Enclosure 3. Department of Army Permit to the Department of Air Force to Use Property Located on JPG

ENCLOSURE 3

NO.________________

DEPARTMENT OF THE ARMY

PERMIT TO THE DEPARTMENT OF THE AIR FORCE

TO USE PROPERTY LOCATED ON JEFFERSON PROVING GROUND

THE SECRETARY OF THE ARMY, hereinafter referred to as the Secretary hereby grants to the Department of the Air Force, hereinafter referred to as the grantee, a permit for the continued use of a Bombing Range at the Jefferson Proving Ground (JPG), 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, 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 180 days written notice.

2. The grantee agrees to the care and management of the property as specified in the Memorandum of Agreement (MOA) attached hereto 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 ____________________________, and if to the Secretary, to the District Engineer, Louisville District, __________________________ with a copy furnished to the JPG Commander, ______________________________ , or as may from time to time otherwise be directed by the parties. Notice shall be deemed to have been duly given if 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, attached hereto and made apart hereof. 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 Bombing Range 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 JPG commander.

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 JPG Commander, 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 Site Access Plan that is attached hereto and is made a part hereof. The Army must first approve any variation from this Plan and a revised Site Access Plan shall be made 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 may grant a license to the Indiana Air National Guard to exercise its rights to use the premises subject to the terms of this permit.

16. **NOTICE OF THE PRESENCE OF LEAD BASED PAINT AND COVENANT AGAINST THE USE OF THE PROPERTY FOR RESIDENTIAL PURPOSES.**

The grantee is hereby informed and does acknowledge that all buildings on the Property, 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 extent practical, post warning signs, etc.) to all unoccupied buildings except those buildings located in the 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 Property 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 Property.

17. NOTICE OF THE PRESENCE OF ASBESTOS AND COVENANT:

The grantee is hereby informed and does acknowledge that friable and non-friable asbestos or asbestos containing materials (ACM) has been found on the Property. The grantee acknowledges that it will inspect any building it will occupy as to its asbestos content and condition and any hazardous or environmental conditions relating thereto. The grantee will restrict access (e.g. secure buildings to the extent practical, post warning signs, etc.) to all unoccupied buildings except those buildings located in the 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 be deemed to have relied solely on its own judgment in assessing the condition of the Property 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 Property.

18. This permit supercedes Permit No. DACA 27-4-83-03, dated 23 July 1982, as amended. Said Permit No. DACA 27-4-83-03 is hereby terminated, effective the date of execution of this permit.

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 ____________________ day of ________________, ___________________.

____

This permit is also executed by the grantee this ________________________ day of ____________________, _______________.

____

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JEFFERSON RANGE ACCESS PLAN

(Revised 12 Apr 00)

Prepared by:
Air National Guard

Major William Nolen
Commander
Jefferson Range

Reviewed by:
U.S. Fish and Wildlife Service

Lee Herzberger
Refuge Manager
Muscatatuck National Wildlife Refuge

Approved by:
U.S. Army

Major Mark Welch
Commander
Jefferson Proving Ground

JEFFERSON RANGE ACCESS PLAN

This Operating Instruction will provide access procedures onto Jefferson Range. All access onto Jefferson Range and Old Timbers Lodge will be coordinated through Jefferson Range Operations Center (JROC).

Jefferson Range Operations Center (JROC) describes the range primary operations area. This area encompasses those buildings located at the intersection of Bomb Field and K roads. All access to the JROC is through Big Oaks National Wildlife Refuge.

Jefferson Range consists of 983 acres used as the primary training range. Geographical boundaries for this area illustrated in Attachment 1.

A 50 acre Precision Guided Munitions (PGM) target is located approximately 6nm south of the primary range. Geographical boundaries for this target are illustrated in Attachment 2.

Old Timbers Lodge and approximately 5 acres surrounding the lodge will be considered part of Jefferson Range for the purposes of this access plan.

Four gates allow access to the primary range. These gates are located as follows:

Intersection of Machine Gun and K roads
Intersection of Shape Charge and K roads
Intersection of Bethel Hole and J roads
Intersection of Cottrell and J roads

Range Personnel. All assigned personnel will be issued one key for perimeter gates and one key for range gates. Entry/Exit will be made through the gate most advantageous to their needs. Upon entry/exit the perimeter gate will be closed and locked.

Visitors. All visitors will coordinate range visits through the JROC. Visitors will be met at the appropriate perimeter gate and escorted to the JROC. Upon completion of visit, visitors will be escorted to appropriate gate for departure. There will be no unescorted visitors to and from Jefferson Range.

Contractors. Prior to any contractor performing duties on JPG real estate, coordination will be made through JROC and FWS office on all planned activities. Those contractors scheduled per Air Force (AF) requirements will be assigned a specific key for the duration of their activity. This key will be to an exclusive use lock located on the perimeter gate/interior gate nearest the planned activity and will only be utilized during duty hours.

Gate. All locks presently on all perimeter gates will be replaced by AF to ensure access by FWS, Army and AF personnel only. All locks will be changed prior to the issuance of a real estate license.

Fence. AF personnel and/or contractors will maintain the perimeter. Range personnel/contractors will perform weekly inspections of entire perimeter fence. All discrepancies will be reported so that any necessary repair action may be taken. FWS personnel are required to report any fence discrepancies to Jefferson Range NCOIC so the appropriate action may be taken. AF personnel or the designated contractor will perform fence repairs. Inspection documentation will include 1) date of inspection, 2) name of inspector, 3) description of damage, and 4) the location of the damage. Holes in the fence large enough to permit human access, damaged gates and missing " windchimes" of the creek barriers will be repaired within 72 hours of being documented. For every incident of damage a record shall be maintained documenting the action taken to make repairs. If any repairs take more than 72 hours, the Army shall be notified and milestones shall be given for completion of the repair.

Barricades. To ensure no trespass of the PGM target safety footprint and the interior of JPG, gate style barricades will be placed on all access roads into the footprint and interior areas. These barricades will be located at the point where all interior roads leave the East and West Perimeter Roads. Other than during the limited deer and turkey hunt, these barricade gates will remain closed and locked at all times. Only AF, Army and FWS personnel or required contractors will be allowed access to the footprint and interior areas of JPG. During the annual turkey and deer hunt, FWS will control access into these areas.

Key Control. All range personnel will be assigned 4 keys for range access. These keys include the perimeter gate keys, PGM target/interior road gate keys, range keys and building keys. Spare keys for these four series of keys will be kept in the JROC. All keys will be signed for on the Jefferson Range key control log. The FWS will be assigned the appropriate number of keys for distribution to FWS personnel. The FWS will be responsible for the control of these keys. The FWS will distribute the local law enforcement units perimeter gate keys from the FWS key allotment. The Army site staff will be issued 2 sets of keys and will be responsible for the control of these keys. Quarterly lock and key inventories will be made of all issued keys. In the event of a lost or missing key, the individual responsible for that key shall bear the cost for re-coring of applicable locks. Lock and Key Control guidance will be from 181st FW Instruction 32-1003. The Jefferson Range Commander has the ultimate responsibility for lock and key control on the range and refuge.

Safety Signs. The appropriate UXO safety signs will be maintained on the perimeter fence and gates. Gate numbers will be posted on all gates. Range and footprint gates will be posted with both Bombing Range and Laser Range danger signs. Radiation hazard signs will be maintained on DU field perimeter. Safety signs will be maintained on the west side of Machine Gun Road from K Road to Little Otter Creek.

Safety Brief. All visitors and contractors will receive a safety briefing from Jefferson Range Safety NCO. The safety brief will cover UXO, DU, driving hazards, flying operations and FWS operations. At no time will visitors or contractors be permitted to leave the JROC without first receiving an initial safety briefing.

Communications. Good communications between range, Army site staff and FWS personnel are a must to ensure a safe working environment for all concerned. The Range Operations Officer (ROO) will furnish FWS with a monthly flying schedule. The ROO will also inform FWS of any scheduled use of the PGM target. Use of this target will preclude any activity inside the safety footprint. All maintenance of the facilities will be coordinated with the Refuge Manager. At a minimum, monthly meetings will be conducted between the Refuge Manager and the Range Operations Officer to better facilitate a smooth work environment.

Weapons Safety Footprint. Two composite weapons safety footprints are associated with Jefferson Range. A composite footprint of approximately 5,100 acres supports the primary target area and a composite footprint of approximately 14,860 acres supports the PGM target area. During flight operations no personnel other than AF personnel will be allowed access inside the weapons footprints. The use of both footprints will be coordinated with the Refuge Manager through monthly scheduling or as necessary to meet mission requirements. When not in use, FWS personnel will have access to the safety footprints.

Emergency Response. Any emergency requiring an immediate response will be accomplished through the Ripley County Communication Supervisor. Emergency response personnel will be directed to Gate 8 for entrance and directions to the location of the emergency. AF personnel will provide escort to the incident location. Emergency response personnel will be informed of any hazards associated with the emergency. The Army site and staff and FWS will be notified of all needs for emergency response.

Aircraft Accident. In the event of an aircraft accident, the Range Control Officer (RCO) will be the on-scene commander until relieved by the appropriate authority. Emergency response will be through the Ripley County Communication Supervisor. Fire and medical support will be directed to the perimeter gate most advantageous to the crash site. Due to the dangers posed by military aircraft, no persons will be allowed access to a crash site until deemed appropriate by the on-scene commander. Access to an aircraft or pilot in a designated restricted area will be accomplished by the appropriate Jefferson Range vehicle. Only the necessary rescue personnel will be permitted access to any restricted area. Access to aircraft or pilot outside of a restricted area will be made by the appropriate vehicle for the situation. The Army site staff and FWS will be notified immediately of any aircraft mishap.

Fire Response. Request for fire response will be made through the Ripley County Communication Supervisor. Fire fighters will be directed to Gate 8 for entrance and directions to the fire. Fire fighters will not leave any roadway to fight fires per US Army directives. In the event of a need for fire department response after duty hours, the local fire department will be instructed to cut the lock on the gate most advantageous to their response. In this case, fire department response will only occur if it is apparent that the fire will cause life or property damage outside JPG. A complete list of AF and FWS contacts will be provided all local fire departments in the area. Attachment 4 lists the Jefferson Range contacts available on a 24 hour basis.

Law Enforcement Response . Request for law enforcement response will be made through the Ripley County Communication Supervisor or the appropriate law enforcement agency. Caller will state the nature of the emergency, location of the emergency and the most accessible gate to respond to the emergency. Local law enforcement units will have perimeter gate keys issued to them from the FWS key allotment. All local law enforcement units will be issued a 24 hour contact list of Jefferson Range personnel.

Old Timbers Lodge. Access to Old Timbers Lodge will be through Gate 1B. The sponsor that has reserved the lodge will contact Jefferson Range to arrange a time for key sign out and the required safety briefing. The sponsor and all guests will be required this safety brief. A single key to Gate 1B will be assigned the sponsor. The sponsor is responsible for the behavior and safe conduct of his/her guests. If the sponsor and/or guests wish to take part in recreational activities of Big Oaks NWR, those activities will fall under the rules and guidelines of the refuge. Use of Old Timbers Lodge does not guarantee hunting and fishing activities on the refuge. Attachment 3 depicts that area around the lodge to be maintained by the AF.

Attachment 4

24 Hour Contact List

Major Bill Nolen
Jefferson Range Commander
Office: 812-689-7295
Home: 317-738-2719
Cell Phone: 317-441-3653

Major Matt Sweeney
Jefferson Range Operations Officer
Office: 812-689-7295
Home: 812-988-6787
Cell Phone: 812-528-0974

Senior Master Sergeant Jim Bergdoll
Jefferson Range NCOIC
Office: 812-689-7295
Home: 812-265-2372

Master Sergeant Kerry Brinson
Jefferson Range Asst NCOIC
Office: 812-689-7295
Home: 812-839-3557

Master Sergeant Todd Bass
Jefferson Range Safety NCOIC
Office: 812-689-7295
Home: 812-265-2153

Enclosure 4. North of the Firing Line UXO Response Standard Operating Procedure

ENCLOSURE 4—North of the Firing Line
Unexploded Ordnance (UXO) Response
Standing Operating Procedure

1. **PURPOSE:** To establish procedures to support emergency management/disposition of UXO items in the Firing Range area at Jefferson Proving Ground (JPG).

2. **OBJECTIVE:** To prescribe an explicit course of action for the safe and efficient management of situations involving UXOs in the Firing Range area at JPG.

3. **POLICY:**

a. The Senior Explosive Ordnance Disposal (EOD) technician assumes primary responsibility for command and control of operations at the scene of a UXO.

b. Only EOD technicians may attempt to perform render-safe procedures (RSP) on UXO.

4. **UXO OPERATIONAL PROCEDURES:**

a. If the FWS or Air Force discovers UXO which poses an imminent and substantial hazard to Refuge or Bombing Range operations (e.g., UXO has migrated to the surface of a roadway), the FWS or Air Force will immediately:

(1) Restrict access to the UXO site,

(2) Cease all work, mark location of the item,

(3) Move all personnel away,

(4) Ensure that no one uses a two-way radio, and

(5) Notify the Army JPG Site Management Team if present at 812-273-2522/2551/6075. If the JPG Site Management Team is not

available, notify the Commander, Newport Chemical Depot at 765-245-4317.

b. Upon verification by the Commander, Newport Chemical Depot or the JPG Site Management Team that the UXO poses an imminent and substantial hazard to Refuge or Bombing Range operations, the Army shall notify the Fort Knox 703rd EOD Ordnance Company at 502-624-5631, and request disposal of the UXO item[1].

c. EOD personnel shall coordinate their activities and gain access to areas in the Firing Range area by contacting the Commander, Newport Chemical Depot at 765-245-4317 and Army JPG Site Management Team at 812-273-2522/2551/6075.

d. The Senior EOD Technician shall determine if the UXO item is inert. If an inert verification is not possible the munition shall be blown in place. If detonation in place is not possible, the Senior EOD Technician will determine whether it is appropriate to attempt a RSP or use other approved means to move the item to a more suitable location for safe disposal.

e. Until the item is disposed of, the Army at its discretion may impose additional access restrictions to the Firing Range area.

5. <u>REVIEW:</u> This SOP shall be reviewed annually. Any revisions/updates shall be provided to the FWS, Air Force, the 703rd Fort Knox EOD Ordnance Company, the Real Estate Division of the Louisville Corps of Engineers, and Newport Chemical Depot Commander or the Army JPG Site Management Team.

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[1] The Army will not be required to remove UXO that the JPG Site Management Team determines does not pose an imminent and substantial hazard to Refuge or Bombing Range operations.

Enclosure 5. FWS/Air Force Infrastructure Maintenance Responsibilities

ENCLOSURE 5 – FWS/Air Force Infrastructure Maintenance Responsibilities

AIR FORCE

1. Air Force shall maintain all roads, road shoulders and low water crossings, as well as associated bridges and culverts, that are shaded in green on the map at Tab A, in accordance with Army Regulation 420-72.

2. The perimeter fence shall be patrolled and inspected weekly. Inspections shall be documented to include: 1) the date of inspection, 2) the name of the inspector(s), 3) a description of any damage observed, and 4) the location of the damage. Holes in the fence large enough to permit human access, damaged gates and missing "windchimes" of the creek barriers will be repaired within 72 hours of being documented. For every incident of damage a record shall be maintained documenting the action taken to make repairs. In extraordinary circumstances when a repair will take more than 72 hours to complete (e.g. storm damage), the Air Force shall notify the Army in writing and milestones shall be given for completion of the repair. The Air Force shall take action to remove tress that fall into/onto the fence. Grass and other vegetation, located between the perimeter fence and perimeter road, shall be mowed or otherwise controlled to assure capability for visual inspection of the perimeter fence from the perimeter road: such mowing shall be done twice annually, usually in the April-June and September-October timeframes.

3. All roads approaching the DU area shall be barricaded and marked with radiation warning signs. In addition the Air Force will maintain warning signs around the entire perimeter of the firing range as well as around the submunitions area west of Machine Gun Road and the former Open Detonation area.

4. The Air Force shall maintain the cultural resource properties of the Firing Range (i.e., four stone-arch bridges as well as the Old Timbers Lodge) in accordance with the Cultural Resources Management Plan (reference maintenance standards in Table III-1 at Tab B). A complete copy of the Cultural Resources Management Plan was mailed to the Air Force(i.e. Mr. Masse) in March, 2000.

FWS

1. The FWS shall maintain all buildings, roads, road shoulders, bridges, low water crossings, and culverts, not maintained by the Air Force, which are required for Refuge operations. The FWS shall maintain such facilities in accordance with Army Regulation 420-72. Prior to the start date of the Real Estate permit, the FWS will provide a map with clear identification of the roads, road shoulders, buildings, bridges, low water crossings and culverts that it shall maintain under terms of the real estate permit. This map will be

updated annually by the FWS to reflect their maintenance commitment for the next year. No later than December 1, 2000, the FWS will close all bridges in the Refuge footprint that are not required for Refuge operations or not maintained by the Air Force. The FWS shall provide access control signs on the east perimeter road between Gate 1B and K Road, as well as the minefield area on L Road.

