particular, have evolved as the regulations pertaining to DU have developed and changed. Information related to the Proposed Action is derived from numerous source documents, which are referenced throughout this report. The Decommissioning Plan (DP) [U.S. Army 2002b] includes additional information related to the U.S. Army's proposed action to terminate NRC License SUB-1435.

1.1 FACILITY OPERATING HISTORY

The Army's mission at JPG was to perform production and post-production tests of conventional ammunition components and other ordnance items and to conduct tests of propellant ammunition/weapons systems and components. The base was closed in September 1995 under the Defense Authorization Amendments and Base Realignment and Closure Act of 1988 (BRAC). The NRC license was amended for possession of DU only in May 1996 (NRC 1996a) until license termination.

The installation is divided into two areas separated by a firing line consisting of 268 gun positions formerly used for testing ordnance. An east-west fence separates the area north of the firing line from the cantonment area. The firing line demarcates the ordnance impact area to the north from the cantonment area to the south. The cantonment area houses the support facilities that were used for administrative ammunition assembly and testing, vehicle maintenance, and residential housing. The area north of the firing line consists of 51,000 acres (206 km^2) of undeveloped and heavily wooded land and contains the NRC-licensed area [Science Applications International Corporation (SAIC) 1997a]. The DU Impact Area is located in the south-central portion of this area, as shown on Figure 1-1.

JPG was used as a proving ground from 1941 to 1994. During this time, more than 24 million rounds of conventional explosive ammunition were fired. Approximately 1.5 million rounds did not detonate upon impact, remaining as high explosive unexploded ordnance (UXO) either on or beneath the ground surface. In addition, the Army estimates that 7 million inert filled rounds with live detonators, primers or fuzes did not function properly (SAIC 1997a).

Under NRC license SUB-1435, the Army tested DU projectiles and munitions from 1983 to 1994 (NRC, Docket 040-08838). This testing was conducted in approximately a 2,080-acre [8.4-square kilometer (km^2)] area located in the south–central portion of the installation, referred to as the DU Impact Area (Figure 1-1, located at the end of this report). During its 10-year use, more than 220,462 pounds (100,000 kg) of DU projectiles were fired into the DU Impact Area (SEG 1995, 1996). Approximately 66,139 pounds (30,000) kilograms (kg) of DU have been removed. This surface recovery occurred semiannually when the installation was operational and resulted in removal of most of the DU projectiles located on the ground surface. Approximately 154,323 pounds [70,000 kg] of DU remain in the DU Impact Area, which also contains one of the largest concentrations of UXO [Scientific Ecology Group (SEG) 1995, 1996]. Removal of the remaining DU would be extremely difficult, posing high risks to workers and costing $45 million to $1.6 billion because of the necessity to complete surface and subsurface remediation in the presence of UXO (see Sections 5.1 and 6).

NRC license SUB-1435 was amended for possession of DU only in May 1996 (NRC 1996a) until license termination. Amendment 10 currently is in effect. NRC License No. 13-12416-01, for the use of scandium-46, was terminated in 1993. Other radionuclides were used under a general Army-wide license.

The DU varies in size from microscopic particles to complete projectiles (SEG 1996). Other NRC-licensed activities at JPG included the storage of DU in buildings located in the cantonment area of the installation. This portion of the site was released for unrestricted use in 1996. The Indiana State Department of

(This oversized figure can be found in the sleeve at the end of this report.)

Figure 1-1. Jefferson Proving Ground

Health, Division of Indoor and Radiological Health, concurred with the findings and recommendations for release of this latter area (NRC 1996b).

The DU projectiles were fired from three fixed gun positions on the firing line at soft targets placed at intervals of 3,280 feet (ft) [1,000 meters (m)], starting at 3,280 ft (1,000 m) from the gun position and continuing to 13,123 ft (4,000 m). Because of the type of testing performed, the DU projectiles would impact in approximately the same location each time on their respective lines-of-fire (SEG 1996). This firing protocol, with repeated impacts in the same area, resulted in the formation of a trench approximately 3.4 ft (1 m) deep by 16.4 to 26.3 ft (5 to 8 m) wide extending for approximately 3,937 ft (1,200 m) at the most frequently used gun position. The primary impact location was the trench. Secondary impact locations developed when the projectile skipped, either whole or in fragments. A similar pattern was repeated at each of the other two firing positions but to a lesser extent and magnitude because a smaller quantity of DU was fired from each of these locations (SEG 1996).

1.2 PURPOSE AND NEED FOR ACTION

The active Army mission at JPG ceased on September 30, 1994. Under the Defense Authorization Amendments and BRAC, all mission activities at JPG ceased and were realigned to Yuma Proving Ground, Arizona (SAIC 1997a). Therefore, with the termination of mission operations at the installation, the Army is required to terminate the NRC license for the DU Impact Area. In accordance with 10 *Code of Federal Regulations* (*CFR*) 40.42, the Army notified the NRC of the decision to terminate the NRC license and release the DU Impact Area with a restriction on future land use.

1.3 THE PROPOSED ACTION

The Proposed Action is license termination under restricted conditions. More specifically, the NRC license SUB-1435 would be terminated, and institutional control of the DU Impact Area would be maintained through physical, administrative, and legal mechanisms. Section 4.1 provides additional detail on this proposed action.

1.4 OTHER ENVIRONMENTAL PROGRAMS

Environmental restoration programs at JPG are being conducted under the BRAC Installation Restoration Program (IRP). An environmental restoration program has been in place at JPG for approximately 11 years. In support of the BRAC process, the Army currently is completing a remedial investigation and feasibility study (RI/FS) to evaluate the area south of the firing line and to recommend cleanup activities [Montgomery Watson Harza (MWH) 2002]. These investigations are described in Section 3.2.2. This work has been conducted under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and in compliance with applicable Department of the Army requirements. The area north of the firing line has had limited investigation because of the physical hazards associated with UXO (SAIC 1997a).

A Restoration Advisory Board (RAB), an advisory organization composed of local citizens and staff from the Army, the U.S. Environmental Protection Agency (EPA), the Indiana Department of Environmental Management (IDEM), and county officials, was established in 1994 under CERCLA and the BRAC program. The RAB, which meets quarterly, provides the public and community an opportunity to identify environmental and reuse issues and concerns and to participate in the Army's decision-making process. Meeting minutes are documented and included in the Administrative Record. The U.S. Army developed

and is implementing its Community Involvement Plan (SAIC 1997b) and maintains a web site to inform the public on the site closure process (http://jpg.sbccom.army.mil/). Public participation requirements associated with 10 *CFR* Part 20.1403 (d) are being conducted through this forum.

In addition, the Army has been identifying and transferring property in accordance with the Community Environmental Response Facilitation Act of 1992 (CERFA) [Earth Technology Corporation 1994]. CERFA amended Section 120 (h) of CERCLA, establishing requirements to identify real property that can be reused and redeveloped. To date, approximately 1,469 acres (6 km^2) located south of the firing line have been transferred for private, recreational, or commercial use. In addition, approximately 2,400 acres (9.8 km^2) south of the firing line are being leased to a local businessman. Currently, 765 acres (3 km^2) are in the process of being transferred. A UXO clearance of approximately 300 acres (1.2 km^2) located south of the firing line began in November 2001 (see http://jpg.sbccom.army.mil/). Disposition of this additional approximate 300 acre parcel south of the firing line and west of the Airfield area (west of Tokyo Road and south of Woodfill Road) has not been determined.

UXO present on JPG is managed in accordance with the U.S. Army and U.S. Army Engineering and Support Center, Huntsville, requirements involving ordnance and explosives (OE) investigations and removal actions. UXO potentially is present throughout the 55,264-acre (224-km^2) facility (USACE 1995).

1.5 APPLICABLE REGULATORY REQUIREMENTS, PERMITS, AND REQUIRED CONSULTATIONS

This section identifies agreements, consultations, and permits relating to the management of JPG, including the DU Impact Area. Table 1-1 summarizes the consultations completed in support of installation operations and BRAC closure.

1.5.1 Memorandum of Agreement and Permits

A Memorandum of Agreement (MOA) [Appendix A] between the U.S. Army, U.S. Air Force (USAF), and the U.S. Fish and Wildlife Service (FWS), signed in May 2000, establishes a framework to authorize the future use of the firing range by the FWS and USAF and assigns responsibilities for the management of the area of JPG north of the firing line (.S. Army 2000a). These responsibilities include shared infrastructure management activities, including maintaining buildings, roads, fencing, and signs (see Enclosure 5 of the MOA). The MOA grants permits to both organizations, which remain in effect for 25 years and may be renewed for additional 10-year periods upon mutual agreement of all parties. Separate permits (U.S. Army 2000b and c) have been issued by the Army to the FWS and USAF defining the terms and conditions associated with the use of the property (Appendix A).

Under the MOA, the Army retains the authority, responsibility, and liability for contamination (including UXO and DU) resulting from past Army activities. The Army also is authorized to conduct specific activities in the area north of the firing range, such as environmental remediation, UXO technology demonstrations, and property administration (e.g., site inspections). The Army is required to consult with the FWS and USAF prior to transferring fee title or property interests in the firing range.

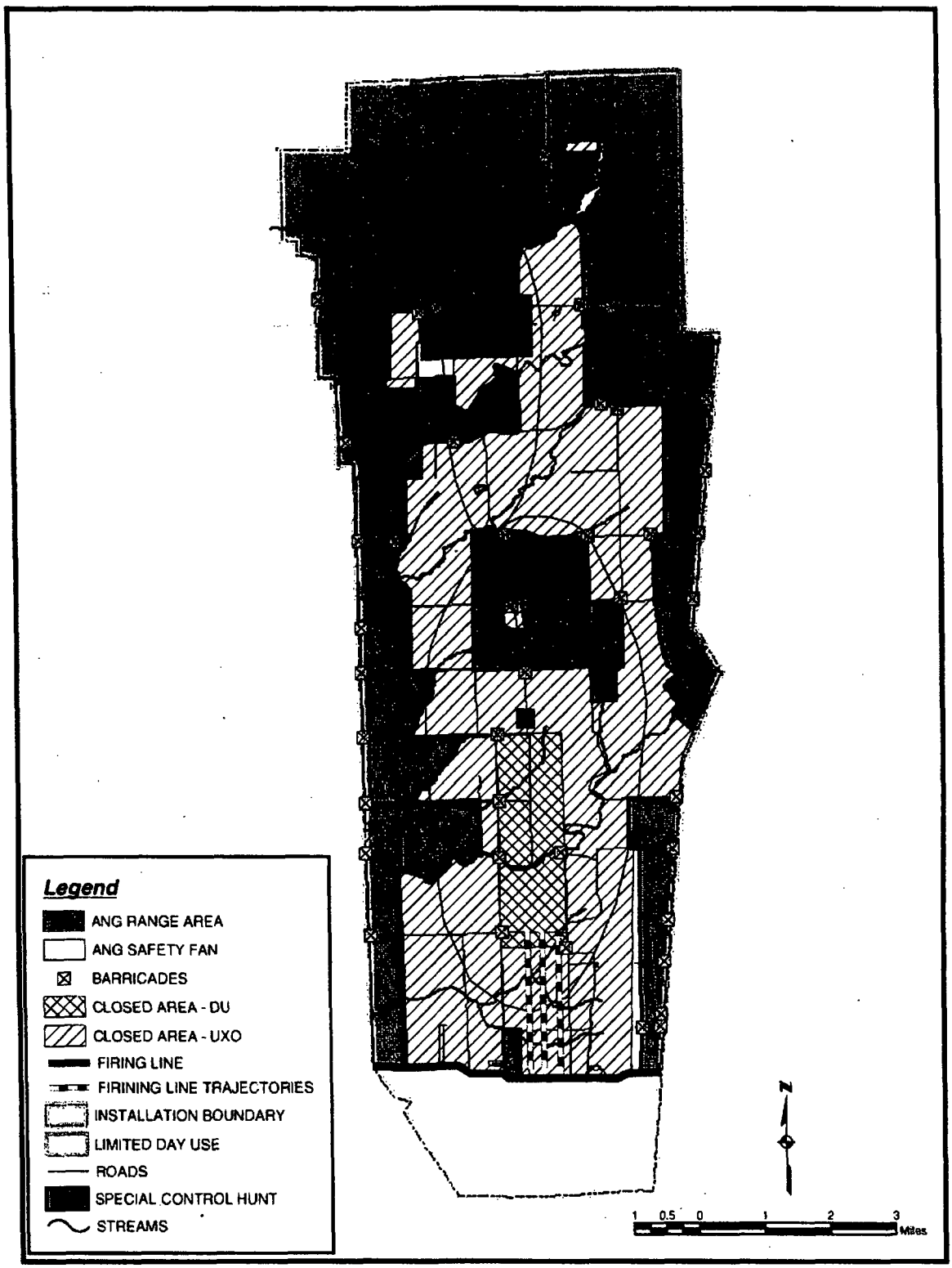
The FWS is responsible for providing UXO, DU, and environmental contamination safety/awareness training to all personnel and visitors to the Big Oaks National Wildlife Refuge (NWR) and maintaining infrastructure elements not maintained by the USAF. The MOA includes an interim public access plan that identifies requirements and protocols for public access to the Big Oaks NWR. This plan also outlines FWS, Army, and USAF-related responsibilities regarding safety briefings, entry procedures, types of

Table 1-1. Consultations and Agreements Completed at JPG to Support Operations and BRAC Closure

Consultation	Applicable Law or Regulation	Activity	Status	Reference
Retrocession of Authority	• U.S. Code Section 2683 (a) • Indiana Code Annotated Sections 4-20.5-18-1 to 2.20.5-18-3	Retrocession of exclusive jurisdiction	Complete	U.S. Army 1995a
Cultural Resources Management Plan	• NHPA of 1966 • EO 11593 • ADA of 1992 • ARPA 1979 • NAGPRA of 1990 • AR 200-4 and 420-40 • MOA between DA, Advisory Council on Historic Preservation, and Indiana State Historic Preservation Officer • MOA between U.S. Army, ACHP, and NCSHPO	Identification, evaluation, and management of historic properties	Complete	Geo-Marine 1996
Fish and Wild life Management Plan	• Fish and Wildlife Conservation Act of 1958 • Endangered Species Act of 1973 • Migratory Bird Treaty Act of 1918	Development of plan to manage fish and wildlife resources	Complete	FWS 1994a
National Wildlife Refuge	• National Wildlife Refuge Administration Act of 1966 • MOA and permit for JPG Firing Range	Establishment of National Wildlife Refuge	Complete	U.S. Army 2000a and b
Bombing Range	• MOA and permit for JPG Firing Range • Air Force Instruction 13-2-2, Test and Training Ranges	Continued Use of the Bombing Range	Complete	U.S. Army 2000a a and c

ACHP = Advisory Council on Historic Preservation.
ADA = Americans with Disabilities Act.
ARPA = Archeological Resources Protection Act.
AR = Army Regulation.
BRAC = Base Realignment and Closure Act of 1988.
EO = Executive Order.
FWS = U.S. Fish and Wildlife Service.
MOA = Memorandum of Agreement.
JPG = Jefferson Proving Ground.
NAGPRA = Native American Graves Protection and Repatriation Act.
NHPA = National Historic Preservation Act.
NCSHPO = National Conference of State Historic Preservation Officers.

public use and areas of accessibility (see Figure 1-2), and monitoring and control procedures. Public use of the Big Oaks NWR is limited to hunting, fishing, wildlife observation, photography, and guided tours. The maximum one-time capacity on the refuge is limited to 423 people during deer hunting season in November. Visitors to the Big Oaks NWR must check in and check out and receive a safety briefing at the refuge office before being issued a public access permit. Public access to the refuge is controlled strictly at one gate and is limited to two areas: limited day use recreation and special controlled hunting zones. All of these recreational areas were used previously in the Army recreation program. Public use areas are delineated by maps and on signs placed at strategic locations within the Big Oaks NWR.



Source: SAIC 1997a.

Figure 1-2. Potential Public Use of Big Oaks National Wildlife Refuge

C01

In support of its responsibilities under the MOA, the FWS has issued several related documents. These documents include an Interim Comprehensive Conservation Plan (FWS 2001a), a Big Oaks NWR Interim Hunting and Fishing Plan (FWS 2001b), an Interim Compatibility Determination (FWS 2001c), a Fire Management Plan (FMP) [FWS 2001d], and an Environmental Assessment (EA) [FWS 2001e]. The FMP describes the goals, objectives, and procedures for implementing prescribed fires within the Big Oaks NWR. Prescribed burns are used to enhance habitat critical to maintain the diversity of plant community and associated wildlife species. Two of the four fire management units outlined in this plan encompass the DU Impact Area. The EA addresses the impact of implementing the FMP at the Big Oaks NWR. The FWS determined that this proposed action would have no significant impact on the environment. Accordingly, a Finding of No Significant Impact (FONSI) was issued.

The USAF via the Indiana Air National Guard (IANG) (hereafter referred to as USAF/IANG) operates the Jefferson Range Operations Center within a demarcated area north of the firing line. The Jefferson Range consists of 983 acres (3.9 km^2) used as the primary training range, a 50-acre (0.2-km^2) precision-guided munitions target, and the Old Timbers Lodge and the surrounding 5 acres (0.02 km^2).

All access to the range is through the Big Oaks NWR. Each range has an associated weapons safety footprint. The primary training range has a composite footprint of approximately 5,100 acres (20.6 km^2). The precision-guided munitions target has a composite footprint of approximately 14,860 acres (60.1 km^2) [see Figure 1-1].

During flight operations, only USAF/IANG personnel are permitted access into the weapons safety footprints. When the USAF/IANG is not using the safety footprints, the FWS has access to this area. Access to the range is controlled through four gates. USAF/IANG personnel or their contractor maintain and inspect the JPG perimeter fence. The USAF/IANG also maintains the barricades on access roads to the footprint of the precision-guided munitions target and interior areas north of the firing line. These barricades are located where the interior roads exit to the eastern and western perimeter roads. The USAF/IANG also maintains UXO safety signs on the perimeter fence and gates, as well as radiation hazard signs around the perimeter of the DU Impact Area.

1.5.2 Section 106 Consultation

Cultural resources at JPG are addressed in the Amended Programmatic Agreement \between the Army, Advisory Council on Historic Preservation (ACHP), and the National Conference of State Historic Preservation Officers (NCSHPO) (U.S. Army 1992a) as well as the MOA between the Army, ACHP, and the Indiana State Historic Preservation Officer (SHPO)[U.S. Army 1992b]. All of the National Register of Historic Places (NRHP)-listed or NRHP-eligible properties at JPG are protected, preserved, or mitigated for loss if primary or secondary impact is unavoidable. The MOA indicates that properties of unknown NRHP eligibility must be considered potentially eligible and should be protected and preserved until the NRHP evaluation process is complete (SAIC 1997a).

JPG's Cultural Resources Management Plan provides guidelines and procedures to identify, evaluate, and manage historic properties under its jurisdiction (Geo-Marine 1996). Plans and procedures for inventorying cultural resources and assessment of archaeological sites and resources for nomination to the NRHP have been in effect since the mid-1990s. To date, there are two buildings and four bridges at JPG listed on the NRHP.

1.5.3 Other Permits

Prior to installation closure in 1995, JPG maintained various permits in support of mission operations. These permits included a Resource Conservation and Recovery Act of 1976 (RCRA) permit (Part A,

"Interim," and Part B, "Application"), a National Pollutant Discharge Elimination System (NPDES) permit, a Fire Training Permit, an Open Burning/Open Detonation Permit, and an Air Permit. After installation closure, these permits were transferred or allowed to expire. Currently, there are no permits in effect at JPG (MWH 2002).

As a result of the installation's closure, the Federal government retroceded exclusive jurisdiction over JPG to the State of Indiana. In effect, the state was granted the authority to enforce its laws for activities occurring on the facility (U.S. Army 1995a).

The U.S. Army was issued and maintains NRC license SUB-1435 pursuant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974, and 10 *CFR* Chapter I, Parts 30–40 and 70. A request to terminate this license under restricted conditions currently is under evaluation (U.S. Army 2002b).

1.6 ORGANIZATION OF THIS REPORT

This ER includes the following sections:

- Section 1.0 – This section provides an overview of the purpose and need for the proposed action, other environmental programs at JPG, and applicable regulations, permits and consultations.
- Section 2.0 – In this section the site location and environmental condition is described.
- Section 3.0 – The nature and external contamination in the DU Impact Area is described.
- Section 4.0 – The Proposed Action and alternatives are identified in this section.
- Section 5.0 – In this section, the impact of the Proposed Action and alternatives is assessed.
- Section 6.0 – This section presents the as low as reasonably achievable (ALARA) analysis results.
- Section 7.0 – References in this report are specified.
- Appendices – The following appendices are included in this report:

  Appendix A – Permits and Memorandum of Agreement

  Appendix B – JPG Photos

  Appendix C – Visual Resource Inventory

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2.0 FACILITY DESCRIPTION

The characterization of the existing environment is based primarily on information contained in the 1995 Final Environmental Impact Statement (EIS) that evaluated disposal and reuse of JPG (U.S. Army 1995b) and the RI/FS [Rust Environment and Infrastructure (Rust E&I) 1994, 1998; MWH 2002], and supplemented by Internet searches to obtain current information. The discussion of land use north of the firing line is based on information from the MOA between the U.S. Army, USAF, and FWS, signed in 2000 (U.S. Army 2000a) and the Department of Army's permits with the USAF and FWS (U.S. Army 2000b and c) [Appendix A].

2.1 SITE LOCATION AND DESCRIPTION

Prior to closure and property transfers (see Section 2.3) JPG occupied approximately 55,264 acres (224 km^2) in Jefferson, Jennings, and Ripley Counties in southeastern Indiana. JPG is located west of U.S. Highway 421, approximately 5 miles (8 km) north of Madison, Indiana. Major metropolitan areas include Louisville, Kentucky, approximately 60 miles (96 km) southwest; Cincinnati, Ohio, approximately 75 miles (121 km) northeast; and Indianapolis, Indiana, approximately 100 miles (161 km) north-northwest (SAIC 1997a). The installation is located approximately 8 miles (13 km) north of the Indiana-Kentucky border (Figure 2-1).

The DU Impact Area is approximately 17,283 ft (5,268 m) long and 5,240 ft (1,597 m) wide and covers an area of approximately 2,080 acres (8.4 km^2). The northern and southern boundaries of the DU Impact Area are F Road and slightly south of C Road, respectively. Morgan Road and Wonju Road form the western and eastern boundaries, respectively (see Figure 1-1).

There is inconsistency in source documentation (e.g., SEG 1995, 1996; U.S. Army 1995b; NRC 1995, 1996c, 2000a) on the shape and size of the DU Impact Area. The size and borders depicted in this ER are consistent with the SEG reports, the NRC's annual safety reviews of the site (NRC 2001a), and the signage present around the perimeter of the DU Impact Area.

The terrain in the area is rolling with both wooded and grassy areas. In addition to the natural rolling topography, there are several munitions-made trenches. Man-made features are limited, but a fence system (7 ft (2.1 m) chain link topped with V-shaped, three-strand barbed wire) surrounds the entire installation, and an east-west fence (7 ft [2.1 km] chain link topped with V-shaped, three-strand barbed wire) separates the area north of the firing line from the cantonment area.

2.2 SOCIOECONOMICS AND POPULATION

The DU Impact Area is located in Jefferson County, which has a population of approximately 31,705 people. The county has undergone approximately 6.4 percent (%) growth from 1990 to 2000, based on 1990 and 2000 census data (U.S. Census Bureau 2000). The nearest population center is the city of Madison, Indiana, which has a population of 12,004 people, approximately one-third of the Jefferson County population. The 2000 census data indicate that approximately 85,782 people live in Jefferson, Jennings, and Ripley Counties combined, covering a radius of more than 15 miles (24 km) from the DU Impact Area. The population in Jefferson, Jennings, and Ripley Counties is projected to increase an average of 2.8, 5.0, and 4.1%, respectively, every 5 years to the year 2020, based on the 1990 census data (U.S. Census Bureau 2000). Table 2-1 indicates the population trends in the vicinity of JPG.

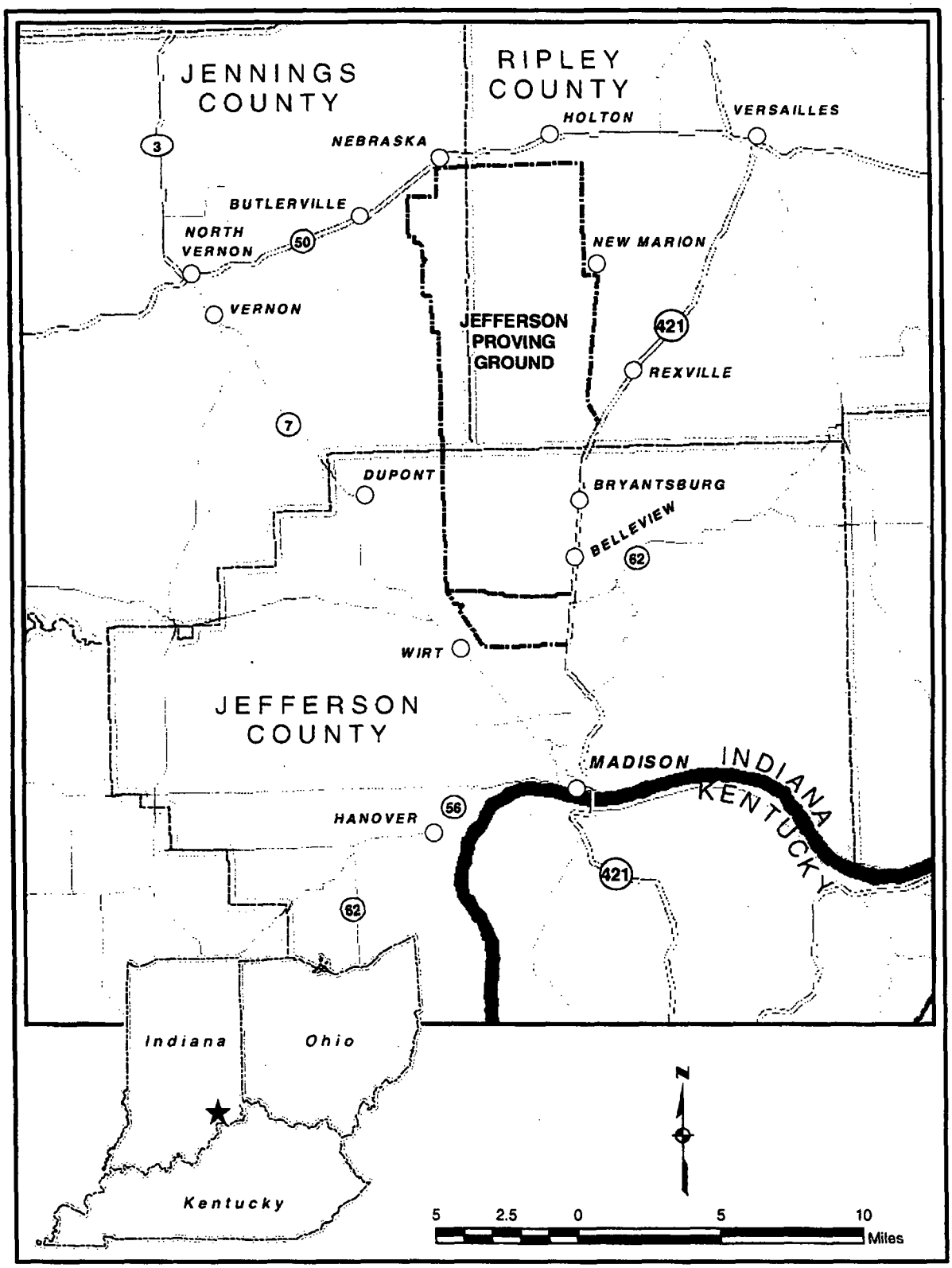


Figure 2-1. Jefferson Proving Ground, Indiana

Table 2-1. Population Trends Near Jefferson Proving Ground

Location	Compass Vector	Population			Population by Race				Household Income				
		2000 Population	% Change (1990–2000)	2020 Projected Population[c]	% White	% Black	% Asian	% Other	Median Income	% Under Poverty Level[d]	% Under $50K	% $50-$100K	% Over $100K
State of Indiana[a]	NA	6,080,485	9.7	6,481,489	87.5	8.4	1.0	3.1	$37,909	9.9	NA	NA	NA
Jefferson County[a]	NA	31,705	6.4	35,340	96.2	1.5	0.6	1.7	$33,630	11.6	NA	NA	NA
City of Madison[a]	S	12,004	NA	NA	94.6	2.4	0.8	2.2	$37,651	NA	68.6	25.9	5.6
Jennings County[a]	NW	27,554	16.5	33,404	97.5	0.7	0.3	1.5	$32,121	9.8	NA	NA	NA
City of North Vernon[b]	NW	20,144	NA	NA	98.3	1.1	0.3	0.2	$37,013	NA	70.1	24.9	5
Ripley County[a]	NNE	26,523	7.7	30,983	98.3	0	0.4	1.3	$36,854	9.7	NA	NA	NA
City of Versailles[b]	NE	4,145	NA	NA	99.5	0	0.3	0.2	$34,242	NA	71.3	22.9	5.8
4-Mile (6.4-km) Radius of DU Impact Area[e]	NA	6,943	NA	NA	99.7	0.2	0	0.1	NA	NA	NA	NA	NA

[a]Source: U.S. Census Bureau 2000.
[b]Source: CACI 2000.
[c]Calculated from 1990 census data (U.S. Census Bureau 2000).
[d]Source: U.S. Department of Agriculture (USDA) 1997.
[e]Number biased high (overestimates the actual population) because the census block groups used in the analysis cover an area of 282.9 mi^2 (732.8 km^2) instead of 50.3 mi^2 (130 km^2) [the area within a 4-mile (6.4-km) radius].
NA = Not applicable.

The average minority population in the State of Indiana is 12.5%. The minority population within Jefferson, Jennings, and Ripley Counties averages approximately 2.7% of the total population in these counties as shown in Table 2-1. The minority population within the immediate area [i.e., a 6.4-km (4-mile) radius of the installation] is less than 0.3% of the population living within that radius. The highest median income of $36,854 occurs in Ripley County. The lowest median income of $32,121 occurs in Jennings County. Approximately 12% of people residing in Jefferson County have incomes below poverty level [U.S. Department of Agriculture (USDA) 1997], defined as an income of $17,650 for a family of four [U.S. Department of Health and Human Services (USDHHS) 2001].

Property tax rates in 2001 in Jefferson County ranged from 7.5541 to 9.9703, averaging 8.005 (i.e., $8.005 per $100 of assessed value). These rates are similar to those applied in Ripley and Jennings Counties (see http://www.in.gov/dlgf/taxrates/archive.html) [Indiana State Board of Tax Commissioners 2002]. The distribution of the assessed property value is approximately 35% commercial/industrial, 32% residential, 14% agricultural, and 19% utilities (http://www.stats.indiana.edu/profiles/pr18077.html) [State of Indiana and Indiana Department of Commerce 2002].

The major industry in Jefferson County is automotive manufacturing, supporting heavy-duty trucking, Toyota, and automotive lifts. Approximately 4,000 people are employed in this industry, with approximately 850 working for Grote Manufacturing. Other industries in Jefferson County are chemicals and plastics companies, which employ a small fraction (approximately 200 people) of the population (SAIC 2001a).

Farming in Jefferson County includes the following crops: corn (110 bushels/acre), soybeans (34 bushels/acre), hay [3 tons/acre (2,722 kg/acre)], and tobacco [2,100 pounds/acre (952 kg/acre)]. The growing season lasts from approximately May 5 to October 15.