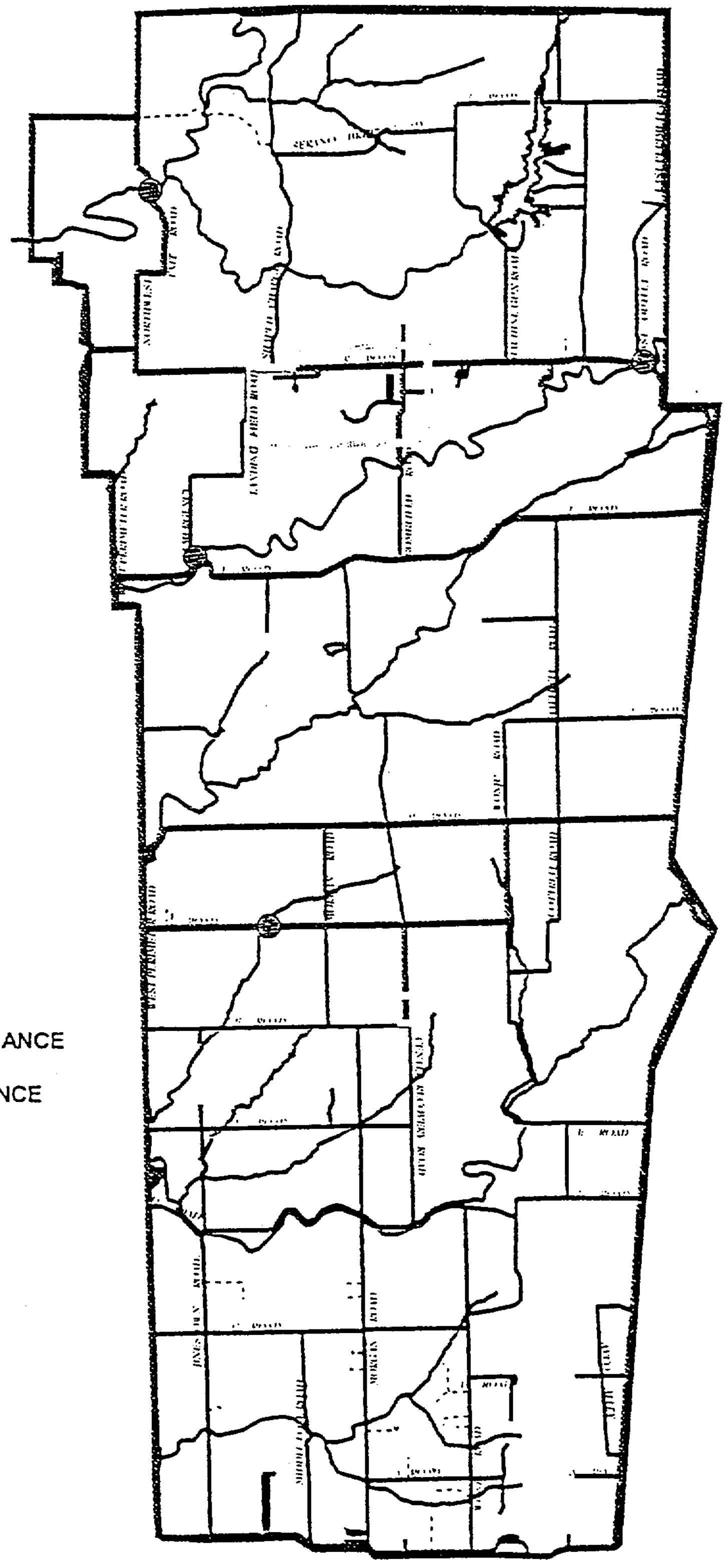
2. FWS shall provide road maintenance sufficient for 4 x 4 vehicle access to the DU monitoring wells identified at Tab C.

3. FWS shall provide or negotiate and/or fund fire suppression, emergency medical response and local law enforcement agreements. Note that three different counties (i.e. Jefferson. Ripley, and Jennings) have different jurisdiction footprints in the firing range property.

4. The FWS shall pay a pro-rated share of the rent charged to the Army for the use of Building 125 and associated utilities beginning with the start date the real estate permit..

TAB A

AIR NATIONAL GUARD
ROAD & BRIDGE MAINTENANCE



ANG BRIDGE MAINTENANCE

ANG ROAD MAINTENANCE

TAB B

Table III-1
Standards for Treatment of Significant Architectural Resources
after the Secretary's Standards and Guidelines for Archeology and Historic Preservation [48 FR 44716]

Preservation is defined as the act of process of applying measures necessary to sustain the existing form, integrity, and materials of an historic property. Work, including preliminary measures to protect and stabilize the property, generally focuses upon the ongoing maintenance and repair of historic materials and features rather than extensive replacement and new construction. New exterior additions are not within the scope of this treatment; however, the limited and sensitive upgrading of mechanical, electrical, and plumbing systems and other coed-required work to make properties functional is appropriate within a preservation project.

Standards for Preservation

1. A property shall be used as it was historically, or be given a new use that maximizes the retention of distinctive materials, features, spaces, and spatial relationships. Where a treatment and use have not been identified, a property shall be protected and, if necessary, stabilized until additional work may be undertaken.
2. The historic character of a property shall be retained anti preserved. The replacement of intact or repairable historic materials or alteration of features, spaces, and spatial relationships that characterize a properly shall be avoided.
3. Each property shall be recognized as a physical record of its time, place, and use. Work needed to stabilize, consolidate, and conserve existing historic materials and features shall be physically and visually compatible, identifiable upon close inspection, and properly documented for future research.
4. Changes to a property that have acquired historic significance in their own right shall be retained and preserved.
5. Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize a property shall be preserved.
6. The existing condition of historic features shall be evaluated to determine the appropriate level of intervention needed. Where the severity of deterioration requires repair or limited replacement of a distinctive feature, the new material shall match the old in composition, design, color, and texture.
7. Chemical or physical treatments, if appropriate, shall be undertaken using the gentlest means possible. Treatments that cause damage to historic materials shall not be used.
8. Archeological resources shall be protected and preserved in place. If such resources must be disturbed, mitigation measures shall be undertaken.

Rehabilitation is defined as the act or process of making possible on efficient compatible use for a property through repair, alternations, and additions while preserving those portions of features that convey its historical, cultural, or architectural values.

Standards for Rehabilitation

1. A property shall be used as it was historically or be given a new use that requires minimal change to its distinctive features, spaces, and spatial relationships.
2. The historic character of a property shall be retained and preserved. The removal of distinctive materials or alteration of features, spaces, and spatial relationships that characterize a property shall be avoided.
3. Each properly shall be recognized as a physical record of its time, place, and use. Changes that create a false lease of historical development, such as adding conjectural features or elements from other historical properties, shall not be undertaken.
4. Changes to a property that have acquired historic significance in their own right shall be retained and preserved.
5. Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize a property shall be preserved.
6. Deteriorated historic features shall be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature shall match the old in design, color, texture, and, where possible, materials. Replacement of missing features shall be substantiated by documentary and physical evidence.
7. Chemical or physical treatments, if appropriate, shall be undertaken using the gentlest means possible. Treatments that cause damage to historic materials shall not be used.
8. Archeological resources shall be protected and preserved in place. If such sources must be disturbed, mitigation measures shall be undertaken.
9. New additions, exterior alterations, or related new construction shall not destroy historic materials, features, and spatial relationships that characterize the property. The new work shall be differentiated from the old and shall be compatible with the historic materials, features, size, scale and proportion, and massing to protect the integrity of the property and its environment.
10. New additions and adjacent or related new construction shall be undertaken in such a manner that, if removed in the future, the essential form and integrity of the historic property and its environment would be unimpaired.

Table III-1
Standards for Treatment of Significant Architectural Resources
after the Secretary's Standards and Guidelines for Archeology and Historic Preservation [48 FR 44716]

Restoration is defined as the act or process of accurately depicting the form, features, and character of a property as is appeared at a particular period of time by means of the removal of features from other periods in its history and reconstruction of missing features from the restoration period. The limited and sensitive upgrading of mechanical, electrical, and plumbing systems and other code required work to make properties functional is appropriate within a restoration project.

Standards for Restoration

1. A property shall be used as it was historically or be given a new use, which interprets the property and its restoration period.
2. Materials and features from the restoration period shall be retained and preserved. The removal of materials or alteration of features, spaces, and spatial relationships that characterize the period shall not be undertaken..
3. Each property shall be recognized as a physical record of its time, place, and use. Work needed to stabilize, consolidate, and conserve materials and features from the restoration period shall be physically and visually compatible, identifiable upon close inspection, and property documented for future research.
4. Materials, features, spaces, and finishes that characterize other historical periods shall be documented prior to their alteration or removal.
5. Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize the restoration period shall be preserved.
6. Deteriorated features from the restoration period shall be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature shall match the old in design, color, texture, and, where possible, materials.
7. Replacement of missing features from the restoration period shall be substantiated by documentary and physical evidence. A false sense of history shall not be created by adding conjectural features, features from other properties, or by combining features that never existed together historically.
8. Chemical or physical treatments, if appropriate, shall be undertaken using the gentlest means possible. Treatments that cause damage to historic materials shall not be used.
9. Archeological resources shall be protected and preserved in place. If such resources must be disturbed, mitigation measures shall be undertaken.
10. Designs that were never executed historically shall not be constructed.

Reconstruction is defined as the act of process of depicting, by means of new construction, the form, features, and detailing of a non-surviving site, landscape, building, structure, or object of the purpose of replicating its appearance at a specific period of time and in its historic location.

Standards for Reconstruction

1. Reconstruction shall be used to depict vanished or non-surviving portions of a properly when documentary and physical evidence is available to permit accurate reconstruction with minimal conjecture, and such reconstruction is essential to the public understanding of the property.
2. Reconstruction of a landscape, building, structure, or object in its historic location shall be preceded by a thorough archeological investigation to identify and evaluate those features and artifacts, which are essential to an accurate reconstruction. If such resources must be disturbed, mitigation measures shall be undertaken.
3. Reconstruction shall include measures to preserve any remaining historic materials, features, and spatial relationships.
4. Reconstruction shall be based on the accurate duplication of historic features and elements substantiated by documentary or physical evidence rather than on conjectural designs or the availability of different features from other historic properties. A reconstructed properly shall re-create the appearance of the non-surviving historic property in materials, design, color, and texture.
5. A reconstruction shall be clearly identified as a contemporary re-creation.
6. Designs that were never executed historically shall not be constructed.

TAB C

JEFFERSON PROVING GROUND: DU SAMPLING
GROUNDWATER MONITORING WELLS

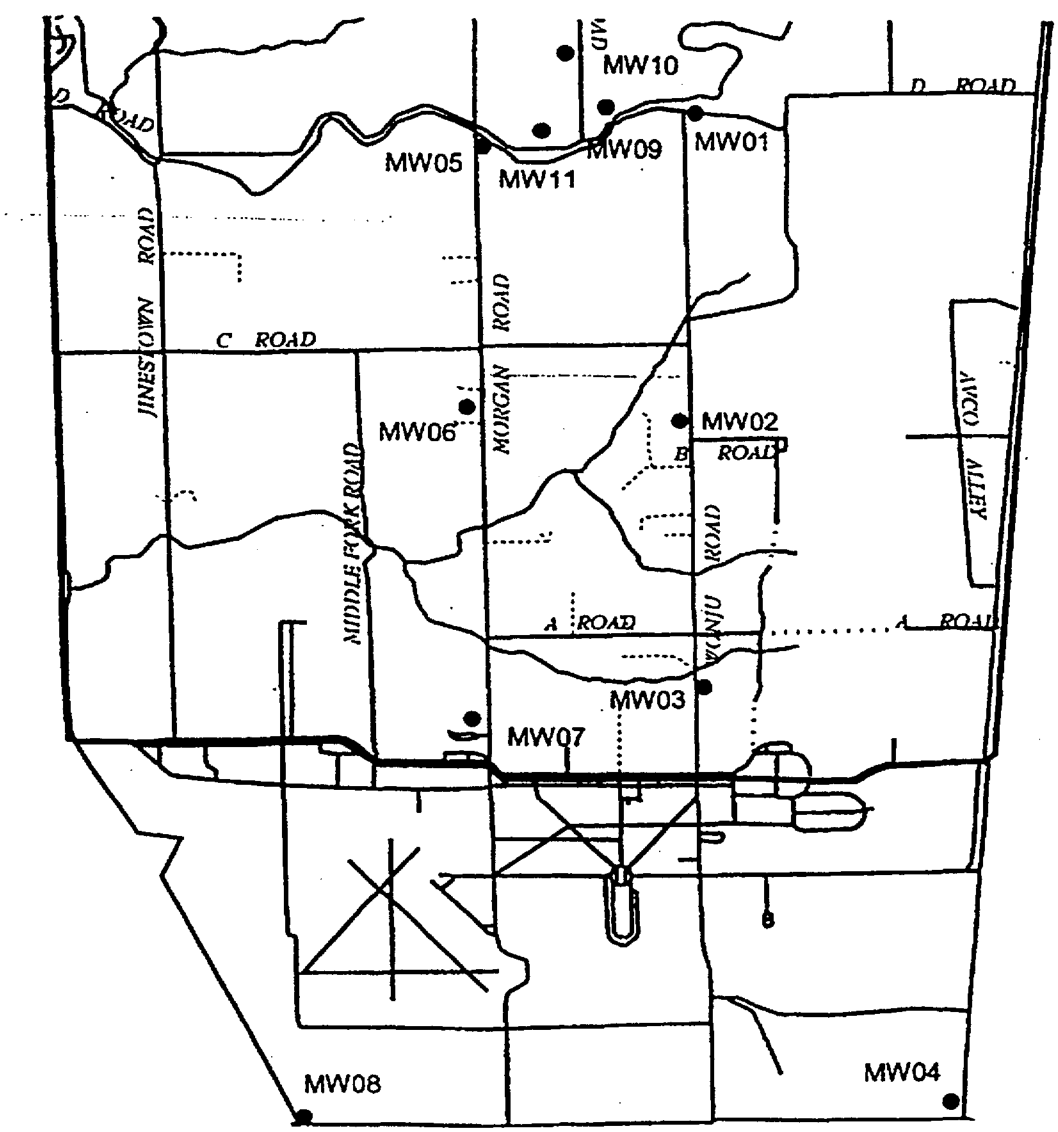


EXHIBIT C. JEFFERSON RANGE ACCESS PLAN

Interim Public Access Plan for the Proposed Big Oaks National Wildlife Refuge

Prepared by:
U. S. Fish and Wildlife Service

Lee Herzberger
Refuge Manager
Muscatatuck National Wildlife Refuge

Reviewed by:
Air National Guard

Maj. William Nolen
Commander
Jefferson Range

Approved by:
U. S. Army

Maj. Mark A. Welch
Commander
Jefferson Proving Ground

EXHIBIT C

Introduction

Approximately 50,000 acres of the decommissioned military base known as Jefferson Proving Ground (JPG) is proposed for inclusion into the National Wildlife Refuge (NWR) System via a Memorandum of Agreement (MOA) with the U.S. Army (Army). The area will become Big Oaks NWR. The primary purposes for this overlay NWR are derived from 2 specific acts:

> 1) The Fish and Wildlife Act of 1956 [16 USC 742a-742j] as amended authorizes the Secretary of the Interior to acquire interests in property "...for the development, advancement, management, conservation, and protection of fish and wildlife resources..."
>
> 2) The Endangered Species Act authorizes the Secretary of Interior to acquire interests in lands "to conserve fish, wildlife, and plants, including those which are listed as endangered or threatened..." [16 USC 1534].

The mission of Big Oaks NWR derives from these two purposes and is "to preserve, conserve, and restore biodiversity and biological integrity for the benefit of present and future generations of Americans." There is also a potential for limited public use in areas designated for such activities. This Interim Public Access Plan (Plan) was developed to allow the Army to review and approve safety procedures prior to public use occurring on Big Oaks NWR. This Plan is in accordance with the terms and conditions of the MOA between the U. S. Fish and Wildlife Service (FWS), Army, and Air Force (AF), and in the event of a conflict between the MOA and this agreement, the MOA shall be the controlling document.

Much of the proposed Big Oaks NWR contains unexploded ordnance (UXO), depleted uranium (DU), and other contaminants. The existence of these contaminants causes safety, management and funding concerns specific to Big Oaks NWR. The FWS accepts that there is no Army plan or budget authority to remove UXO in the Firing Range. However, the Army has agreed to make a good faith effort to request UXO removal in connection with Army Reserve and/or Army National Guard training exercises to support refuge operations. To facilitate the support process, the FWS will incorporate building designs that minimize ground disturbance and will provide the Army a minimum 2-year advance notice of their request to complete UXO removal. If the Army is not able to obtain UXO removal support as part of a training exercise, the FWS agrees to withdraw its request and terminate any plans/operations requiring non-emergency UXO support.

In the central portion of JPG is an active 1,033-acre AF training area known as Jefferson Range. Jefferson Range is composed of a 983-acre air-to-ground bombing and strafing range and a 50-acre Precision Guided Munitions (PGM) range. Both the 983-acre range and the 50-acre range have associated safety fans that extend over a portion of the area proposed as Big Oaks NWR (Fig. 1). A composite footprint of approximately 5,100 acres supports the primary target area and a composite footprint of approximately 14,860 acres supports the PGM target area. During flight operations no personnel other than AF personnel will be allowed access inside the weapons footprints. The use of both footprints will be coordinated with the Refuge Manager through monthly scheduling or as necessary to meet mission requirements. When not in use, FWS personnel will have access to the safety footprints. Safety fans and other closed areas will be barricaded as a precaution. The scheduling of public use on Big Oaks NWR that may conflict with AF activities will be coordinated through periodic meetings between the Refuge Manager and the AF Range Commander designed to eliminate conflicts and ensure safety.

In the event of an aircraft accident, the Jefferson Range Control Officer (RCO) will be the on-scene commander in charge until relieved by the appropriate military authority. Fire and medical support will be directed to the perimeter gate most advantageous to the crash site. Due to the dangers posed by military aircraft, no persons will be allowed access to a crash site until deemed appropriate by the on-scene official. The Jefferson Range Access Plan protocols concerning aircraft accidents will be adhered to by the FWS, and the Refuge Manager will coordinate and cooperatively work with the Jefferson RCO or other on-scene commander.

Safety Briefing Protocols

To ensure visitor safety, the Army will provide safety briefing materials that contain basic information on site history, the hazards of UXO, and the appropriate action when UXO or DU is encountered. The FWS will require all staff and visitors to undergo a safety briefing and will provide safety pamphlets containing this information and a map of Big Oaks NWR. FWS will also brief visitors on other hazards based on local site conditions. All Public Access Permits will be tracked by a permit number. An annual database will be maintained that records individual permit information (e.g., name, address, date of birth, date of safety briefing, etc.). An annual fee or daily fee will be charged for recreational use at Big Oaks NWR. Entrance fees will be waived for official duties conducted by contractors, FWS staff, AF staff, Army staff, and others designated by the Refuge Manager, but everyone will receive a safety briefing (AF visitors will receive briefings in accordance with the AF site access plan).

Entry Procedures

Visitors will check-in and undergo an appropriate safety briefing at the refuge office (presently in Building 125) and be issued a Public Access Permit. The visitor will then be given directions to the access gate controlled by a gate attendant. The gate location will be the sole access point for unescorted FWS visitors and is located adjacent to Gate 1a on the East Perimeter Road (Gate "1b"; Fig. 2). Visitor check-out will also occur at the refuge office. AF visitors, including Old Timbers Lodge guests, will be checked-in and out in accordance with the AF site access plan.

Types of Public Use

The FWS will provide staffing at a level consistent with the safe operation of the refuge. With the expectation of limited or no UXO cleanup in the future, public use levels will be low and limited to hunting, fishing, wildlife observation and photography, and guided tours (Table 1). Activities not covered within the Plan will not be allowed unless first reviewed and approved by the Army and declared compatible by the FWS.

Access

All public activities on the refuge will be controlled and limited within 2 zones identified in consultation with the Army. These areas are 1) Limited Day Use Recreation and 2) Special Control Hunt Zones; a third zone would have no public access and would be considered closed to all types of entry except on established roads or under emergency conditions (Fig. 1). The Limited Day Use Zone will be used for hunting (deer and turkey), fishing (Old Timbers Lake), and limited opportunities for wildlife observation and photography, and guided (accompanied by FWS staff) environmental education and interpretation tours. The Special Control Hunt Zone will only have public access during a limited deer and turkey hunting season, and limited guided tours. All of these recreational units were previously used in the Army recreation program (Fig. 1).

Public use areas will be delineated by maps and by signs placed on their boundaries as required by NWR policies. Recreational opportunities during posted hours and periods will be available to the general public provided they have completed all necessary safety requirements, proper state licenses, appropriate permits for lottery seasons, and there are areas/staff available for the requested activity. Unescorted access will be limited to April through November (Table 1). Recreation units will have maximum capacity limits at any one time for all off-road visitor activities (Table 1, Fig. 1). Guided tours oriented toward environmental education, wildlife observation, interpretation, and the unique story of the property will be scheduled and completed without exposing the public participants to undue risk.

Protocols on How Public Use will be Monitored, Limited, and Controlled

Public access will be limited to specific days of the week and by seasonal periods (e.g., fishing, deer, and turkey seasons) (Table 1). The Army and the FWS will periodically reevaluate public access to determine if different limits are more appropriate.

The standard protocol for public access will be a check-in/check-out procedure to specific areas (e.g., Area 1, see Fig. 1) for those members of the public that have undergone a safety briefing. They will be allowed in areas identified as suitable for that type of activity (e.g., deer hunting in a Special Control Hunt Area; fishing in Old Timbers Lake). A daily entrance log/database will be kept of all public use on Big Oaks NWR. Information on types and locations of public use will be compiled in an annual report that will be distributed to the Army, AF and the FWS Region 3 Office.

Prior to unescorted public access occurring (June 3, 2000), the AF will install road barricades on the East Perimeter Road and the FWS will place closed area signs on these barricades to limit public access into interior areas of the refuge (Fig. 2). A total of 19 barricades will be placed around the periphery of the southern Special Control Hunt Zone. These barricades will be located at the point where all interior roads leave the East and West Perimeter Roads. The barricades on the West Perimeter Road will be in place by deer season (November 1, 2000). Other than during the limited deer and turkey hunts, these barricade gates will remain closed and locked at all times. FWS will control access into these areas during the annual turkey and deer hunts with the previously described protocols. Besides these hunt periods, only AF and FWS personnel or required contractors will be allowed access to these interior areas and the safety fan footprints. Closed area signs will also be placed alternating with the warning signs placed by the Army for closed access areas, especially for those areas adjacent to recreation units. Signs will be placed on existing structures (i.e., fence posts, buildings, etc.), live trees, or on posts with weighted bases to avoid ground intrusion of sign posts.

As described in the MOA, the FWS will work closely with the AF on controlling visitor access and monitoring refuge visitors. The AF will be responsible for maintaining the perimeter fence and overall site security at JPG. The FWS will notify the AF of any damage to the perimeter fence in a timely manner.

The FWS will not tolerate individuals who violate safety regulations. For this reason, anyone who does not comply with safety regulations will forfeit his/her refuge access privileges as determined by the Refuge Manager or by a court of law. The FWS will also continue access restrictions made by the Army to specific individuals because of documented safety violations.

Enforcement of refuge trespass and other public use violations will be the primary responsibility of commissioned Refuge Law Enforcement Officers and cooperatively by Indiana Conservation Officers and other law enforcement agencies. General trespass, poaching, and other violations will be cooperatively enforced by these agencies. The FWS will meet with local law enforcement agencies and develop coordinated law enforcement strategies (these strategies will be in place by June 3, 2000) that will be coordinated with the AF. Procedures for obtaining law enforcement assistance will be based on legal jurisdiction where the incident occurs (e.g., in Ripley County the Ripley County Communication Supervisor will be contacted, likewise, in Jefferson or Jennings Counties the appropriate Communication Radio Dispatch Centers will be contacted). For emergency response situations, the cooperating agency will coordinate activities with a 24 hr point of contact (POC) listed in Attachment 1.

Fire suppression capabilities will be negotiated with a local Volunteer Fire Department and will be in place by June 3, 2000. The agreement will include protocols on suppression of wild fires and on-call assistance during prescribed fires. Protocols will instruct fire fighters to not leave roadways and to follow other Army safety directives. For fire department response after hours, the local fire department will be instructed to coordinate with the POC and to cut the lock on the gate most advantageous to their response. In this case, the fire department response will only occur if it is apparent that the fire could cause loss of life or property damage outside the perimeter fence.

Key Control

The AF will change all locks on the perimeter fence and will issue an appropriate number of perimeter and interior gate keys to the FWS for official use. These keys will be controlled in accordance with standard lock and key control protocols (Air National Guard 181st Fighter Wing Instruction 32-1003). All keys will be signed for on the Jefferson Range key control log. The FWS will inventory these keys quarterly in accordance with these key control protocols. The FWS will coordinate distribution of keys with law enforcement and emergency response agencies. The FWS will be responsible for the control of these keys. The party responsible for missing keys shall bear the cost for the re-coring of locks as applicable. The Jefferson Range Commander has the ultimate responsibility for lock and key control on the range and refuge.

Use of Refuge by Old Timber's Lodge (AF) Guests

The FWS will schedule priority refuge events for Old Timbers Lodge with the Jefferson Range AF Commander; at all other times the Old Timbers Lodge area will be off limits for refuge visitors. The refuge will allow Old Timbers Lodge guests access to refuge recreational activities on days/times those activities are available to the general public. Old Timbers Lodge guests must obtain a valid Big Oaks NWR Public Access Permit to participate in these activities and these guests must participate in an AF safety briefing. While on the refuge, all rules and regulations of the refuge will apply to Old Timbers Lodge guests.

Old Timbers Lodge guests must check-in and check-out at the refuge office to participate in recreational opportunities (e.g., fishing at Old Timbers Lake). If guests do not check-in, especially for fishing at Old Timbers Lake, they cannot be guaranteed the opportunity to participate in the recreational activity. For permitted deer or turkey hunts, Old Timbers Lodge guests must either have a valid state lottery permit for the specific hunt or participate in a reserved hunt drawing during the hunting season at the refuge office.

Table 1. Public use limits (use-days) for activities on Big Oaks NWR [a].

Activity	Description of where use will occur	Maximum one-time capacity	When allowed
Deer Hunting	See Public Access Map	423	November (6 days archery and 9 days gun)
Turkey Hunting	½ of the number hunters/area given on Public Access Map	212	April to Mid- May (15 Days)
Fishing	Max. 10 boats and Max. 40 on shore at Old Timbers Lake. No fishing allowed on any other body of water.	60 [b]	5 - 10 days per month; April through October
Wildlife Observation and Photography	½ of the number persons/area given on Public Access Map; only within Limited Day Use Zone	78 [b]	5 - 10 days per month; April through October
Guided tours (interpretation and environmental education)	Dependent on conveyances available and activity. By definition, accompanied by FWS staff.	12-50	By reservation

[a] Based on staff and funds available in FY 2000.

[b] Based on parking and trail availability

Attachment 1

24 Hour Contact List

Joseph R. Robb
Refuge Operations Specialist
Office: 812-273-0783
Home: 812-265-6633
Cell Phone: 812-498-1154

Donna Stanley
Refuge Law Enforcement Officer
Office: 812-522-4352
Home: 812-523-3414
Cell Phone: 812-528-1998

Stephen A. Miller
Refuge Operation Specialist
Office: 812-273-0783
Home: 812-358-4413
Cell Phone: 812-498-1155

Jason Lewis
Wildlife Biologist
Office: 812-273-0783
Home: 812-574-6015
Cell Phone: 812-498-1156

Teresa Vanosdol-Lewis
Wildlife Biologist
Office: 812-273-0783
Home: 812-574-6015
Cell Phone: 812-498-1157

EXHIBIT D. ROAD AND BRIDGE COMMITMENTS

Road & Bridge Maintenance Commitments for FY 2000

Attached are the Fish and Wildlife Service road & bridge maintenance commitments for FY 2000. We are unable to commit to additional road and bridge maintenance responsibilities until our engineering division has had an opportunity to assess the condition and long term maintenance needs of the roads and bridges. We expect this assessment to take place in early FY 2001.

As agreed to within Attachment 5 of the MOA, all structures that are not indicated as the Air Force's responsibility on the enclosed map and were identified as bridges in the 1997 Bridge Inspection will be inspected prior to December 1, 2000 or they will be closed. In addition, our cultural resources division may require an assessment of at least one bridge as it has been determined to meet conditions for inclusion in the National Register and may require special maintenance needs if we determine that we will upkeep this bridge in the future.

Table 1 gives a breakdown by category of all roads at Jefferson Proving Ground.

Table 1

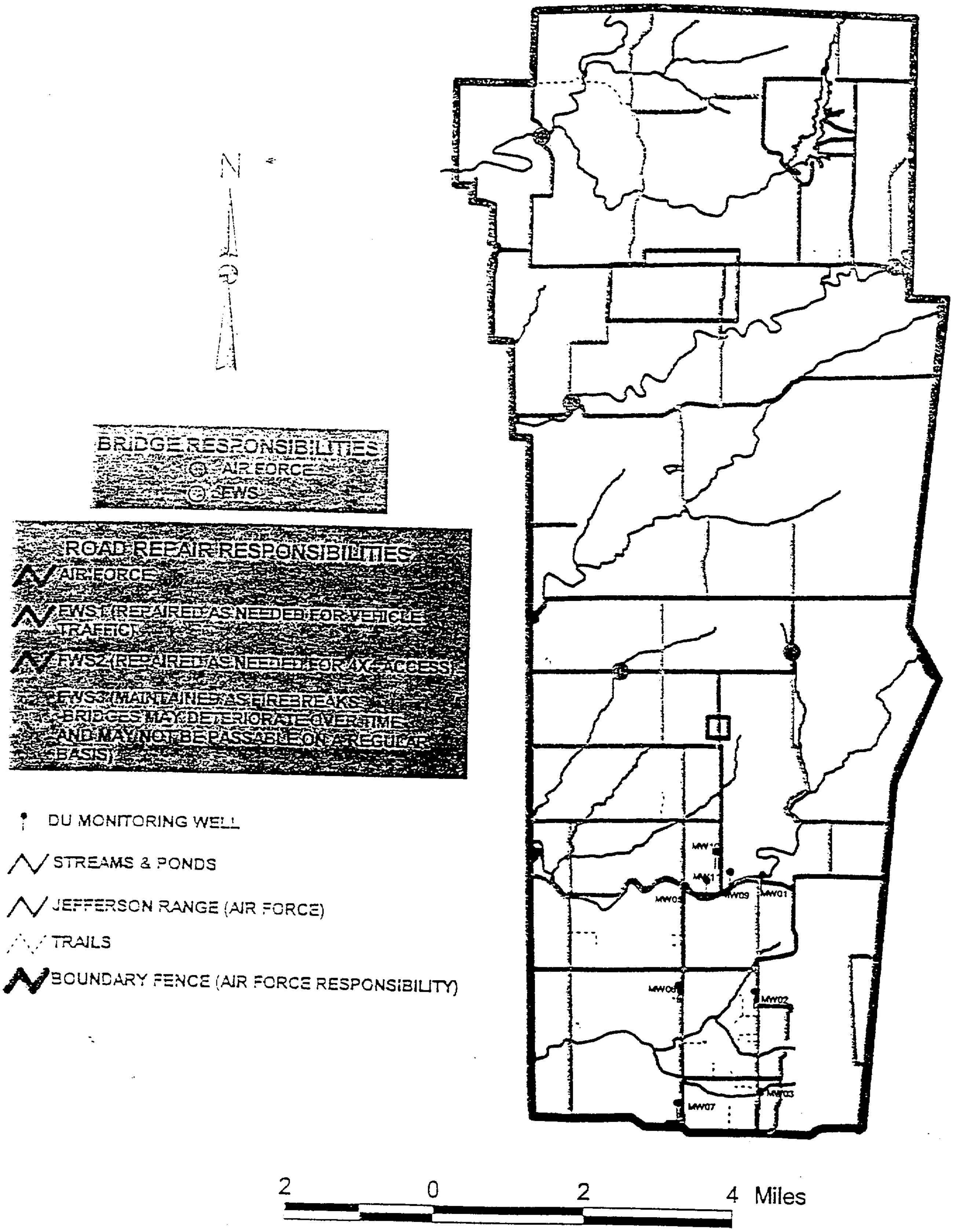
MAINTENANCE RESPONSIBILITY	MILES
Air Force	62
CLOSED	20
FWS (public)	9
FWS (4X4)	10
FWS (firebreaks)	47
TOTAL	148

We have indicated on the attached map those roads we will keep open in FY 2000 for Depleted Uranium monitoring well access. In addition, public access to areas north of K Road will be maintained as indicated for the FY 2000 period. An additional 47 miles of roads are needed for firebreaks and will be evaluated in the future for inclusion in our annual maintenance cycle for roads.

The Service cannot assume responsibility for any buildings this fiscal year. Our engineering division has stated that they will require a site assessment prior to assuming maintenance responsibilities. We expect this assessment to take place in early FY 2001 concurrent with the road and bridge assessment. In addition, our cultural resources division may require an assessment of any buildings along the firing line for which we plan to assume maintenance responsibilities. These buildings, while not eligible for inclusion in the National Register by themselves, are within a historic district and may require special maintenance considerations.

EXHIBIT D

ROAD MAINTENANCE



DEPARTMENT OF ARMY PERMIT TO DEPARTMENT OF THE AIR FORCE TO USE PROPERTY LOCATED ON JEFFERSON PROVING GROUND, MADISON, INDIANA

DEPARTMENT OF ARMY PERMIT TO DEPARTMENT OF THE AIR FORCE 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. Range Access Plan

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.

DEPARTMENT OF THE ARMY PERMIT TO DEPARTMENT OF THE AIR FORCE 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 Department of the Air Force, hereinafter referred to as the Grantee, a permit for the continued use of a Bombing Range at Jefferson Proving Ground (JPG), Indiana, over, across, in and upon the lands and structures 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 Grantee agrees to 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 Department of the Air Force, Director, Air Force Real Estate Agency, AFREA/DR, 112 Luke Avenue, Room 104, Bolling AFB, Washington, D.C. 20332-8020, 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 Bombing Range 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.