Active munitions testing at JPG ceased in September 1994. The number of employees at JPG has dropped from 421 at the time of base closure to a full-time staff of three people (U.S. Army 1995b). Currently, 13 businesses located in the cantonment area employ approximately 100 people for metal stamping, plastics molding, welding, tooling, engineering, and other manufacturing activities (see Section 2.3). Thirteen houses and several apartments also are present, providing homes to approximately 50 people, all adults (SAIC 2001b).

The FWS maintains a full-time staff of six permanent positions for maintenance of the Big Oaks NWR (SAIC 2001c). There are no residents north of the firing line.

The U.S. Army has identified and addressed community interests and concerns throughout its operation and during installation closure. The community involvement program, documented in JPG's Community Involvement Plan (SAIC 1997b), includes the opportunity to participate in the installation's RAB.

Key community groups and planning organizations in this region are identified below:

- **Save the Valley (STV)** – A non-profit volunteer organization for protection of air, water, and land in the Valley of the Ohio River between Lawrenceburg, Indiana, and Louisville, Kentucky. STV represents environmental and public interests before regulatory agencies and at all levels of the court system and has been an active participant in the JPG RAB (see http://www.oldmadison.com/stv/).

- **Jefferson County** – Planning for the county is implemented through the Jefferson County Area Planning Commission (except for Madison and Hanover) [see the Jefferson County website: http://www.indico.net/counties/JEFFERSON/].

- **The Madison-Jefferson County Industrial Development Corporation (MIDCOR)** – A non-profit organization whose mission is to facilitate retention/expansion of existing industries and to attract

new, complimentary industries to Jefferson County and Historic Madison, Indiana (see http://www.madisonindiana.org/midcor/).

- **Ripley County** – Planning for the county is implemented through the Area Planning Commission (see the Ripley County website: http://www.indico.net/counties/RIPLEY/).

- **Jennings County** – Planning for the county is implemented through the Jennings County Area Planning Commission (see the Jennings County website http://www.indico.net/counties/JENNINGS/).

2.3 LAND USE

The majority of land surrounding JPG is rural agricultural (see Figure 2-2). The adjacent land use has changed little since establishment of the installation in the 1940s and has been used predominantly for small family farms since the early 1800s. JPG is surrounded by several small rural towns. Approximately 100 farmhouses and other dwellings are located within 1 mile (1.6 km) of JPG's southern border (Rust E&I 1998; MWH 2002). The major local crops are tobacco, corn, and soybeans.

The FWS established the Big Oaks NWR in the area north of the firing line in June 2000. Under a MOA (Appendix A) between the U.S. Army, USAF, and the FWS, the Army will retain ownership of the land and the FWS will operate the Big Oaks NWR on a 25-year lease with 10-year renewal options. The Big Oaks NWR encompasses more than 50,000 acres (202 km^2) of grasslands, woodlands, and forests, including the DU Impact Area. Access to approximately 24,000 acres (97 km^2) of land is restricted by the FWS within the refuge because of the occurrence of both UXO and DU.

The IANG also operates a bombing range north of the firing line. The bombing range includes an approximately 50-acre (0.2-km^2) precision-guided munitions range, an approximately 983-acre (4-km^2) conventional bombing range, and approximately 5 acres (0.02 km^2) associated with the Old Timbers Lodge (Figure 1-1). These areas are excluded from the real estate permit for the refuge. When in use, the bombing ranges have large safety fans. FWS personnel and visitors are excluded from the bombing ranges (inclusive of the safety fan) during flight operations involving training munitions or laser energy (U.S. Army 2000a and c).

To date, approximately 1,469 acres (6 km^2) located south of the firing line have been transferred for private, recreational, or commercial use. In addition, approximately 2,400 acres (9.8 km^2) south of the firing line are being leased to a local businessman. This property is used for light industrial, commercial, agricultural, and residential purposes. The fee title will be transferred as the parcel is remediated of ordnance and other contamination.

2.4 METEOROLOGY/CLIMATOLOGY AND AIR QUALITY

The climate at JPG is mid-continental with frequent changes in temperature and humidity because of the low- and high-pressure systems that routinely pass through the area and the occasional influx of warm, humid air from the Gulf of Mexico. During the summer, the temperatures average from the mid-70 to the mid-80 degrees Fahrenheit (°F) [21 to 27 degrees Celsius (°C)]. On average, the temperature exceeds 90°F (32.2°C) for 39 days a year. Winter temperatures generally range from 22 to 35°F (-5.6 to 1.7°C) [MWH 2002].

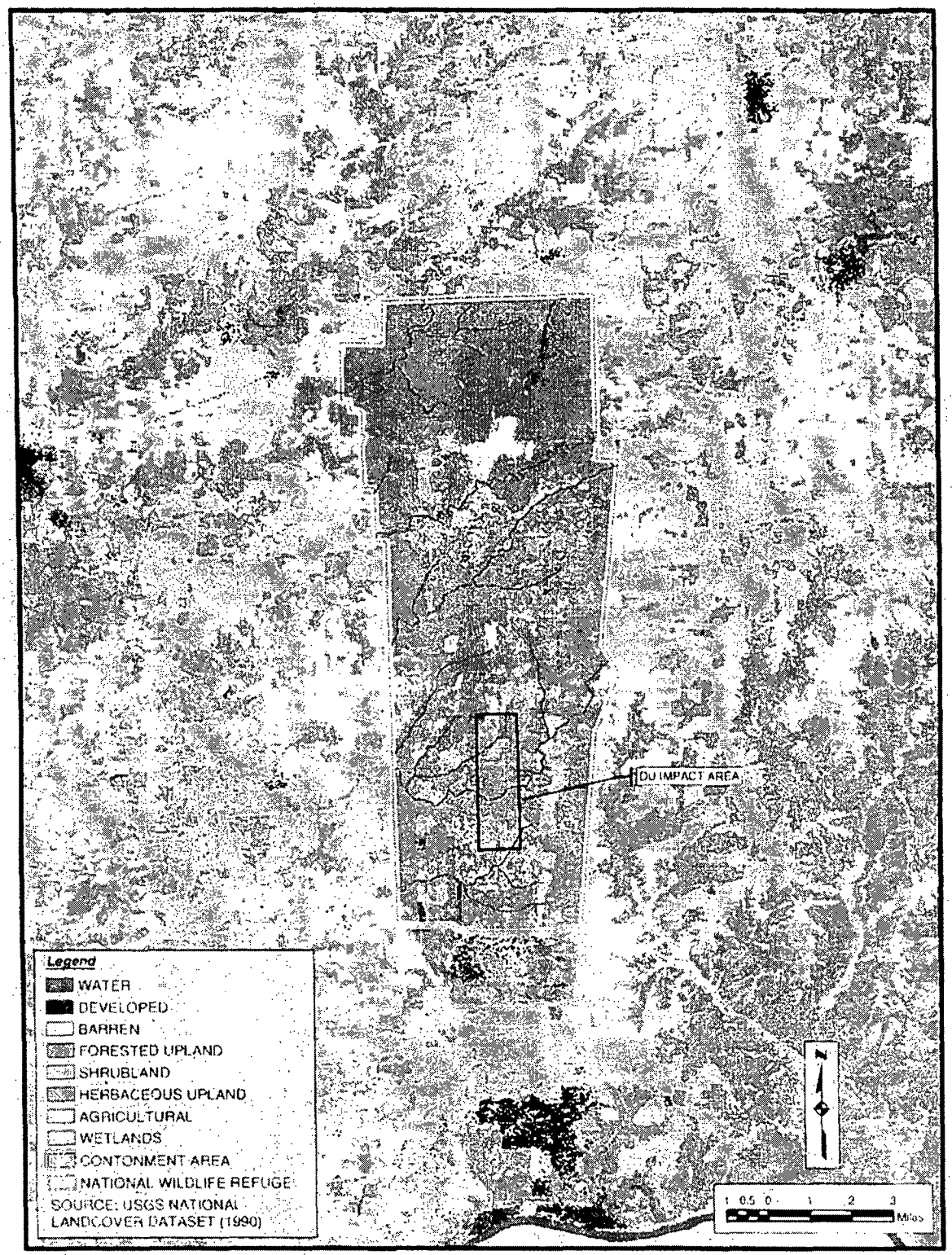


Figure 2-2. Land Use at JPG and Surrounding Areas

C02

Thunderstorms with high rainfall intensities and damaging winds are common during the spring and summer months. Heavy fog, reducing prevailing visibility to ¼-mile (0.4 km) or less, occurs an average of 18 days a year. The prevailing wind direction is to the south with an average velocity of less than 10 miles (16 km) per hour (MWH 2002). The total annual precipitation is approximately 42 to 44 inches (in.) [107 to 112 centimeters (cm)], with nearly 50% occurring during the growing season from May to October. Precipitation is greater than or equal to 0.5 in. (1.3 cm) approximately 28 days per year. Table 2-2 presents climatological data for southern Indiana.

There are four weather stations located in Jefferson County, three of which are active (COOP ID 122184 and 125237 and WBAN 53814). These stations collect limited data (e.g., minimum/maximum temperature, precipitation, etc.) that may be accessed from the National Climatic Data Center (NCDC) [see http://www.ncdc.noaa.gov/]. Information on wind speed and direction at all heights is not available in this region. The closest location where related data are collected is Wilmington, Ohio [National Weather Service (NWS) 2002]. Wind speed and direction data may be obtained from Indianapolis, Indiana, and Louisville, Kentucky. Data for the 30-year period ending in 1990 from the Louisville International Airport are provided in Table 2-3 (NWS 2002). These values are consistent with those reported in MWH (2002).

The FWS installed and began operation of a weather monitoring station within the Big Oaks NWR in April 2002. Typical data collected include rain, wind, temperatures, and relative humidity. Seasonal or trend data are not available given the short duration the station has been operational.

Air monitoring stations are located at six locations in Jefferson County (Wilson Road, Bacon Ridge Road, K Road, Graham Road, Kent Hall-State Hospital, and Sunrise Golf course), which at various points in time were used to monitor for total suspended particulates, sulfur dioxide, nitrogen dioxide, and/or nitrous oxides. The Wilson Road station was the only active station in 2001, which monitored sulfur dioxide. This information is based on EPA's air pollution database, AIRS.

The JPG region also is subject to tornadoes, which are most common in southeastern Indiana from May through July. A tornado occurred at JPG in 1998. The tornado path traversed the area north of the firing line, entering the installation north of F Road and exiting the installation at approximately H Road (see Figure 1-1). If the tornado followed a straight path, it would have touched down approximately 2.5 miles (4 km) north of the DU Impact Area. According to the NCDC, for the period from 1950 to 1995, an annual average of 20 tornadoes per year occurred in the State of Indiana. The annual average number of strong–violent tornadoes (F2–F5 on the Fujita scale) in Indiana is 7 (NCDC 2001).

The State of Indiana's ambient air quality standards are identical to the National Ambient Air Quality Standards. Air quality monitoring is conducted under the IDEM's Office of Air Management. JPG is located in a region that complies with both State of Indiana and Federal ambient air quality standards (IDEM 2001). During operation, JPG was not classified as a major source contributor to air pollution (U.S. Army 1995b). No emission sources are associated with the DU Impact Area.

2.5 GEOLOGY, SOILS, AND SEISMOLOGY

Information on JPG's bedrock and glacial geology, soils, and seismology are provided in Sections 2.5.1, 2.5.2, and 2.5.3, respectively.

2.5.1 Bedrock and Glacial Geology

JPG is located on the western flank of the Cincinnati Arch, a broad structural feature that separates the Illinois and Appalachian Basins (Figure 2-3). Most of the installation is covered by a layer of Pleistocene

Table 2-2. Climatology of Jefferson Proving Ground

Month	Temperature[b]					Precipitation[c]				
				2 Years in 10 Will Have			2 Years in 10 Will Have			
	Average[a] (°F)	Average Maximum[a] (°F)	Average Minimum[a] (°F)	Maximum Higher Than[a] (°F)	Minimum Lower Than[a] (°F)	Average[a] (Inches)	Less Than[a] (Inches)	More Than[a] (Inches)	Average # of Days with 0.10 Inch or More[a]	Average Snowfall[a] (Inches)
Jan	33.0	42.0	24.0	67	-3	3.21	1.8	4.36	7.36	5.4
Feb	36.7	46.7	26.7	69	1	3.34	1.52	4.82	7	2.3
Mar	44.5	55.4	33.7	80	14	4.48	2.48	6.1	9	2.9
Apr	55.8	68.4	43.5	86	25	4.03	2.02	5.66	9	0.1
May	65.2	77.5	52.8	93	33	4.48	2.59	6.01	8	0
Jun	73.8	85.3	62.2	97	45	4.01	2.36	5.46	7	0
Jul	77.0	88.1	65.9	98	51	3.76	2.18	5.03	7	0
Aug	75.8	87.3	64.2	98	50	2.61	1.18	3.78	5	0
Sep	70.1	82.3	57.9	97	40	3.15	1.49	4.49	6	0
Oct	59.0	71.4	46.5	88	27	2.6	1.27	3.68	5	0
Nov	46.4	56.3	36.5	79	14	3.25	1.78	4.44	6	0.6
Dec	35.7	44.7	26.8	70	2	3.05	1.54	4.29	6	1.8
Average	56.1	67.1	45.1	—	—	—	—	—	6.8	1.09
Extreme	—	—	—	102	-5	—	—	—	—	—
Total	—	—	—	—	—	41.97	35.46	48.16	82	13.1

[a]Source: MWH 2002 (data recorded in the period 1951–1976 at Madison, Indiana).
[b]To convert from Fahrenheit to Celsius, subtract 32 and multiply by 5/9.
[c]To convert from inches to centimeters, multiply by 2.54.

Table 2-3. Average Monthly Wind Speed and Direction from 1960–1990, Louisville International Airport

Month	Wind Speed (miles per hour)[a]	Direction (Degrees)
January	9.6	290
February	9.6	300
March	10.1	310
April	9.8	180
May	8.0	180
June	7.4	180
July	6.9	180
August	6.4	180
September	6.8	180
October	7.2	180
November	9.0	180
December	9.1	180
Average	8.3	180

Source: NWS 2002.
[a]To convert from miles/hour to km/hour, multiply by 1.61.

glacial deposits that overlies Paleozoic bedrock. These deposits average about 25 ft (7.6 m) in thickness, and range in thickness from 3.5 to 45 ft (1.1 to 13.7 m) [Figure 2-4]. The underlying bedrock consists of interbedded limestone, dolomite, and shale. The bedrock thickness encountered in wells drilled south of the firing line has varied from approximately 10 to 65 ft (3 to 20 m) [MWH 2002]. The thickness of the underlying bedrock formations is variable, as shown on the cross-section of the cantonment area in Figure 2-5, reflecting the installation's location on the Cincinnati Arch. For example, the Louisville Limestone has a thickness of approximately 50 ft (15.2 m) on the western edge of the installation but pinches out to the east (Figure 2-5) [MWH 2002].

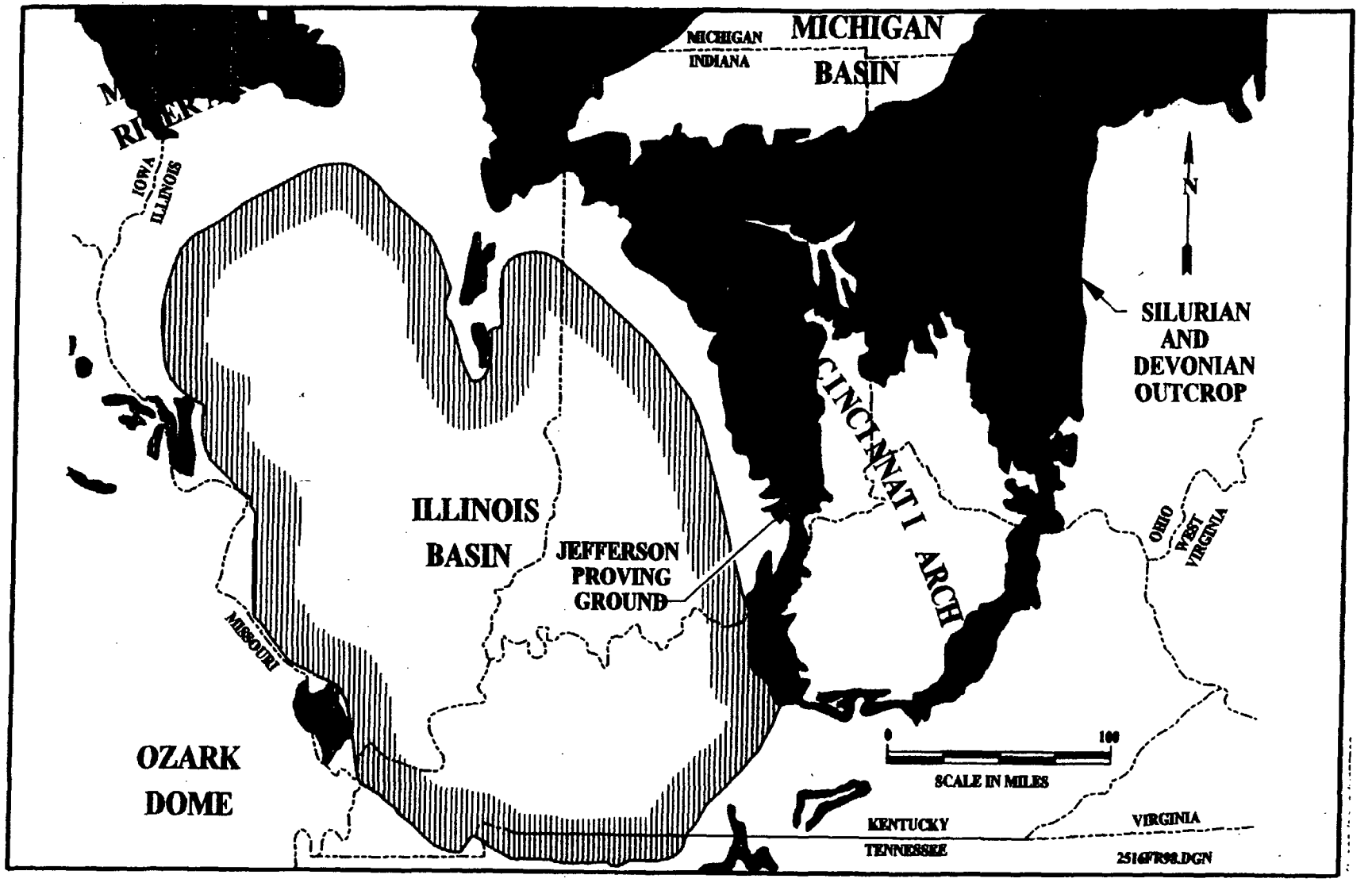
Within the DU Impact Area, the depth to bedrock ranges from 2 to more than 19 ft (0.6 to more than 5.8 m) based on the stratigraphy in the groundwater monitoring wells in this area. The bedrock in this area is described as fine-grained, light-to-medium gray limestone with shale streaks.

The overlying glacial deposits south of the firing line consist of interbedded silts and clays, and silts with gravel, based on a review of borehole logs from wells drilled on the installation. Closer to the bedrock contact, the glacial deposits contain chert, dolomite, and limestone rock fragments overlain by silt and clay layers that contain discontinuous gravel lenses (MWH 2002).

Within the DU Impact Area, the glacial deposits are described as brown, silty clay containing some black gravel/rock fragments and some chalky white rock fragments. From the ground surface to a depth of 1 to 1.5 ft (0.3 to 0.5 m) below ground surface (BGS) has been disturbed from detonation.

2.5.2 Soils

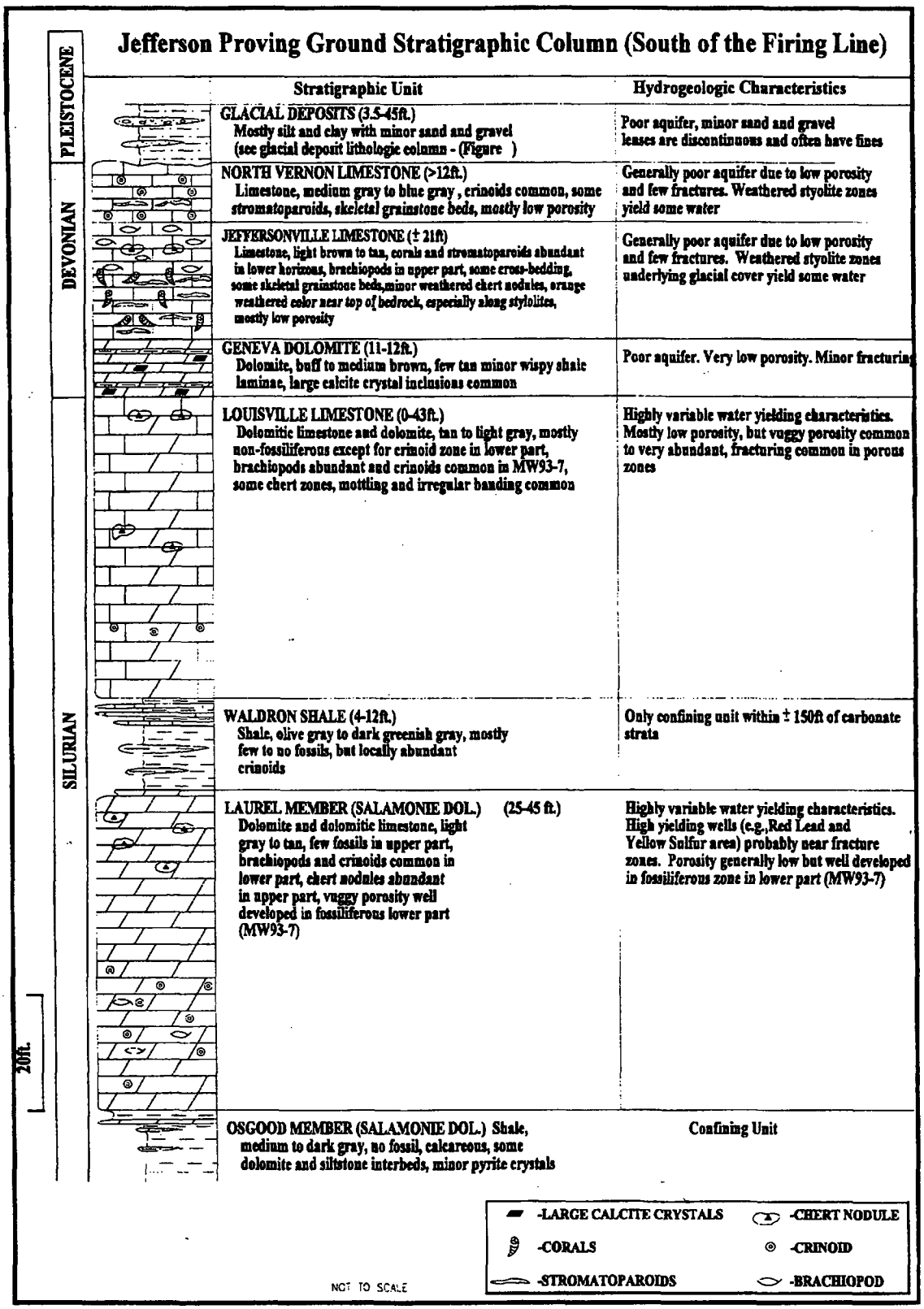
Soils at JPG developed from glacially derived parent material. There are two major soil associations present on the installation: Cobbsfork-Avonburg and Cincinnati-Rossmoyne Hickory (Figure 2-6). The Cobbsfork-Avonburg soils are present on upland glacial drift plains characterized by smooth topography with slopes ranging from 0 to 4%. The nearly level Cobbsfork soils have a seasonal high water table and are located on tabular divides. Typically, these soils have surface and subsurface layers composed of grayish-brown silt loam; both layers are about 6 in. (0.15 m) thick. The Avonburg soils also have a seasonal high water table and are located in relatively broad tabular divides and upper back slopes. These soils have a low-permeability fragipan in the subsoil. These soils have a brown silt loam surface layer about 10 in. (0.25 m) thick (MWH 2002).



Source: MWH 2002.

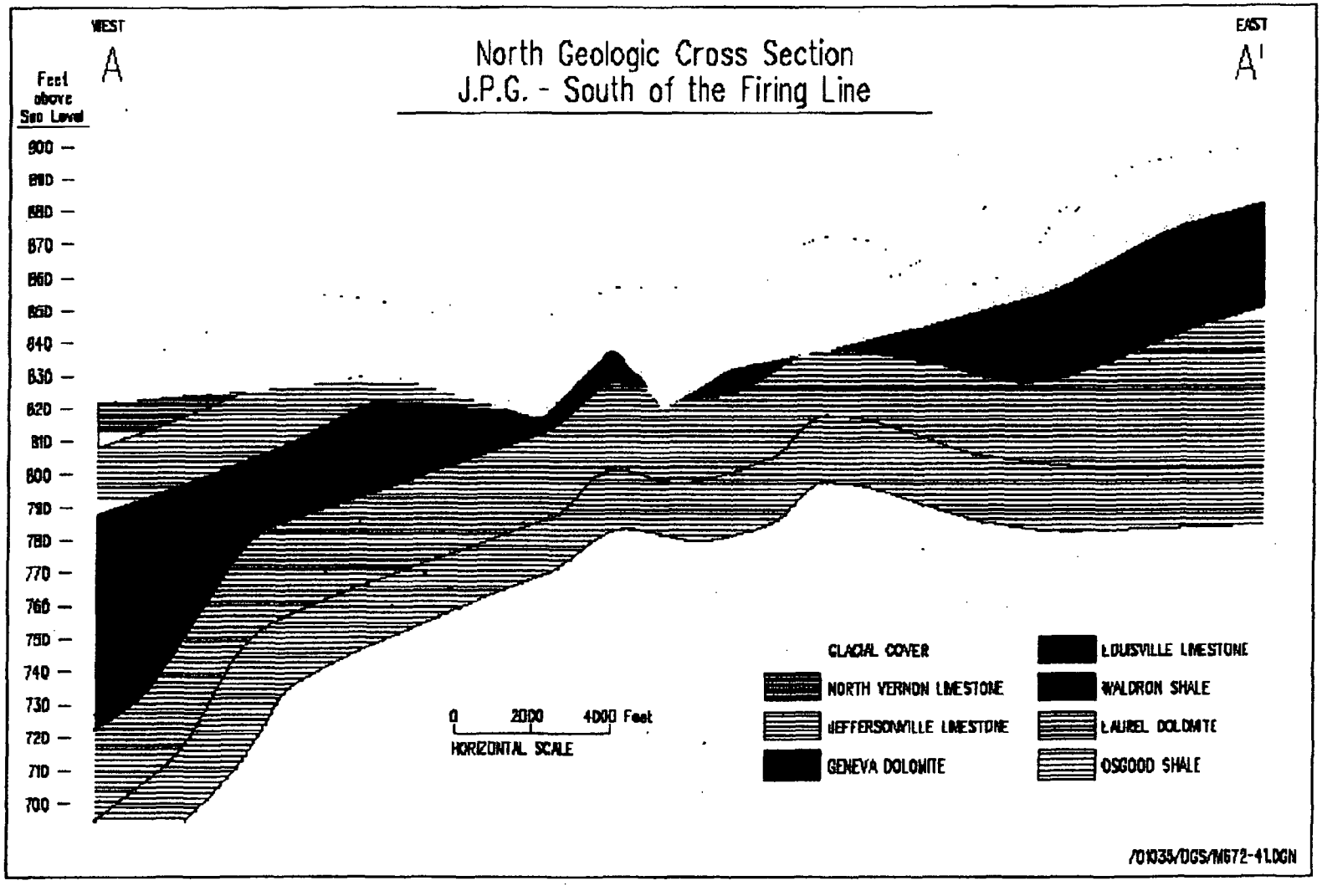
Figure 2-3. Regional Structural Setting of Jefferson Proving Ground

C03



Source: MWH 2002.

Figure 2-4. Stratigraphic Column for Jefferson Proving Ground



Source: MWH 2002.

Figure 2-5. West-East Cross-Section Across the Cantonment Area at Jefferson Proving Ground

C04

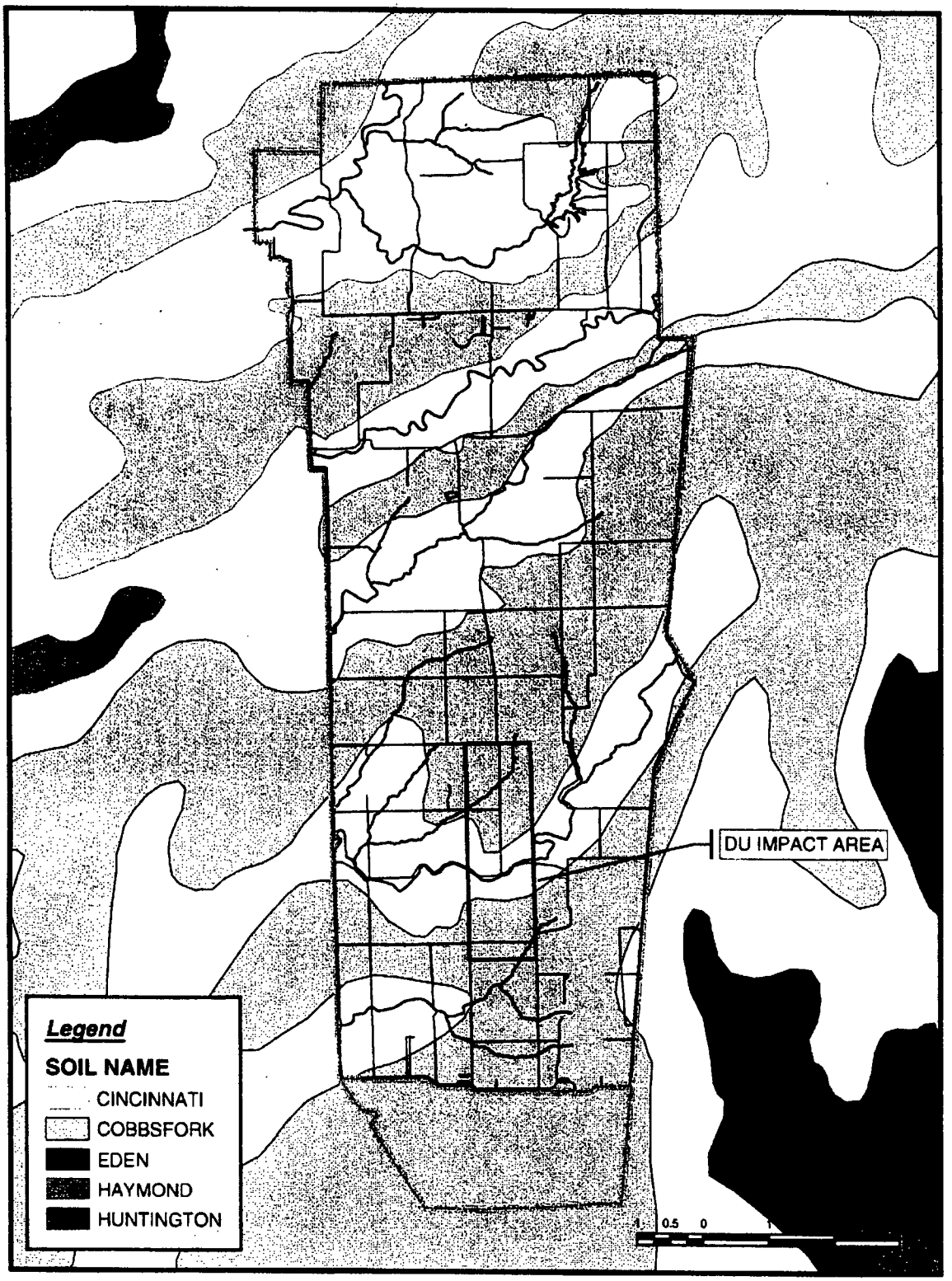


Figure 2-6. Major Soil Associations Present at JPG

C05

The nearly level and gently sloping, moderately drained Rossmoyne soils are located on summits, shoulder slopes, and upper back slopes and have a low-permeability fragipan in the subsoil. Typically, these soils have a dark brown silt loam surface layer about 8 in. (0.23 m) thick. The gently sloping to moderately sloping, well-drained Cincinnati soils are located on summits, shoulder slopes, and back slopes and have a low-permeability fragipan in the subsoil. The dark brown surface layer is about 6 in. thick (MWH 2002).