13. Access to and use of JPG shall be controlled in accordance with the Grantee's Jefferson Range Access Plan 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 may grant a license to the Indiana Air National Guard to exercise its rights to use the premises subject to the terms of this permit.

16. The Grantee is hereby informed and does acknowledge that all buildings on the property, 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 property.

17. The Grantee is hereby informed and does acknowledge that friable and non-friable asbestos or asbestos containing materials (ACM) has been found on the property. 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.

18. This permit supersedes Permit No. DACA27-4-83-03 dated 23 July 1982, as amended. Said Permit No. DACA27-4-83-03 is hereby terminated, effective the date of execution of this permit.

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 Nov 2000.

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

This permit is also executed by the Grantee this 22nd day of November 2000.

U.S. DEPARTMENT OF THE AIR FORCE

JIMMY G. DISHNER
Deputy Assistant Secretary of the Air Force
(Installations)

EXHIBIT A. SITE MAP

JEFFERSON PROVING GROUND
SITE MAP

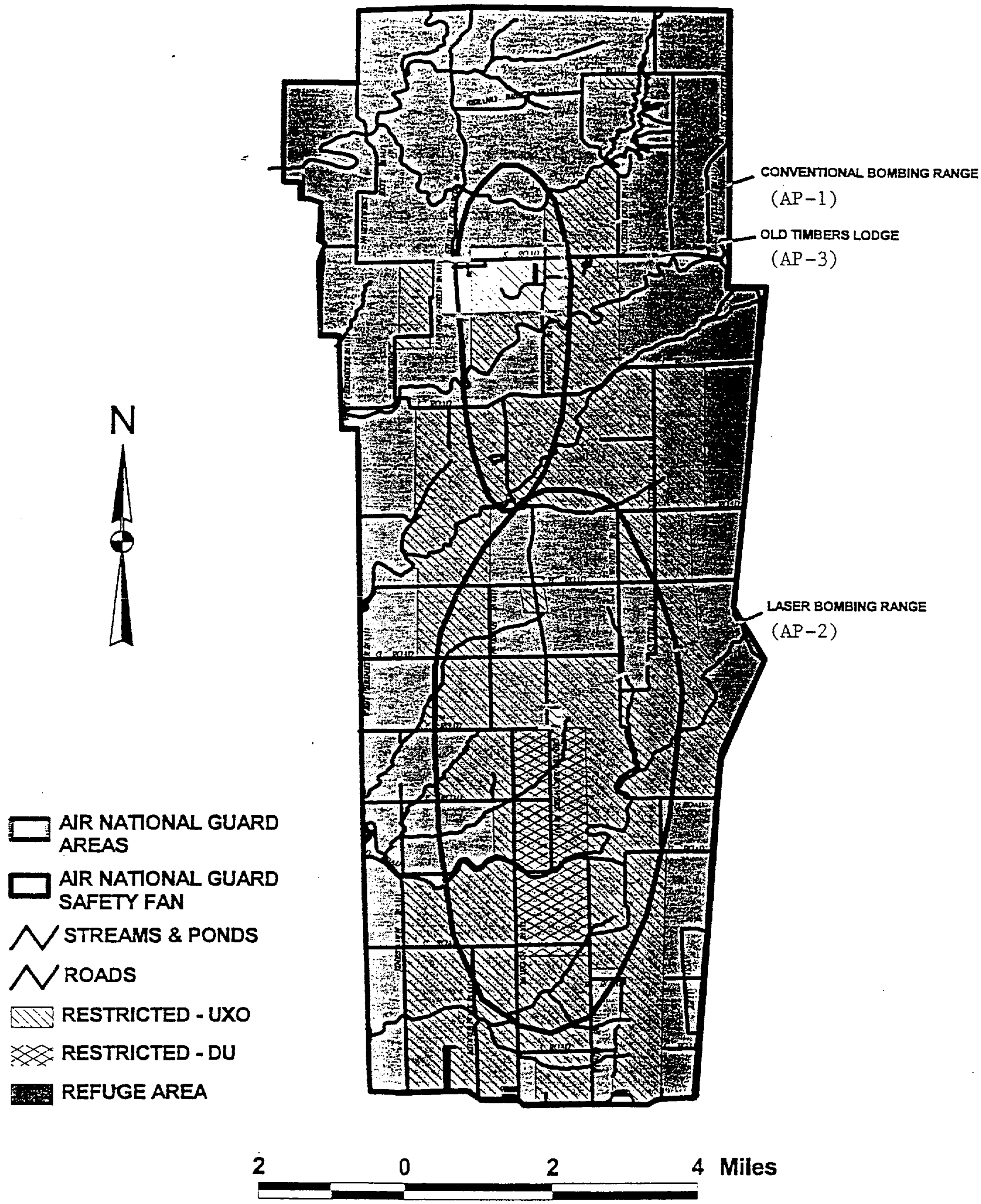


EXHIBIT A

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

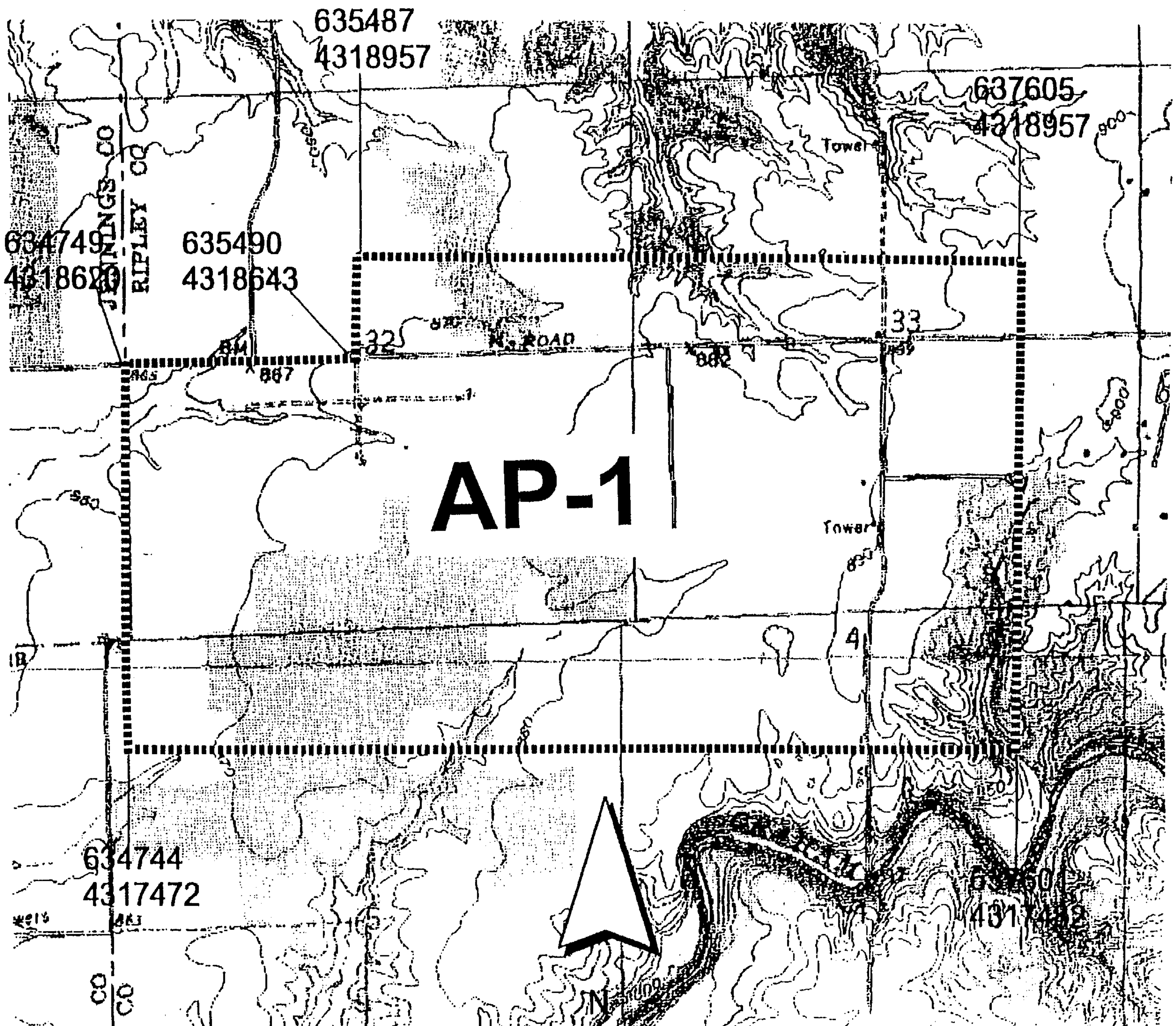
South 00 degrees 09 minutes 19 seconds West 1475.01 meters to a point having an approximate UTM value of FU637601E/4317482N; thence

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

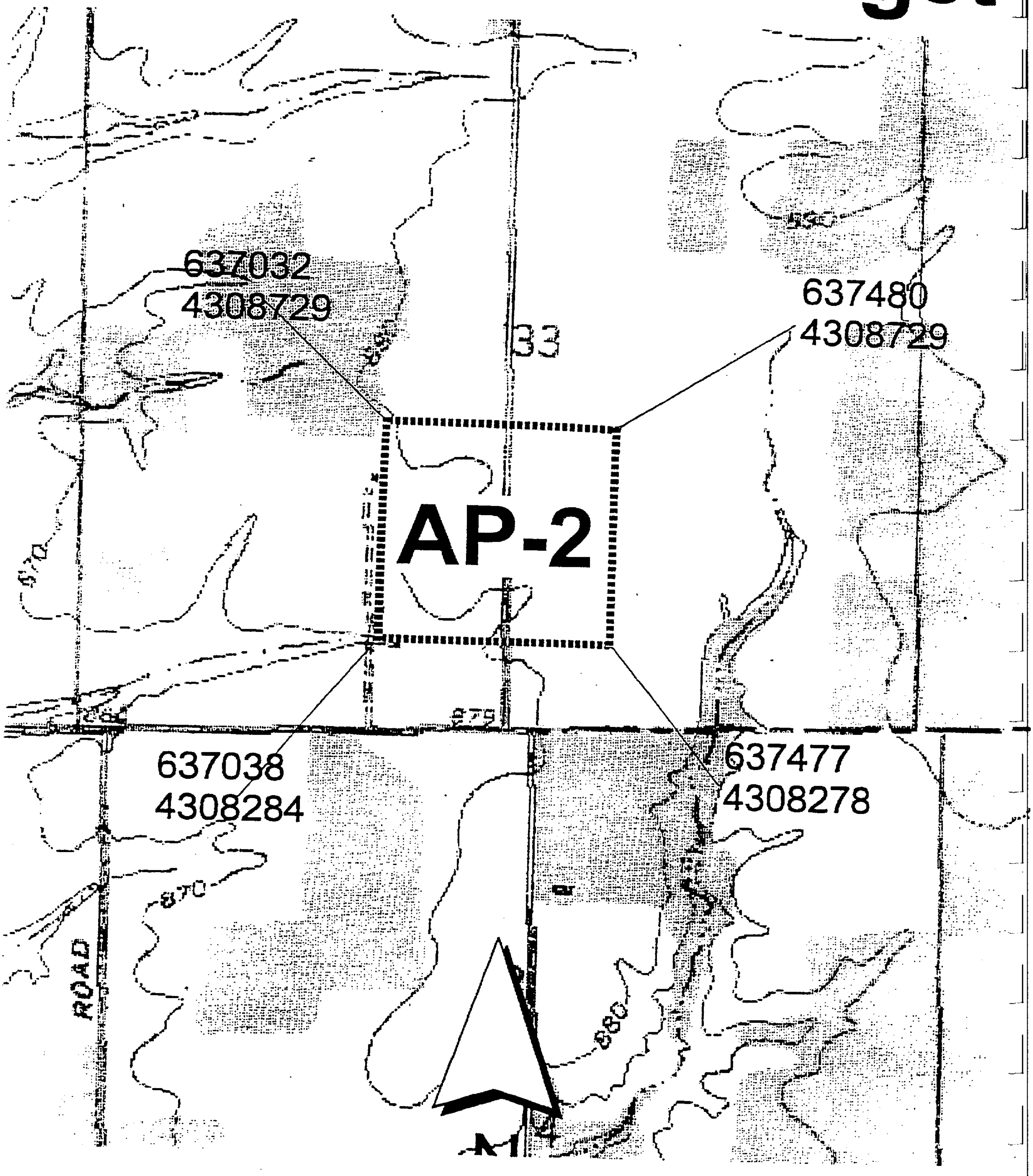
North 00 degrees 14 minutes 58 seconds East 1,148.01 meters to the point of beginning, containing 398.611 hectares (984.967 acres), more or less.

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

ANG Jefferson Range Area



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

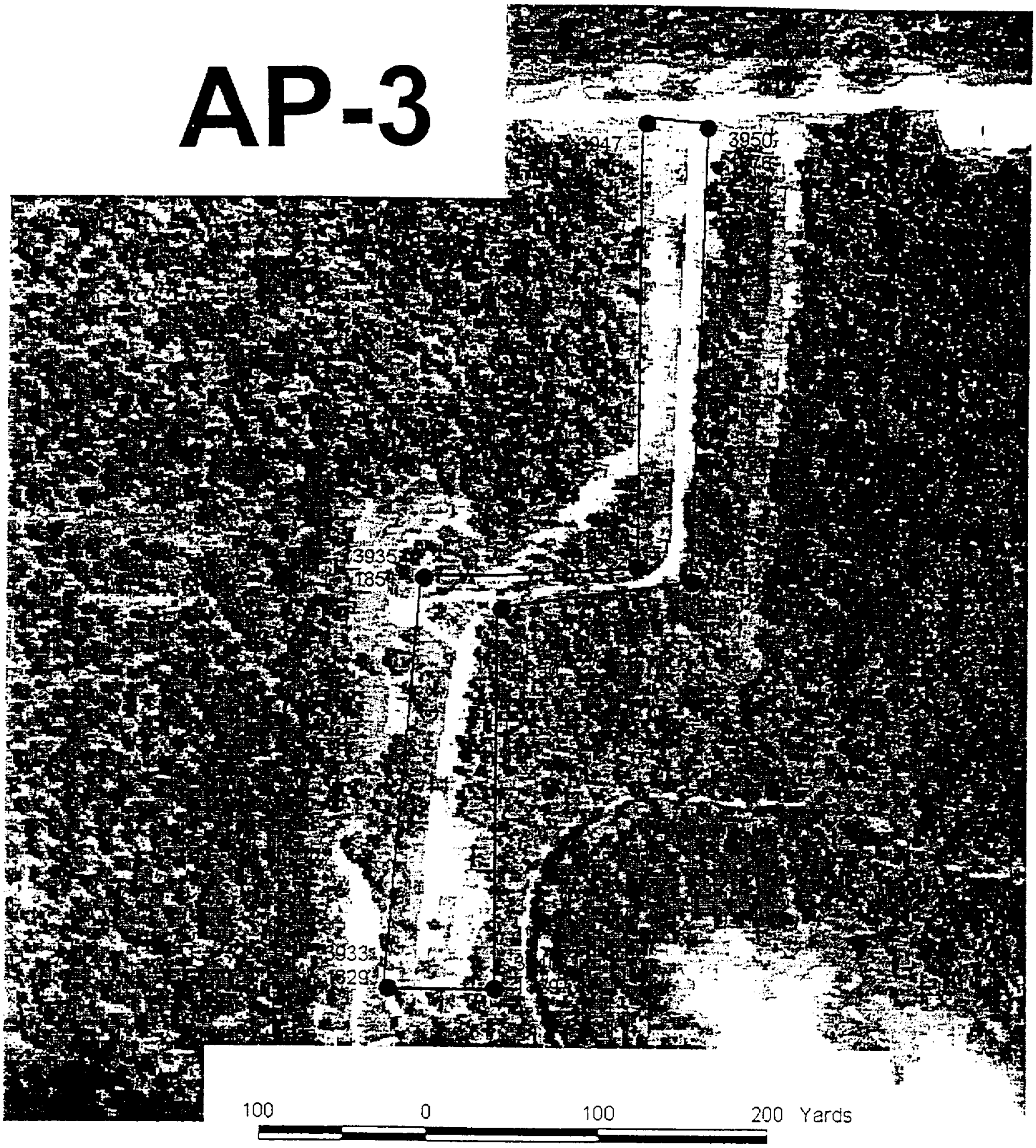
North 05 degrees 11 minutes 40 seconds East 220.9 meters to a point having an approximate UTM value of FU63935E/431851N; thence

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



The following list comprises the structures and/or buildings located at Jefferson Proving Ground, Indiana, for which the Air Force will retain responsibility:

Office Complex. Located on "K" Road. Constructed with concrete, flat tar roof, 12" thick walls. Formerly referred to as "M" building or No. 481.

Main Tower. Located on top of Office Complex. Approximately 45'tall and is 14' x 14'.

Flank Tower. Located on "K" Road. Approximately 50' tall and is 8' x 8'.

Maintenance Barn. Located next to Office Complex. Constructed of wood framing and sheet metal sides/roof with a concrete floor. An office is located in the southeast corner. The barn dimensions are 40' x 60' and the office is 12' x 15'.

Equipment Storage Barn. Located next to Office Complex. Constructed of wood framing and sheet metal sides/roof with a gravel floor. The dimensions are 40' x 100'.

Chemical Containment Building. Located next to Office Complex. Constructed of steel and bolted on a concrete pad. The dimensions are 8' x 8'.

Old Timbers Lodge. Located off "K" Road.

Stone Arch Bridges (4). Considered historically significant. Identifying numbers are 17, 25, 27 and 28.

Ammunition Storage Bunkers (2). Located on "K" Road between Main and Flank Towers. These bunkers are primarily used for storage.

Building No. 488. Located off Bombfield Road. Primarily used as a storage facility.

EXHIBIT B. MEMORANDUM OF AGREEMENT

JEFFERSON PROVING GROUND FIRING RANGE MEMORANDUM OF AGREEMENT (MOA)

This is a Memorandum of Agreement (MOA) among the Department of the Army (Army), the Department of Air Force (Air Force), and the Department of the Interior-United States Fish and Wildlife Service (FWS), all hereafter collectively referred to as the "parties".

I. BACKGROUND AND PURPOSE

1. As a result of the Base Closure and Realignment Act (BRAC) of 1988, the Army's mission at Jefferson Proving Ground (JPG) terminated in September 1995. The JPG property consists of about 55,000 acres located in southeastern Indiana. It is composed of an approximate 4000-acre cantonment area and an approximate 51,000-acre firing range area (Firing Range). The purpose of this MOA is to establish the framework for authorizing the future use of the Firing Range by the U.S. Fish and Wildlife Service (FWS) and continued use by the Air Force. The cantonment area of JPG is being transferred under the BRAC process and is outside the scope of this agreement.

2. Due to unexploded ordnance (UXO), depleted uranium (DU) and other environmental contamination from past Army activities, the Firing Range area is not suitable for commercial or residential development. Despite the UXO and DU contamination, the Firing Range provides wildlife habitat of regional and national significance. In addition, portions of the Firing Range are being used by the Air Force as a bombing range (Bombing Range). The Bombing Range consists of an approximate 983-acre conventional bombing range and an approximate 50-acre laser bombing range, as well as large safety fans, when in use, for each range and associated air space (see map at Enclosure 1). These safety fans overlay significant portions of the Firing Range and are off limits to unauthorized personnel during flight operations involving training munitions or laser energy. The Air Force Bombing Range activities involve training munitions (i.e. an inert munition with a spotting charge) and laser energy, which have had no known significant adverse impact on the wildlife at the Firing Range. As a result of the unique property conditions associated with the Firing Range, the FWS is interested in establishing a National Wildlife

EXHIBIT B

Refuge (Refuge) to preserve significant wildlife habitat values, and the Air Force requires continued use of the Bombing Range as a mission-essential training facility.

3. In order to support the establishment of the Refuge and the continued use of the Bombing Range, the Army agrees to the following:

a. The Army will grant the FWS a real estate permit for the entire Firing Range except for the Bombing Range and the Old Timbers Lodge and associated acreage (See Enclosure 2).

b. The Army will grant the Air Force a real estate permit for the Bombing Range and the Old Timbers Lodge and associated acreage (See Enclosure 3).

The FWS and the Air Force real estate permits will be subject to the terms and conditions set forth in this MOA.

4. The restoration requirements of this MOA and the permits issued under it are authorized by 10 U.S.C. § 2691.

II. OVER-ARCHING PRINCIPLES

The parties recognize the importance of having periodic meetings/conference calls, at least quarterly, among the Jefferson Proving Ground Commander, the Refuge Manager, and the Bombing Range Commander. The relationships between the parties will be governed by the following overarching principles:

1. The Army will consult and coordinate with the other parties to ensure that all Army activities (e.g., remediation activities, UXO demonstration projects, or other future activities) are consistent with Refuge and Bombing Range activities.

2. The FWS will consult and coordinate with the other parties to ensure that all Refuge activities (e.g., development of the interim public access plan, the comprehensive public access plan, the Comprehensive Conservation Plan, any modifications to a public access plan, reviews of requests to conduct non-FWS activities, refuge management activities, etc.) are consistent with Army and Bombing Range activities. The FWS specifically agrees that Refuge activities will be consistent with existing environmental conditions and will not otherwise increase the Army's environmental remediation costs.

3. The Air Force will consult and coordinate with the other parties to ensure that all Bombing Range activities (e.g., development of the site access plan (including any modifications to the site access plan), reviews of requests to conduct non-Air Force activities, training operations, etc.) are consistent with Army and FWS activities. The Air Force specifically agrees that Bombing Range activities will be consistent with existing environmental conditions and will not increase the Army's environmental remediation costs.

4. Except as otherwise provided in this MOA, all disputes between the parties relating to the terms and conditions of this MOA will be subject to the dispute resolution procedure set forth in Section VI.

III. ARMY RESPONSIBILITIES

1. Environmental Remediation.

a. The Army will provide the FWS and Air Force with baseline information concerning the environmental condition of the Firing Range utilizing such reports as The Final Study Cleanup and Reuse Options (Mason and Hanger Report 1992), the Environmental Sampling Plan for the Open Detonation Unit (1994), The Resource Conservation and Recovery Act Facility Assessment (1992), The Community Environmental Response Facilitation Act Report (1994), The Depleted Uranium Decommissioning Plan (Draft 1999), The Archives Search Report for Ordnance and Explosive Waste Chemical Warfare Materials (1995) and the Environmental Impact Statement for Disposal and Reuse (1995).

b. The Army will retain all authority, responsibility, and liability for remediation of all contamination resulting from past Army activities or present on the Firing Range on the date of this MOA, including UXO, DU, and other contamination. In addition, the Army is responsible for all remediation resulting from present and future site activities as set forth in paragraph III(3). Except as otherwise provided in this MOA, the FWS and Air Force shall not have authority, responsibility, or liability for remediation of UXO, DU, and other contamination (see paragraphs IV(3)(a) and (b), V(6))(a) and (b), and V(8)(b)). The Army shall not be responsible for any environmental requirements resulting from operation of the Refuge or the Bombing Range.

c. For purposes of the regulation proposed as 32 CFR 178, *Closed, Transferred, and Transferring Ranges Containing Military Munitions* (Range Rule), should it become a final rule, and any Department of Defense (DoD) Directive or Instruction relating to closed, transferred, or transferring ranges, to the extent any of them apply to the Firing Range, the Army will remain the "responsible DoD component". Unless otherwise required by the Range Rule or DoD Directive or Instruction, the designation of the Army as the "responsible DoD component" will not alter the parties' liabilities under this MOA.

d. The Army is pursuing a license termination under restricted release conditions for the current license issued by the U.S. Nuclear Regulatory Agency (NRC) for its possession of DU for decommissioning at the Firing Range. This license indicates the licensed material (*i.e.*, DU) is onsite in the area known as the "DU Impact Area", located in the southern portion of the Firing Range. The parties recognize the Army will be solely responsible for finalizing the NRC license termination and conducting any actions required by the License Termination Plan at the Firing Range.

2. UXO.

a. UXO Training Materials. The Army will provide training materials and initial UXO and DU safety training for FWS and Air Force personnel. The training materials will include general information regarding the types of munitions used at the Firing Range but are not intended to be an exhaustive/all inclusive listing. After the training, and based on training materials provided by the Army, the FWS and Air Force will be responsible for providing UXO and DU safety training to all of their respective personnel and visitors based on such training materials and knowledge of the FWS and the Air Force of local site conditions.

b. Emergency UXO Removal. If the FWS or Air Force discovers UXO which poses an imminent and substantial hazard to Refuge or Bombing Range operations (e.g., UXO has migrated to the surface of a roadway), the FWS or Air Force will immediately restrict access to the UXO site and notify the Army. The Army will provide for timely removal of UXO found which it determines to be an imminent and substantial hazard to Refuge or Bombing Range operations. The Army will not be required to remove UXO it determines does not pose an imminent and substantial hazard to Refuge or Bombing Range operations (See Enclosure 4 - UXO Response Standing Operating Procedures [SOP]).

c. Non-Emergency UXO Removal. The FWS and Air Force accept that there is no Army plan or budget authority to remove UXO in the Firing Range. However, the Army will make a good faith effort to request non-emergency UXO removal in connection with Army Reserve and/or Army National Guard training exercises to support Refuge or Bombing Range operations. Any type of non-emergency UXO removal in the Firing Range will be subject to the License Termination Plan as approved by the NRC. The FWS and Air Force recognize that any such Army support is contingent on the availability and timing of Army Reserve or Army National Guard exercises. To obtain Army non-emergency UXO removal support, the FWS and Air Force will follow these procedures:

(1) FWS Non-Emergency UXO Removal Support. The FWS will request non-emergency UXO removal support from the Army. To facilitate the support process, the FWS will incorporate building designs that minimize ground disturbance and will provide the Army a minimum 2-year advance notice of their request to complete non-emergency UXO removal. The Army will make a good faith effort to request UXO removal in connection with Army Reserve and/or Army National Guard Training exercises to support Refuge operations. If the Army is not able to obtain non-emergency UXO removal support as part of a training exercise, the FWS agrees to withdraw its request and terminate any plans/operations requiring non-emergency UXO support.

(2) Air Force Non-Emergency UXO Removal Support. The Air Force may request non-emergency UXO removal support from the Army in accordance with paragraph III 2. c. above or it may conduct its own non-emergency UXO removals. Any Air Force non-emergency UXO removals must be conducted by properly certified personnel and in accordance with Department of Defense Explosive Safety Board (DDESB) and all other applicable requirements. If the Air Force elects to conduct its own non-emergency UXO

removal action, the Army and FWS will have no responsibility for any costs resulting from the UXO removal action.

3. **Future Site Activity.**

The Army is specifically authorized to conduct the following activities on the Firing Range:

a. Army Environmental Restoration Activities. The Army is authorized to conduct environmental restoration and remediation activities to the extent required by law. For purposes of this MOA, environmental restoration and remediation include NRC license termination activities. The Army assumes no liability should its restoration and remediation activities interfere with FWS or Air Force operations.

b. UXO Removal Technology Demonstration Projects. The Army reserves the right to authorize UXO Removal Technology Demonstration Projects and other similar UXO related projects on the Firing Range.

c. Property Administration. The Army reserves the right to enter the property to conduct property administration activities (e.g., site inspections, etc.).

Any Army proposals to conduct other activities on the Refuge or Bombing Range will be processed in accordance with the terms and conditions of this MOA (see paragraph IV(4) or paragraph V(4)).

4. **Future Property Transfer.**

The Army will not transfer fee title or other property interests in the Firing Range without consulting with the FWS and Air Force. If in the future the Firing Range is determined suitable for transfer, the Army shall, to the extent legally authorized, provide the FWS and Air Force the right of first refusal on their respective property interests before conveying any property interests. If the Air Force no longer requires use of the Bombing Range and the property is no longer needed for other military purposes, the Army will offer the FWS a real estate permit for the Bombing Range subject to the same terms of this agreement or any other mutually agreeable terms.

5. **Tort Claims.**

The Army will be responsible for accepting and processing any tort claims for incidents arising out of UXO, DU, or any other conditions related to the Army's past, present, or future use of the Firing Range. The FWS and Air Force will cooperate in providing information relating to any such tort claims. Any liability on the part of parties will be determined in accordance with the Federal Torts Claim Act and other applicable laws.

IV. FWS RESPONSIBILITIES

1. National Wildlife Refuge.

a. The Refuge will be called Big Oaks National Wildlife Refuge. It will be managed as a unit of the National Wildlife Refuge System in accordance with the National Wildlife Refuge Administration Act of 1966 as amended (16 U.S.C. 668 et. seq.) and other applicable laws, regulations, and policies. Following the issuance of the real estate permit, the FWS will be responsible for all natural resource management decisions on the Refuge. As the Refuge includes the DU Impact Area, management of the Refuge will be subject to the License Termination Plan as approved by the NRC.

b. The FWS will develop a Comprehensive Conservation Plan (CCP) outlining its management plan for the Refuge. The CCP will provide natural resource management at a level typical of units of the National Wildlife Refuge System.

c. The FWS will conduct any National Environmental Policy Act (NEPA) analysis required to support establishment of the Refuge.

d. The FWS will be responsible for infrastructure maintenance and repairs as outlined in Enclosure 5 (FWS/Air Force Infrastructure Maintenance Responsibilities).

2. Site Security.

a. The FWS will be responsible for providing UXO, DU and environmental contamination Safety/Awareness Training to all Refuge personnel and visitors (see paragraph III.2.a. above). The FWS will develop an interim public access plan prior to the Army executing a real estate permit. After the interim public access plan, the FWS will develop a comprehensive public access plan that identifies appropriate public uses of the property and ensures that all visitors are provided UXO, DU and environmental contamination Safety/Awareness Training. The public access plan will include: (a) types of public use, (b) UXO, DU and environmental contamination Safety Training protocols (e.g., training materials, training rosters, and waivers), and (c) annual public use reporting requirements. The interim public access plan and the comprehensive public access plan and any revisions will be subject to Army approval.

b. The FWS will provide staffing at a level consistent with the safe operation of the Refuge. With the expectation of limited or no UXO cleanup in the future, public use levels will be low and may be limited to hunting, gathering, fishing, and guided tours as determined by the interim or comprehensive public access plan. All visitors will be escorted or receive a safety briefing on the hazards found on the property. If the FWS fails to maintain adequate public access control, the Army reserves the right to suspend the FWS's right of access to the Firing Range until such time as the FWS takes appropriate corrective action.

3. Environmental Remediation.

a. The FWS shall not be responsible for any environmental requirements related to the Army's past, present, or future activities at the Firing Range or the Air Force activities at the Bombing Range. However, the FWS will be responsible for all environmental compliance and remediation requirements resulting from operation of the Refuge.

b. The FWS shall not be responsible for remediation of UXO, DU, and other environmental contamination related to past, present, or future Army activities, or present on the Firing Range on the date of this MOA, or resulting from Air Force Bombing Range activities. If a FWS Refuge activity will result in increased remediation costs for the Army (e.g. UXO removal, fencing, or site remediation), the FWS shall terminate the activity.

c. The FWS will not undertake any Refuge activities that interfere with the Army environmental remediation program at the Firing Range.

4. Other Activities on the Refuge.

The FWS will be responsible for reviewing all requests to conduct non-FWS activities on the Refuge (i.e. requests from other organizations to conduct activities not otherwise authorized by the CCP), not otherwise allowed by this MOA. All requests for non-FWS activities on the Refuge will be reviewed in accordance with the National Wildlife Refuge Administration Act and other applicable laws, regulations, or policies. The interim or comprehensive public access plan will be revised as necessary to ensure that any approved non-FWS operations on the Refuge are conducted in a safe manner.

5. Tort Claims.

The FWS will be responsible for accepting and processing any tort claims for incidents arising out of its operation of the Refuge. The Army and Air Force will cooperate in providing information relating to any such tort claims. Any liability on the part of the parties will be determined in accordance with the Federal Torts Claim Act and other applicable laws.

V. AIR FORCE RESPONSIBILITIES

1. Air Force Bombing Range.

a. The Air Force will operate a Bombing Range which includes an approximate 50-acre laser bombing range, an approximate 983-acre conventional bombing range, and the Old Timbers Lodge with associated acreage of approximately 5 acres, which shall be excluded from the real estate permit for the Refuge. The bombing ranges, when in use, will have large safety fans that will be off limits for FWS personnel and visitors during flight operations involving training munitions or laser energy. While the safety fans overlay significant portions of the Firing Range, their land area is included in the real estate permit for the Refuge. As the laser bombing range safety fan includes the DU Impact Area, management of the Bombing Range will be subject to the License Termination Plan as approved by the NRC. The Air Force will comply with Air Force Instruction 13-212, Test and Training Ranges, concerning range maintenance, ammunition. explosives, and dangerous articles (AEDA), and range residue cleanup/decontamination on the Bombing Range.

b. The Air Force will conduct any NEPA analysis required to support operation of the Bombing Range.

c. The Air Force will take the following actions to ensure that its operation of the Bombing Range is not inconsistent with the establishment of the Refuge:

(1) The Air Force will limit its total annual bombing sorties to 3000 sorties per year (including non- Air Force sorties). The Air Force is authorized to conduct 4000 sorties in any one-year period provided the additional sorties are conducted in accordance with applicable laws and regulations. The Air Force may only exceed the 3000 sorties per year cap once every three years. Any increase in sorties above these levels will be negotiated in good faith by the parties.

(2) The Air Force will provide wildfire suppression support on the Refuge for situations arising from Air Force actions or activities, as to be determined by the Bombing Range Commander and the FWS Refuge Manager.

2. Perimeter Fence/Road and Warning Signs.

a. The Air Force will be responsible for patrolling and maintaining the perimeter fence and related infrastructure to ensure the overall security of the Firing Range. The perimeter fence infrastructure includes warning signs, the road system associated with the perimeter fence, and mowing the perimeter fence area. The Army and FWS staff will report to the Air Force in a timely manner any damage to the perimeter fence that they observe in the course of performing their respective activities on the Firing Range.

b. The Air Force will maintain warning signs around the entire perimeter, the submunitions area west of Machine Gun Road, the DU area and the former Open Detonation area. If additional fencing, cleanup, or site security improvements are required due to past, present, or future Army activities, the Army will be responsible for the additional requirement. The Air Force agrees to negotiate in good faith regarding appropriate arrangements to assist the Army in meeting the new requirements.