Soils within the DU Impact Area vary depending on the location. Six different types of soils occur either on or adjacent to stream beds. These soils are described as silt loam, loam, and silty clay loam. At more inland locations, the soil type is generally deep and moderately well drained, with slopes of 0 to 35%, occurring mainly on the ridge tops, breaks, and hillsides. Further inland, the soil type is generally nearly level to gently sloping, somewhat poorly drained, and located on tabular divides (U.S. Army 1995b).

Seismology

The U.S. Geological Survey (USGS) maps of seismic hazards published in 1997, for Central and Eastern United States (CEUS), were reviewed to determine the potential seismic hazard for the JPG site (USGS 2001a). The number of earthquakes within radii of 100 and 200 miles (161 and 322 km) of Modified Mercalli Intensity (MMI) IV (note that an earthquake of Richter Magnitude 4 ~ 5 is comparable to an earthquake with MMI IV ~ V) or greater over the last 100 years are listed in Table 2-4. A total of 24 earthquakes of MMI IV have occurred within 200 miles (322 km) of the site since 1901. No earthquakes of MMI IV have occurred within 50 miles (80 km) of the site over the last 100 years. The largest magnitude earthquake recorded was magnitude 5.5 in November 1968 at a distance of approximately 172 miles (276 km) from the site.

Table 2-4. Historical Earthquakes Within 200 miles (322 km) of the JPG

Date	Location		Depth (km)[b]	Magnitude	Distance (km)[b]
	Latitude (degrees)	Longitude (degrees)			
May 17, 1901	38.75	-83.00	NR[a]	4.2	210
September 27, 1909	39.80	-87.20	NR	5.1	189
March 14, 1921	39.50	-87.50	NR	4.4	196
November 27, 1922	37.80	-88.50	NR	4.8	291
April 27, 1925	38.20	-87.80	NR	4.8	217
September 2, 1925	37.80	-87.50	NR	4.6	212
November 5, 1926	39.10	-82.10	NR	3.8	289
September 30, 1930	40.30	-84.30	NR	4.2	192
September 20, 1931	40.43	-84.27	5	4.7	206
March 2, 1937	40.49	-84.27	2	5.0	211
March 9, 1937	40.47	-84.28	3	5.4	209
June 20, 1952	39.64	-82.02	9	4.0	307
January 2, 1954	36.60	-83.70	NR	4.3	286
September 7, 1956	36.44	-83.79	5	4.1	297
November 8, 1958	38.44	-88.01	5	4.4	229
November 9, 1968	37.91	-88.37	21	5.5	276
April 3, 1974	38.55	-88.07	14	4.7	232
January 19, 1976	36.87	-83.86	1	4.0	254
June 17, 1977	40.71	-84.71	1	3.2	220
July 27, 1980	38.19	-83.89	6	5.1	148
June 29, 1984	37.70	-88.47	2	4.1	293
July 12, 1986	40.54	-84.37	10	4.6	213
June 10, 1987	38.71	-87.95	10	5.2	220
September 7, 1988	38.14	-83.88	10	4.6	152

Source: USGS 2001a.
[a]NR = Not reported.
[b]To convert from k to miles multiply bty 0.621
km = kilometer.

A review of the seismicity in this area reveals that the greatest threat at the site could result from the so-called New Madrid Seismic Zone (NMSZ). Based on the Peak Ground Acceleration (PGA) hazard parameters (based on the USGS 2001a) for the JPG Site, an earthquake with a 1,000-year return period could result in a PGA of approximately 0.047 g at the JPG site (U.S Army 2002b).

2.6 WATER RESOURCES

Surface water (Section 2.6.1) and groundwater (Section 2.6.2) hydrology are discussed in this section.

2.6.1 Surface Water Hydrology

Surface water features are abundant at the installation and include ponds, lakes, streams, and wetland areas, along with numerous ephemeral streams, ponding sites, and wet areas. Seven streams and their tributaries drain the JPG area, generally flowing from northeast to southwest, and include Otter Creek, Graham Creek, Little Graham Creek, Marble Creek, Big Creek, Middle Fork Creek, and Harberts Creek (Figure 2-7). JPG lies within the White River Drainage Basin (a sub-basin of the Wabash River Basin, which is a sub-basin of the Ohio River Basin) [U.S. Army 1995b].

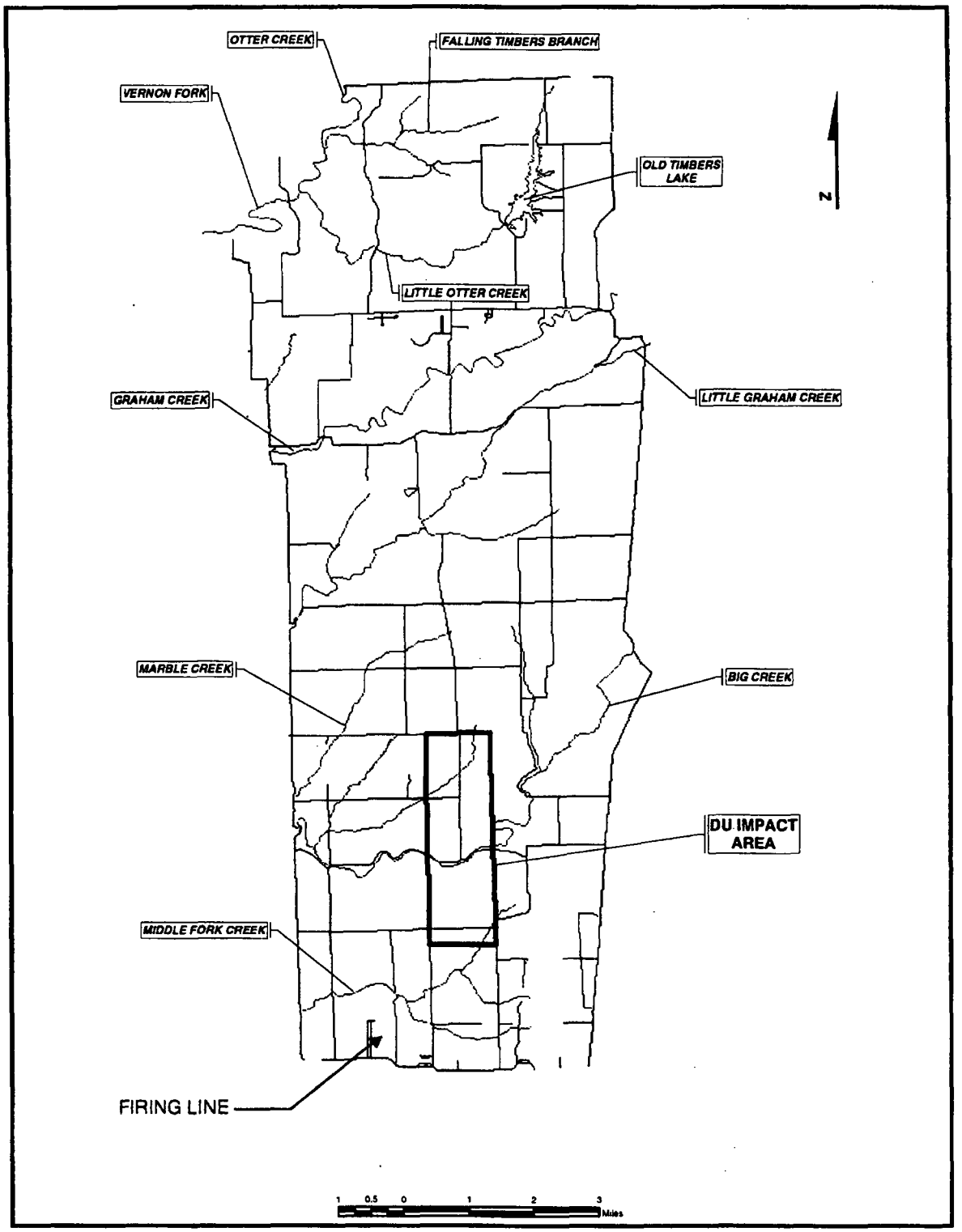
JPG is located in the Muscatatuck watershed of the White River Drainage Basin. EPA's Index of Watershed Indicators (IWI) rates the condition and vulnerability of aquatic systems in the United States. The overall IWI score for this watershed is 3, which indicates "Less Serious Water Quality Problems - Low Vulnerability to stressors such as pollutant loadings" (see http://cfpub.epa.gov/surf/huc.cfm?huc_code=05120207). Additional information is provided in the White River Basin Study (USGS 2001b).

Big Creek bisects the DU Impact Area, and Middle Fork Creek crosses the southeastern DU Impact Area boundary, as shown in Figure 2-7. Big Creek originates off-site and flows 9.2 stream miles across JPG. It is fed by numerous unnamed intermittent tributaries and has a sandy/gravelly substrate. Middle Fork Creek originates on JPG and is fed by several unnamed intermittent tributaries. It has a gravel substrate and meanders approximately 4.5 miles (7.2 km)across the facility, draining 6,520 acres. Information on the other five streams is provided in the Final EIS for Disposal and Reuse of the JPG (U.S. Army 1995b). The DP includes estimates of the flood flow and associated sediment transport and yield (U.S. Army 2002b). For a 10-year return period, for instance, the peak flow rate is 5,159 cfs (146 m^3/s) and the sediment yield is 66,973 tons (60,757 metric tons).

Surface water is not used as a domestic drinking water supply in the vicinity of JPG; its primary use is for recreation and livestock watering (MWH 2002). Within the Big Oaks NWR, fishing is permitted only at the 165-acre Old Timbers Lake (FWS 2001b). The streams have no segments listed in the Nationwide Rivers inventory, nor are they a part of the National Wild and Scenic Rivers System (Mason and Hanger 1992). All surface water bodies at JPG are classified as "warm-water aquatic and full-body contact" by the State of Indiana water quality standards (Clark 1993).

Flooding is common in southeastern Indiana because of the proximity to the Ohio River. One major flood has occurred along the Ohio River in southeastern Indiana since 1998. Heavy rains also may cause the tributaries of the Ohio River that cross JPG (i.e., Big Creek) to swell (MWH 2002).

At least 10 ponds or lakes that vary in size from less than 1 acre to 165 acres (0.004 to 0.7 km^2) are located on the installation. No ponds or lakes are located in the DU Impact Area.



Source: MWH (2002).

Figure 2-7. Surface Water Drainage at Jefferson Proving Ground

Water quality, biological, and physical data available on EPA's STORET (short for STOrage and RETrieval) do not include any of the streams on JPG. Surface water sampling data involving total uranium concentrations are available for Big Creek and Middle Fork Creek and are discussed in Section 3.1 of this report. There are no surface water or subsurface uses (e.g., withdrawals, consumption, or returns) currently within the installation boundaries. There is no evidence of past, current, or future pollutant sources with discharges to water in the area north of the firing line, which includes the DU Impact Area (U.S. Army 1995b; Mason and Hanger 1992). Detailed flow information on these streams (e.g., historic monthly flow information, drought stages and discharges by month, and short-duration flow fluctuations) is not available for the JPG streams. Current Federal Emergency Management Agency data (see http://www.fema.gov/mit/tsd) indicate that JPG is not located within a floodplain.

2.6.2 Groundwater Hydrology

In this section the hydrostatic units are described (Section 2.6.2.1). Groundwater use and off-site groundwater wells are identified in Sections 2.6.2.2 and 2.6.2.3, respectively.

2.6.2.1 Hydrostatic units

Three hydrostratigraphic units are located in the JPG area. The unconsolidated glacial deposits underlying the site form one unit. The Paleozoic limestones and dolomites that underlie the unconsolidated glacial deposits form a second unit. The third hydrostratigraphic unit consists of the alluvial deposits in the Ohio River Valley south of the installation.

Unconsolidated Glacial Deposits

The unconsolidated glacial deposits range in thickness from 4 to 43 ft (1.2 to 13.1 m) south of the firing line and are composed predominantly of glacial till (MWH 2002). The hydraulic conductivity of the till ranges from 1.1×10^{-5} to 3.3×10^{-5} in./sec [2.9×10^{-5} to 8.4×10^{-5} centimeters per second (cm/sec)] based on slug tests in wells (Rust E&I 1998; MWH 2002). The direction of groundwater flow is roughly the same as the surface water drainage, which is to the west-southwest over most of the installation. Results indicate that the matrix hydraulic conductivity of the tills at JPG ranges from 1.3×10^{-8} to 3.9×10^{-8} in./sec (3.4×10^{-8} cm/sec to 9.8×10^{-8} cm/sec) [MWH 2002]. Small-scale fractures and sand lenses within the till contribute to the higher hydraulic conductivity measured by the slug tests.

Silurian and Devonian Limestones and Dolomites

The shallow bedrock groundwater in the vicinity of JPG is stored primarily in the bedrock hydrostratigraphic unit comprised of Silurian and Devonian limestone and dolomite members. The aquifer is unconfined to semi-confined and is recharged by infiltration of precipitation to the bedrock aquifer concentrated along fractures within the glacial till and in areas where the creek channels are losing water to the groundwater system. Groundwater in the bedrock shows a direct and rapid response to changing climatic conditions (MWH 2002).

Groundwater flow in the bedrock aquifer is controlled primarily by fractures. The bedrock aquifer is unconfined and recharged by surface water flow. In areas where the overlying till is not fractured, the groundwater in the bedrock aquifer appears to be confined. Cores of limestone bedrock from the site contained fractures 3.94×10^{-3} in. (100 μm) or larger and showed evidence of solutioning (MWH 2002).

Karst features, such as sinkholes, have been recognized along the Otter Creek and Big Graham Creek drainages a few miles west of JPG; however, no karst features have been mapped at JPG (MWH 2002).

A karst study to identify caves was conducted at the installation from 1994 to 1997 along five creeks: Big Creek, Middle Fork Creek, Graham Creek, Little Graham Creek, and Otter Creek (Sheldon 1997). During this inventory, 32 caves with 52 entrances were identified. The cave lengths ranged from approximately 26 ft (7.9 m) to the longest cave length of 1,507 ft (459 m). Nineteen caves were identified along Big Creek, with an average cave length of approximately 162 ft (49.4 m).

The water-level elevations of wells screened in bedrock loosely conform to the configuration of the surface topography. The direction of groundwater flow in bedrock generally is to the west-southwest. The water level elevations measured in the DU Impact Area are variable, ranging from a minimum of 3 ft below the surface in monitoring well (MW)-10 to a maximum of 32 ft (9.8 m) below the surface in MW-09 (refer to Figure 3-2 for well locations) [U.S. Army 2001]. The variability in the depth to groundwater may reflect the occurrence of fractures in bedrock. Table 2-5 provides data for the DU Impact Area groundwater monitoring wells (SEC Donahue, Inc. 1992). Figure 2-8 shows the potentiometric contours based on these data. The wells are too widely spaced to interpret the potentiometric surface or identify preferred flow paths. It appears, however, that in the vicinity of incised surface drainages, the potentiometric surface slopes toward the streams at roughly the same gradient as the surface topography. Therefore, on a local scale, the bedrock groundwater tends to discharge to surface streams (SEC Donahue, Inc. 1992).

Slug and pump tests were completed on 51 wells located south of the firing line screened in the bedrock aquifer. The hydraulic conductivity of the bedrock aquifer computed from slug tests ranges from 0.67×10^{-5} to 2.3×10^{-4} in./sec (1.7×10^{-5} to 5.8×10^{-4} cm/sec) [MWH 2002]. The pumping test results indicate hydraulic conductivities ranging from 0.55×10^{-4} to 2.4×10^{-3} (1.4×10^{-4} cm/sec to 6×10^{-3} cm/sec) [MWH 2002].

Ohio River Alluvial Deposits

The third hydrostratigraphic unit, the Ohio River valley alluvium, does not underlie the site and is significant because it is the only major, source of groundwater in the region that is available for domestic use (MWH 2002). However, the closest location of this unit is approximately 5 miles (8 km) south of JPG. Because the bedrock groundwater flow direction at JPG generally is to the southwest, and the north-south stream drainages are located west of JPG, it is unlikely that potential contamination present at JPG could reach the Ohio River alluvial aquifers. The southwest groundwater flow direction at JPG is in agreement with the regional groundwater flow direction documented in the USGS Open File Report 90-151 (see Figure 2-9) [Bugliosi 1990].

2.6.2.2 Groundwater use

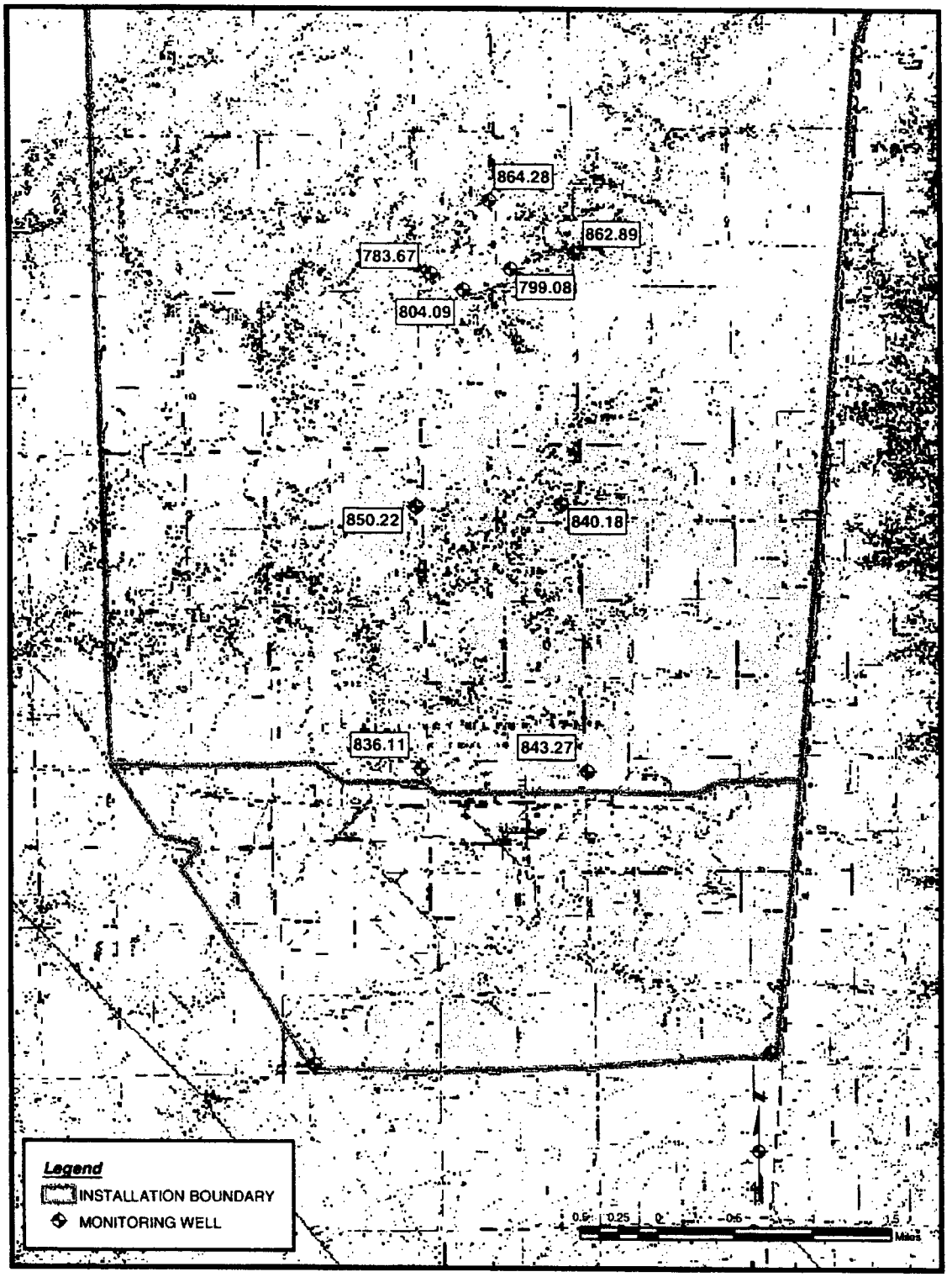
There are no sole source aquifers on or in the vicinity of JPG based on a review of EPA Region 5's sole source aquifer designations (EPA 2002). A sole source aquifer is an aquifer designated by EPA as the sole, or principal, source of drinking water for a given area (i.e., an aquifer that supplies 50% or more of the area), and for which there is no reasonable alternative should the aquifer become contaminated.

The groundwater under JPG generally is of poor quality and is not used for drinking purposes or for other purposes in any significant capacity. The drinking water at JPG is obtained from the City of Madison Municipal Supply Systems and the Canaan Deposits in the Ohio River Valley, approximately 5 miles (8 km) from JPG (MWH 2002).

Table 2-5. DU Impact Area -Groundwater Monitoring Wells

Well No.	Date Completed	Total Depth (ft)[a]	Depth to Bedrock (ft)[a]	Water Level Depth[b] (ft Below Ground Surface)	Comment
1	12/6/83	33.2	4.5	10	1.5 feet (ft) disturbed by detonation. Fire-granted gray limestone. Loss of recirculation water near 8 ft.
2	12/13/83	23.7	7	10	1.5 ft disturbed by detonation. Fractured gray to brownish-gray limestone. Loss of recirculation water near 14.8 ft. Large solution cavities and shaley-clay-filled voids.
3	12/13/83	4.3	18.5	8	1.5 ft disturbed by detonation.
4	12/14/83	28.5	10	3	
5	12/7/83	33.4	20.3	5.6	1 ft disturbed by detonation.
6	12/17/83	40	NA	18.25	1.5 ft disturbed by detonation. No bedrock encountered.
7	12/8/83	53.7	26.5	8.8	
8	12/9/83	28.2	14.5	23	Loss of recirculation water at 20 ft.
9	9/18/88	38.2	3.7	32	
10	9/18/88	41.3	NA	3	No bedrock encountered. Borehole encountered glacial till.
11	9/19/88	41.9	2	6.8	Limestone with horizontal solution features. Solution cavities filled with sediment.

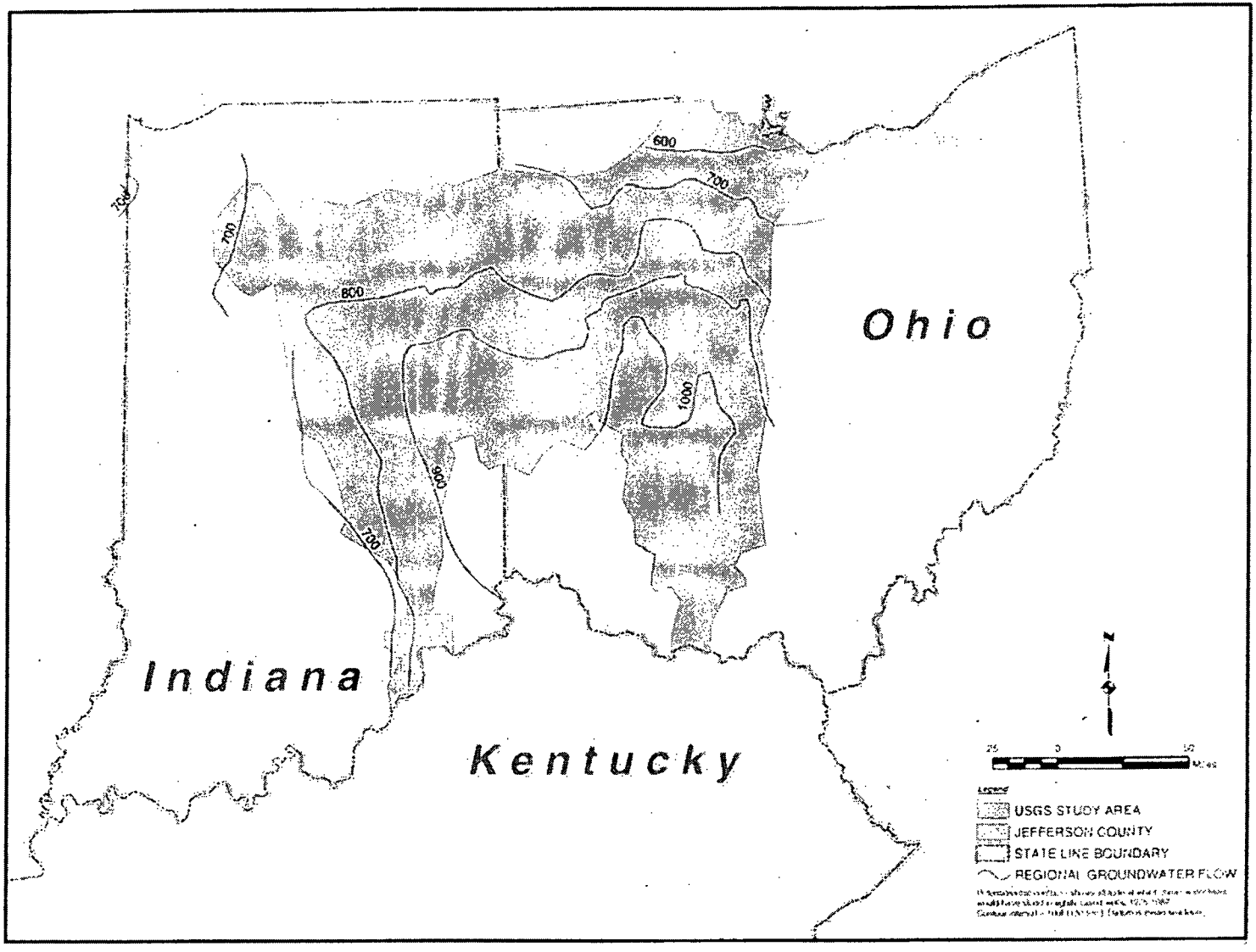
Source: SEC Donahue, Inc. 1992.
[a]To convert feet to meters, multiply by 0.3.
[b]Groundwater levels from borehole drilling logs.
NA – not applicable.



Source: SEC Donahue, Inc. 1992.

Figure 2-8. Groundwater Contours of the DU Impact Area

C06



Source: Bugliosi 1990.

Figure 2-9. Regional Groundwater Flow Direction for the Cincinnati Arch

C07

2.6.2.3 Off-site groundwater wells

A review of the State of Indiana records of groundwater wells drilled off-site in a downgradient direction indicated that nine groundwater wells completed in bedrock had been drilled from 1945 to 1966 for domestic and stock use. Table 2-6 summarizes water wells identified by an online search of the Indiana Department of Natural Resources (IDNR) well data files. It is unknown if these wells currently are operational. The closest well location is approximately 4 miles (6.4 km) southwest of the DU Impact Area. The Draft Final RI provides additional information on wells in Jennings, Ripley, and Jefferson Counties (MWH 2002).

2.7 CULTURAL RESOURCES

Cultural resources at JPG have been investigated as part of either archaeological overviews or previous archeological surveys. A total of 153 sites have been recorded in 4,872 surveyed acres (19.7 km^2) [Geo-Marine 1996]. The majority of the identified sites are located in the cantonment area, located south of the firing line. Much of the installation, particularly the area north of the firing line (including the DU Impact Area), has had limited access and development during the last 50 years. However, because of its use as a proving ground, there has been loss of potential archaeological sites (Geo-Marine 1996).

Cultural resources at JPG are protected under two separate agreements. The Amended Programmatic Agreement (U.S. Army 1992a) between the Department of the Army, the ACHP, and the NCSHPO requires the Army to identify and evaluate historic properties, determine the effects of BRAC actions on historic properties, and take actions to ensure that the effects of BRAC actions on historic properties are in accordance with the agreements in the BRAC Programmatic Agreement. The MOA (U.S. Army 1992b) between the Army, the ACHP, and the Indiana SHPO stipulates that the Army implement a Cultural Resources Management Plan, among other requirements. The Cultural Resources Management Plan provides guidelines and procedures to enable JPG to meet its legal responsibilities while under Army control for the identification, evaluation, and treatment of historic properties under its jurisdiction (Geo-Marine 1996).

Six structures at the installation are on the NRHP, including the Oakdale School, Old Timbers Lodge, and four stone arch bridges over Otter Creek, Marble Creek, and Graham Creek (IDNR 1996). None of these sites is located within the DU Impact Area, as shown on Figure 2-10.

A cultural resources sensitivity model was developed for the installation that excludes a total area of 33,645 acres (136 km^2) of the site because either the land has been previously disturbed by construction, use, or maintenance of the facility, or the areas have been surveyed previously. The DU Impact Area falls into the excluded area both because portions of the land area have been disturbed to a depth greater than 6 ft (1.8 m) BGS and because of the presence of UXO. Although no cultural resources survey has been conducted at the DU Impact Area because of the UXO and DU hazards, 10 potential historic site locations were documented through research of historic maps and atlases between 1876 and 1921. These sites were determined to be in poor condition because of the extensive land disturbance and were determined to be ineligible for the NRHP (Geo-Marine 1996).

In 1994, a chert survey was conducted along the banks of Big Creek up to the western border of the DU Impact Area. One archeological site was found downstream from the DU Impact Area. The site was not eligible for listing on the NRHP (Geo-Marine 1996).

Table 2-6. Groundwater Wells Located Downgradient of the DU Impact Area

Township	Range	Section	Reference Number	Well Depth (ft)[a]	Depth to Bedrock (ft)[a]	Formation	Static Water Level (ft)[a]	Well Use	Install Date	Status
5N	9E	10	220845	189	Unknown	Unknown	11	Home	Unknown	Unknown
5N	9E	10	220850	78	Unknown	Limestone	11	Home	1945	Unknown
5N	9E	11	220873	85	20	Limestone	10	Home	1960	Unknown
5N	9E	11	220878	80	10	Grey and Blue Limestone	Unknown	Home	1960	Unknown
5N	9E	15	220868	111	17	Limestone	17	Home	1966	Unknown
5N	9E	23	220843	60	35	Hard Blue Limestone	15	Stock	1960	Unknown
5N	9E	34	220811	78	15	Blue Shale and White Lime	27	Home	1966	Unknown
5N	9E	34	220816	96	15	Blue Stone or Soapstone	14	Home	1964	Unknown
5N	9E	34	220821	285	16	Limestone	Unknown	Home	1963	Unknown

Source: IDNR 2001a.
[a]To convert from feet to meters, multiply by 0.3.

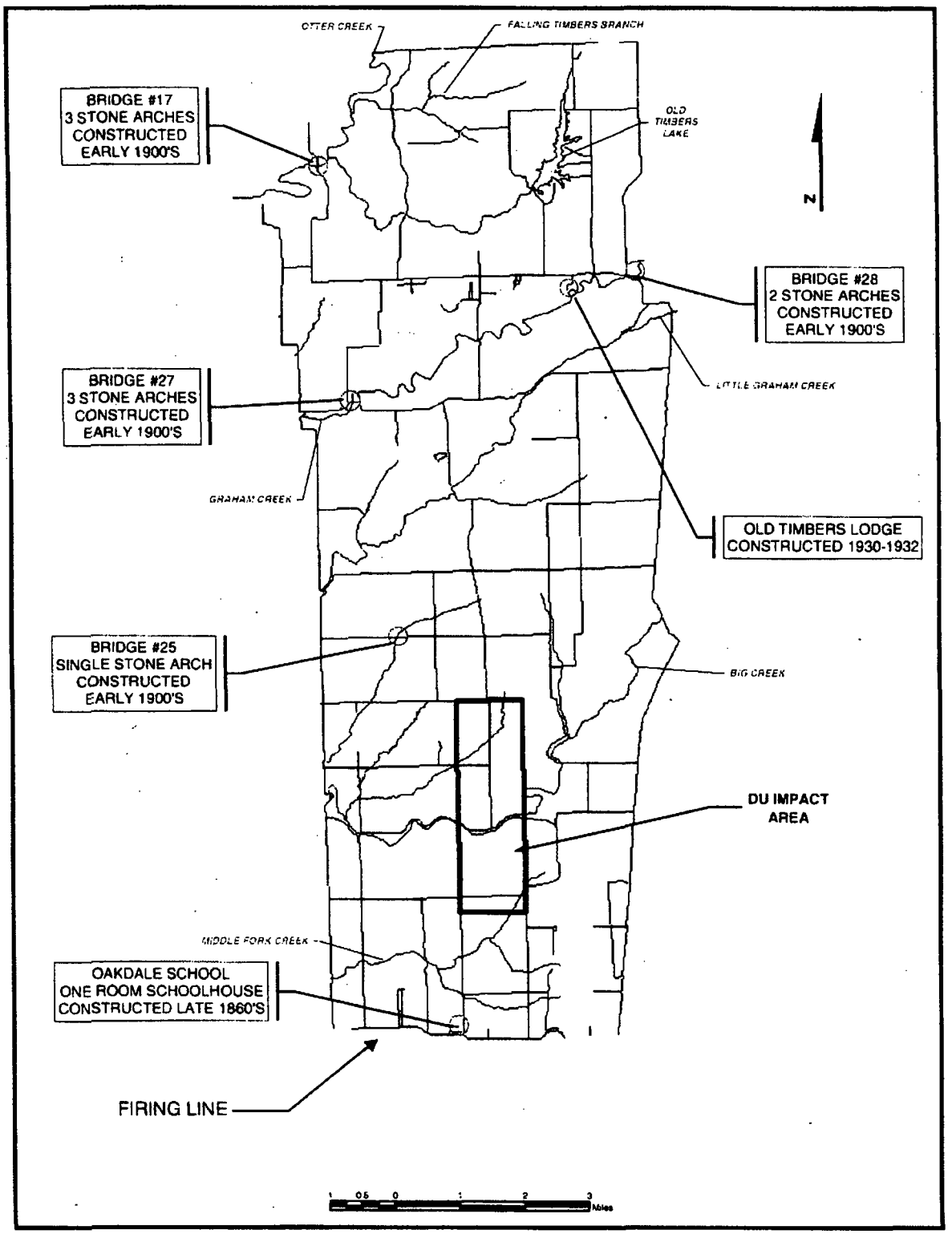


Figure 2-10. Sites Listed on the National Register of Historic Places
Jefferson Proving Ground, Indiana

C08

2.8 BIOLOGICAL RESOURCES

In this section, characteristics of wetlands (Section 2.8.1), plants (Section 2.8.2), and wildlife (Section 2.8.3) at JPG are described. Information is derived from numerous sources, including FWS 1994a,b and 2001a–e; IDNR 1999; SAIC 1997a; Kentucky State Nature Preserves Commission (KSNPC) 2001; and MWH 2002.

2.8.1 Wetlands

The current estimate of wetland acreage on JPG is 6,470 acres (26 km^2). Of these wetlands, there are 353 acres (1.4 km^2) located on the DU Impact Area based on maps published by the FWS. Within the DU Impact Area, the wetlands are located predominately south of Big Creek (see Figure 2-11).

Most of the wetlands on JPG are classified as palustrine forested lands, which are dominated by woody vegetation 20 ft (6 m) high or taller. The wetlands within the DU Impact Area are classified as palustrine scrub-shrub dominated by broadleaf, scrub-shrub, with woody vegetation less than 20 ft (6.1 m) high. Riverine upper perennial wetlands are located along sections of Big Creek (FWS 1994b).

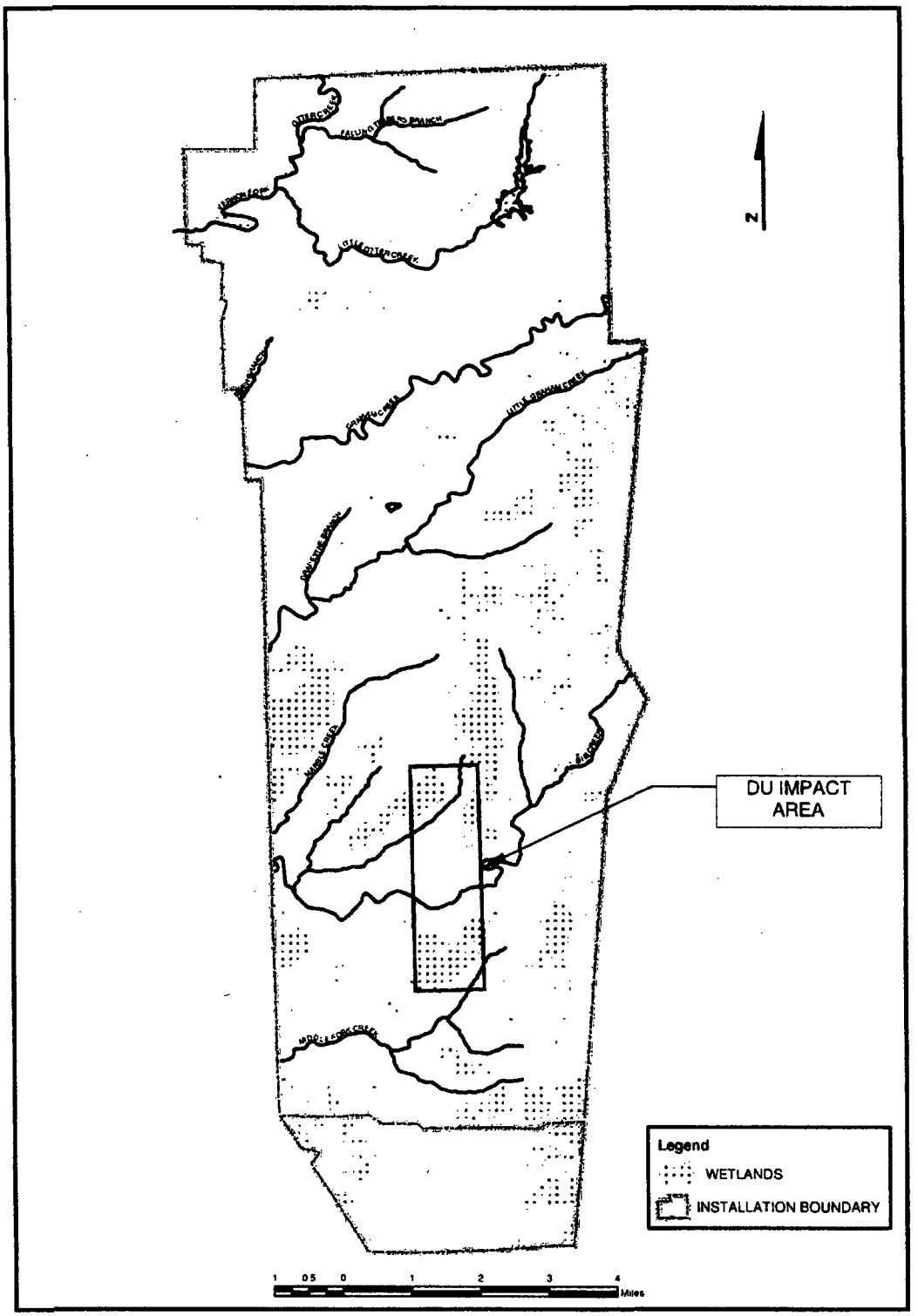
2.8.2 Plants

Upland forests make up 27,400 acres (111 km^2) or 55% of the JPG acreage (see Figure 2-12). The primary evergreen species at JPG is eastern red cedar (*Juniperus virginiana*). Dominant deciduous trees include sweetgum (*Liquidambar styraciflua*), red maple (Acer rubrum), and black gum (Nyssa sylvatica) on poorly drained upland depression sites. Tulip poplar (*Liriodendron tulipifera*) and white ash (*Fraxinus americana*) are the species making up a majority of the young upland forests on well-drained sites. White oak (*Quercus alba*), red oak (*Quercus rubra*), and shagbark hickory (*Carya ovata*) are the dominant species on intermediate and some mature upland forests. American beech (*Fagus grandifolia*) and sugar maple (*Acer saccharum*) dominate the remainder of the mature upland forests (FWS 2001d).

The second most abundant habitat at the JPG is grasslands. This habitat type comprises 8,400 acres (12.14 km^2 or 17%). The dominant grassland species appears to be broom sedge (*Andropogon* sp.) [FWS 2001d].

Other habitat types at JPG include 5,200 acres (21 km^2 or 10%) of palustrine wetland, 3,000 acres (12.14 km^2 or 6%) of woodland, 6,200 acres (25 km^2 or 12%) of early successional, and less than 250 acres (1 km^2) each of open water and bare soil areas. Woodland species composition is comparable to that of upland forest. The palustrine wetland category includes all growth stages of palustrine vegetation, including early successional and forested wetland (FWS 2001d).

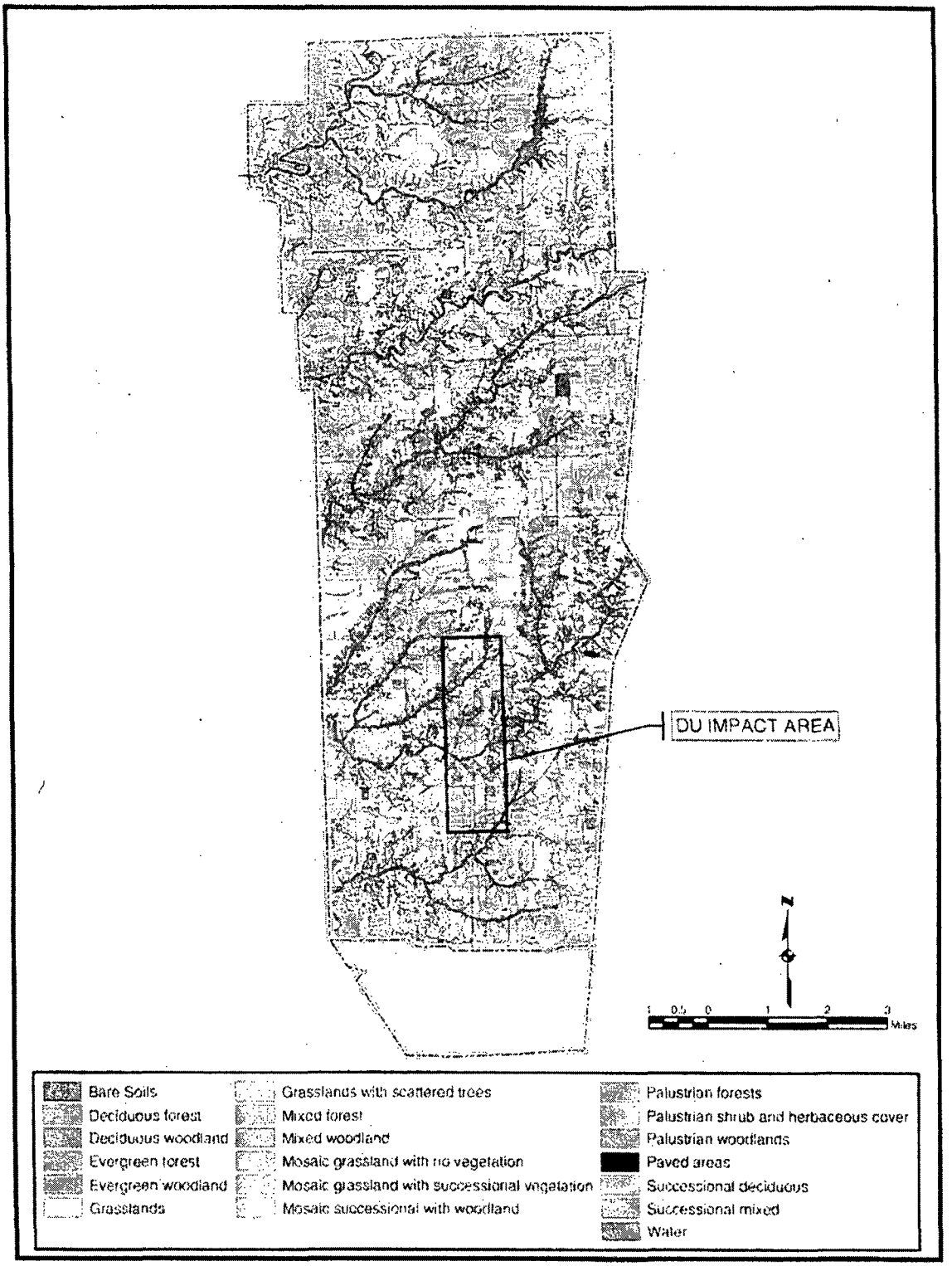
A plant inventory of JPG conducted in 1999 identified 46 species of vascular plants designated as endangered, threatened, or rare, or that are on the State of Indiana's watch list. These plants and their statuses are listed in Table 2-7. No federally listed plants were found (IDNR 1999). An inventory of the DU Impact Area was not conducted during the 1999 survey. Therefore, the occurrence of endangered plants within the DU Impact Area is unknown. Other references (IDNR 1993; MWH 2002) include inventories of observed and potential plant species within JPG. These previous inventories also do not indicate probable locations of these species within the facility.



Source: FWS (1994a).

Figure 2-11. National Wetlands Inventory
Jefferson Proving Ground

C09



Source: FWS 2001a.

Figure 2-12. Vegetation Classes at Big Oaks NWR

C10

Table 2-7. State of Indiana Endangered Plants

Species Name	Common Name	1999 Status
Crotonopsis elliptica	Elliptical rushfoil	E
Helianthus angustifolius	Narrow-leaved sunflower	E
Hypericum gymnanthum	Clasping St. John's wort	E
Lycopodeiella inundata	Northern bog clubmoss	E
Lygodium palmatum	Climbing fern	E
Najas gracillima	Thread-like naiad	E
Panicum scoparium	Broom panic-grass	E
Rhexia mariana var. *mariana*	Maryland meadow beauty	E
Scirpus purshianus	Weakstalk bulrush	E
Asplenium ruta-muraria	Wall-rue spleenwort	T
Oenothera perennis	Small sundrops	T
Strophostyles leiosperma	Slick seed wild-bean	T
Lycopodium obscurum	Tree clubmoss	R
Oxalis illinoensis	Illinois woodsorrel	R
Poa wolfii	Wolf bluegrass	R
Sagittaria autralis	Longbeak arrowhead	R
Waldsteinia fragarioides	Barren strawberry	R
Woodwardia areolata	Nettled chain-fern	R
Aesculus octandra	Yellow buckeye	WL
Agalinis fasciculata	Clustered foxglove	WL
Andropogon ternarius	Silver bluestem	WL
*Antennaria solitaria**	Single-headed pussytoes	WL
Bartonia paniculata	Twining bartonia	WL
Botrychium biternatum	Sparse-lobe grape fern	WL
Botrychium oneidense	Blunt-lobe grape fern	WL
Carex abscondita	Thicket sedge	WL
Carex louisianica	Louisiana sedge	WL
Carex woodii	Pretty sedge	WL
Chimaphila maculata	Spotted wintergreen	WL
Cimicifuga racemosa	Black bugbane	WL
Dentaria diphylla	Crinkleroot	WL
Eupatorium rotundifolium	Round-leaved boneset	WL
Hydrastis canadensis	Goldenseal	WL
Linum striatum	Ridged yellow flax	WL
Lycopodium clavatum	Running pine	WL
Monotropa hypopithes	American pinesap	WL
Panax quinquefolium	American ginseng	WL
Panax trifolium	Dwarf ginseng	WL
Platanthera lacera	Green-fringed orchis	WL
Platanthera peramoena	Purple fringeless orchis	WL
Salix caroliniana	Carolina willow	WL
Scleria pauciflora	Fewflower nutrush	WL
Spiranthes ovalis	Lesser ladies'-tresses	WL
Spiranthes tuberosa	Little ladies'-tresses	WL
Veratrum woodii	False hellebore	WL
Viola blanda	Smooth white violet	WL

Source: IDNR 1999.
Notes:
*Tentative identification.
E = State of Indiana Endangered.
R = State of Indiana Rare.
T = State of Indiana Threatened.
WL = State of Indiana Watch List.
No threatened or endangered species were found federally or in Carroll or Trimble Counties, Kentucky.

2.8.3 Wildlife

JPG provides quality habitat for a variety of terrestrial and aquatic species. Forty-one species of fish, 8 species of freshwater mussels, 24 species of amphibians, and 18 species of reptiles have been found on the installation. Mammal species include white-tail deer, raccoon, coyote, opossum, gray and fox squirrel, skunk, beaver, red fox, weasel, and mink. Large populations of small mammals, including mice and moles, attract significant numbers of reptiles and raptors. JPG is approximately 80% reforested, and the unbroken stands of mature and young trees are used by migrating neo-tropical birds. More than 100 breeding birds have been recorded at the installation. The American Bird Conservancy has listed the Big Oaks NWR as a Globally Important Bird Area because of its importance to grassland birds (e.g., Henslow's sparrow) and forest birds (e.g., cerulean warbler). The FWS and the Institute for Bird Populations are conducting ongoing census surveys of wildlife at the installation. Wildlife management continues even with the JPG's closure in September 1995. Twenty-five river otters were released in January 1996 at the Old Timbers Lake in support of Indiana's Otter Restoration Program. Six additional otters were released into Otter Creek at Bue Hole on January 31, 1999.(SAIC 2002).

JPG provides habitat for a wide variety of game animals and fish that are harvested on the installation. Until the early 1990s, there was some stocking of game birds, fish, and other creatures to maintain stable populations of some species. Hunting is allowed on approximately 27,700 acres (112 km^2). The remaining area, approximately 27,300 acres (110 km^2), provides habitat for small game; however, this land is closed to hunters because of the presence and hazards of UXO and DU. The staff of the Big Oaks NWR manage the hunting program at JPG (FWS 2001b).

White-tailed deer and wild turkey hunting is permitted in designated areas administered by the FWS as part of the Big Oaks NWR (FWS 2001b). Mammals and fowl historically harvested on JPG include white-tail deer, fox squirrel, eastern gray squirrel, eastern cottontail rabbit, and wild turkey. The historical average annual harvest has risen from approximately 400 to 500 (FWS 2001b) to 700 whitetail deer. The average annual wild turkey harvest has almost doubled from 50 to 90 birds per year (MWH 2002). Permit drawn hunts for the general public have been conducted for deer since the 1960s and for turkey since 1984. Fish harvested on JPG include bass, bluegill, sunfish, crappie, and catfish.

There are 11 federally endangered animals (3 birds, 1 mammal, and 7 mollusks) that may occur within the boundaries of JPG. The three bird species are transients that may be present during migration, including the Piping plover (*Charadrius melodus*), Kirtland's warbler (*Dendroica kirtlandi*), and interior least tern (*Sterna antillarum athalassos*). The Indiana bat (*Myotis sodalis*) also has been documented at JPG (Rust E&I 1998). The white catspaw (*Epioblasma obliquata perobliqua*), northern riffleshell (*Epioblasma torulosa rangiana*), tubercled blossom (*Epioblasma torulosa torulosa*), pink mucket (*Lampsilis abrupta*), ring pink (*Obovaria refusa*), orange-foot pimpleback (*Plethobasus cooperianus*), and fat pocketbook (*Potamilus capax*) are all federally endangered mollusks. The bald eagle (*Haliaeetus leucocephalus*) is the only federally threatened animal (IDNR 2001b). Table 2-8 identifies Federal, State of Indiana, and Carroll and Trimble Counties, Kentucky, endangered species.

In addition to the 11 federally endangered species, 9 State of Indiana-endangered species (6 birds, 2 mammals, and 1 reptile) and 2 Carroll and Trimble County, Kentucky, endangered species (2 mollusks) also have been identified. Additionally, Henslow's sparrow (*Ammodramus henslowii*) has been identified as a breeding species at JPG. Ten species in Indiana and five species in Kentucky are listed as species of special concern (IDNR 2001b; KSNPC 2001).

2.9 NOISE

Prior to closure in 1995, JPG conducted operations in accordance with an Installation Compatible Use Zone program based on a 1983 environmental noise assessment to quantify major noise sources.

Table 2-8. Federal and State Endangered Species

Species Type	Species Name	Common Name	Status
Bird	*Charadrius melodus*	Piping plover	FE
Bird	*Dendroica kirtlandii*	Kirtland's warbler	FE
Bird	*Sterna antillarum athalassos*	Interior least tern	FE, INE
Mollusk	*Epioblasma obliquata perobliqua*	White catspaw	FE
Mollusk	*Epioblasma torulosa rangiana*	Northern riffleshell	FE
Mollusk	*Epioblasma torulosa torulosa*	Tubercled blossom	FE
Mollusk	*Lampsilis abrupta*	Pink mucket	FE, KYE
Mollusk	*Obovaria retusa*	Ring pink	FE, KYE
Mollusk	*Plethobasus cooperianus*	Orangefoot pimpleback	FE, KYE
Mollusk	*Potamilus capax*	Fat pocketbook	FE, INE
Mammal	*Myotis sodalis*	Indiana bat	FE, INE
Bird	*Haliaeetus leucocephalus*	Bald eagle	FT
Bird	*Aimophila aestivalis*	Bachman's sparrow	INE
Bird	*Ammodramus henslowii*	Henslow's sparrow	INE
Bird	*Asio flammeus*	Short-eared owl	INE
Bird	*Circus cyaneus*	Northern harrier	INE
Bird	*Falco peregrinus*	Peregrine falcon	INE
Bird	*Tyto alba*	Barn owl	INE, KYSC
Mammal	*Lutra Canadensis*	River otter	INE
Mammal	*Lynx rufus*	Bobcat	INE
Mammal	*Nycticeius humeralis*	Evening bat	INE
Mammal	*Taxidea taxus*	American badger	INE
Reptile	*Clonophis kirtlandii*	Kirtland's snake	INE
Mollusk	*Lampsilis ovata*	Pocketbook	KYE
Mollusk	*Pleurobema pyramindatum*	Pyramid pigtoe	KYE
Bird	*Ixobrychus exilis*	Least bittern	KYT
Mollusk	*Simpsonaias ambigua*	Salamander mussel	KYT
Amphibian	*Necturus maculosus*	Mudpuppy	INSC
Bird	*Accipiter striatus*	Sharp-shinned hawk	INSC
Bird	*Buteo lineatus*	Red-shouldered hawk	INSC
Bird	*Buteo platypterus*	Broad-winged hawk	INSC
Bird	*Dendroica cerulea*	Cerulean warbler	INSC
Bird	*Helmitheros vermivorus*	Worm-eating warbler	INSC
Bird	*Mniotilta varia*	Black-and-white warbler	INSC
Bird	*Wilsonia citrina*	Hooded warbler	INSC
Mammal	*Condylura cristata*	Star-nosed mole	INSC
Mammal	*Mustela nivalis*	Least weasel	INSC
Amphibian	*Rana Pipiens*	Northern Leopard Frog	KYSC
Bird	*Ardea herodias*	Great Blue Heron	KYSC
Bird	*Riparia riparia*	Bank swallow	KYSC
Mollusk	*Plethobasus cyphyus*	Sheepnose	KYSC

Sources: IDNR 2001a and KSNPC 2001.
FE = Federally Endangered
FT = Federally Threatened
INE = Indiana Endangered
INSC = Indiana Special Concern
KYE = Carroll and/or Trimble County, Kentucky Endangered
KYSC = Carroll and/or Trimble County, Kentucky Special Concern

Typically, 90 to 120 decibels are generated by the Indiana ANG's current air-to-ground gunnery range operations. Note that less than 65 decibels is considered an acceptable level of noise. However, since the cessation of the JPG's firing mission in September 1994, impulse noise impacts beyond the base boundaries have been eliminated. The only remaining noise zone identified at JPG is an aerial track used by aircraft at the air-to-ground gunnery range located in the northwestern section of the installation.

There is no noise generated in the DU Impact Area. There are no activities in the cantonment area that would generate noise above acceptable levels.

2.10 PUBLIC AND OCCUPATIONAL HEALTH

Information on sources and levels of background radiation and current sources of radioactive material is presented in Section 3.1 of this report. The potential human exposures to DU are presented in the DP and summarized in Sections 5 and 6 of this ER.

Major sources of chemical exposure, addressed in Section 3.2 of this ER, are confined to the cantonment area of the installation. Additional information on these sources and expected levels of exposure are contained in the RI (MWH 2002).

2.11 TRANSPORTATION

JPG includes 196 miles of improved roads, 22 bridges, and 10 low-water crossings. Improved roadways of concrete or asphalt surface total 34 miles (55 km), and gravel-surfaced roads constitute the remainder of the road network. There also are some unimproved roads on the installation. Most of the roads are in good condition. Most of the roads in the cantonment are paved, the remainder are graveled. Sections at low-water crossings of the West Perimeter Road, East Perimeter Road, and a section of K Road east of Machine Gun Road are the only paved roads in the test range area (U.S. Army 1995b). Under the MOA, and in accordance with the permit conditions (Appendix A), the USAF/IANG and FWS share responsibilities for infrastructure maintenance north of the firing line.

Three interstate highways are near JPG. Interstate 65, running north–south, is 30 miles (48 km) to the west. Interstate 74, running east–west, is 40 miles (64 km) north of JPG. Access to the installation is via Route 421, a two-lane road following the eastern border of the installation.

Prior to closure in 1995, JPG had a railway system and airfield. The airfield is presently closed and the rail system was transferred to the Madison Port Authority under the BRAC program. The Madison Railroad, a Division of City of Madison Port Authority, is a 25-mile (40-km) shortline operating from Madison to North Vernon, Indiana. The railroad acquired an engine house, 17 miles (27 km) of trackage, and a loading dock located on JPG. As a result of this acquisition, the railroad now offers transloading and car storage (see http://jpg.sbccom.army.mil/).

2.12 VISUAL/SCENIC RESOURCES

JPG is divided visually into the areas north and south of the firing line. The area south of the firing line, or cantonment areas, is a well-maintained area with buildings that formerly supported the installation staff. The main gate entrance is flanked by well-manicured grounds and tree-lined, open spaces that provide a visually attractive entrance to the facility. The road to the administrative area is lined with mature maple trees. The buildings in these areas are predominantly wood structures. Operations and

maintenance buildings are red brick and were heated by steam through an aboveground steam system when the facility was operational. Thirteen housing units are arranged along a tree-lined, elongated, horseshoe-shaped drive. Other visual resources include Krueger Lake, approximately 1,200 ft (366 m) long by 250 ft (76 m) wide. A closed airfield occupies the southwestern area of the base (U.S. Army 1995b). The remaining area includes woodlands and grassy areas. A dominant feature in this area is a water tower. With closure of this area in 1995, the Army entered into a Lease in Furtherance of Conveyance with a local businessman for this property . Various parcels are under private or public ownership. The fee title will be transferred as the parcel is remediated of ordnance and other contamination. Residential, light manufacturing operations, and farming are the predominant land uses currently (see http://jpg.sbccom.army.mil/).

The area north of the firing line is characterized as heavily vegetated rolling hills, with some open spaces. The DU Impact Area and the ANG bombing range are located within this portion of JPG (see Figure 1-1). Appendix B includes photographs of the cantonment and DU Impact Areas from different directions.

There are several landfill/disposal and open burning/open detonation areas dispersed in this area north of the firing line (see Section 2.12). In the northeast corner of the base is a 165-acre (0.67-m^2) lake (Old Timbers Lake) used for fishing. Historic structures are present in this area and include two buildings and four stone bridges (see Section 2.7). For security reasons, cables with polyvinyl chloride pipes were installed at stream exit locations along the base's western fence line. More than 48 miles (77 km) of chain-link fence topped with barbed wire surrounds the facility. The view of the facility from the fence line is obscured primarily by trees 30 to 50 ft (9 to 15 m) tall with thin undergrowth. Occasional open spaces around the fence line permit views of up to several hundred yards.

The Bureau of Land Management (BLM) Visual Resource Inventory and Evaluation System rating for the DU Impact Area is Class I. The rating for the cantonment area is Class IV. Refer to Appendix C for more information on the visual resource inventory.

2.13 WASTE MANAGEMENT

Prior to closure in 1995, JPG generated and managed hazardous waste from munitions testing activities [e.g., scrap propellant and scrap High Explosives (HE) projectiles], hazardous waste from installation maintenance and support activities (e.g., spent solvents, paint, and photo finishing chemicals), and miscellaneous solid waste (e.g., packaging materials, construction rubble, and sanitary wastewater). The locations of these operations and related disposal areas occurred throughout the installation. Figure 2-13 indicates the locations of related activities in the area north of the firing line where the DU Impact Area is located. In addition, the RI in the cantonment area (MWH 2002) assesses 50 sites, which were for potential contamination releases as a result of mission operations (see Section 3.2.2).

As a result of its munitions testing mission, OE[1] remains at JPG. The types, quantities, and probable locations of ordnance items utilized by the U.S. Department of Defense (DOD) at JPG were identified in an Archive Search Report (USACE 1995). Information contained in this report is based on the review of existing documents, interviews, observations, site-specific geology, aerial photography, and descriptions of known or suspected contamination. The probable and known locations of OE are reflected in Figure 1-1.

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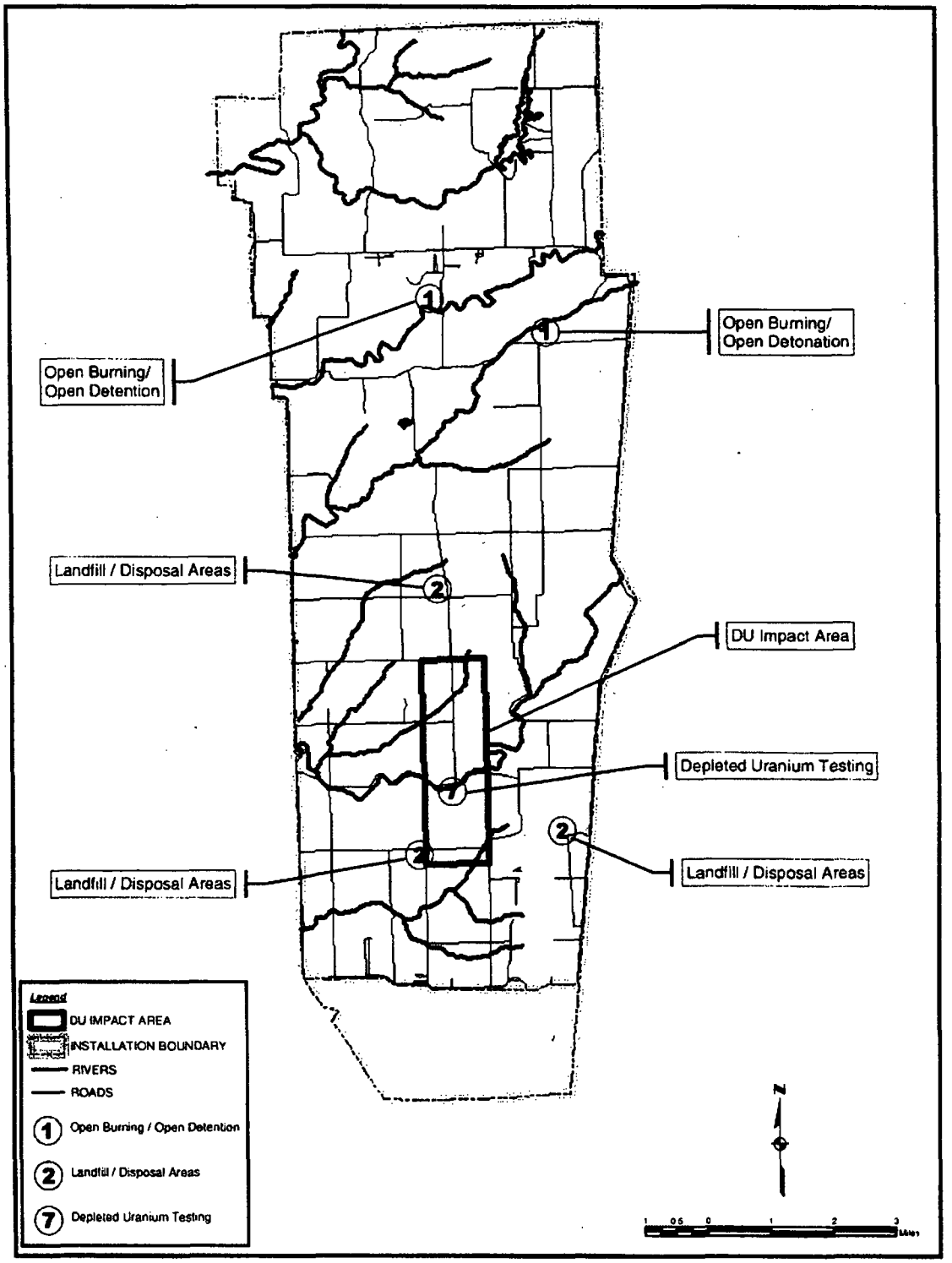
[1]Ordnance and explosives (OE) is ammunition, ammunition components, chemical or biological warfare materiel, or explosives that have been abandoned, expelled from demolition pits or burning pads, lost, discarded, buried, or fired. Unexploded ordnance (UXO), a subcategory of OE, refers to military munitions that have been primed, fuzed, or otherwise prepared for action, and have been fired, dropped, launched, projected, or placed in such a manner as to constitute a hazard and remain unexploded.