3. Maintenance of Firing Range Infrastructure.

The FWS/Air Force infrastructure maintenance responsibilities are provided in Enclosure 5. The properties permitted to the Air Force (i.e., the Old Timbers Lodge and the four stone arch bridges) shall be preserved in accordance with the Jefferson Proving Ground Cultural Resource Management Plan dated August 1996. The Army and Air Force will prepare an Interservice Support Agreement to cover the Army's historic preservation responsibilities for the Oakdale School House. If other infrastructure maintenance requirements are subsequently identified, the Air Force agrees to negotiate in good faith regarding appropriate arrangements to assist the Army in meeting the new requirements.

4. Other Bombing Range Activities.

The Air Force will be responsible for reviewing all requests to conduct non-Air Force operations (including Army and FWS requests) on the Bombing Range. All requests for non-Air Force operations on the Bombing Range will be reviewed in accordance with the provisions of Air Force Instruction 13-212 and the License Termination Plan as approved by the NRC. The comprehensive site access plan will be revised as necessary to ensure that any approved non-Air Force operations on the Bombing Range are conducted in a safe manner.

5. Site Security.

a. The Air Force will be responsible for providing UXO, DU and environmental contamination Safety/Awareness Training to all Bombing Range personnel and visitors. Prior to the Army executing a new real estate permit, the Air Force will develop a comprehensive site access plan that includes: (a) types of official use, (b) UXO, DU and environmental contamination Safety Training protocols (e.g., training materials, training rosters, and waivers), and (c) annual official use reporting requirements. The comprehensive site access plan and any revisions will be subject to Army approval.

b. The Air Force will provide staffing at a level consistent with the safe operation of the Bombing Range. It is anticipated that the Air Force access will consist primarily of Bombing Range personnel, support personnel, and official visitors. If the Air Force fails to maintain adequate access control, the Army reserves the right to suspend Air Force's right of access to the Firing Range until such time as the Air Force takes appropriate corrective action.

6. Environmental Remediation.

a. The Air Force shall not be responsible for any environmental requirements related to the Army's past, present, or future activities at the Firing Range or the FWS activities at the Refuge. However, the Air Force will be responsible for all environmental compliance and remediation requirements resulting from its operation of the Bombing Range.

b. The Air Force shall not be responsible for remediation of UXO, DU, and other environmental contamination related to past, present, or future Army activities, or present on the Firing Range on the date of this MOA (except as provided in paragraph V.8.b. below), or resulting from FWS Refuge activities. If an Air Force Bombing Range activity will result in increased environmental remediation costs for the Army (e.g. UXO removal, fencing, or site remediation), the Air Force will be solely responsible for these increased costs or shall terminate the activity.

c. The Air Force will not conduct any Bombing Range activities that interfere with Army environmental remediation activities at the Firing Range.

7. Tort Claims.

The Air Force will be responsible for accepting and processing any tort claims for incidents arising out of its operation of the Bombing Range. The Army and FWS will cooperate in providing information relating to any such tort claims. Any liability on the part of the parties will be determined in accordance with the Federal Torts Claim Act and other applicable laws.

8. Existing Permit to the Air Force

a. Pending issuance of the new real estate permit (Enclosure 3), the existing permit between the Department of the Army and the Department of the Air Force, DACA 27-4-83-03, dated 23 July 1982, to use property on JPG will continue in effect without change. Upon the effective date of the new permit, the existing permit will terminate.

b. Nothing in this MOA will be construed to affect any liability or responsibility of the Air Force or Army established by the existing permit between the Department of the Army and the Department of the Air Force, DACA 27-4-83-03, dated 23 July 1982, or any prior permits between the Air Force and Army relating to the Firing Range.

9. Licensing to Indiana Air National Guard

The Air Force may grant a license to the Indiana Air National Guard to assume its rights and responsibilities under the real estate permit. Any such license may include and apply all the responsibilities of the Air Force under this MOA and the permit to the Indiana Air National Guard, excluding only the authority to amend this MOA or the real estate permit.

VI. DISPUTE RESOLUTION PROCEDURE

1. Except as otherwise provided in this MOA, all disputes between the parties relating to the terms and conditions of this MOA will be subject to the following dispute resolution procedures:

a. Informal - All parties to this agreement shall make reasonable efforts to informally resolve disputes at the Installation Commander, the Bombing Range Commander, and the Refuge Manager Level. If the parties can not resolve a dispute informally, any party may invoke dispute resolution procedures by requesting a Level I meeting. The request to invoke dispute resolution shall include a written summary of the dispute, the party's position, and any other information necessary to the resolution of the dispute. In the event that a dispute involves a matter of national significance, the parties may mutually agree to elevate the dispute directly to the Level II dispute resolution process.

b. Level I - The Level I dispute resolution shall consist of a meeting/conference call among the Army Materiel Command (AMC) Point of Contact (POC), the FWS's Regional Office POC, and Air National Guard Readiness Center POC. Any agreed resolution shall be in writing and signed by all the parties. If agreement cannot be reached within 30 days, AMC shall state its position in writing and provide it to the other parties. Within 30 days of receipt of the AMC statement of position, the other parties may submit a written notice to AMC elevating this matter to Level II for resolution. If the matter is not elevated to Level II dispute resolution within 30 days, the other parties will be deemed to have agreed with the AMC statement of position.

c. Level II - The Level II dispute resolution shall consist of a meeting/conference among the Department of the Army (DA), HQ FWS POC, and HQ Air Force POC. The agreed resolution shall be in writing and signed by all the parties.

2. No resolution of a dispute under this provision shall result in a change to the MOA or to any permit issued pursuant to it unless the modification is executed in accordance with paragraph VIII below or the terms of the permit.

VII. FUNDING

Unless otherwise agreed, all parties will be solely responsible for funding their respective responsibilities under this Memorandum of Agreement. Nothing in this agreement shall be interpreted to require obligation or payment of funds in violation of the Anti-Deficiency Act. 31 U.S.C. Section 1341.

VIII. EFFECTIVE DATE, MODIFICATION, AND TERMINATION

1. This agreement may be executed in multiple copies, each of which shall be considered an original document. This agreement shall take effect upon the date last executed by the parties. and shall remain in effect for 25 (twenty five) years. This agreement may be renewed for additional 10 (ten) year periods upon mutual agreement.

2. Modifications to this agreement may be submitted in writing by any party at any time and shall become effective upon the written acceptance of all the parties. Such modifications must be signed by the signatories hereto or their successors in office.

3. This agreement may be terminated by any party by providing a written 180 (one hundred eighty) day notice to the other parties. A decision to terminate this agreement is not subject to the dispute resolution provision of this MOA. In the event of termination, any Air Force and FWS built improvements will be disposed of following applicable disposal regulations.

IX. ENTIRE AGREEMENT

It is expressly understood and agreed that this written instrument and its enclosures when executed embody the entire agreement among the parties regarding the use of the Firing Range, and there are no understandings or agreements, verbal or otherwise, among the parties except as expressly set forth herein.

APPROVED BY:

PAUL W. JOHNSON
Deputy Assistant Secretary of the Army
(Installations and Housing)

Date 12 MAY 2000

JAMIE RAPPAPORT CLARK
Director
U.S. Fish and Wildlife Service

Date 5/15/00

JIMMY G. DISHNER
Deputy Assistant Secretary
Of the Air Force (Installations)

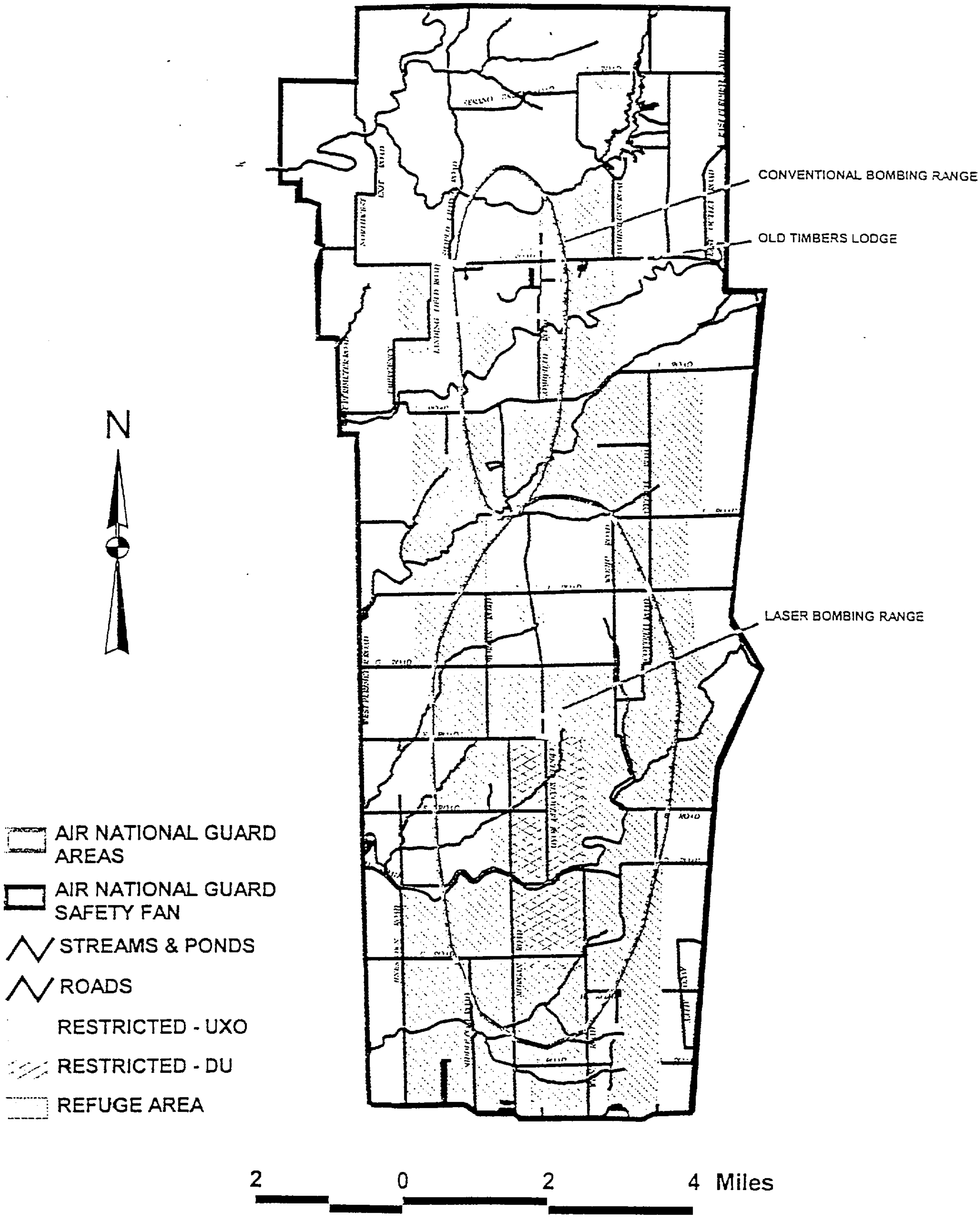
Date 5/11/2000

Enclosures

1. Site Map
2. FWS Real Estate Permit
3. Air Force Real Estate Permit
4. UXO Response Standing Operating Procedures
5. FWS/Air Force Infrastructure Maintenance Responsibilities

Enclosure 1. Site Map

JEFFERSON PROVING GROUND
SITE MAP



Enclosure 1

Enclosure 2. Department of Army Permit to FWS to Use Property Located on JPG

ENCLOSURE 2

NO.________________

DEPARTMENT OF THE ARMY

PERMIT TO FISH AND WILDLIFE SERVICE

TO USE PROPERTY LOCATED ON JEFFERSON PROVING GROUND

THE SECRETARY OF THE ARMY, hereinafter referred to as the Secretary hereby grants to the United States Fish and Wildlife Service, hereinafter referred to as the grantee, a permit for the establishment of a National Wildlife Refuge at the Jefferson Proving Ground (JPG), 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, 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 180 days written notice.

2. The consideration given by the grantee is the management of the Property as a National Wildlife Refuge as well as the care and maintenance of the property as specified in the Memorandum of Agreement (MOA) attached hereto and made part of hereof..

3. All correspondence and notices to be given pursuant to this permit shall be addressed, if to the grantee , to ________________________, and if to the Secretary, to the District Engineer, Louisville District, ________________________ with a copy furnished to the JPG Commander, ________________________, or as may from time to time otherwise be directed by the parties. Notice shall be deemed to have been duly given if 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, attached hereto and made apart hereof. 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 JPG commander.

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 JPG commander, 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 Site Access Plan that is attached hereto and is made apart hereof. The Army must first approve any variation from this Plan and a revised Site Access Plan shall be made 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. NOTICE OF THE PRESENCE OF LEAD BASED PAINT AND COVENANT AGAINST THE USE OF THE PROPERTY FOR RESIDENTIAL PURPOSES.

The grantee is hereby informed and does acknowledge that all buildings on the Property, 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 Property 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 property.

16. NOTICE OF THE PRESENCE OF ASBESTOS AND COVENANT:

The grantee is hereby informed and does acknowledge that friable and non-friable asbestos or asbestos containing materials (ACM) has been found on the Property. 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 the 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 property 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 property.

17. Prior to the start date of this Permit the grantee will provide a map with clear identification of the buildings it shall occupy. This map will be updated 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 ____________ day of __________, ____________.

____

This permit is also executed by the grantee this ________________
day of ______________, __________.

____

Interim Public Access Plan for the Proposed Big Oaks National Wildlife Refuge

Prepared by:
U. S. Fish and Wildlife Service

Lee Herzberger
Refuge Manager
Muscatatuck National Wildlife Refuge

Reviewed by:
Air National Guard

20 Apr 00

Maj. William Nolen
Commander
Jefferson Range

Approved by:
U. S. Army

Maj. Mark A. Welch
Commander
Jefferson Proving Ground

Introduction

Approximately 50,000 acres of the decommissioned military base known as Jefferson Proving Ground (JPG) is proposed for inclusion into the National Wildlife Refuge (NWR) System via a Memorandum of Agreement (MOA) with the U.S. Army (Army). The area will become Big Oaks NWR. The primary purposes for this overlay NWR are derived from 2 specific acts:

1) The Fish and Wildlife Act of 1956 [16 USC 742a-742j] as amended authorizes the Secretary of the Interior to acquire interests in property "...for the development, advancement, management, conservation, and protection of fish and wildlife resources..."

2) The Endangered Species Act authorizes the Secretary of Interior to acquire interests in lands "to conserve fish, wildlife, and plants, including those which are listed as endangered or threatened..." [16 USC 1534].

The mission of Big Oaks NWR derives from these two purposes and is "to preserve, conserve, and restore biodiversity and biological integrity for the benefit of present and future generations of Americans." There is also a potential for limited public use in areas designated for such activities. This Interim Public Access Plan (Plan) was developed to allow the Army to review and approve safety procedures prior to public use occurring on Big Oaks NWR. This Plan is in accordance with the terms and conditions of the MOA between the U. S. Fish and Wildlife Service (FWS), Army, and Air Force (AF), and in the event of a conflict between the MOA and this agreement, the MOA shall be the controlling document.

Much of the proposed Big Oaks NWR contains unexploded ordnance (UXO), depleted uranium (DU), and other contaminants. The existence of these contaminants causes safety, management and funding concerns specific to Big Oaks NWR. The FWS accepts that there is no Army plan or budget authority to remove UXO in the Firing Range. However, the Army has agreed to make a good faith effort to request UXO removal in connection with Army Reserve and/or Army National Guard training exercises to support refuge operations. To facilitate the support process, the FWS will incorporate building designs that minimize ground disturbance and will provide the Army a minimum 2-year advance notice of their request to complete UXO removal. If the Army is not able to obtain UXO removal support as part of a training exercise, the FWS agrees to withdraw its request and terminate any plans/operations requiring non-emergency UXO support.

In the central portion of JPG is an active 1,033-acre AF training area known as Jefferson Range. Jefferson Range is composed of a 983-acre air-to-ground bombing and strafing range and a 50-acre Precision Guided Munitions (PGM) range. Both the 983-acre range and the 50-acre range have associated safety fans that extend over a portion of the area proposed as Big Oaks NWR (Fig. 1). A composite footprint of approximately 5,100 acres supports the primary target area and a composite footprint of approximately 14,860 acres supports the PGM target area. During flight operations no personnel other than AF personnel will be allowed access inside the weapons footprints. The use of both footprints will be coordinated with the Refuge Manager through monthly scheduling or as necessary to meet mission requirements. When not in use, FWS personnel will have access to the safety footprints. Safety fans and other closed areas will be barricaded as a precaution. The scheduling of public use on Big Oaks NWR that may conflict with AF activities will be coordinated through periodic meetings between the Refuge Manager and the AF Range Commander designed to eliminate conflicts and ensure safety.