Source: SAIC 1997a.

Figure 2-13. Location of Past Hazardous Substance Activities North of the Firing Line

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The DU Impact Area contains approximately 154,323 pounds (70,000 kg) of DU varying in size from microscopic particles to complete penetrators. This DU remains as a result of DU penetrator testing from 1983 to 1994. Approximately 66,139 pounds (30,000 kg) of the 220,462 pounds (100,000 kg) fired were retrieved and disposed, leaving the remaining 154,323 pounds (70,000 kg) of DU. Additional information on DU, which is based on the scoping and characterization surveys (SEG 1995, 1996), is provided in Section 3.1.

3.0 NATURE AND EXTENT OF CONTAMINATION

Both radiological and non-radiological investigations have been completed at JPG. Section 3.1 summarizes the radiological investigations conducted at the DU Impact Area. Section 3.2 summarizes the non-radiological investigations that have focused primarily on the area south of the firing line. Data supporting radiological characterization of the site are based on SEG scoping and characterization surveys (SEG 1995, 1996). Characterizations south of the firing line are based on the Draft Final RI (MWH 2002).

3.1 RADIOLOGICAL STATUS

In this section the status of radiological contamination in the DU Impact Area is summarized (Sections 3.1.2 and 3.1.3). This discussion is preceded by an overview of DU (Section 3.1.1). Section 3.1.4 summarizes anticipated impacts from implementation of the FWS's FMP, which will impact the DU Impact Area. The DP (U.S. Army 2002b) includes additional information related to the radiological status of the facility.

3.1.1 Introduction

DU results from the enrichment of natural uranium for use in nuclear reactors and nuclear weapons. It is defined as uranium that has less than 0.711% of the isotope uranium-235. DU consists principally of uranium-238, with trace amounts of uranium-235. Although 0.7 times as radioactive as natural uranium, DU metal is pyrophoric (able to ignite spontaneously) and extremely dense (Ebinger et al. 1996). DOD Military Specifications require that DU must have 0.335% or less uranium-235, and DU actually used by DOD has only 0.2% uranium-235. When manufactured as 30 millimeter (mm) DU rounds, each DU projectile contains approximately 0.3 kg of extruded DU, alloyed with 0.754% by weight titanium. The projectile is encased in a 0.8 mm-thick aluminum shell as the final DU round (Lockheed Martin 1995). Only 105 mm and 120 mm anti-tank/armor rounds were fired at JPG against soft cloth targets.

Natural uranium is a slightly radioactive metal that is present in most rocks and soils as well as in many rivers and sea water. Natural uranium primarily consists of a mixture of two isotopes of uranium, uranium-235 and uranium-238, in the proportion of about 0.7 and 99.3%, respectively.

The average background radiation dose normally received by an individual is about 360 millirems (mrem) per year. A mrem is a measurement unit that expresses the amount of absorbed dose from a radiation source that has a biological effect on human tissue. Millirem per hour or year expresses the rate at which a person may receive this dose when directly exposed to the source. Uranium accounts for approximately 4% of the average annual background radiation dose received by individuals. Background radiation doses are the result of naturally occurring uranium; radionuclides in air and water, such as radon; and water, cosmic radiation, and other common sources, such as medical and dental X-rays and consumer products (Gollnick 1994). Additionally, less than one mrem per year is the result of fall-out from past atmospheric nuclear weapons testing.

Potential threats to human health from DU are radioactivity and toxic chemical hazards, with the chemical hazards posing the highest risk (Davis 1990). If inhaled in soluble form, compounds of DU can cause chemical toxicity to the kidney. Radioactive dangers are less for compounds of DU than for natural uranium. One gram of natural uranium emits 0.68 microcurie (μCi) of radiation, while DU emits 0.36 μCi of radiation per gram. This difference is due most to removal of radioactive products during the enrichment processes that produce DU (Davis 1990).

The U.S. Army has completed several studies on the health and environmental effects of DU use in both peacetime training operations at Yuma Proving Ground, Arizona; Aberdeen Proving Ground, Maryland; and battlefield operations in the Persian Gulf. These studies generally involve differences in the modes in which DU firing occurs and in the potential exposure of personnel to DU during these operations. The Army's use of DU includes a variety of caliber applications in the M1 and M60 series tanks, the Bradley Fighting Vehicle, and Armored Guns System in ground-firing activities. Related operations present a greater potential for ground disturbance and personnel exposure to DU particulates than firing DU from fixed positions or from aircraft where personnel are not present. Relevant conclusions from these studies are cited in this ER where appropriate. It is recognized that additional studies are needed to more fully define current DU health and environmental effects (USAF 2002).

3.1.2 Regional Background Radiation

A background study was performed in 1995 to determine site background levels prior to conducting measurements in the DU Impact Area. Thirty-five background measurements were taken south of the firing line in an unaffected area. An average background value of 12 microroentgen per hour (μR/hr) was established for this area consistent with background levels determined in 1983. Background values ranged from 6 to 8 μR/hr on roads and in creek beds to a high of 10 to 12 μR/hr in open fields and wooded areas (SEG 1995).

3.1.3 DU Impact Area

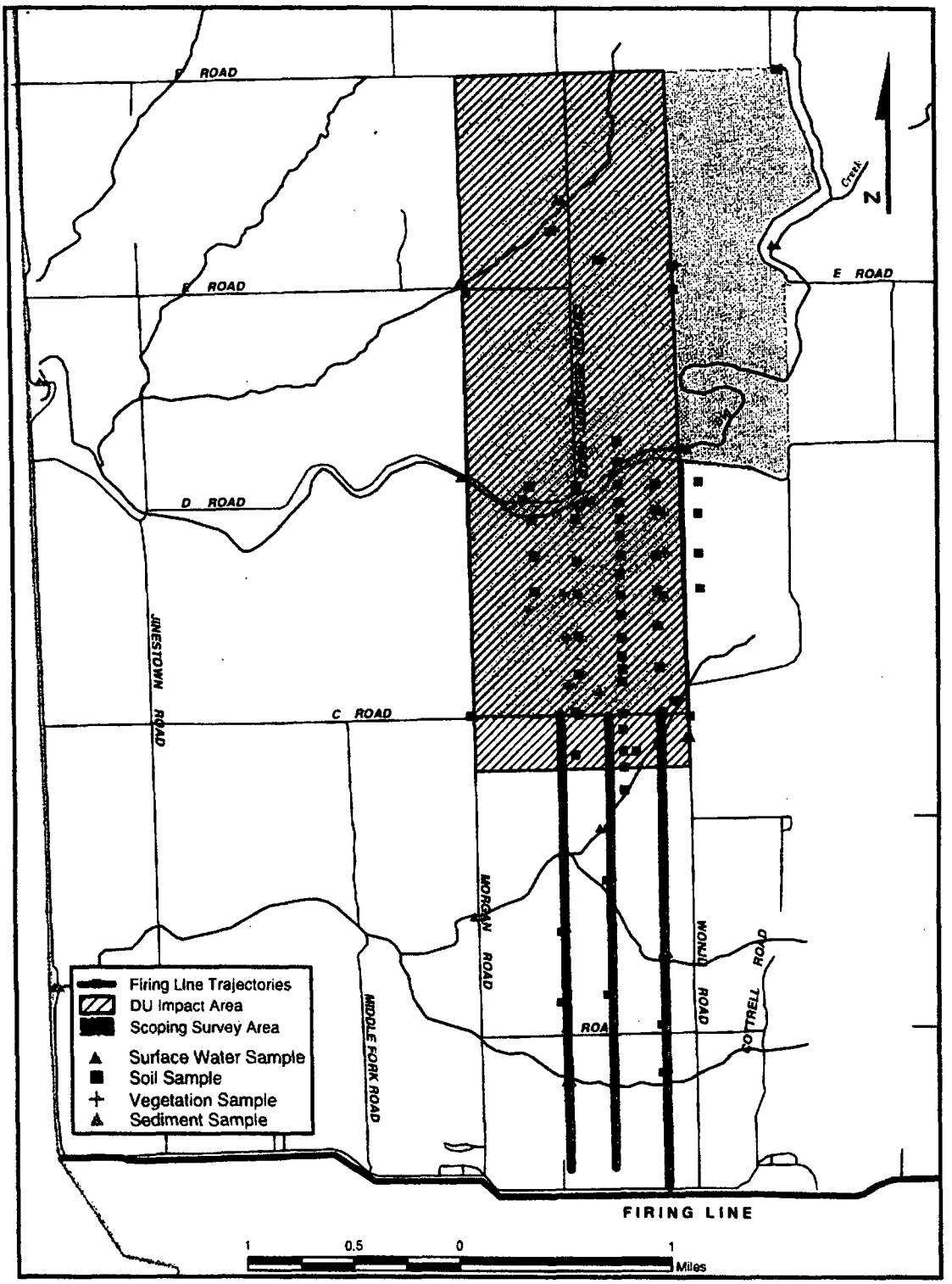
A scoping survey was conducted in 1995 (SEG 1995) to determine the boundaries of the DU Impact Area. This survey evaluated areas located to the north and east of the DU Impact Area as well as radiation surveys along the three affected trajectories from the firing line. A characterization survey (SEG 1996) of the DU Impact Area was conducted to confirm the amount and extent of activity in the area. The results of these investigations are discussed in this section.

A scoping survey conducted in 1994 identified and delineated the affected portion of the DU Impact Area. The survey included gamma radiation measurements and environmental sampling (soil, groundwater, surface water, sediment, and vegetation samples) [SEG 1995]. The impacted area was defined as that area that contained radioactivity in excess of 35 picocuries per gram (pCi/g) of DU in soil. A characterization survey was conducted in 1995 to confirm and document the amount and extent of radioactivity in the DU Impact Area to estimate remedial costs, waste volumes, and techniques for decontamination of the area (SEG 1996). The findings of the SEG surveys are consistent with the results from the annual environmental monitoring program.

3.1.3.1 Scoping Survey Results

The scoping survey consisted of a radiation survey of the DU Impact Area, a radiation survey of the trajectories from the firing line into the DU Impact Area, and environmental sampling and analysis (Figure 3-1). Samples of all media were obtained both within and exterior to the 2,080-acre (8.4-km^2) DU Impact Area. Collection methods and locations were similar to those used for the environmental monitoring program (SEG 1995).

The radiation survey of the DU Impact Area was based on an unbiased, gridded survey with grid lines established at intervals of 164 ft (50 m) from north to south on the eastern and western boundaries (SEG 1995). Radiation measurements were collected 3.3 ft (1 m) from the ground every 32.8 ft (10 m) along the grid line. The Ludlum Model 3250 Data Logger™ and the Ludlum Model 44-2™ sodium iodide (NaI) detector were used for the exposure rate surveys. The radiation survey of the firing lines was performed



Source: SEG 1995.

Figure 3-1. Scoping Survey Sample Locations
Jefferson Proving Ground, Indiana

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similarly to the impact area survey except that the grid lines ran south to north from the firing points to C Road (Figure 3-1). Three grids were established along the trajectory from the firing point: one down the center of the trajectory path, one 164 ft (50 m) east, and one 164 ft (50 m) west. Measurements were collected at intervals of 32.8 ft (10 m) along each grid.

Soil, groundwater, surface water, sediment, and vegetation samples were collected prior to the radiation survey. These samples were collected in accordance with approved SEG procedures and shipped to an approved off-site laboratory for analysis (SEG 1995) [see Figure 3-2]. Volume 2 of SEG (1995) provides details on the survey plan and SEG procedures. The procedures identify survey instrumentation requirements, measurement and sample collection procedures, data quality objectives, and data reduction and evaluation methods. Table 3-1 summarizes the soil sampling results from the scoping survey. Details of the results by sample number for each medium sampled are provided in the SEG report (SEG 1995).

Table 3-1. Scoping Survey Sample Results

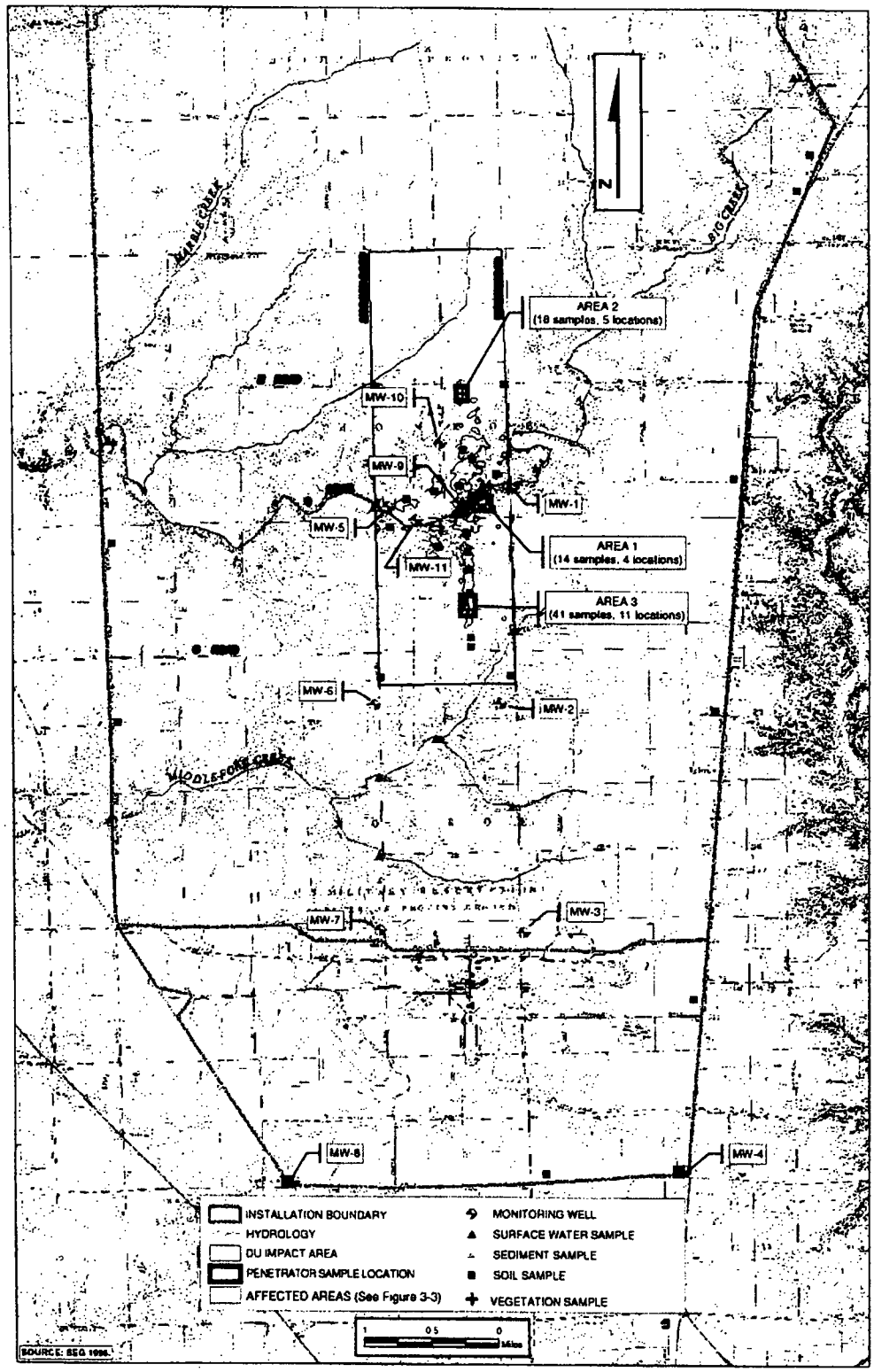
Sample Location	No. of Samples	Total Uranium Range in Concentration
DU Impact Area and Environs		
Soil	50	1.35–201 pCi/g
Sediment	11	0.42–1.9 pCi/g
Surface Water	12	0.21–3.6 pCi/L
Vegetation	14	0.01–0.50 pCi/g
Trajectory Locations		
Soil	12	1.42–1.87 pCi/g
Sediment	2	2.03–3.08 pCi/g
Surface Water	2	0.35–0.88 pCi/L
Groundwater	11	0.43–3.6 pCi/L
Vegetation	6	0.06–0.65 pCi/g

Source: Compiled from SEG 1995.
DU = depleted uranium.
pCi/L = picocuries per liter.
pCi/g = picocuries per gram.

Soil Samples—Sixty-two soil samples were collected during the scoping survey. Fifty samples were collected from within the DU Impact Area, and 12 samples were collected along the 3 trajectories between the firing line and C Road (Figure 3-1). The soil sampling program was unbiased and based on a 492-ft (150-m) grid system. Samples were collected along the 500 center firing position, along lines parallel to and 984 ft (300 m) east and west of the 500 center firing position, and along lines 1,968 ft (600 m) east and west, respectively, of the 500 center firing position. Each sample was collected to a depth of approximately 0.5 in (1.27 cm).

Soil samples were analyzed by Quanterra Environmental Services Richland Laboratory for radiochemical analyses. The samples were analyzed using alpha spectroscopy for uranium (U)-234, -235, and -238 by method ITAS-RD-323A.

The results of this sampling indicated that the highest uranium concentrations were detected south of Big Creek within the DU Impact Area. Total uranium concentrations ranged from <1.3 to 201 pCi/g, with an average concentration of 12.9 pCi/g. Soil samples collected along the trajectories south of the DU Impact Area had concentrations ranging from 1.4 to 1.8 pCi/g of total uranium.



Source: SEG 1996.

Figure 3-2. Characterization Survey Sample Locations
Jefferson Proving Ground, Indiana

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Soil samples were analyzed for concentrations of the three major uranium isotopes: U-234, U-235, and U-238. The U-238 to U-234 activity ratio (unitless) was reviewed to determine whether the uranium is naturally occurring or includes DU. In samples containing naturally occurring uranium, the activity ratio of U-238 to U-234 is approximately 1 (0.5 to 1.3). The activity ratio for DU is 5.5 to 9 based on a review of isotopic analysis of penetrators collected from the field within the DU Impact Area (SEG 1995). Therefore, environmental measurements with U-238 to U-234 activity ratios greater than two are indicative of DU contamination.

The scoping survey soil samples indicated evidence of DU contamination primarily along the central and eastern trajectories within the DU Impact Area.

Sediment Samples—Sediment samples were collected at the same locations where surface water samples were obtained during the scoping survey. The total uranium concentration in sediment samples ranged from 0.88 to 1.09 pCi/g within the DU Impact Area. Along the firing line trajectories, the total uranium concentration in sediment was measured at 2 and 3 pCi/g along two different streams south of the DU Impact Area. The U-238 to U-234 activity ratio in the sediment samples collected during the scoping survey indicates that the uranium is naturally occurring.

Surface Water Samples—Fourteen surface water samples were collected during the scoping survey using the same methods described above for soil sampling. Eight samples were collected from the DU Impact Area and environs, and six samples were collected from the firing line trajectories in the vicinity of Middle Fork Creek. Near the DU Impact Area, three samples were collected upstream along Big Creek; two samples were collected from within the DU Impact Area; one sample was collected from Big Creek, downstream of the DU Impact Area; and the remaining two samples were collected from streams that flow into Big Creek.

The firing line trajectories were sampled at six locations: a sampling point located upstream of the firing line trajectories along Middle Fork Creek, one sampling point that coincided with a firing line trajectory, two downstream sampling locations, and two sampling points along streams that flow into Middle Fork Creek.

The total uranium concentrations in surface water that flowed through the DU Impact Area ranged from 0.21 to 4.11 pCi/L. The uranium concentration in surface water samples collected from streams intersecting the trajectories south of the firing line ranged from 1.42 to 1.87 pCi/L. The U-238 to U-234 activity ratio in the surface water samples collected during the scoping survey ranged from 0.35 to 1.0, indicating that the uranium is naturally occurring.

Groundwater Samples—Total uranium ranged from 0.43 to 3.609 pCi/L in 11 groundwater samples. These levels were well below the guideline level of 15 pCi/L. There was no indication of contamination when background concentration was subtracted.

Vegetation Samples—Twenty vegetation samples were collected during the scoping survey using the same methods for soil sampling. Fourteen samples were obtained from within the DU Impact Area, and six samples were obtained along the firing line trajectories. The total uranium concentration in vegetation samples was less than 0.7 pCi/g in all samples. Two lichen samples from the south-central portion of the DU Impact Area had U-238 to U-234 activity ratios of 2.3 and 2.6, which indicate DU contamination.

3.1.3.2 Characterization Survey Results

The characterization survey included the collection of exposure rate and in situ gamma spectroscopy measurements and soil, groundwater, surface water, sediment, vegetation, and biological samples. Background sampling was completed for surface and subsurface soil (10 locations), groundwater

(6 locations), surface water (3 locations), and sediment (3 locations). All samples were analyzed by alpha spectroscopy for U-234, U-235, and U-238 by Lockheed Analytical Laboratories. The isotopic uranium analysis was performed using Standard Operating Procedure (SOP) No. LAL-91-SOP-0108 (SEG 1996). Figure 3-2 shows the sampling locations for environmental media collected in support of site characterization. Soil sample results from the characterization survey are provided in Table 3-2.

Table 3-2. Soil Characterization Survey Results

Depth (cm) BGS	No. of Samples	Total Uranium Range in Concentration (pCi/g)	Average (pCi/g)
Background			
0–15	10	1.52–2.53	1.97
15–30	10	1.33–2.59	1.84
30–45	10	1.33–2.76	1.95
Penetrator Soil Samples			
0–15	20	2.9–12,318	2,881
15–30	20	1.5–547	79.5
30–45	20	1.8–63	12.7
45–60	13	1.4–11.5	4.50
Random Soil Samples			
0–15	20	1.46–4.73	2.60
15–30	20	1.51–6.91	2.40
30–45	20	1.34–4.21	2.00

Source: Compiled from SEG 1996.
BGS = below ground surface.
cm = centimeter.
pCi/g = picocuries per gram.

Soil Samples—Background surface and subsurface soil samples were collected from 10 sites in areas not impacted by the DU testing. Soil sample results from the characterization survey are provided in Table 3-2. The background locations were selected to ensure that these locations were representative of the different types of soils in the impact area and consistent with those locations sampled in 1983 as part of the baseline environmental impact survey. Background soil samples were collected from three depths at each location: 0 to 5.9 in. (0 to 15 cm), 5.9 to 11.8 in. (15 to 30 cm), and 11.8 to 17.7 in. (30 to 45 cm) below BGS. Total uranium concentrations ranged from 1.33 to 2.76 pCi/g in the background soil samples (see Table 3-2). The U-238 to U-234 activity ratio in the background soil samples ranged from 0.5 to 1.3.

Both random soil and penetrator soil samples were collected in support of the site characterization program. Surface and subsurface soil samples also were collected from 20 randomly selected locations in the impacted area (SEG 1996). Surface and subsurface soil samples were collected directly under penetrators or penetrator fragments. Twenty locations were identified within three areas where the penetrators or fragments were at the surface. The random soil sampling locations and the three penetrator sampling locations are shown on Figure 3-2.

Penetrator Soil Samples—Sixty soil samples were collected beneath 20 penetrators. The total uranium concentrations ranged from 1.5 pCi/g at a depth of 11.8 to 17.7 in. (30 to 45 cm) BGS to 12,318 pCi/g at a depth of 0 to 5.9 in. (0 to 15 cm) BGS in Area 3 (Figure 3-2). The uranium concentration decreased with depth as indicated in Table 3-2. At a depth from the surface to 5.9 in. (15 cm) BGS, the average concentration was 2,881 pCi/g of total uranium (Table 3-2). At a depth from 11.8 to 17.7 in. (30 to 45 cm) BGS, the average concentration of total uranium was 12.7 pCi/g. At a depth from 17.7 to 23.6 in. (45 to 60 cm) BGS, the average concentration of total uranium was 4.5 pCi/g. The U-238 to U-234 activity ratio

in the penetrator soil samples indicated DU contamination to depths of 11.9 in. (30 cm) BGS at some locations and to depths of 23.6 in. (60 cm) BGS at others.

Random Soil Samples—Sixty soil samples also were collected from 20 randomly selected locations within the impact area. None of the samples was from trenches within the DU Impact Area. The total uranium concentrations ranged from 1.34 to 6.91 pCi/g, with an average concentration of 2.33 pCi/g. Most samples were at background concentrations. The U-238 to U-234 activity ratio in the random soil samples indicated that most of the uranium was naturally occurring.

The results of the soil sampling program indicate that soil contamination outside of the impact trenches is associated with proximity to penetrator fragments. Therefore, soil contamination that could result in doses above release criteria would be limited to either the primary impact trenches or areas containing penetrator fragments.

Surface Water and Sediment Samples—Surface water samples were collected from 10 stream locations within the impact area. The characterization survey results for the surface water, sediment, and vegetation samples are provided in Table 3-3. Six locations were sampled in Big Creek at locations both upstream and downstream of the DU Impact Area. Four locations in Middle Fork Creek were sampled. Upstream of the DU Impact Area at the site boundary, the total uranium concentration was measured at 0.62 pCi/L; at locations within the DU Impact Area, the total uranium concentration in surface water ranged from 0.77 to 25.02 pCi/L. At the sample location on the western boundary of the installation, the total uranium concentration in surface water measured 0.89 pCi/L. All samples were at or near background except for two sampling locations within the DU Impact Area. The surface water samples from the DU Impact Area that had higher total uranium concentrations were collected from static pools of water. The U-238 to U-234 activity ratio in the samples from static pools of water was 4.4 and 7.3, indicating the presence of DU contamination. The total uranium concentration in surface water samples collected from Middle Fork Creek ranged from 0.63 to 1.80 pCi/L.

Table 3-3. Characterization Survey Results for Surface Water, Sediment, and Vegetation

Environmental Media	No. of Samples	Total Uranium Range in Concentration (pCi/g)	Average Concentration (pCi/g)
Surface Water	10	0.62–25.02	3.55
Sediment	10	0.75–6.20	2.5
Vegetation	10	17.0–3,447	627.5
Vegetation Root Wash	10	46.1–14,258	2,868.8

Source: Compiled from SEG 1996.
pCi/g = picocuries per gram.

Sediment samples were collected at the same locations as the surface water samples. At the Big Creek upstream location, the total uranium concentration in sediment was measured at 0.78 pCi/g. The total uranium concentration in sediment samples from within the DU Impact Area boundary ranged from 0.75 to 6.20 pCi/g. On the western boundary of the installation, the total uranium concentration was measured at 0.75 pCi/g. The sediment samples taken from static pools of water also had U-238 to U-234 activity ratios, indicating DU contamination.

Sediment samples collected from Middle Fork Creek had total uranium concentrations ranging from 1.81 to 3.46 pCi/g.

Vegetation Samples—Ten vegetation samples of lichens, leaves, or grasses were collected from the affected area trenches during site characterization. Samples were collected from the three penetrator fragment areas shown on Figure 3-2. Five vegetation samples were collected from Area 1, four samples from Area 2, and one sample from Area 3, and were analyzed for total uranium.

Samples were washed with deionized water prior to analysis, and the wash water was analyzed separately from the vegetation sample to determine the amount of uranium on the surface of, and in, the sample. The total uranium concentration in vegetation samples ranged from 0.75 to 3,447 pCi/g, with an average concentration of 627.5 pCi/g. The total uranium concentration in the root wash samples ranged from 46.1 to 14,258 pCi/g, with an average concentration of 2,869 pCi/g. The U-238 to U-234 activity ratio ranged from 6.1 to 8.4, indicating the presence of DU contamination.

Biological Samples—A total of eight biological samples were collected from deer, freshwater clams, fish, and a soft-shelled turtle. All of the biological samples from Big Creek were collected from the area adjacent to the DU Impact Area. The total uranium concentrations ranged from 0.091 pCi/g in deer liver to a maximum of 0.774 pCi/g in a freshwater clam. The results of the biological sampling are shown in Table 3-4. The U-238 to U-234 activity ratio ranged from 0.4 to 1.2 and does not indicate the presence of DU contamination.

Table 3-4. Biological Sample Results

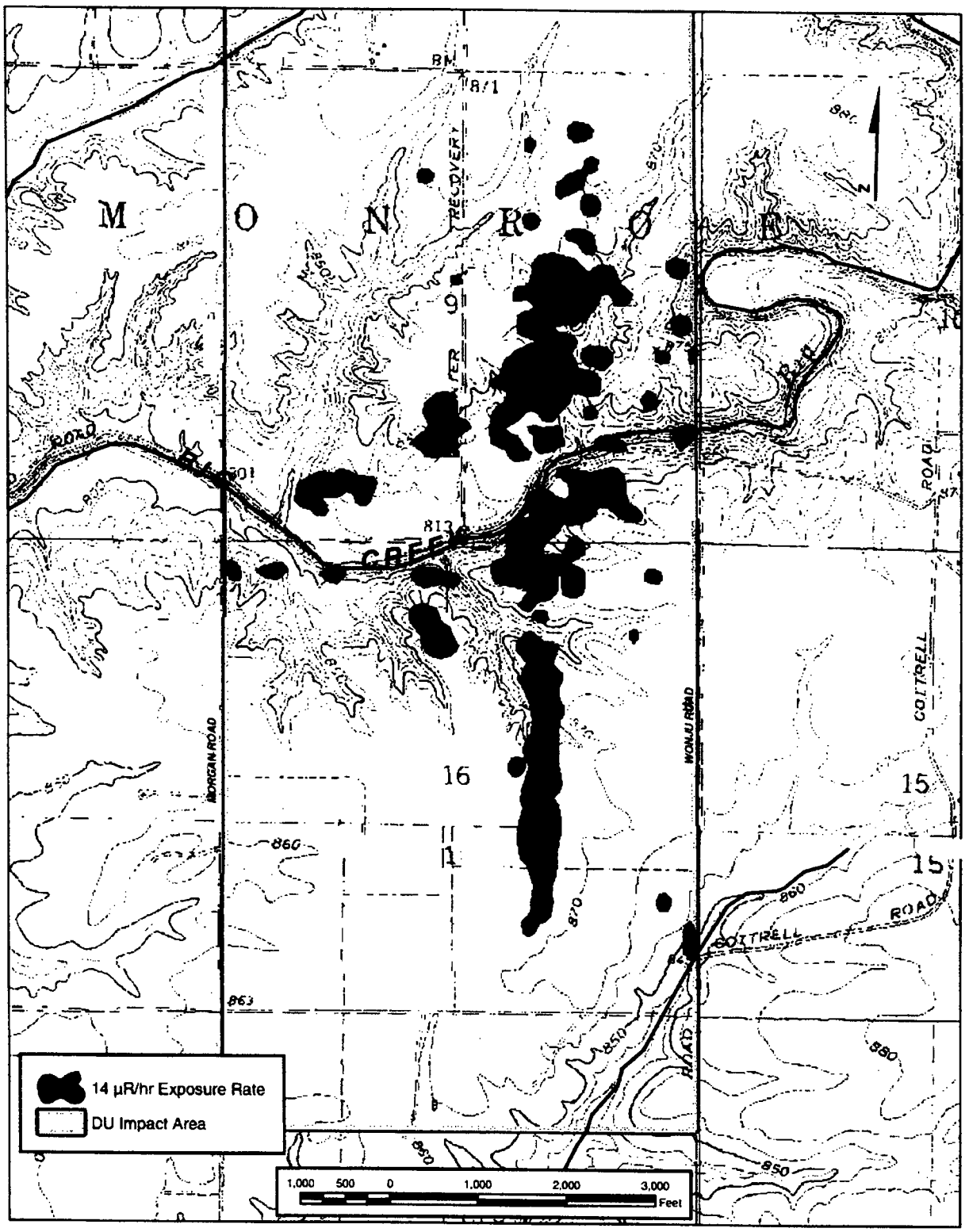
Sample Type	Total Uranium (pCi/g)
Deer Liver	0.091
Deer Kidney	0.151
Deer Bone	0.416
Freshwater Clams	0.774
Freshwater Clams	0.334
Fish	0.150
Fish	0.282
Soft Shelled Turtle	0.245

Source: Compiled from SEG 1996.
pCi/g = picocuries per gram.

Groundwater Samples—The total uranium concentration in groundwater samples collected as part of the site characterization program ranged from 0.33 to 5.09 pCi/L at background levels at the site. The U-238 to U-234 activity ratio in groundwater water samples indicates that the uranium is naturally occurring.

In situ Gamma Spectroscopy and Exposure Rate Measurements—To further define the affected area, the relationship between the average concentration of DU in the ground and exposure rate was analyzed to determine the isotopic concentration from the in situ gamma spectroscopy data. These measurements were obtained with the same instrument used in the scoping survey (SEG 1995).

At each location, a single in situ gamma spectroscopy measurement yielded the total inventory of activity for each nuclide presented as an area of activity concentration at the surface. Using these results, the concentrations of thorium-234 and polonium-234m were calculated for depth ranges of 0 to 5.9 in. (0 to 15 cm), 5.9 to 11.8 in. (15 to 30 cm), and 11.8 to 17.7 in. (30 to 45 cm) BGS. The specific assumptions used to determine this relationship are presented in SEG (1996). The exposure rate corresponding to a DU concentration of 35 pCi/g is 14.4 μR/hr. The contour map showing areas with an exposure rate greater than 14.4 μR/hr is shown in Figure 3-3.



Source: SEG 1996.

Figure 3-3. Exposure Rate of 14 µR/hr from Soil at Jefferson Proving Ground, Indiana

C14

Based on the 35 pCi/g contour, SEG estimated the volume of DU contamination as 72,000 yd^3 (55,000 m^3). If this volume of soil is removed uniformly from the estimated 125 acres (500,000 m^2), the average depth of DU contamination would be 4.3 in. (0.11 m). The actual depth of contaminated soil above unrestricted release criterion is expected to vary because of the nonhomogeneous nature of the DU contamination. For example, in the vicinity of penetrators, the remediation depth has been measured at depths of 18 in. (45 cm) [SEG 1996]. Annual **Environmental** Monitoring Program

An environmental monitoring plan was developed for the JPG DU Impact Area before the initial DU munitions were fired in 1984, and this plan guided sample collection and analysis through 1995. This sampling plan and protocol were updated in 1996 (U.S. Army 1996) and 2000 (U.S. Army 2000a U.S. Army 2000a). Sampling locations for soils, surface water, and groundwater are shown in the environmental monitoring plan, and the sampling design for vegetation and biota are also presented. Samples were collected and analyzed semiannually for total uranium and, often, the isotopic composition of uranium in samples. The environmental sampling data are summarized for the 1984–1994 period (Ebinger and Hansen 1996). Soil concentration data for the DU Impact Area from 1984–2000 are skewed left with a mean value of 18.8 pCi/g and a median value of 1.5 pCi/g; the standard deviation of these samples is almost 200 pCi/g (Table 3-5). Of nearly 400 soil samples analyzed since 1984, most are less than 2 pCi/g, which is identical to the average background soil concentration of uranium at JPG. Similar distributions for DU concentrations in groundwater and surface water were obtained for the same period (Table 3-5). The environmental data indicate that the expected concentrations of uranium or DU are significantly less than the derived concentration guideline of 35 pCi/g for soil and 150 pCi/L for surface water and groundwater (U. S. Army 1996).

Table 3-5. Descriptive Statistics of DU concentrations in Soil, Groundwater, and Surface Water Samples (1984–2000)

	Soil (pCi/g)	Groundwater (pCi/L)	Surface Water (pCi/L)
Mean	18.8	2.7	1.6
Median	1.5	1.3	0.26
Standard Deviation	197.1	5.6	5.6
Minimum	-0.8	-0.1	-1.2
Maximum	3857	81.1	49
Number of Samples	388	365	312

Source: Ebinger and Hansen 1996.
pCi/g = picocuries per gram.
pCi/L = picocuries per liter.

As noted in Section 3.1.2, several monitoring wells were completed around the DU firing range between 1984 and 1994. These wells were bored to various depths that ranged to over 40 ft from the surface (SEC Donohue 1992). The groundwater data show some variation in the concentration of uranium in wells between 1984 and 2000, the largest of which was attributed to error in sample handling at the analytical laboratories (Ebinger and Hansen 1996). Overall, the data indicate that DU contamination has not moved to the groundwater or surface water from the DU Impact Area. This conclusion was further supported by the isotopic composition of uranium in the groundwater samples (Ebinger and Hansen 1996).

Surface water samples from monitoring locations on Big Creek upstream and downstream from the DU Impact Area varied in uranium and DU concentration during the 1984–2000 period, but there was neither long-term elevation of the concentration, nor sustained, elevated concentration at any sampling site. Some of the observed variation in surface water samples may be attributable to uranium incidentally being used as a trace constituent of phosphate fertilizer (Ebinger and Hansen 1996). Isotopic ratios of these samples indicate that most of the observed variation was due to a natural uranium in surface water and not DU. The summary data suggest that the main source of uranium in surface waters is natural in origin, that is,

from fertilizers or geologic deposits, which were transported via water or erosion. Whether from natural sources or agricultural fertilizer, the concentrations are well below the Army derived concentration guideline levels (DCGLs) [U.S. Army 1996] and low enough to be of little concern. In addition, surface water samples collected from Big Creek and Middle Fork Creek on a monthly basis for the year 2001 by the ISDH (ISDH 2002) indicate the presence of only background levels of radioactivity.

Vegetation and animal sampling also was conducted (Ebinger and Hansen 1996); however, the data set is not as complete as for the abiotic media. From the reported data there does not appear to be an adverse impact on the vegetation and animals. One lichen sample indicated a high concentration, probably from DU in resuspended soil collecting on the lichen surface. Deer samples and raccoon and freshwater clam tissue show little uranium, either natural or from DU, was found in the tissues.

3.1.4 FWS Fire Management Program's Impact on the Area North of the Firing Line

In support of its management responsibilities for the Big Oaks NWR, the FWS is implementing a Fire Management Plan (FMP) (FWS 2001d). The goals of this plan are to manage the use of fire to complement or augment other means of maintaining refuge habitat and reduce fuels in areas that may pose risks to human and natural resources. The Big Oaks NWR is subdivided into four fire management units (FMUs), two of which include portions of the DU Impact Area (i.e., FMU-3 and FMU-4). The FWS recognizes the presence of both UXO and DU in the FMP and requires suppression activities to occur only on the boundary of the refuge.

Table 3-6 summarizes the environmental consequences anticipated from implementing the FMP.

Table 3-6. Summary of Environmental Consequences for Management Ignited Prescribed Fire and Management Response to Wildland Fire

Resource	Impacts
Soil and Water Resources	Minor short-term impacts from prescribed fires
Vegetation and Fuels	No change from the current condition is expected. A more natural landscape would result from natural wildland fires.
Wildlife	No immediate change from the current conditions. A more natural assemblage of species would result from natural wildland fires over time.
Endangered and Threatened Species	No change from the current condition. Prescribed burns would be designed to avoid direct impacts to *M. sodalis* (i.e., suppressing all fires between April 15 and September 15).
Cultural Resources	No change from the current condition.
Visual/Aesthetics/Air Shed	Periodic extreme fire events could cause impacts to visual/aesthetics/air shed.

Source: FWS 2001e.

The effects of burning efforts at the Big Oaks NWR and the combined effects on the environment of all burning and other sources of particulate matter and overall impacts to habitats throughout the region were assessed. Cumulative impacts of the implementation of this plan on air quality in Indiana were anticipated to be minimal. No area within the region is a nonattainment air quality area, and none is likely to be directly or indirectly affected to approaching a level of significance needing to be addressed.

No cumulative loss of early successional habitats or contiguous forest would result at the Big Oaks NWR or within the state or region from implementation of this FMP. This plan strives to maintain the

8,000 acres of grassland and 6,000 acres of other early successional habitats that currently exist within the Big Oaks NWR.

The FWS indicates the air quality impacts would be minimal. In addition, the EA notes that DU is not readily transported in smoke associated with burning of natural vegetation in an environment similar to that occurring at the Big Oaks NWR (Williams et al. 1998).

Williams et al. (1998) used atmospheric dispersion computer models to evaluate the potential for human health impacts from exposure to contaminants that could be dispersed by fires on testing ranges at Aberdeen Proving Ground. The screening-level assessment does not actually estimate actual human health risks. One of the contaminants present in soil and vegetation as a result of past operations was DU.

The computer plume model, FIREPLUME, was used to predict ground-level concentrations resulting from releases of hazardous materials from a forest fire. The primary fire scenario was represented by a 100-m line source of fire occurring in either 25 acres of forest or grassland. Three classes of meteorological stability were considered (Classes A, D, and E). The maximum release concentration for DU was 6.58×10^{-5} mg/m^3. This exposure level was four orders of magnitude lower than the non-carcinogenic air screening levels for an adult and child, 0.9 and 0.44 mg/m^3, respectively. The carcinogenic air screening level for DU was not calculated because it is known to be lower than the non-carcinogenic risk (Davis 1990).

3.2 NON-RADIOLOGICAL STATUS

Current and historical ordnance testing and other environmental investigations at JPG are discussed in this section. The historical ordnance testing that has been conducted north of the firing line at the site is discussed in Section 3.2.1. Other environmental investigations being conducted south of the firing line are discussed in Section 3.2.2. Recent environmental investigations have included both installation-wide and site-specific studies. Investigations have focused on the extent of soil and groundwater contamination at potentially contaminated sites in the cantonment area.

The JPG mission was primarily to plan and conduct production acceptance tests, reconditioning tests, surveillance tests, and other studies of ammunition and weapons systems. Activities involved with this mission included detonation, burning, and disposal of many types of waste propellants, explosives, and pyrotechnic substances at the facility.

Ordnance testing operations at JPG were initiated in May 1941. JPG's mission was to test all types of ordnance: ammunition, projectiles, propellants, cartridge cases, primers, fuses, boosters, bombs, and grenades. The Army estimates that from World War II until base closure, 23 million rounds of ammunition were tested and that 1.5 million UXO items still may exist (Mason and Hanger 1992). In addition, another 7 million inert projectiles having live fuses or spotting charges may be present (U.S. Army 1995b). Because of the historical practices at the installation, UXO may be found anywhere north of the firing line.

3.2.1 North of Firing Line

In general, the ordnance ranges consist of the weapon firing point; the impact zone, a designated area of land where the projectile was expected to impact; recovery areas within the impact zone consisting of areas cleared of vegetation; and a safety zone, a designated area of land surrounding the firing position, flight path, and impact zone. JPG operated up to 125 permanent weapon firing positions and 143 temporary gun positions for a total of 268 gun positions. The majority of the large-caliber weapons

were situated to fire north from the firing line. However, weapons also were fired from north to south and from east to west to meet testing requirements (Mason and Hanger 1992; USACE 1995). In 1992, JPG had 50 designated impact zones spread across approximately 8,600 acres (34.8 km^2). Based on interviews with JPG personnel, impact fields designated for inert munitions also contain HE, UXO, and impact zones, and the immediate surrounding land areas contain large quantities of residual inert metal fragments and munitions parts (Mason and Hanger 1992; USACE 1995).

Munitions tested at JPG varied in size from 20 mm, small-caliber cannon (HE rounds) and improved conventional munitions submunitions (approximately 1 in. in diameter) to 240 mm Howitzer projectiles and 2,000-pound (907-kg) bombs. UXO and residual metal parts are located from the surface to a depth greater than 25 ft (7.6 m) BGS. Figure 1-1, located at the end of this report, shows the occurrence of UXO north of the firing line. The majority of munitions and residue are concentrated at or near the impact zones; however, singular munitions are distributed across a vast area of JPG outside of the impact zones (Mason and Hanger 1992; USACE 1995).

Mason and Hanger (1992) have indicated UXO removal at JPG would present a substantially greater challenge compared to other ranges because of the type and nature of the munitions and extent of the land area contaminated. UXO cleanup would be challenging because of the quantity and diverse types of ordnance evaluated at the installation; the numerous multipurpose range sites geographically situated over the area; the overlap of trajectory paths versus impact/target zones; occurrence of malfunctioning and/or erratic munition performance resulting in an unknown terminal impact location; munition earth penetration into a variety of surface conditions (wooded, grassy, dry, wet, etc.); availability of records; condition of UXO munitions exposed to corrosive elements; and the land area used at different periods for ordnance evaluations (Mason and Hanger 1992).

Based on interviews with installation personnel, the most accurate munition records are available for the DU projectiles (Mason and Hanger 1992; USACE 1995). All firings of DU were conducted from specific gun positions toward the DU impact zone. During active operations of the DU Impact Area, explosives ordnance personnel periodically would sweep the range area surrounding the DU impact zone to recover DU. The recovered projectiles and fragments were weighed and the recovered weights subtracted from the fired projectile weights to determine the total DU material weight remaining in the range. DU projectiles were fired from large-caliber guns at high velocities. Upon impact, the projectiles penetrated into the earth, ricocheted, or broke into two or more pieces in addition to the preceding. DU projectiles would break into chunks rather than shatter into pieces (Mason and Hanger 1992). Firing of DU projectiles against metal target plates, which could contribute to minute particle fragmentation/aerosolization of DU rods and particle burning, was neither authorized by the NRC license nor conducted by the Army at JPG.

The Army currently is deferring an RI/FS of the area north of the firing line due to the physical and personnel safety hazards associated with UXO in this area (SAIC 1997a). Therefore, no intrusive studies have been conducted on the 22 sites identified north of the firing line. The area north of the firing line was subject to routine clearing of vegetation by disc plowing and infrequent herbicide application in addition to detonation of weapons (MWH 2002).

The time frame for an environmental investigation of this area is dependent on regulatory requirements, the level of safety that must be attained during an investigation, the technology available to eliminate potential hazards, and the identification of reuse options and associated cleanup requirements for this area (SAIC 1997a).

3.2.2 South of the Firing Line

Potentially hazardous substances identified at JPG include various explosive compounds, waste propellants, lead, chlorinated solvents, wood preservatives, sulfur, silver, photographic development wastes, sanitary wastes, and petroleum products. Some substances are known to have been released to the soil as a result of waste disposal activities. Subsequently, groundwater also became contaminated. Recent environmental investigations into the potential contamination at JPG have included site-specific, as well as base-wide, studies. Investigations have focused on the extent of contamination of the soil and groundwater at potentially contaminated sites in the cantonment area. Groundwater studies also have been conducted around the southern cantonment area (SAIC 1997a).

In support of the BRAC process, the Army is implementing an RI/FS of the area south of the firing line. The objective of the RI portion of this study is to define the extent and magnitude of environmental contamination within 50 identified sites (54 locations) and to assess the potential risks to receptors. The Phase I Final Draft RI, which investigated 50 sites, was issued in 1994 (Rust E&I 1994) and followed by additional investigations for 23 of the sites. The Phase II Draft RI, which incorporates the Phase I and Phase II results, was issued in August 1998 (Rust E&I 1998). The Phase II Draft Final RI (MWH 2002) addresses regulatory comments on the Draft RI and incorporates additional work completed since the Draft RI was submitted. The sites for which No Further Action (NFA) was recommended during the Phase I RI (Rust E&I 1994) are not addressed in the Phase II Draft Final RI (MWH 2002)

There are 30 sites addressed in the Phase II RI (23 sites with Phase II sampling and 7 Phase I sites without sampling) [MWH 2002]. For these and other sites where risks are at acceptable levels, technical memoranda will be prepared that recommend NFA, resulting in removal of these sites from the RI/FS process. Table 3-7 identifies the 30 sites evaluated during the Phase II RI and indicates the 15 sites for which NFA is recommended (includes 14 sites which have undergone interim remedial removal actions). Fifteen sites will be assessed in the FS and are summarized in Table 3-8.

Table 3-7. Sites South of the Firing Line Evaluated in the RI

Site No.	Site Name
1	Building 185 Incinerator[c]
2	Sewage Treatment Plant[c]
3	Explosive Burning Area[c]
4	Abandoned Landfill[c]
5	Wood Storage Pile[b]
6	Wood Burning Area[b]
7	**Red Lead Disposal Area[a,c]**
8	**Building 295 Small Arms Firing Range[a,b]**
9	Burning Ground South of Gate 19 Landfill[c]
10	**Gate 19 Landfill[a,c]**
12A	**Building 602 Solvent Pit[a,c]**
12B	**Building 617 Solvent Pit[a,c]**
12C	**Building 279 Solvent Pit[a,c]**
13	Old Fire Training Pit[a,b]
14	**Yellow Sulfur Disposal Area[a,c]**
15	**Burn Area South of New Incinerator[a,b]**
21A	Building 204 Temporary Storage Area[c]
21B	Temporary Methylene Chloride Storage Area[c]
25	**Papermill Road Disposal Area[a,b]**
26	**DRMO Storage Area and Possible Sites South of DRMO[a,b]**
27	Sewage Sludge Application Areas[c]
28	**Gator Z Open Burn Area[a,b]**
29	**Gator Z Mine Scrap Disposal Area[a,b]**
30	Building 204 Pesticide Storage Area[c]
31	Building 227 Former Storage Pad[b]
33	**Building 333 New Incinerator[a,b]**
34	Building 136 Sandblasting Area[b]
38	Northwest-Southeast Runway Flare Test Area[b]
39	Gator Z Mine Test Area[b]
42	Building 281 Indoor Range[b]

Source: MWH 2002.
[a]Bolded sites are those that have had interim remedial removal actions completed by the Army.
[b]Sites for which No Further Action is recommended.
[c]Sites recommended for further evaluation in the Feasibility Study.
RI = Remedial Investigation.

Table 3-8. Feasibility Study Sites Located South of the Firing Line

Site Number and Name	Rationale for Inclusion in the FS	Proposed Solution/Action	COCs
1 – Incinerator (Bldg. 185)	Future residential risks exceed EPA risk-based criteria	Completion of close-out process; restrictions on residential/agricultural land uses	Soil – Dioxins and metals
2/27 – Sewage Treatment Plant and Sludge Application Areas	Chronic health hazards associated with the future residential land use	Restrictions on residential/agricultural land uses	Soil – Aluminum, arsenic, beryllium, chromium, manganese, silver, and thallium Sediments – Aluminum, arsenic, beryllium, chromium, iron, manganese, and vanadium
3/4 – Explosive Burn Area and Abandoned Landfill	Future human health risks and hazards exceeding EPA risk-based criteria	Monitoring of groundwater and crops	Soil – Metals, SVOCs, and dioxins Groundwater – Metals Dust – VOCs and metals
7/21B – Red Lead Disposal Area and Bldg. 211	Future on-site worker and resident health hazard estimates exceed EPA risk-based criteria	Possible additional investigation of arsenic	Soil – Aluminum, barium, beryllium, lead, manganese, and pesticides Groundwater – Arsenic and barium
9/10 – Burning Ground South of Gate 19 Landfill and Gate 19 Landfill	Chronic health hazard estimates exceed EPA risk-based criteria	Additional sampling of several chemicals	Groundwater – metals
12A, 12B, and 12C – Buildings 602, 617, and 279 Solvent Pits	Elevated risks to potential future residents and industrial workers	Natural attenuation and soil venting	Groundwater – 1,1,1-trichloroethane, 1,1-dichloroethylene, and 1,1-dichloroethane
14 – Yellow Sulfur Disposal Area	Presence of UXO, remaining acidic environment, and future potential human health risks	To be determined	Soil – UXO, chromium Groundwater – Arsenic
21A/30 – Temporary Storage Area (Bldg. 204) and Adjacent Shed	Future residential health hazard exceed EPA target range	Additional sampling of subsurface soil and groundwater	Surface soil – Dieldrin

Sources: MWH 2002.
COC = Chemical of concern.
EPA = U.S. Environmental Protection Agency.
FS = Feasibility Study.
SVOC = Semivolatile organic compound.
UXO = Unexploded ordnance.
VOC = Volatile organic compound.

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4.0 PROPOSED ACTION AND ALTERNATIVES

Alternatives that were considered for the JPG DU Impact Area include Alternative 1, termination of the NRC license for restricted release (Proposed Action) [Section 4.1]; Alternative 2, termination of the NRC license to allow unrestricted use (Section 4.2); and Alternative 3, the No Action Alternative (Section 4.3). Section 4.4 discusses alternatives considered but eliminated from detailed analysis. The discussion of the Proposed Action is based on information contained in the DP (U.S. Army 2002b). The discussion of the unrestricted use alternative is based on information in the 1999 DP (U.S. Army 1999) and in Mason and Hanger (1992).

4.1 ALTERNATIVE 1: LICENSE TERMINATION UNDER RESTRICTED CONDITIONS (PROPOSED ACTION)

Under the Proposed Action, the U.S. Army would terminate NRC license SUB-1435 but maintain institutional control of the DU Impact Area. Because of the presence of DU and UXO throughout the licensed area, this area is not suitable for commercial or residential development. Institutional controls would be enforced to restrict access to the DU Impact Area. Under the MOA, and in accordance with the permit conditions (U.S. Army 2000a, b, and c), the FWS and the USAF/IANG have assigned infrastructure maintenance responsibilities.

The installation would remain fenced with a 7-ft (2.1-m) chain-link fence topped with V-shaped three-strand barbed wire. Approximately 48 miles (77.2 km) of fencing surround the installation. Security warning signs are placed around the property to caution persons not to enter the property. Damaged gates and holes in the fence large enough to permit human access would have to be repaired within 72 hours of being documented (U.S. Army 2002b). The impact area north of the firing line, which contains the DU Impact Area, would remain fenced from the cantonment area. Gates through this fenced area would remain locked, and only authorized access would be allowed. At each location where a stream crosses the fence line, a steel cable would be placed with warning signs attached and weighted tubing suspended. All roads approaching the DU area would remain barricaded and marked with a radiation warning sign. On-site personnel entering the DU Impact Area on these roads would be instructed to neither remove nor pass any barricade.

The perimeter fence surrounding the installation would be patrolled and inspected weekly by the USAF/IANG. The date of inspection, the name of the inspector, a description, and the location of damage observed would be recorded. All roads approaching the DU Impact Area would remain barricaded and posted with warning signs with the radiation hazard symbol and the words, "Caution, Radioactive Materials." These radiation warning signs would be posted around the perimeter of the DU Impact Area.

Visitors to the Big Oaks NWR would be required to obtain an annual (or daily) public access permit, attend a safety briefing, and sign an acknowledgment of danger agreement before entering the refuge. Hunting on the refuge would be permitted only in designated areas. The DU Impact Area would remain closed to the public visiting the refuge (FWS 2001a,b).

No environmental monitoring would be conducted.

4.2 ALTERNATIVE 2: LICENSE TERMINATION FOR UNRESTRICTED USE

Under this alternative, a portion of the 2,080-acre (8.4-km^2) DU Impact Area would be remediated to allow unrestricted use of the land. UXO, DU fragments, and DU-contaminated soil would be removed from the DU Impact Area so that the residual dose to the average member of the critical group would be 25 mrem per year or less. Approximately 150 to 1,300 acres (0.6 to 5.3 km^2) of the DU Impact Area would be disturbed to remove DU fragments and contaminated soil. The UXO and DU would be removed using a multi-phase remediation process: manual extraction, radiological survey, and soil treatment. First, a manual extraction process would be used to remove UXO first and then large DU fragments or complete penetrators to minimize impacts to the ecosystem. Multiple passes could be required to increase the likelihood of finding all UXO and DU penetrators or fragments. Human search rates were estimated to range from approximately one-third to a few acres per person per day (Mason and Hanger 1992). Electronic equipment searches would be conducted using both existing and developing technologies.

After the DU fragments or penetrators were collected, a radiological survey would be conducted to identify the remaining areas of concern. The volume of soil removed depends on the areal extent of remediation and the depth of soil removal. For UXO detection and clearance, the acreage ranges from 150 to 1,300 acres (0.6 to 5.3 km^2) to a depth of 4 to 10 ft (1.2 to 2.0 m). DU survey and removal could involve 150 to 1,300 acres (0.6 to 5.3 km^2) and involve depths of 2 to 4 ft (0.6 to 1.2 m). The range in the estimated soil volume, therefore, is large, approximately 13 to >500 $\times$ 10^6 ft^3 (0.4 to 14 $\times$ 10^6 m) [U.S. Army 2002b]. Under this alternative, not all of the 1,300 acres would be remediated.).

UXO clearance could be required to a depth of 4 to 10 ft (1.2 to 3.0 m) BGS (U.S. Army 2002b). Subsurface cleanup of UXO would depend upon the state of the art in detection and/or cleanup (Mason and Hanger 1992). Cleanup of UXO could be accomplished using either human search lines or different state-of-the-art detection technologies, such as a surface-towed ordnance locator system (STOLS), ground-penetrating radar (GPR), and harmonic radar (Mason and Hanger 1992). Note that GPR is not as effectiveneat JPG because of the high clay and gh moisture content of the soil. Use of a towed ordnance location system would be restricted by a combination of terrain and vegetation within the DU area. Should any DU and explosive waste (i.e., "mixed waste") be generated, waste disposition would not be possible because there is currently no known waste disposal site for this type of waste. If further remediation is required, several inches to several feet of soil would be removed, and the DU remaining in the soil would be extracted for disposal off-site. Three potential extraction technologies to remove the small, more mobile DU component include bicarbonate soil washing, vacuuming soil into a collection vehicle and packaging it for disposal, and a gravity-based separation of DU fragments from excavated soil (U.S. Army 1999).

The DU metal and DU-contaminated soil would be assayed, packaged, and disposed of off-site. A radiological survey would be conducted to verify that residual DU concentrations meet unrestricted use concentration limits.

No environmental monitoring would be conducted after remediation is completed.

4.3 ALTERNATIVE 3: NO ACTION

Under the No Action alternative, the NRC license would remain in effect in accordance with the requirements of 10 *CFR* Part 40. Licensed material would remain in the DU Impact Area; the environmental monitoring program for soil, sediment, groundwater, and surface water would continue; and the existing site security plan would be implemented to minimize unauthorized entries into the DU Impact Area.

4.4 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED ANALYSIS

The alternative of remediating 1,300 acres (5.3 km^2) of the 2,080-acre (8.4-km^2) DU Impact Area to remove DU from the surface and subsurface soil was considered but eliminated from detailed analysis for several reasons. Factors affecting this decision include worker safety, impacts to the environment, and the potential cost.

The removal of UXO and DU penetrators or fragments and contaminated soil would be a significant effort. Mason and Hanger (1992) estimated that the cleanup of the entire DU Impact Area could require a minimum of 1,000 weeks (approximately 19 years). Because of the occurrence of UXO in the DU Impact Area, excavation would be done remotely to ensure worker safety, thus increasing the time and cost to complete the project (U.S. Army 1999). Also, if UXO is buried throughout the DU Impact Area, then approximately 1,300 acres (5.3 km^2) of the 2,080 acres (8.4 km^2) of land would have to be excavated, resulting in the destruction of habitat for many species of plants and animals, significant soil erosion, increased runoff, and disturbance of stream sediment. Estimated cleanup costs for the DU Impact Area ranged from $715 million to $3.3 billion (Mason and Hanger 1992). Escalating these costs to current dollars, based on changes in the Bureau of Labor Statistics consumer price index, results in 2001 costs ranging from $900 million to $4.1 billion.

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5.0 ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION AND ALTERNATIVES

The environmental impacts from implementing Alternative 1, license termination under restricted conditions (Proposed Action) [Section 5.1]; Alternative 2, license termination for unrestricted use; and Alternative 3, the No Action Alternative, are described in this section. Table 5-1 compares the impacts from implementing these three alternatives.

5.1 ENVIRONMENTAL IMPACTS OF ALTERNATIVE 1: LICENSE TERMINATION UNDER RESTRICTED CONDITIONS (PROPOSED ACTION)

This section discusses the short- and long-term impacts from implementing the Proposed Action. Sections 5.3.1 to 5.3.13 address land use; transportation; geology and soils; water; ecological; air quality; noise; historic and cultural; visual/scenic; socioeconomics; environmental justice; public and occupational health; and waste management impacts. Section 5.1.14 discusses cumulative effects of the Proposed Action while Section 5.1.15 addresses mitigative measures.

5.1.1 Land Use

Implementation of the Proposed Action would not result in any changes to current land use. Access to the DU Impact Area would continue to be controlled in accordance with the MOA negotiated between the Army, the USAF, and the FWS and the U.S. Army permits issued (U.S. Army 2000a–c). The Army would continue to consult with both the FWS and USAF to ensure that ongoing Army activities (e.g., remediation and UXO demonstration projects) are compatible with refuge and bombing range activities. The FWS and USAF would continue to implement related institutional controls in accordance with the MOA and associated permits (Appendix A), and as described in Section 1.5.1. The Army will retain authority, responsibility, and liability for remediation of all UXO, DU, and other contamination resulting from past Army activities or present activities on the firing range as of the date of the MOA. If the MOA or permit expires or the FWS and/or USAF/IANG terminates the agreement or permit, the U.S. Army, as the holder of the deed title, would be responsible for the institutional controls.

5.1.2 Transportation

There would no impacts to transportation-related impacts (i.e., contaminant releases or impacts on transportation routes and traffic patterns) under the Proposed Action.

5.1.3 Geology and Soils

No additional short- or long-term impacts to geology would result from the Proposed Action. Soil contamination levels and depth in the DU Impact Area would essentially remain the same in the short-term, with possible migration of uranium with depth in the soil over the long-term. Monitoring data collected over an 11-year time frame indicate sols concentrations are at the average background soil concentration of uranium at JPG (see Section 3.1.2.3).