In the event of an aircraft accident, the Jefferson Range Control Officer (RCO) will be the on-scene commander in charge until relieved by the appropriate military authority. Fire and medical support will be directed to the perimeter gate most advantageous to the crash site. Due to the dangers posed by military aircraft, no persons will be allowed access to a crash site until deemed appropriate by the on-scene official. The Jefferson Range Access Plan protocols concerning aircraft accidents will be adhered to by the FWS, and the Refuge Manager will coordinate and cooperatively work with the Jefferson RCO or other on-scene commander.

Safety Briefing Protocols

To ensure visitor safety, the Army will provide safety briefing materials that contain basic information on site history, the hazards of UXO, and the appropriate action when UXO or DU is encountered. The FWS will require all staff and visitors to undergo a safety briefing and will provide safety pamphlets containing this information and a map of Big Oaks NWR. FWS will also brief visitors on other hazards based on local site conditions. All Public Access Permits will be tracked by a permit number. An annual database will be maintained that records individual permit information (e.g., name, address, date of birth, date of safety briefing, etc.). An annual fee or daily fee will be charged for recreational use at Big Oaks NWR. Entrance fees will be waived for official duties conducted by contractors, FWS staff, AF staff, Army staff, and others designated by the Refuge Manager, but everyone will receive a safety briefing (AF visitors will receive briefings in accordance with the AF site access plan).

Entry Procedures

Visitors will check-in and undergo an appropriate safety briefing at the refuge office (presently in Building 125) and be issued a Public Access Permit. The visitor will then be given directions to the access gate controlled by a gate attendant. The gate location will be the sole access point for unescorted FWS visitors and is located adjacent to Gate 1a on the East Perimeter Road (Gate "1b"; Fig. 2). Visitor check-out will also occur at the refuge office. AF visitors, including Old Timbers Lodge guests, will be checked-in and out in accordance with the AF site access plan.

Types of Public Use

The FWS will provide staffing at a level consistent with the safe operation of the refuge. With the expectation of limited or no UXO cleanup in the future, public use levels will be low and limited to hunting, fishing, wildlife observation and photography, and guided tours (Table 1). Activities not covered within the Plan will not be allowed unless first reviewed and approved by the Army and declared compatible by the FWS.

Access

All public activities on the refuge will be controlled and limited within 2 zones identified in consultation with the Army. These areas are 1) Limited Day Use Recreation and 2) Special Control Hunt Zones; a third zone would have no public access and would be considered closed to all types of entry except on established roads or under emergency conditions (Fig. 1). The Limited Day Use Zone will be used for hunting (deer and turkey), fishing (Old Timbers Lake), and limited opportunities for wildlife observation and photography, and guided (accompanied by FWS staff) environmental education and interpretation tours. The Special Control Hunt Zone will only have public access during a limited deer and turkey hunting season, and limited guided tours. All of these recreational units were previously used in the Army recreation program (Fig. 1).

Public use areas will be delineated by maps and by signs placed on their boundaries as required by NWR policies. Recreational opportunities during posted hours and periods will be available to the general public provided they have completed all necessary safety requirements, proper state licenses, appropriate permits for lottery seasons, and there are areas/staff available for the requested activity. Unescorted access will be limited to April through November (Table 1). Recreation units will have maximum capacity limits at any one time for all off-road visitor activities (Table 1, Fig. 1). Guided tours oriented toward environmental education, wildlife observation, interpretation, and the unique story of the property will be scheduled and completed without exposing the public participants to undue risk.

Protocols on How Public Use will be Monitored, Limited, and Controlled

Public access will be limited to specific days of the week and by seasonal periods (e.g., fishing, deer, and turkey seasons) (Table 1). The Army and the FWS will periodically reevaluate public access to determine if different limits are more appropriate.

The standard protocol for public access will be a check-in/check-out procedure to specific areas (e.g., Area 1, see Fig. 1) for those members of the public that have undergone a safety briefing. They will be allowed in areas identified as suitable for that type of activity (e.g., deer hunting in a Special Control Hunt Area; fishing in Old Timbers Lake). A daily entrance log/database will be kept of all public use on Big Oaks NWR. Information on types and locations of public use will be compiled in an annual report that will be distributed to the Army, AF and the FWS Region 3 Office.

Prior to unescorted public access occurring (June 3, 2000), the AF will install road barricades on the East Perimeter Road and the FWS will place closed area signs on these barricades to limit public access into interior areas of the refuge (Fig. 2). A total of 19 barricades will be placed around the periphery of the southern Special Control Hunt Zone. These barricades will be located at the point where all interior roads leave the East and West Perimeter Roads. The barricades on the West Perimeter Road will be in place by deer season (November 1, 2000). Other than during the limited deer and turkey hunts, these barricade gates will remain closed and locked at all times. FWS will control access into these areas during the annual turkey and deer hunts with the previously described protocols. Besides these hunt periods, only AF and FWS personnel or required contractors will be allowed access to these interior areas and the safety fan footprints. Closed area signs will also be placed alternating with the warning signs placed by the Army for closed access areas, especially for those areas adjacent to recreation units. Signs will be placed on existing structures (i.e., fence posts, buildings, etc.), live trees, or on posts with weighted bases to avoid ground intrusion of sign posts.

As described in the MOA, the FWS will work closely with the AF on controlling visitor access and monitoring refuge visitors. The AF will be responsible for maintaining the perimeter fence and overall site security at JPG. The FWS will notify the AF of any damage to the perimeter fence in a timely manner.

The FWS will not tolerate individuals who violate safety regulations. For this reason, anyone who does not comply with safety regulations will forfeit his/her refuge access privileges as determined by the Refuge Manager or by a court of law. The FWS will also continue access restrictions made by the Army to specific individuals because of documented safety violations.

Enforcement of refuge trespass and other public use violations will be the primary responsibility of commissioned Refuge Law Enforcement Officers and cooperatively by Indiana Conservation Officers and other law enforcement agencies. General trespass, poaching, and other violations will be cooperatively enforced by these agencies. The FWS will meet with local law enforcement agencies and develop coordinated law enforcement strategies (these strategies will be in place by June 3, 2000) that will be coordinated with the AF. Procedures for obtaining law enforcement assistance will be based on legal jurisdiction where the incident occurs (e.g., in Ripley County the Ripley County Communication Supervisor will be contacted, likewise, in Jefferson or Jennings Counties the appropriate Communication Radio Dispatch Centers will be contacted). For emergency response situations, the cooperating agency will coordinate activities with a 24 hr point of contact (POC) listed in Attachment 1.

Fire suppression capabilities will be negotiated with a local Volunteer Fire Department and will be in place by June 3, 2000. The agreement will include protocols on suppression of wild fires and on-call assistance during prescribed fires. Protocols will instruct fire fighters to not leave roadways and to follow other Army safety directives. For fire department response after hours, the local fire department will be instructed to coordinate with the POC and to cut the lock on the gate most advantageous to their response. In this case, the fire department response will only occur if it is apparent that the fire could cause loss of life or property damage outside the perimeter fence.

Key Control

The AF will change all locks on the perimeter fence and will issue an appropriate number of perimeter and interior gate keys to the FWS for official use. These keys will be controlled in accordance with standard lock and key control protocols (Air National Guard 181st Fighter Wing Instruction 32-1003). All keys will be signed for on the Jefferson Range key control log. The FWS will inventory these keys quarterly in accordance with these key control protocols. The FWS will coordinate distribution of keys with law enforcement and emergency response agencies. The FWS will be responsible for the control of these keys. The party responsible for missing keys shall bear the cost for the re-coring of locks as applicable. The Jefferson Range Commander has the ultimate responsibility for lock and key control on the range and refuge.

Use of Refuge by Old Timber's Lodge (AF) Guests

The FWS will schedule priority refuge events for Old Timbers Lodge with the Jefferson Range AF Commander; at all other times the Old Timbers Lodge area will be off limits for refuge visitors. The refuge will allow Old Timbers Lodge guests access to refuge recreational activities on days/times those activities are available to the general public. Old Timbers Lodge guests must obtain a valid Big Oaks NWR Public Access Permit to participate in these activities and these guests must participate in an AF safety briefing. While on the refuge, all rules and regulations of the refuge will apply to Old Timbers Lodge guests.

Old Timbers Lodge guests must check-in and check-out at the refuge office to participate in recreational opportunities (e.g., fishing at Old Timbers Lake). If guests do not check-in, especially for fishing at Old Timbers Lake, they cannot be guaranteed the opportunity to participate in the recreational activity. For permitted deer or turkey hunts, Old Timbers Lodge guests must either have a valid state lottery permit for the specific hunt or participate in a reserved hunt drawing during the hunting season at the refuge office.

Table 1. Public use limits (use-days) for activities on Big Oaks NWR [a].

Activity	Description of where use will occur	Maximum one-time capacity	When allowed
Deer Hunting	See Public Access Map	423	November (6 days archery and 9 days gun)
Turkey Hunting	½ of the number hunters/area given on Public Access Map	212	April to Mid- May (15 Days)
Fishing	Max. 10 boats and Max. 40 on shore at Old Timbers Lake. No fishing allowed on any other body of water.	60 [b]	5 - 10 days per month; April through October
Wildlife Observation and Photography	½ of the number persons/area given on Public Access Map; only within Limited Day Use Zone	78 [b]	5 - 10 days per month; April through October
Guided tours (interpretation and environmental education)	Dependent on conveyances available and activity. By definition, accompanied by FWS staff.	12-50	By reservation

[a] Based on staff and funds available in FY 2000.

[b] Based on parking and trail availability

Attachment 1

24 Hour Contact List

Joseph R. Robb
Refuge Operations Specialist
Office: 812-273-0783
Home: 812-265-6633
Cell Phone: 812-498-1154

Donna Stanley
Refuge Law Enforcement Officer
Office: 812-522-4352
Home: 812-523-3414
Cell Phone: 812-528-1998

Stephen A. Miller
Refuge Operation Specialist
Office: 812-273-0783
Home: 812-358-4413
Cell Phone: 812-498-1155

Jason Lewis
Wildlife Biologist
Office: 812-273-0783
Home: 812-574-6015
Cell Phone: 812-498-1156

Teresa Vanosdol-Lewis
Wildlife Biologist
Office: 812-273-0783
Home: 812-574-6015
Cell Phone: 812-498-1157

Enclosure 3. Department of Army Permit to the Department of Air Force to Use Property Located on JPG

ENCLOSURE 3

NO.________________

DEPARTMENT OF THE ARMY

PERMIT TO THE DEPARTMENT OF THE AIR FORCE

TO USE PROPERTY LOCATED ON JEFFERSON PROVING GROUND

THE SECRETARY OF THE ARMY, hereinafter referred to as the Secretary hereby grants to the Department of the Air Force, hereinafter referred to as the grantee, a permit for the continued use of a Bombing Range at the Jefferson Proving Ground (JPG), 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, 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 180 days written notice.

2. The grantee agrees to the care and management of the property as specified in the Memorandum of Agreement (MOA) attached hereto 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 ____________________________, and if to the Secretary, to the District Engineer, Louisville District, __________________________ with a copy furnished to the JPG Commander, ______________________________ , or as may from time to time otherwise be directed by the parties. Notice shall be deemed to have been duly given if 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, attached hereto and made apart hereof. 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 Bombing Range 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 JPG commander.

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 JPG Commander, 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 Site Access Plan that is attached hereto and is made a part hereof. The Army must first approve any variation from this Plan and a revised Site Access Plan shall be made 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 may grant a license to the Indiana Air National Guard to exercise its rights to use the premises subject to the terms of this permit.

16. NOTICE OF THE PRESENCE OF LEAD BASED PAINT AND COVENANT AGAINST THE USE OF THE PROPERTY FOR RESIDENTIAL PURPOSES.

The grantee is hereby informed and does acknowledge that all buildings on the Property, 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 extent practical, post warning signs, etc.) to all unoccupied buildings except those buildings located in the 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 Property 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 Property.

17. NOTICE OF THE PRESENCE OF ASBESTOS AND COVENANT:

The grantee is hereby informed and does acknowledge that friable and non-friable asbestos or asbestos containing materials (ACM) has been found on the Property. The grantee acknowledges that it will inspect any building it will occupy as to its asbestos content and condition and any hazardous or environmental conditions relating thereto. The grantee will restrict access (e.g. secure buildings to the extent practical, post warning signs, etc.) to all unoccupied buildings except those buildings located in the 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 be deemed to have relied solely on its own judgment in assessing the condition of the Property 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 Property.

18. This permit supercedes Permit No. DACA 27-4-83-03, dated 23 July 1982, as amended. Said Permit No. DACA 27-4-83-03 is hereby terminated, effective the date of execution of this permit.

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 ____________________ day of ________________, ___________________.

____

This permit is also executed by the grantee this _________________________ day of ______________________, _______________.

____

2

JEFFERSON RANGE ACCESS PLAN

(Revised 12 Apr 00)

Prepared by:
Air National Guard

Major William Nolen
Commander
Jefferson Range

Reviewed by:
U.S. Fish and Wildlife Service

Lee Herzberger
Refuge Manager
Muscatatuck National Wildlife Refuge

Approved by:
U.S. Army

Major Mark Welch
Commander
Jefferson Proving Ground

JEFFERSON RANGE ACCESS PLAN

This Operating Instruction will provide access procedures onto Jefferson Range. All access onto Jefferson Range and Old Timbers Lodge will be coordinated through Jefferson Range Operations Center (JROC).

Jefferson Range Operations Center (JROC) describes the range primary operations area. This area encompasses those buildings located at the intersection of Bomb Field and K roads. All access to the JROC is through Big Oaks National Wildlife Refuge.

Jefferson Range consists of 983 acres used as the primary training range. Geographical boundaries for this area illustrated in Attachment 1.

A 50 acre Precision Guided Munitions (PGM) target is located approximately 6nm south of the primary range. Geographical boundaries for this target are illustrated in Attachment 2.

Old Timbers Lodge and approximately 5 acres surrounding the lodge will be considered part of Jefferson Range for the purposes of this access plan.

Four gates allow access to the primary range. These gates are located as follows:

Intersection of Machine Gun and K roads
Intersection of Shape Charge and K roads
Intersection of Bethel Hole and J roads
Intersection of Cottrell and J roads

Range Personnel. All assigned personnel will be issued one key for perimeter gates and one key for range gates. Entry/Exit will be made through the gate most advantageous to their needs. Upon entry/exit the perimeter gate will be closed and locked.

Visitors. All visitors will coordinate range visits through the JROC. Visitors will be met at the appropriate perimeter gate and escorted to the JROC. Upon completion of visit, visitors will be escorted to appropriate gate for departure. There will be no unescorted visitors to and from Jefferson Range.

Contractors. Prior to any contractor performing duties on JPG real estate, coordination will be made through JROC and FWS office on all planned activities. Those contractors scheduled per Air Force (AF) requirements will be assigned a specific key for the duration of their activity. This key will be to an exclusive use lock located on the perimeter gate/interior gate nearest the planned activity and will only be utilized during duty hours.

Gate. All locks presently on all perimeter gates will be replaced by AF to ensure access by FWS, Army and AF personnel only. All locks will be changed prior to the issuance of a real estate license.

Fence. AF personnel and/or contractors will maintain the perimeter. Range personnel/contractors will perform weekly inspections of entire perimeter fence. All discrepancies will be reported so that any necessary repair action may be taken. FWS personnel are required to report any fence discrepancies to Jefferson Range NCOIC so the appropriate action may be taken. AF personnel or the designated contractor will perform fence repairs. Inspection documentation will include 1) date of inspection, 2) name of inspector, 3) description of damage, and 4) the location of the damage. Holes in the fence large enough to permit human access, damaged gates and missing " windchimes" of the creek barriers will be repaired within 72 hours of being documented. For every incident of damage a record shall be maintained documenting the action taken to make repairs. If any repairs take more than 72 hours, the Army shall be notified and milestones shall be given for completion of the repair.

Barricades. To ensure no trespass of the PGM target safety footprint and the interior of JPG, gate style barricades will be placed on all access roads into the footprint and interior areas. These barricades will be located at the point where all interior roads leave the East and West Perimeter Roads. Other than during the limited deer and turkey hunt, these barricade gates will remain closed and locked at all times. Only AF, Army and FWS personnel or required contractors will be allowed access to the footprint and interior areas of JPG. During the annual turkey and deer hunt, FWS will control access into these areas.

Key Control. All range personnel will be assigned 4 keys for range access. These keys include the perimeter gate keys, PGM target/interior road gate keys, range keys and building keys. Spare keys for these four series of keys will be kept in the JROC. All keys will be signed for on the Jefferson Range key control log. The FWS will be assigned the appropriate number of keys for distribution to FWS personnel. The FWS will be responsible for the control of these keys. The FWS will distribute the local law enforcement units perimeter gate keys from the FWS key allotment. The Army site staff will be issued 2 sets of keys and will be responsible for the control of these keys. Quarterly lock and key inventories will be made of all issued keys. In the event of a lost or missing key, the individual responsible for that key shall bear the cost for re-coring of applicable locks. Lock and Key Control guidance will be from 181st FW Instruction 32-1003. The Jefferson Range Commander has the ultimate responsibility for lock and key control on the range and refuge.