Table 5-1. Comparison of Environmental Impacts
Jefferson Proving Ground, Madison, Indiana

Environmental Impact	Alternative 1: License Termination Under Restricted Conditions (Proposed Action)	Alternative 2: License Termination for Unrestricted Use of DU Impact Area	Alternative 3: No Action
Land Use	No impacts. Land use at the DU Impact Area will remain restricted in accordance with the MOA and associated permits.	No impacts. Because the DU Impact Area is surrounded by areas containing UXO, it is unlikely that the land would be available for other uses. Access to the area north of the firing line would still be restricted.	Impacts identical to the Proposed Action.
Transportation	No impacts	Short-term impacts including fugitive dust and noise.	No impacts
Geology and Soil	No short-term impacts. Possible long-term impacts associated with uranium migration with soil depth.	Short-term impacts associated with soil disturbance and removal. Landform would be transformed and surface drainage patterns altered.	Impacts identical to the Proposed Action.
Water Resources	No short-term impacts to either surface water or groundwater. Over the long term, there could be localized increases of uranium in surface water and groundwater from uranium migration.	Short-term impacts on surface water quality. Potential discharges to surface water via runoff during earth-moving activities. Positive long-term impact on groundwater quality from removing the source material.	Impacts identical to the Proposed Action.
Ecological Resources	No short-term impacts to biotic resources. Over the long term, uranium could accumulate in biotic resources.	Destruction of approximately 150 to 1,300 acres (0.6 to 2.8 km^2); loss of riparian habitat and biotic resources.	Impacts identical to the Proposed Action.
Air Quality	Possible short-term, local impacts with resuspension of DU particulates and oxides (low probability event).	Short-term impacts on air quality from the generation of fugitive dust emissions during earth-moving activities and from vehicular exhaust.	Impacts identical to the Proposed Action.
Noise	No impacts.	Short-term localized noise impacts from heavy equipment operation during the implementation phase. Noise impacts would be limited to the implementation phase when earth-moving activities occurred.	No impacts
Historic and Cultural Resources	No impacts. DU Impact Area previously was disturbed by ammunition testing.	No impacts. Potential cultural resources in DU Impact Area previously disturbed by ammunition testing.	No impacts. DU Impact Area previously was disturbed by ammunition testing.
Visual/Scenic Resources	No impacts	Visual/scenic resources impacted in the short term with destruction of local habitat.	No impacts
Socioeconomics	No impacts.	Potential short-term impacts would occur during remediation and are associated with the influx of the workforce supporting the site cleanup. Housing demand would rise to accommodate the increase in local employment.	No impacts
Environmental Justice	No impacts.	No impacts.	No impacts

Table 5-1. Comparison of Environmental Impacts
Jefferson Proving Ground, Madison, Indiana (Continued)

Environmental Impact	Alternative 1: License Termination Under Restricted Conditions (Proposed Action)	Alternative 2: License Termination for Unrestricted Use of DU Impact Area	Alternative 3: No Action
Public and Occupational Exposure	If institutional controls are maintained, then both UXO and radiological hazards would be minimized. UXO hazards and risks predominate and could result in injury or fatality. Radiological impact to site workers and public would be a few millirem per year (mrem/year) and below the NRC standard of 25 mrem/year. With a loss of institutional controls, the potential for health effects would increase. The site hazards would be dominated by the presence of UXO. The radiological impact to intruders would be less than 100 mrem/yr.	Potential for short-term impacts remediation. UXO related incidents and industrial accidents could occur. UXO hazard would remain in the areas surrounding the DU Impact Area.	Impacts identical to the Proposed Action.
Waste Management	No impacts.	Significant quantities of soil contaminated with DU would require management and disposal in accordance with federal, state, and local laws and regulations. Ordnance and explosive was also would have to be managed and dispositioned (mixed waste generated would pose insurmountable regulatory and management issues unless a disposal site was available.	No impacts.

DU = Depleted uranium.
MOA = Memorandum of Agreement.
mrem/yr = Millirem per year.
NRC = Nuclear Regulatory Commission.
UXO = Unexploded ordnance.

5.1.4 Water Resources

Under the Proposed Action, residual DU could be transported to surface water. However, because the DU was fired at soft cloth, rather than hard/armored, targets, most DU penetrators could be found intact, minimizing the area of contamination (Mason and Hanger 1992). As the projectiles age, uranium oxides will form, producing smaller flakes of DU material that could be carried off by surface water.

Surface water monitoring conducted along Big Creek upstream and downstream of the DU Impact Area from 1984 to 2000 detected variations in the concentration of uranium in surface water samples, but no long-term trends are evident. The isotopic ratios in the environmental monitoring data support the finding that most of the variation in uranium concentrations observed in surface water samples has been natural in origin (see Section 3.2). Naturally occurring uranium that has eroded from geologic deposits could be transported by surface water flowing across the DU Impact Area and draining into Big Creek.

Historic variations in uranium concentrations in groundwater have been attributed primarily to errors in sample handling (Ebinger and Hansen 1996). The data indicate no groundwater contamination attributable to the DU Impact Area. The ratio of U-234 to U-238 in groundwater samples has been near 1, indicating the presence of naturally occurring uranium (U.S. Army 2002b).

5.1.5 Ecologic Resources

The Proposed Action would not result in direct impacts because no earthmoving activities would occur; however, residual DU would remain in the DU Impact Area. DU could leach into soil and groundwater, be taken up by plants, and, ultimately, consumed by animals. Results of the biotic sampling discussed in Section 3.1.2.2 do not indicate high uranium concentrations in tissue samples. However, the results of the vegetation sampling discussed in Sections 3.1.2.1 and 3.1.2.2 indicate that those samples taken from near penetrator locations have uranium concentrations up to 3,447 pCi/g (Table 3-4 in Section 3.0). At these locations, minor impacts would be indicated to animals consuming vegetation.

Little to no impacts to wildlife are anticipated under the Proposed Action. Biological sampling does not indicate the presence of uranium, except in one lichen sample (see Section 3.0).

5.1.6 Air Quality

No air quality impacts would result from implementing the Proposed Action. Activities that could degrade air quality would be limited to occasional vehicle movement near the DU Impact Area for fence and sign checking and maintenance. Short-term, minor impacts to the air quality and visibility would result as a result of FWS prescribed burns; however, these impacts are independent of the Proposed Action. Related modeling assumptions for the range fire assessment are detailed in Williams et al. (1998).

Past use of DU munitions has resulted in DU particulates and oxides possibly remaining in the soil in areas near the penetrator impact areas. These particulates and oxides can be resuspended into the air during windstorms. Air sampling was conducted at Yuma Proving Ground to determine the significance and magnitude of the soil to human exposure pathway. Particles greater than 20 microns in diameter would not remain airborne long enough to reach air samplers in the area. Furthermore, the soil sampling indicated that 13 percent of the particles were under 125 microns – particles greater than 100 microns are not likely to be resuspended by wind. Because of the high density of DU, resuspension of uranium would be less than those particles of soil containing small amounts of uranium as observed in naturally occurring uranium soils. The results of this study and earlier studies conducted during 1979 to 1982 concluded that DU operations have no measurable impact on air quality (Gutierrez-Palmenber, Inc. 1996). These results confirm that DU particles and oxides would not impact air quality at JPG.

5.1.7 Noise

There would be no noise impacts from the Proposed Action. No earth moving or vehicular traffic activities that could generate noise in the DU Impact Area would occur under the Proposed Action.

5.1.8 Historic and Cultural Resources

There would be no direct impact to cultural resources from implementing the Proposed Action because no earthmoving activities are proposed. The land in the DU Impact Area has been disturbed previously to depths of 3 to 25 feet (0.9 to 7.6 m) BGS by ordnance testing activities over the course of JPG's operational history (Geo-Marine 1996). Termination of the NRC license under the Proposed Action will not result in further disturbance of the land in the DU Impact Area.

5.1.9 Visual/Scenic Resources Impacts

There would be no impacts on visual or scenic resources within the DU Impact Area under the Proposed Action because there would be no construction or cleanup activities associated with license termination under restricted release conditions. Short-term impacts to the visual landscape would continue as a result of FWS prescribed burns; however, these impacts are independent of the Proposed Action.

5.1.10 Socioeconomics

There would be no socioeconomic impacts associated with the Proposed Action. Army personnel will visit the site on a regular basis to verify that the FWS and USAF are complying with the terms of the Memorandum of Agreement. Currently the U.S. Army has three full-time personnel, and the FWS has six personnel at the installation.

South of the firing line, approximately 200 people currently live and/or work in the JPG cantonment area on a daily basis. There are 13 residences south of the firing line. Individuals are employed in light industry and a small number of individuals support farming.

5.1.11 Environmental Justice

To determine if there would be an environmental justice impact from the Army terminating its NRC license for the DU Impact Area, the procedures established by the Office of Nuclear Material Safety and Safeguards were implemented (NRC 1999). Demographic data were obtained for the immediate site area, surrounding communities, the State, and the surrounding counties and towns. JPG is located in a rural area; therefore, a 4-mile (6.4 km) radius was selected for analysis (NRC 1999). The distance from the DU Impact Area to the western and eastern boundaries of the installation is approximately 2 miles (3.2 km). The distance to the southern boundary of the installation (which includes the cantonment area where the land either has been or is being transferred for private use) is approximately 4 miles (6.4 km). The distance from the DU Impact Area to the northern boundary of the installation is approximately 11 miles (3.2 km).

The total population residing in a 4-mile radius (6.4 km) is estimated conservatively (i.e., tends to be overestimated) because these data are available at the census block group level. Table 2-1 in Section 2.0 summarizes population data at the city, county, and State levels. After determining the number of people who resided in the 4-mile (6.4 km) radius, the percentage of minority and economically stressed households (defined as the number of people below the U.S. poverty level of $17,650 for a family of four) within that population was determined and compared to the total population of such groups at the State and county levels.

The minority population within the 4-mile (6.4 km) radius was determined to be 0.3 percent. The minority populations of Jefferson County and the State of Indiana are 3.8 and 12.5 percent, respectively. The percentage of minority population in the affected 4-mile (6.4 km) radius is greater than 10 percent below the county and State levels.

The potential for disproportionately high and adverse impacts to economically stressed households was then evaluated using county data published through 1997 because more recent data are not available and no data are available for low-income populations at the census block group level in this area. Following the guidance in NRC (1999), the percentage of the affected population that was economically stressed was determined. This value was compared to the percentage of economically stressed households at the State level. Because JPG spans three counties in Indiana (Jefferson, Jennings, and Ripley), the percentage of economically stressed populations residing in each was averaged to obtain a value of 10.4 percent of the population being stressed economically. Table 2-1 indicates that the percentage of economically stressed households in the affected area at JPG is only approximately one-half a percentage point higher than at the State level (9.9 percent, see Table 2-1).

Because the minority and low-income populations residing in the area are significantly less than 20 percent of the affected population, environmental justice was not evaluated further as discussed in NRC (1999). There would be no environmental justice impacts from the Proposed Action to terminate the license.

5.1.12 Public and Occupational Health

Under the Proposed Action, the Army would maintain control of and restrict access to the area north of the firing line. The use of institutional controls would ensure that individuals who access the area north of the firing line are aware of the potential hazards. The DU Impact Area contains both UXO and DU; the UXO presents the immediate and most serious hazard to potential intruders into the DU Impact Area.

This section identifies potential exposure scenarios and estimates the human health impact from implementation of these scenarios. The analysis evaluates the impacts over two periods: an implementation phase (i.e., the period over which actions to terminate the license are conducted) and a post-implementation phase (i.e., the period after the license has been terminated). Both normal, expected case scenarios and abnormal or accidental scenarios are identified and evaluated. Both radiological and non-radiological hazards are addressed. This analysis provides a basis for understanding the impacts of the Proposed Action and determining compliance with NRC license termination standards for the action.

5.1.12.1 Implementation Phase Impacts

The Proposed Action does not include an implementation phase. Access to the area north of the firing line would continue to be controlled in accordance with the MOA and associated permits, as described in Section 7.0. Minimal human health impacts would occur during this period.

5.1.12.2 Post-Implementation Phase Impacts

Under the Proposed Action, institutional control of the site would be maintained and access to the DU Impact Area would be limited. This section identifies and analyzes scenarios that could result in impacts either to site workers or members of the public under expected conditions (i.e., institutional controls remain in place) and conditions not expected to occur (i.e., the failure of institutional controls). For each scenario, both radiological and non-radiological impacts are discussed. Impacts of scenarios involving

exposure to radioactive materials were analyzed using the Residual Radiation (RESRAD V 6.1) model (Yu et al. 1993).

5.1.12.2.1 Expected Conditions (Institutional Controls Function)

Institutional controls for JPG include maintenance of a 7-ft (2.1-m)–high, chain-link fence that surrounds the border of the installation; access control to JPG through a main gate; placement of warning signs around the DU Impact Area; maintenance of barricades on interior roads accessing the DU Impact Area; and use of a physical barrier, a fence, to separate the area north of the firing line from the southern portion of the installation. The exterior fence would be inspected on a weekly basis. In accordance with the MOA and permit (Appendix A), the USAF/IANG would perform these activities. Public access to areas north of the firing line would be strictly controlled. Hunters and visitors are permitted within the Big Oaks NWR. Access to Big Oaks NWR would be allowed for hunting seasons (6 to 15 days) but not within the DU Impact Area. Awareness training and permits would be required for these visitors and workers prior to accessing the refuge. No public access would be allowed into the DU Impact Area, which is located within the NWR (Figure 1-1).

Under these circumstances, only site workers and visitors (under the direct supervision of site workers) could enter the DU Impact Area, and exposure times would be limited. These conditions support selection of site workers and occasional visitors as members of the group most likely to experience the greatest impacts if the Proposed Action is implemented.

Site Worker Activities—The maintenance of institutional controls would require site personnel to occasionally access the DU Impact Area for inspection or maintenance. These activities are expected to be of short duration and not involve site remediation. A radiological exposure scenario for these activities was developed and analyzed in Appendix C of the Decommissioning Plan (U.S. Army 2002b). Under this scenario, a site worker is assumed to spend 4 weeks per year in the DU Impact Area. Exposure modes include direct external, dust inhalation, and inadvertent ingestion modes. The estimated peak annual dose for this site worker ranged from 1.2 to 2.9 mrem/yr, depending on the average uranium soil concentration and the value of the uranium soil-water partition coefficient (U.S. Army 2002b). This dose is a small fraction of the annual background dose to an individual, which ranges from 200 to 300 mrem/yr. Such a site worker also could be exposed to UXO and be injured or killed.

Because the DU originated at DOE facilities that processed recycled uranium, there is the potential for very low levels of plutonium to be associated with the DU. Based on information from the DOE (DOE 2000) and plutonium measurements in samples of DU ammunition fired in Kosovo [British Broadcasting Corporation (BBC) 2001], the alpha-emitting isotopes Pu-238/239/Pu-240 could be present in the DU at concentrations of approximately 5 picocuries of plutonium per gram of armor (pCi/g). The beta-emitting fission product technetium-99 could be present at levels below 540 pCi/g. If Pu-238/239/240 and Tc-99 are present at these levels in the DU at JPG, the dose for this exposure scenario would increase by less than 0.4 percent, a negligible increase.

Site Visitor Activities—The planned institutional controls also would allow members of the public to have access to the Big Oaks NWR. The FWS has rules and regulations for assigning visitors to areas on the refuge. The DU Impact Area is closed from public access (Appendix A). Visitors to Big Oaks NWR can participate in guided tours, wildlife observation and photography, fishing in Old Timbers Lake, and turkey or deer hunting. Because all of these activities occur outside of the areas with DU contamination, no doses to the public from residual DU are anticipated. Hunters who consume game that has grazed within the DU Impact Area could receive some dose from residual DU contamination. Calculations of the dose to humans from consuming deer meat yield estimates of dose ranging from 0.8 to 2.0 mrem/yr for total concentrations of uranium ranging from 94 to 225 pCi/g.

The NRC standard for license termination with restrictions (10 *CFR* 20.1403[b]) is that the total effective dose equivalent (TEDE) from residual radioactivity distinguishable from background to the average member of the critical group will not exceed 25 mrem/yr. These occasional site users are considered the average members of the critical group, and the near-zero dose complies with the NRC standard.

Offsite Activities—Uranium also could be transported offsite in surface water flowing through the DU Impact Area. Sediment from the contaminated zone containing DU could affect offsite residents through fish consumption or residential farmer scenarios. The dose estimated due to consumption of 15 kg/yr of fish is 0.81 mrem/yr while the dose estimated for all pathways of the residential farmer scenario is 0.2 mrem/yr.. . . . . The sum of these doses is a small fraction of the NRC standard (25 mrem/yr) for this scenario. Because surface water draining the JPG flows westward to the East Fork of the White River, the nearest population affected by releases to surface water would be the town of Bedford, Indiana. Population dose for this town due to erosion-mediated release of uranium is 0.04 per-rem/yr.

5.1.12.2.2 Conditions not Expected to Occur (Failure of Institutional Controls)

Although institutional controls are intended to restrict public access to areas north of the firing line that contain UXO and DU, a failure of these controls could occur. The hazard from a short-term failure of institutional controls, resulting in an individual spending time in the DU Impact Area, would be dominated by the UXO hazard. Contact with UXO could lead to injury or death.

The radiological hazard from spending moderate periods in the DU Impact Area (4 weeks per year) would result in a small dose (1.2 to 2.9 mrem/yr) for the site worker discussed above. The impact of a scenario that involves longer occupancy times and greater contact with residual contamination was identified and analyzed in the risk assessment (U.S. Army 2002b). In this scenario, the critical group establishes a residence and garden in the DU Impact Area. Exposure modes for this scenario include:

- Direct external
- Ingestion of drinking water
- Inhalation of dust
- Ingestion of plants and animal products
- Inadvertent ingestion of soil.

A series of conservative resident farmer scenarios were developed and analyzed in Appendix C of the Decommissioning Plan (U.S. Army 2002b). These scenarios are conservative given that construction of a house and garden in areas containing UXO and water use from the local aquifer are assumed. However, groundwater is not potable without extensive treatment because of the presence of sodium sulfate, and total dissolved solids (MWH 2002). The doses for these conservative resident farmer scenarios range from 15.4 to 37.0 mrem/yr, depending on the average uranium soil concentration and the uranium soil-water partition coefficient value (U.S. Army 2002b). The dominant pathways for this dose are external exposure and consumption of crops. If the isotopes Pu-238/239/240 and Tc-99 were present at the levels of 5 and 540 pCi/g as discussed above, the dose for this exposure scenario would increase by less than 0.4 percent, a negligible increase. As in the case of effective institutional controls, the potentially affected offsite population is located at Bedford, Indiana, and the estimated population dose was 0.04 per-rem/yr.

The NRC standard for license termination with restrictions applies additional standards in the event institutional controls fail. The additional standard allows the license to be terminated if there is reasonable assurance that the TEDE from residual radioactivity to the average member of the critical group will not exceed 100 mrem/yr if institutional controls fail. The results of the conservative resident farmer scenarios

provide reasonable assurance that the TEDE to the average member of the critical group would be less than 100 mrem/yr.

5.1.13 Waste Management

No waste would be generated, transported, or disposed of under the Proposed Action. Therefore, there would be no related impacts. UXO and DU currently located in the DU Impact Area would remain and be subject to the institutional controls defined in the MOA and associated permits (Appendix A).

5.1.14 Cumulative Impacts

This section evaluates the cumulative environmental impacts of the Proposed Action coupled with the impacts of other Federal, non-Federal, and private actions. No reasonably foreseeable actions were identified as occurring simultaneously with the Proposed Action. No other Federal actions at the installation were identified. The FWS will continue to operate the Big Oaks NWR and the USAF/IANG will continue to operate the Jefferson Range in accordance with the MOA and associated permit. The continued ownership of the land north of the firing line by the Army would prohibit the development of approximately 51,000 acres of land for other uses. However, because of the occurrence of UXO throughout this area, the land is unavailable for other uses.

Most of the acreage south of the firing line is considered to be prime mixed development property and has been sold to a private individual. The Southeast Indiana Planning Commission did not identify any planned or ongoing major development efforts outside of the installation boundaries (SAIC 2001d). Therefore, no cumulative impacts beyond those from the Proposed Action were identified.

5.1.15 Mitigative Measures

Mitigative measures that could reduce the adverse impacts or enhance beneficial impacts are incorporated into this Proposed Action. The Army would continue to implement measures consistent with its authority and responsibilities under the BRAC program. These include, but are not necessarily limited to, implementing environmental remediation activities, leasing and transferring property south of the firing line, and executing its responsibilities under the MOA and associated permits (Appendix A). The FWS and USAF/IANG would implement institutional controls in accordance with the MOA and associated permits to ensure the facility is secure and operated safely.

The Army has no plans to continue environmental monitoring after license termination. Based on the anticipated environmental impacts, this potential measure would not provide significant value to mitigating the effects of the Proposed Action.

5.2 ENVIRONMENTAL IMPACTS OF ALTERNATIVE 2: LICENSE TERMINATION FOR UNRESTRICTED USE

Under Alternative 2, the DU Impact Area would be remediated to permit license termination for unrestricted use. Soil contaminated with DU would be removed to allow free release of the area. In addition, UXO also would be cleared to access DU-contaminated soils. Sections 5.2.1 to 5.2.13 address land use; transportation; geology and soils; water; ecological; air quality; noise; historic and cultural; visual/scenic; socioeconomics; environmental justice; public and occupational health; and waste management impacts. Section 5.2.14 discusses cumulative effects of the Proposed Action while Section 5.2.15 addresses mitigative measures.

5.2.1 Land Use

Under Alternative 2, approximately 150 to 1,300 acres (0.6 to 2.8 km^2) of land in the DU Impact Area would be disturbed to remove DU fragments and contaminated soil [Scientific Ecology Group (SEG) 1995]. However, because the DU Impact Area is surrounded by areas containing UXO, development of the land for other purposes would be unlikely.

5.2.2 Transportation

Short-term adverse impacts are anticipated to result from the remediation of the DU Impact Area. These impacts include noise, fugitive dust, siltation, and some plant and wildlife loss as a result of truck and vehicular movements along the perimeter of and to a smaller degree the interior to of the DU Impact Area (after appropriate clearance activities).

5.2.3 Geology and Soils Impacts

Both short and long-term impacts would result from remediation of the DU Impact Area. Short-term impacts to soils include movement and removal of existing soil and vegetation, siltation, and erosion. In addition, the landform would be transformed and surface drainage patterns altered as a result of the excavation and soil removal activities. With appropriate mitigative and restoration measures (e.g., erosion control measures, seeding, and other restoration activities), impacts would be mitigated.

5.2.4 Water Resources

Surface water impacts would result from increased runoff during excavation activities, resulting in potential downstream sedimentation and uncontrolled migration of chemical or radiological constituents. Standard erosion control practices would be used during implementation of this alternative to minimize soil loss, downgradient sedimentation, and degradation of surface water quality.

Soil removal would eliminate the source for potential groundwater contamination. To date, no groundwater contamination attributable to the DU Impact Area has been detected.

5.2.5 Ecological Resources

Implementation of this alternative would have a significant impact on biotic resources and wetlands. Approximately 150 to 1,300 acres (0.6 to 2.8 km^2) would be disturbed, resulting in the loss of habitat and destruction of plants and animals. Although wetlands have not been surveyed in this area, based on the National Wetlands Inventory map (FWS 1994b), approximately one-half of the DU Impact Area contains wetlands (Figure 2-11 in Section 2.0). The impact of removing these wetlands would be the possible death of riparian biota and loss of habitat. No impacts to floodplains would occur under this alternative since the DU Impact Area is not located within the 100-year floodplain of the Ohio River.

5.2.6 Air Quality

Under Alternative 2, air quality impacts would result from fugitive dust emissions generated by excavating contaminated soil, operating equipment and vehicles, and transporting contaminated soil and UXO from the site.

5.2.7 Noise

Implementation of Alternative 2 would result in short-term, localized noise impacts during operation of heavy equipment used for soil excavation and from truck traffic. However, no offsite noise impacts would be expected because of the distance from the DU Impact Area to the installation boundary.

5.2.8 Historic and Cultural Resources

Implementation of Alternative 2 would result in the disturbance of approximately 150 to 1,300 acres (0.6 to 2.8 km^2) of land; however, because this area has been disturbed previously by ordnance testing activities, no adverse impacts to significant historical and archaeological resources would be expected.

5.2.9 Visual/Scenic Resources

Alternative 2 would substantially alter the nature appearance and character of the DU Impact Area. Vegetation cover would be removed and the natural contours of the land regraded. These changes would have an adverse impact on the quality and unity of this area's visual resources. With appropriate restoration measures and time (1-3 years), the local ecology would be reestablished.

5.2.10 Socioeconomics

License termination to allow unrestricted use would result in positive short-term socioeconomic impacts. Mason and Hanger (1992) estimate that cleanup of the DU Impact Area (including UXO) could take up to nearly 19 years. Therefore, local procurement of goods, services, and jobs would be generated if this alternative were implemented. These activities could result in increased housing demand and tax revenues for the local communities while the action was being implemented. At the end of the implementation period, a negative socioeconomic impact could result from workers leaving the area reducing the demand for public services.

5.2.11 Environmental Justice

There would be no disproportionately high and adverse impact from implementing Alternative 2. As discussed in Section 5.1.11, no potentially affected populations were identified.

5.2.12 Public and Occupational Health

Remediation of the affected portion of the DU Impact Area to meet unrestricted use criteria would generate dust containing both natural and DU dust that could pose a radiological hazard to site workers and the public. To manage this hazard, the Army would use protective measures such as soil wetting and work suspension on windy days. These measures would reduce the generation of contaminated fugitive dust emissions. In addition, other personal protection measures, such as respirators, could be used to ensure that worker doses are ALARA. The potential doses would be well below the occupational regulatory limits of 5 rem per year (5 rem/yr).

Individuals offsite also could be exposed to uranium-containing dust; however, given the distance to the installation boundary and the use of mitigative measures, the magnitude of the potential dose to an offsite individual would be reduced. Review of the resident farmer scenario evaluated in Appendix C of the DP (U.S. Army 2002b) indicates the potential dose to an offsite individual during the implementation phase. The resident farmer analyzed in U.S. Army (2002b) would be exposed to soil with an average uranium concentration of 90 pCi/g and receive a peak inhalation dose of less than 1 mrem/yr. This dose is well below the applicable public dose standards of 25 mrem/yr for operating nuclear facilities.

If the DU Impact Area were decontaminated to levels to allow unrestricted use, the dose to members of the public who could use the remediated DU Impact Area would be less than the applicable NRC dose standard of 25 mrem/yr for unrestricted release.

5.2.13 Waste Management Impacts

Radioactive waste and UXO excavated during the remediation process will be stored, transported, and disposed of in accordance with federal, state, and local regulations. Waste designated for disposal offsite would be screened to minimize the volume of waste. Approximately 167,000 to over 4 million cubic feet (4,730 to 113,000 m^3). of the soil is assumed to be contaminated with DU. UXO items detected and recovered will be transported to a secure area for detonation, if feasible. Otherwise, the ordnance item would be blown in place. Management of explosive and radiological (mixed waste) would pose insurmountable problems if a disposal site were not available. Onsite treatment and disposal of this type of waste is cost prohibitive.

5.2.14 Cumulative Impacts

Cumulative impacts associated with remediation of the DU Impact Area for unrestricted use are similar to those discussed in Section 5.2.14.

5.2.15 Mitigative Measures

Mitigative measures that could reduce the adverse impacts or enhance beneficial impacts are included in this alternative. The Army would continue to implement measures consistent with its authority and responsibilities under the BRAC program for the DU Impact Area during the remediation process. These include but are not necessarily limited to implementing other environmental remediation activities, leasing and transferring property south of the firing line, and executing its responsibilities under the MOA and associated permits (Appendix A). The FWS and USAF/IANG would implement institutional controls in accordance with the MOA and associated permits to ensure the facility is secure and operated safely.

Mitigative measures would be applied before, during, and after remediation of the DU Impact Area. These measures include, but are not necessarily limited to the following: soil erosion control, site regrading, seeding, and revegetation. Operational procedures used by workers during planning and cleanup activities would incorporate measures to mitigate potential adverse impacts to the environment and to protect the health and safety of onsite and offsite personnel. The Army would not continue environmental monitoring after license termination and remediation was deemed complete

5.3 ENVIRONMENTAL IMPACTS OF ALTERNATIVE 3: NO ACTION

Under the No Action alternative, the NRC license would remain in effect. The environmental impacts would be similar to those for implementing the Proposed Action. Sections 5.3.1 to 5.3.13 address land use; transportation; geology and soils; water; ecological; air quality; noise; historic and cultural; visual/scenic; socioeconomics; environmental justice; public and occupational health; and waste management impacts. Section 5.3.14 discusses cumulative effects of the Proposed Action while Section 5.3.15 addresses mitigative measures.

5.3.1 Land Use

There would be no land use impacts from implementing Alternative 3. The DU Impact Area would continue to be restricted from public access. The land in the area north of the firing line would continue to be managed in accordance with the MOA and associated permits.

5.3.2 Transportation

There would no impacts to transportation-related impacts (i.e., contaminant releases or impacts on transportation routes and traffic patterns) under the no action alternative.

5.3.3 Geology and Soils

Existing vegetation covers would be preserved and no modifications to topographic contours would be made under the No Action Alternative; therefore, no impacts to geology and soils are expected to occur.

5.3.4 Water Resources

Under the No Action Alternative, impacts to water resources would be similar to those described under the Proposed Action.

5.3.5 Ecological Resources

The No Action Alternative is not expected to have any negative effects on the biological resources near or within the DU Impact Area. Impacts would be similar to those described under the Proposed Action.

5.3.6 Air Quality

Air quality impacts under the No Action Alternative would be similar to those described for the Proposed Action. There would be minimal impacts to air quality since no action would be taken that could degrade air quality. Impacts would be similar to those described under the Proposed Action.

5.3.7 Noise

There would be no noise impacts associated with the No Action Alternative.

5.3.8 Historic and Cultural Resources

There would be no impacts to cultural resources from implementing Alternative 3. The DU Impact Area has been disturbed previously by the former UXO testing operations in this area.

5.3.9 Visual/Scenic Impacts

Impacts to visual or scenic resources under the No Action Alternative are identical to those anticipated under the Proposed Action..

5.3.10 Socioeconomics

The socioeconomic impacts of Alternative 3 would be the same as the Proposed Action.

5.3.11 Environmental Justice

There would be no disproportionately high and adverse impacts to any segment of the population from implementing the No Action Alternative.

5.3.12 Public and Occupational Health Effects

The human health effects from implementing the No Action Alternative would be the same as described for the Proposed Action.

5.3.13 Waste Management

Under the No Action Alternative, waste would not be generated or managed; therefore, no short- or long-term impacts are anticipated.

5.3.14 Cumulative Impacts

No cumulative impacts are anticipated under the No Action Alternative. These results are similar to those anticipated under the Proposed Action.

5.3.15 Mitigative Measures

The Army would continue to implement measures currently in place as caretaker of the facility, including retention of the NRC SUB1435 license and implementing related monitoring and reporting requirements and executing its responsibilities under the MOA and associated permits (Appendix A).

6.0 ALARA ANALYSIS

This section summarizes the ALARA analysis presented in the DP (U.S. Army 2002b). This analysis was conducted to determine if the residual DU contamination in the DU Impact Area is consistent with ALARA.

The ALARA analysis consisted of identifying and quantifying, to the extent practical, the benefits and costs associated with decontamination of the DU Impact Area to unrestricted release conditions. The benefits identified and analyzed in the DP included: averted population dose, avoided regulatory and institutional costs, increased land value, aesthetics, and reduced public opposition. The total discounted benefit accruing from decontamination of the DU Impact Area to terminate the license without restrictions is estimated to range from $268,286 to $353,429 (see Table 6-1). The benefits are primarily the result of avoided institutional costs and averted population dose.

Table 6-1. Benefits of License Termination for Unrestricted Use of the DU Impact Area Jefferson Proving Ground, Indiana

Parameter	Benefit ($)[a]
Averted Population Dose	61,143 to 146,286
Avoided Regulatory and Institutional Costs	207,143
Increased Land Value	--[b]
Aesthetics	--[b]
Reduced Public Opposition	--[b]
Total	**268,286 to 353,429**

[a] Based on an annual discount rate of 7 percent calculated over 1,000 years.
[b] Benefit is minimal to none relative to other benefits quantified.

The costs identified and quantified included: UXO and DU remediation costs, occupational and public radiological exposure, occupational non-radiological risk to on-site personnel during decontamination, radiological and non-radiological transportation risks, and environmental degradation. The uncertainty regarding the nature and extent of both UXO and DU contamination and the associated remediation costs does not impact the conclusions of this ALARA analysis.

The total costs of remediating the DU Impact Area to achieve unrestricted release range from $45 million to $1.6 billion. The dominant cost elements being UXO and DU detection, removal, and disposition. These costs are summarized in Table 6-2.

Table 6-2. Costs of License Termination for Unrestricted Use of the DU Impact Area Jefferson Proving Ground, Indiana

Remediation Cost Element	Cost ($)[a]
UXO and DU Remediation Cost	45,000,000 – 1,609,000,000
Occupational and Public Radiological Exposure	2,000
Occupational Non-Radiological Risk	6,300
Non-radiological Transportation Risk	132,000 – 3,670,000
Environmental Degradation	0[b]
Total[c]	**45,000,000 – 1,613,000,000**

[a]Based on an annual discount rate of 7 percent calculated over 1,000 years.
[b]No environmental degradation costs are anticipated over the long-term.
[c]Total cost rounded to nearest million dollars.

The ALARA analysis determined that the costs of remediating the DU Impact Area to meet the criteria for unrestricted use are greater than the benefits, i.e., the costs are about 167 to almost 4,500 times the benefits. The ALARA analysis demonstrates that terminating the JPG license with restrictions would be consistent with the ALARA requirement of 20.1403(a).

In addition to the ALARA analysis, a "net public or environmental harm" analysis was conducted. This analysis compares the benefits of dose reduction with costs. These costs include occupational fatalities, occupational doses, transportation fatalities, and environmental degradation. The benefits were estimated to range between $268,286 and $353,429. Table 6-3 summarizes the costs for the categories enumerated above.

Table 6-3. Summary of Costs for "Net Public or Environmental Harm" Analysis Jefferson Proving Ground, Indiana

Cost Element	Estimated Cost ($)
Occupational Fatalities (Non-Radiological)	6,300 – 12,600
Occupational and Public Radiological Exposures	2,000
Transportation Fatalities	132,000 – 3,670,000
Environmental Degradation	0
Total	**140,300 – 3,684,000**

This analysis indicates that for most situations, the benefits are less than the net public or environmental harm cost elements. It is expected that remediation of the DU Impact Area would result in "net public or environmental harm."

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APPENDIX A

PERMITS AND MEMORANDUM OF AGREEMENT

This Appendix contains the following permits:

- Department of Army Permit to the Fish and Wildlife Service
- Department of Army Permit to the Department of the Air Force

The Memorandum of Agreement, which establishes the framework for the partnership between the Department of Army, Fish and Wildlife Service, and Department of Air Force, is included as an exhibit in each permit.

DEPARTMENT OF ARMY PERMIT TO FISH AND WILDLIFE SERVICE TO USE PROPERTY LOCATED ON JEFFERSON PROVING GROUND, MADISON, INDIANA

DEPARTMENT OF ARMY PERMIT TO FISH AND WILDLIFE SERVICE TO USE PROPERTY LOCATED ON JEFFERSON PROVING GROUND, MADISON, INDIANA

This permit is organized as follows:

- Permit
- Exhibit A. Site Map. This exhibit also includes descriptions and maps of permitted areas.
- Exhibit B. Memorandum of Agreement. This document includes five enclosures:
  - Enclosure 1. Site Map
  - Enclosure 2. Department of Army Permit to FWS to Use Property Located on JPG. The Interim Public Access Plan for the Proposed Big Oaks National Wildlife Refuge is included in this enclosure.
  - Enclosure 3. Department of Army Permit to the Department of Air Force to Use Property Located on JPG. The Range Access Plan is included with this enclosure.
  - Enclosure 4. North of the Firing Line UXO Response Standard Operating Procedure
  - Enclosure 5. FWS/Air Force Infrastructure Maintenance Responsibilities
- Exhibit C. Interim Public Access Plan
- Exhibit D. Road and Bridge Commitments

Maps depicting the potential location of unexploded ordance (UXO) were current at the time of permit execution. Refer to the main body of this report for the current status of UXO within the installation.

NO. DACA27-4-00-087

DEPARTMENT OF THE ARMY
PERMIT TO FISH AND WILDLIFE SERVICE
TO USE PROPERTY LOCATED ON
JEFFERSON PROVING GROUND
MADISON, INDIANA

THE SECRETARY OF THE ARMY, hereinafter referred to as the Secretary, hereby grants to the United States Fish and Wildlife Service (USFWS), hereinafter referred to as the Grantee, a permit for the establishment of a National Wildlife refuge at Jefferson Proving Ground (JPG), Indiana, over, across, in and upon the lands identified in Exhibit "A", attached hereto and made a part hereof, hereinafter referred to as the premises. The Secretary and the Grantee are collectively hereinafter referred to as the "Parties".

THIS PERMIT is granted subject to the following conditions.

1. This permit is hereby granted for a term of twenty-five (25) years, beginning 1 July 2000 and ending 30 June 2025, with renewable ten (10) year periods upon mutual agreement of the Parties. This permit may be terminated earlier, by either the Secretary or Grantee, by providing one hundred eighty (180) days' written notice.

2. The consideration given by the Grantee is the management of the premises as a National Wildlife Refuge as well as the care and maintenance of the premises as specified in the Memorandum of Agreement (MOA) attached hereto as Exhibit "B" and made a part hereof.

3. All correspondence and notices to be given pursuant to this permit shall be addressed, if to the Grantee, to USFWS, Bishop Henry Whipple Federal Building, 1 Federal Drive, Ft. Snelling, Minnesota 55111 (Attn: Mr. John Christian) and, if to the Secretary, to the District Engineer, Louisville District, P.O. Box 59, Louisville, Kentucky 40201 (Attn: CELRL-RE-C), with a copy furnished to the Jefferson Proving Ground (JPG) Commander, Newport Chemical Depot, P.O. Box 160, Newport, Indiana 47966-0160, or as may from time to time otherwise be directed by the parties. Notice shall be deemed to have been duly given if and when enclosed in a properly sealed envelope or wrapper addressed as aforesaid

and deposited, postage prepaid, in a post office regularly maintained by the United States Postal Service.

4. The use and occupation of the premises shall be without cost or expense to the Department of the Army and under the general supervision of the JPG Commander and in accordance with the terms and conditions of the MOA. In the event of a conflict between the MOA and this permit, the MOA shall be the controlling instrument.

5. The Grantee acknowledges that it has inspected the premises, knows its condition, and understands that same is granted without any representations or warranties whatsoever and without obligation on the part of the Department of the Army, except as provided in the MOA.

6. In accordance with the MOA, the Grantee shall, at its own expense and without cost or expense to the Department of the Army, maintain and keep the premises at a level sufficient to support Refuge operations and in accordance with the tasks in Enclosure 5 of the MOA.

7. The Department of the Army shall not be responsible for providing utilities to the Grantee and it shall be the Grantee's responsibility for obtaining any utilities necessary for its use and occupation of the premises at no expense to the Department of the Army.

8. No additions or alterations of the premises shall be made without the prior written approval of the District Engineer.

9. On or before the expiration of this permit or the termination by either party, in accordance with paragraph one (1), the Grantee shall vacate the premises, remove its property therefrom and restore the premises to a condition satisfactory to the District Engineer, ordinary wear and tear and damage beyond the control of the Grantee excepted.

10. The Grantee shall comply with all applicable Federal, state, interstate, and local laws and regulations wherein the premises are located.

11. The Army will provide the Grantee with baseline information concerning the environmental condition of the premises in accordance with paragraph III 1(a) of the MOA documenting the known history of the property with regard to storage, release or disposal of hazardous substances

on the property. Upon expiration or termination of this permit, the Grantee shall, at its own expense and without cost or expense to the Department of the Army, document any storage, release or disposal of hazardous substances in excess of 40 CFR Part 373 reportable quantities and any petroleum products in excess of 55 gallons. A comparison of the two assessments will assist the Army in determining any environmental restoration requirements of the Grantee. Any such requirements will be completed by the Grantee in accordance with the Environmental Remediation provisions in the MOA and paragraph nine (9) of this permit.

12. It is understood that the requirements of this permit pertaining to maintenance, repair, protection, and restoration of the premises and providing utilities and other services shall be effective only insofar as they do not conflict with the MOA or any other agreement pertaining to such matters made between local representatives of the Army and Grantee in accordance with existing regulations.

13. Access to and use of JPG shall be controlled in accordance with the Grantee's Interim Public Access Plan for the Proposed Big Oaks National Wildlife Refuge included in the MOA and attached hereto as Exhibit "C". The Army must first approve any variation from this Plan and a revised Site Access Plan shall be made a part of this permit.

14. The Grantee shall not use the premises for the storage, treatment or disposal of non-Department of Defense owned hazardous or toxic materials as defined in 10 U.S.C. 2692, unless authorized under 10 U.S.C. and properly approved by the Government.

15. The Grantee is hereby informed and does acknowledge that all buildings on the premises, which were constructed or rehabilitated prior to 1978, are presumed to contain lead-based paint. For those buildings the Grantee uses and occupies, it shall comply with all applicable Federal, state and local laws and regulations pertaining to lead-based paint and/or lead-based paint hazards. The Grantee shall restrict access (e.g., secure buildings to the extent practical, post warning signs, etc.) to all unoccupied buildings except those buildings located in UXO Restricted Areas (see Site Map at MOA Enclosure 1). The Grantee shall restrict access to the UXO Restricted Areas in accordance with the Site Access Plan. The Grantee shall not permit the use of any of the buildings or structures on the premises for residential habitation. Residential habitation does not include use of the Old Timbers

Lodge for conference purposes including overnight visits on a non-permanent basis. The Grantee assumes all lead-based paint related liability arising from its use of the premises.

16. The Grantee is hereby informed and does acknowledge that friable and non-friable asbestos or asbestos containing materials (ACM) has been found on the premises. The Grantee acknowledges that it will inspect any building it proposes to occupy as to its asbestos content and condition and any hazardous or environmental conditions relating thereto. The Grantee shall restrict access (e.g., secure buildings to the extent practical, post warning signs, etc.) to all unoccupied buildings except those buildings located in UXO Restricted Areas (see Site Map at MOA Enclosure 1). The Grantee shall restrict access to UXO Restricted Areas in accordance with the Site Access Plan. The Grantee shall be deemed to have relied on its own judgment in assessing the condition of the premises with respect to any asbestos hazards or concerns. The Grantee covenants and agrees that its use and occupancy of a building will be in compliance with all applicable laws relating to asbestos. The Grantee assumes all asbestos related liability arising from its use of the premises.

17. The Grantee does not plan to occupy any buildings this fiscal year; however, Exhibit "D" attached hereto identifies Road & Bridge Maintenance Commitments for FY 2000. This information will be updated at least annually by the Grantee.

THIS PERMIT is not subject to Title 10, United States Code, Section 2662, as amended.

IN WITNESS whereof, I have hereunto set my hand by authority of the Secretary of the Army this 30th day of JUNE 2000.

Michael G. Barter

MICHAEL G. BARTER
Chief, Real Estate Division
Louisville District, Corps of Engineers
Louisville, Kentucky

NO. DACA27-4-00-087

This permit is also executed by the Grantee this 27 day of August 2000.

U.S. FISH AND WILDLIFE SERVICE

By: _____

Title: Assistant Regional Director
Indiana/Michigan/Ohio and
Wisconsin

EXHIBIT A. SITE MAP

JEFFERSON PROVING GROUND
SITE MAP

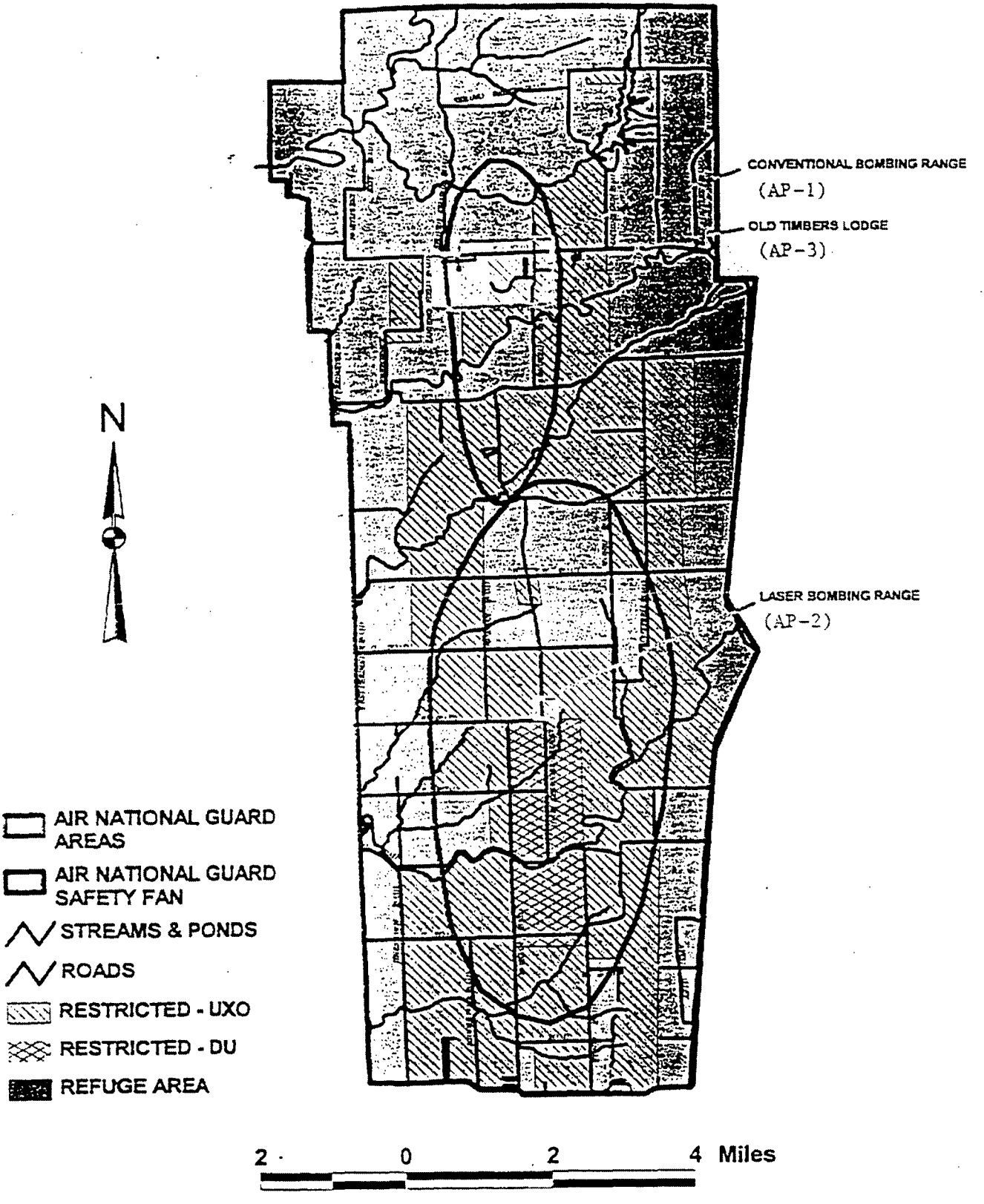


EXHIBIT A

PERMIT AREA NO. AP-1
FOR U.S. AIR FORCE

JEFFERSON PROVING GROUND
MILITARY RESERVATION
JEFFERSON COUNTY, INDIANA

PERMIT DESCRIPTION

Situate in the State of Indiana, County of Ripley, Township of Shelby, Township 6 North, Range 10 East, in parts of Sections 4 and 5, and Township 7 North, Range 10 East, in parts of Sections 32 and 33, in the Jefferson Proving Ground reservation, and more particularly described with referenced to the attached map showing coordinates based on the Universal Transverse Mercator (UTM) Metric Grid Coordinate System (NAD 27), Zone 16S, as follows:

Beginning at a point having an approximate UTM value of FU634749E/4318620N, said point being in the center of 'K' Road at the eastern boundary of the County of Ripley, and being at or near the west quarter corner of said Section 32; thence

North 88 degrees 13 minutes 20 seconds East 741.36 meters to a point having an approximate UTM value of FU635490E/4318643N; thence

North 00 degrees 32 minutes 51 seconds West 314.01 meters to a point having an approximate UTM value of FU635487E/4318957N; thence

East 2,118.00 meters to a point having an approximate UTM value of FU637605E/4318957N; thence

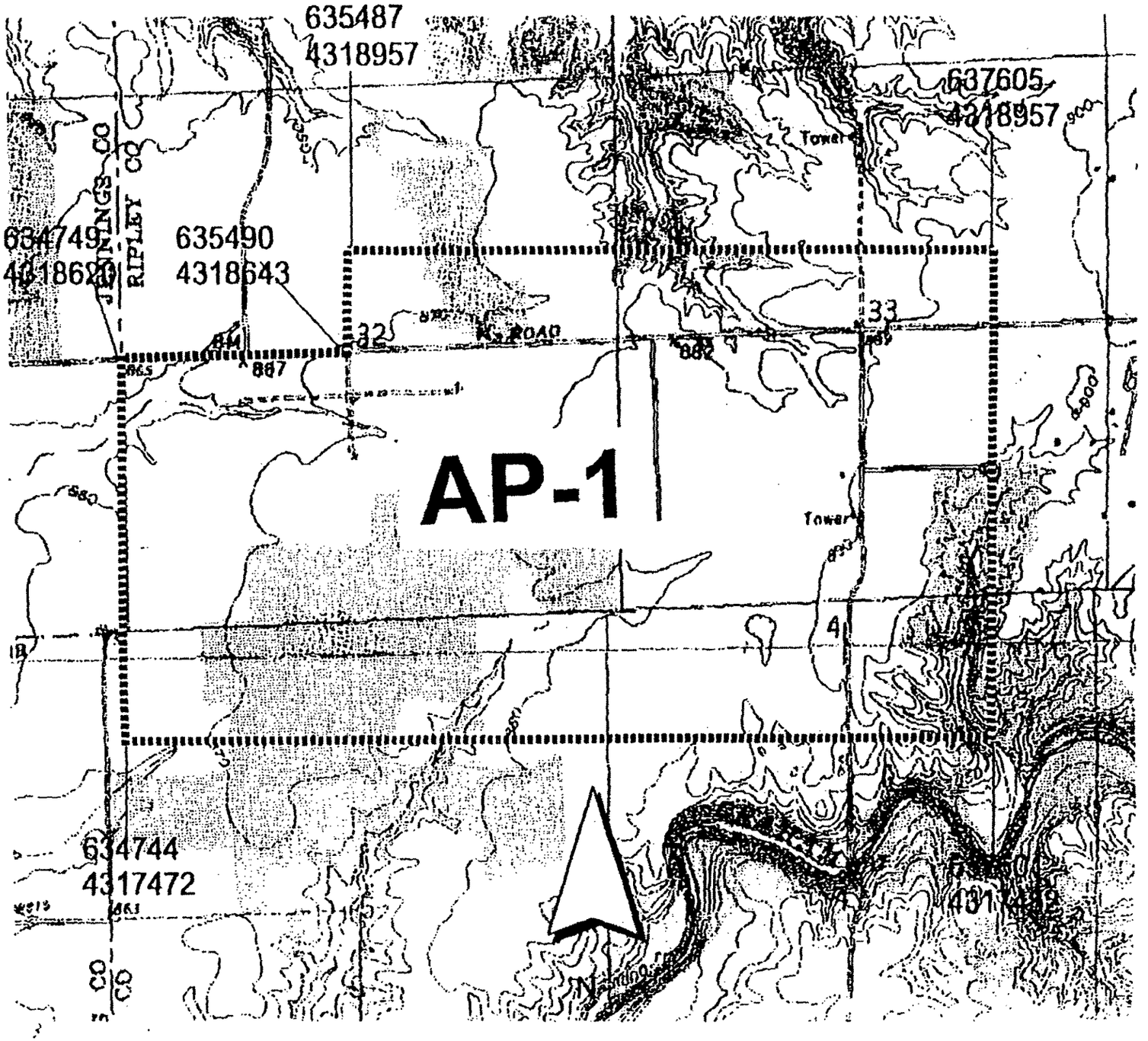
South 00 degrees 09 minutes 19 seconds West 1475.01 meters to a point having an approximate UTM value of FU637601E/4317482N; thence

South 89 degrees 47 minutes 58 seconds West 2,857.02 meters to a point having an approximate UTM value of FU634744E/4317472N; thence

North 00 degrees 14 minutes 58 seconds East 1,148.01 meters to the point of beginning, containing 398.611 hectares (984.967 acres), more or less.

15 June 2000, BLB; Rev 23 June 2000, BLB (3,4)

ANG Jefferson Range Area



PERMIT AREA NO. AP-2
FOR U.S. AIR FORCE

JEFFERSON PROVING GROUND
MILITARY RESERVATION
JEFFERSON COUNTY, INDIANA

PERMIT DESCRIPTION

Situate in the State of Indiana, County of Ripley, Township of Shelby, Township 6 North, Range 10 East, in part of Section 33, in the Jefferson Proving Ground reservation, and more particularly described with referenced to the attached map showing coordinates based on the Universal Transverse Mercator (UTM) Metric Grid Coordinate System(NAD 27), Zone 16S, as follows:

Beginning at a point having an approximate UTM value of FU637038E/4308284N, said point being 205 meters west of Center Recovery Road and 90 meters north of 'F' Road; thence

North 00 degrees 46 minutes 21 seconds West 445.04 meters to a point having an approximate UTM value of FU637032E/4308729N; thence

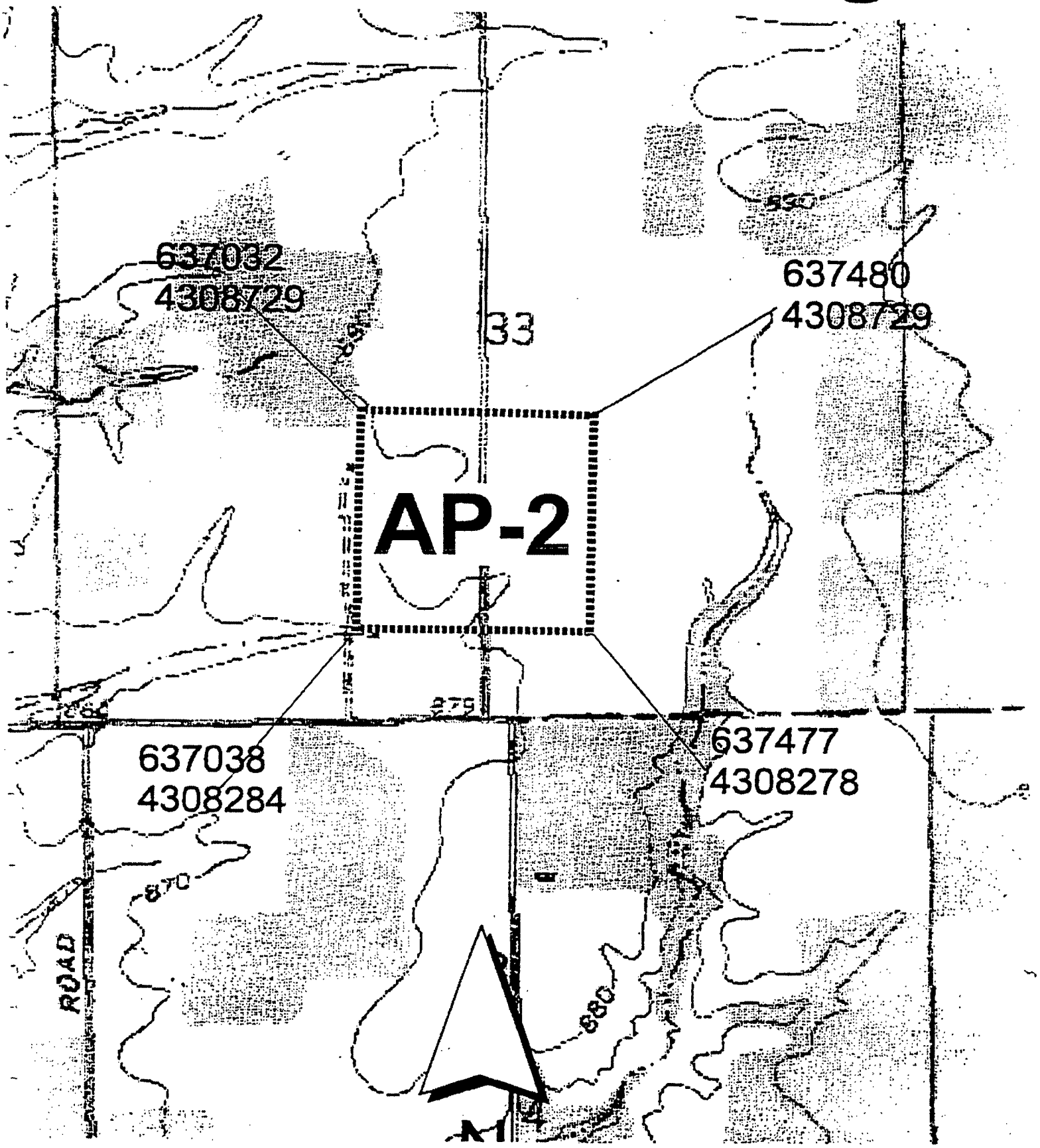
East 448.00 meters to a point having an approximate UTM value of FU637480E/4308729N; thence

South 00 degrees 22 minutes 52 seconds East 451.01 meters to a point having an approximate UTM value of FU637477E/4308278N; thence

North 89 degrees 13 minutes 01 seconds West 439.04 meters to the point of beginning, containing 19.869 hectares (49.096 acres), more or less.

15 June 2000, BLB; Rev 23 June 2000, BLB (3,4)

50-acre PGM Target



PERMIT AREA NO. AP-3
FOR U.S. AIR FORCE

JEFFERSON PROVING GROUND
MILITARY RESERVATION
JEFFERSON COUNTY, INDIANA

PERMIT DESCRIPTION

Situate in the State of Indiana, County of Ripley, Township of Shelby, Township 7 North, Range 10 East, in part of Section 34, in the Jefferson Proving Ground reservation, and more particularly described with referenced to the attached map showing coordinates based on the Universal Transverse Mercator (UTM) Metric Grid Coordinate System (NAD 27), Zone 16S, as follows:

Beginning at a point having an approximate UTM value of FU63947E/431876N, said point being 4731.5 meters east of the intersection of 'K' Road with the eastern boundary of the County of Ripley, and being at or near the west quarter corner of Section 32; thence

East 30.0 meters to a point having an approximate UTM value of FU63950E/431876N; thence

South 250.0 meters to a point having an approximate UTM value of FU63950E/431851N; thence

South 84 degrees 17 minutes 22 seconds West 100.5 meters to a point having an approximate UTM value of FU63940E/431850N; thence

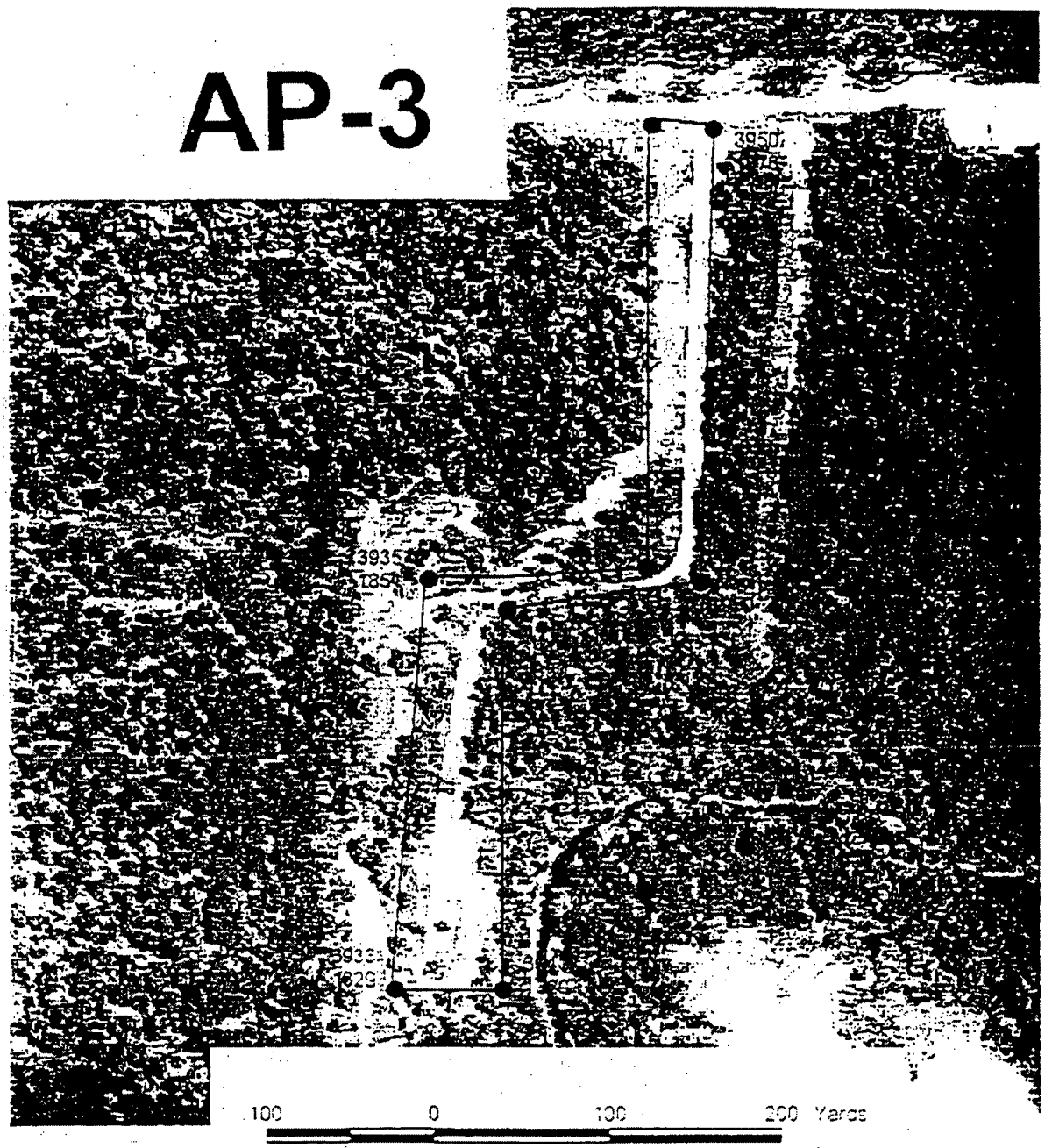
South 210 meters to a point having an approximate UTM value of FU63940E/431829N; thence

West 70 meters to a point having an approximate UTM value of FU63933E/431829N; thence

North 05 degrees 11 minutes 40 seconds East 220.9 meters to a point having an approximate UTM value of FU63935E/431851N; thence

North 85 degrees 14 minutes 11 seconds East 120.4 meters to a point having an approximate UTM value of FU63947E/431852N; thence

North 240.0 meters to the point of beginning, containing 2.18 hectares (5.388 acres), more or less.

15 June 2000, BLB

AP-3