Safety Signs. The appropriate UXO safety signs will be maintained on the perimeter fence and gates. Gate numbers will be posted on all gates. Range and footprint gates will be posted with both Bombing Range and Laser Range danger signs. Radiation hazard signs will be maintained on DU field perimeter. Safety signs will be maintained on the west side of Machine Gun Road from K Road to Little Otter Creek.

Safety Brief. All visitors and contractors will receive a safety briefing from Jefferson Range Safety NCO. The safety brief will cover UXO, DU, driving hazards, flying operations and FWS operations. At no time will visitors or contractors be permitted to leave the JROC without first receiving an initial safety briefing.

Communications. Good communications between range, Army site staff and FWS personnel are a must to ensure a safe working environment for all concerned. The Range Operations Officer (ROO) will furnish FWS with a monthly flying schedule. The ROO will also inform FWS of any scheduled use of the PGM target. Use of this target will preclude any activity inside the safety footprint. All maintenance of the facilities will be coordinated with the Refuge Manager. At a minimum, monthly meetings will be conducted between the Refuge Manager and the Range Operations Officer to better facilitate a smooth work environment.

Weapons Safety Footprint. Two composite weapons safety footprints are associated with Jefferson Range. A composite footprint of approximately 5,100 acres supports the primary target area and a composite footprint of approximately 14,860 acres supports the PGM target area. During flight operations no personnel other than AF personnel will be allowed access inside the weapons footprints. The use of both footprints will be coordinated with the Refuge Manager through monthly scheduling or as necessary to meet mission requirements. When not in use, FWS personnel will have access to the safety footprints.

Emergency Response. Any emergency requiring an immediate response will be accomplished through the Ripley County Communication Supervisor. Emergency response personnel will be directed to Gate 8 for entrance and directions to the location of the emergency. AF personnel will provide escort to the incident location. Emergency response personnel will be informed of any hazards associated with the emergency. The Army site and staff and FWS will be notified of all needs for emergency response.

Aircraft Accident. In the event of an aircraft accident, the Range Control Officer (RCO) will be the on-scene commander until relieved by the appropriate authority. Emergency response will be through the Ripley County Communication Supervisor. Fire and medical support will be directed to the perimeter gate most advantageous to the crash site. Due to the dangers posed by military aircraft, no persons will be allowed access to a crash site until deemed appropriate by the on-scene commander. Access to an aircraft or pilot in a designated restricted area will be accomplished by the appropriate Jefferson Range vehicle. Only the necessary rescue personnel will be permitted access to any restricted area. Access to aircraft or pilot outside of a restricted area will be made by the appropriate vehicle for the situation. The Army site staff and FWS will be notified immediately of any aircraft mishap.

Fire Response. Request for fire response will be made through the Ripley County Communication Supervisor. Fire fighters will be directed to Gate 8 for entrance and directions to the fire. Fire fighters will not leave any roadway to fight fires per US Army directives. In the event of a need for fire department response after duty hours, the local fire department will be instructed to cut the lock on the gate most advantageous to their response. In this case, fire department response will only occur if it is apparent that the fire will cause life or property damage outside JPG. A complete list of AF and FWS contacts will be provided all local fire departments in the area. Attachment 4 lists the Jefferson Range contacts available on a 24 hour basis.

Law Enforcement Response . Request for law enforcement response will be made through the Ripley County Communication Supervisor or the appropriate law enforcement agency. Caller will state the nature of the emergency, location of the emergency and the most accessible gate to respond to the emergency. Local law enforcement units will have perimeter gate keys issued to them from the FWS key allotment. All local law enforcement units will be issued a 24 hour contact list of Jefferson Range personnel.

Old Timbers Lodge. Access to Old Timbers Lodge will be through Gate 1B. The sponsor that has reserved the lodge will contact Jefferson Range to arrange a time for key sign out and the required safety briefing. The sponsor and all guests will be required this safety brief. A single key to Gate 1B will be assigned the sponsor. The sponsor is responsible for the behavior and safe conduct of his/her guests. If the sponsor and/or guests wish to take part in recreational activities of Big Oaks NWR, those activities will fall under the rules and guidelines of the refuge. Use of Old Timbers Lodge does not guarantee hunting and fishing activities on the refuge. Attachment 3 depicts that area around the lodge to be maintained by the AF.

Attachment 4

24 Hour Contact List

Major Bill Nolen
Jefferson Range Commander
Office: 812-689-7295
Home: 317-738-2719
Cell Phone: 317-441-3653

Major Matt Sweeney
Jefferson Range Operations Officer
Office: 812-689-7295
Home: 812-988-6787
Cell Phone: 812-528-0974

Senior Master Sergeant Jim Bergdoll
Jefferson Range NCOIC
Office: 812-689-7295
Home: 812-265-2372

Master Sergeant Kerry Brinson
Jefferson Range Asst NCOIC
Office: 812-689-7295
Home: 812-839-3557

Master Sergeant Todd Bass
Jefferson Range Safety NCOIC
Office: 812-689-7295
Home: 812-265-2153

Enclosure 4. North of the Firing Line UXO Response Standard Operating Procedure

ENCLOSURE 4—North of the Firing Line
Unexploded Ordnance (UXO) Response
Standing Operating Procedure

1. PURPOSE: To establish procedures to support emergency management/disposition of UXO items in the Firing Range area at Jefferson Proving Ground (JPG).

2. OBJECTIVE: To prescribe an explicit course of action for the safe and efficient management of situations involving UXOs in the Firing Range area at JPG.

3. POLICY:

a. The Senior Explosive Ordnance Disposal (EOD) technician assumes primary responsibility for command and control of operations at the scene of a UXO.

b. Only EOD technicians may attempt to perform render-safe procedures (RSP) on UXO.

4. UXO OPERATIONAL PROCEDURES:

a. If the FWS or Air Force discovers UXO which poses an imminent and substantial hazard to Refuge or Bombing Range operations (e.g., UXO has migrated to the surface of a roadway), the FWS or Air Force will immediately:

(1) Restrict access to the UXO site,

(2) Cease all work, mark location of the item,

(3) Move all personnel away,

(4) Ensure that no one uses a two-way radio, and

(5) Notify the Army JPG Site Management Team if present at 812-273-2522/2551/6075. If the JPG Site Management Team is not

available, notify the Commander, Newport Chemical Depot at 765-245-4317.

b. Upon verification by the Commander, Newport Chemical Depot or the JPG Site Management Team that the UXO poses an imminent and substantial hazard to Refuge or Bombing Range operations, the Army shall notify the Fort Knox 703rd EOD Ordnance Company at 502-624-5631, and request disposal of the UXO item[1].

c. EOD personnel shall coordinate their activities and gain access to areas in the Firing Range area by contacting the Commander, Newport Chemical Depot at 765-245-4317 and Army JPG Site Management Team at 812-273-2522/2551/6075.

d. The Senior EOD Technician shall determine if the UXO item is inert. If an inert verification is not possible the munition shall be blown in place. If detonation in place is not possible, the Senior EOD Technician will determine whether it is appropriate to attempt a RSP or use other approved means to move the item to a more suitable location for safe disposal.

e. Until the item is disposed of, the Army at its discretion may impose additional access restrictions to the Firing Range area.

5. REVIEW: This SOP shall be reviewed annually. Any revisions/updates shall be provided to the FWS, Air Force, the 703rd Fort Knox EOD Ordnance Company, the Real Estate Division of the Louisville Corps of Engineers, and Newport Chemical Depot Commander or the Army JPG Site Management Team.

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[1] The Army will not be required to remove UXO that the JPG Site Management Team determines does not pose an imminent and substantial hazard to Refuge or Bombing Range operations.

Enclosure 5. FWS/Air Force Infrastructure Maintenance Responsibilities

ENCLOSURE 5 – FWS/Air Force Infrastructure Maintenance Responsibilities

AIR FORCE

1. Air Force shall maintain all roads, road shoulders and low water crossings, as well as associated bridges and culverts, that are shaded in green on the map at Tab A, in accordance with Army Regulation 420-72.

2. The perimeter fence shall be patrolled and inspected weekly. Inspections shall be documented to include: 1) the date of inspection, 2) the name of the inspector(s), 3) a description of any damage observed, and 4) the location of the damage. Holes in the fence large enough to permit human access, damaged gates and missing "windchimes" of the creek barriers will be repaired within 72 hours of being documented. For every incident of damage a record shall be maintained documenting the action taken to make repairs. In extraordinary circumstances when a repair will take more than 72 hours to complete (e.g. storm damage), the Air Force shall notify the Army in writing and milestones shall be given for completion of the repair. The Air Force shall take action to remove tress that fall into/onto the fence. Grass and other vegetation, located between the perimeter fence and perimeter road, shall be mowed or otherwise controlled to assure capability for visual inspection of the perimeter fence from the perimeter road: such mowing shall be done twice annually, usually in the April-June and September-October timeframes.

3. All roads approaching the DU area shall be barricaded and marked with radiation warning signs. In addition the Air Force will maintain warning signs around the entire perimeter of the firing range as well as around the submunitions area west of Machine Gun Road and the former Open Detonation area.

4. The Air Force shall maintain the cultural resource properties of the Firing Range (i.e., four stone-arch bridges as well as the Old Timbers Lodge) in accordance with the Cultural Resources Management Plan (reference maintenance standards in Table III-1 at Tab B). A complete copy of the Cultural Resources Management Plan was mailed to the Air Force(i.e. Mr. Masse) in March, 2000.

FWS

1. The FWS shall maintain all buildings, roads, road shoulders, bridges, low water crossings, and culverts, not maintained by the Air Force, which are required for Refuge operations. The FWS shall maintain such facilities in accordance with Army Regulation 420-72. Prior to the start date of the Real Estate permit, the FWS will provide a map with clear identification of the roads, road shoulders, buildings, bridges, low water crossings and culverts that it shall maintain under terms of the real estate permit. This map will be

updated annually by the FWS to reflect their maintenance commitment for the next year. No later than December 1, 2000, the FWS will close all bridges in the Refuge footprint that are not required for Refuge operations or not maintained by the Air Force. The FWS shall provide access control signs on the east perimeter road between Gate 1B and K Road, as well as the minefield area on L Road.

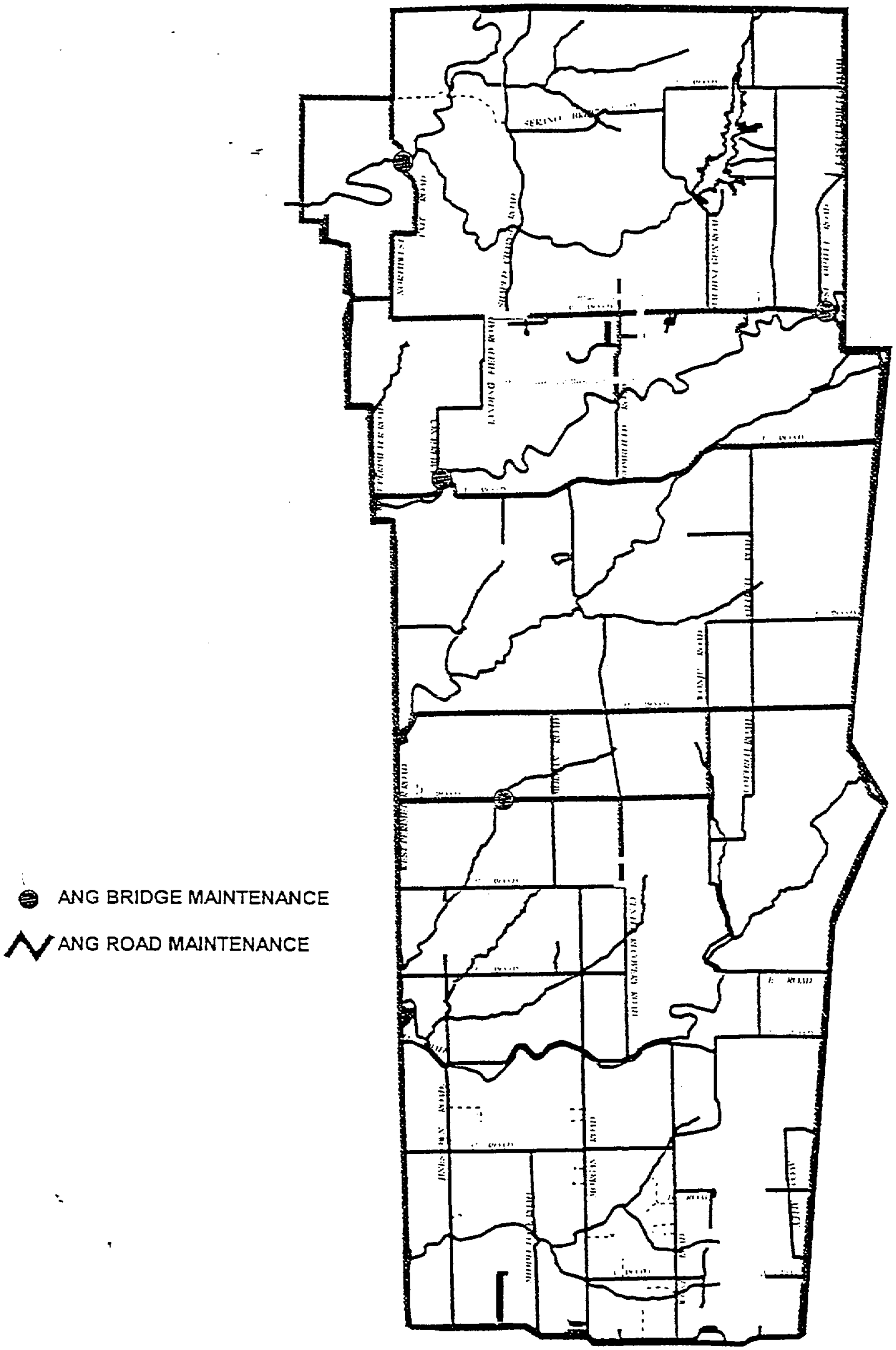
2. FWS shall provide road maintenance sufficient for 4 x 4 vehicle access to the DU monitoring wells identified at Tab C.

3. FWS shall provide or negotiate and/or fund fire suppression, emergency medical response and local law enforcement agreements. Note that three different counties (i.e. Jefferson. Ripley, and Jennings) have different jurisdiction footprints in the firing range property.

4. The FWS shall pay a pro-rated share of the rent charged to the Army for the use of Building 125 and associated utilities beginning with the start date the real estate permit..

TAB A

AIR NATIONAL GUARD
ROAD & BRIDGE MAINTENANCE



TAB B

Table III-1
Standards for Treatment of Significant Architectural Resources
after the Secretary's Standards and Guidelines for Archeology and Historic Preservation [48 FR 44716]

Preservation is defined as the act of process of applying measures necessary to sustain the existing form, integrity, and materials of an historic property. Work, including preliminary measures to protect and stabilize the property, generally focuses upon the ongoing maintenance and repair of historic materials and features rather than extensive replacement and new construction. New exterior additions are not within the scope of this treatment; however, the limited and sensitive upgrading of mechanical, electrical, and plumbing systems and other coed-required work to make properties functional is appropriate within a preservation project.

Standards for Preservation

1. A property shall be used as it was historically, or be given a new use that maximizes the retention of distinctive materials, features, spaces, and spatial relationships. Where a treatment and use have not been identified, a property shall be protected and, if necessary, stabilized until additional work may be undertaken.
2. The historic character of a property shall be retained anti preserved. The replacement of intact or repairable historic materials or alteration of features, spaces, and spatial relationships that characterize a properly shall be avoided.
3. Each property shall be recognized as a physical record of its time, place, and use. Work needed to stabilize, consolidate, and conserve existing historic materials and features shall be physically and visually compatible, identifiable upon close inspection, and properly documented for future research.
4. Changes to a property that have acquired historic significance in their own right shall be retained and preserved.
5. Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize a property shall be preserved.
6. The existing condition of historic features shall be evaluated to determine the appropriate level of intervention needed. Where the severity of deterioration requires repair or limited replacement of a distinctive feature, the new material shall match the old in composition, design, color, and texture.
7. Chemical or physical treatments, if appropriate, shall be undertaken using the gentlest means possible. Treatments that cause damage to historic materials shall not be used.
8. Archeological resources shall be protected and preserved in place. If such resources must be disturbed, mitigation measures shall be undertaken.

Rehabilitation is defined as the act or process of making possible on efficient compatible use for a property through repair, alternations, and additions while preserving those portions of features that convey its historical, cultural, or architectural values.

Standards for Rehabilitation

1. A property shall be used as it was historically or be given a new use that requires minimal change to its distinctive features, spaces, and spatial relationships.
2. The historic character of a property shall be retained and preserved. The removal of distinctive materials or alteration of features, spaces, and spatial relationships that characterize a property shall be avoided.
3. Each properly shall be recognized as a physical record of its time, place, and use. Changes that create a false lease of historical development, such as adding conjectural features or elements from other historical properties, shall not be undertaken.
4. Changes to a property that have acquired historic significance in their own right shall be retained and preserved.
5. Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize a property shall be preserved.
6. Deteriorated historic features shall be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature shall match the old in design, color, texture, and, where possible, materials. Replacement of missing features shall be substantiated by documentary and physical evidence.
7. Chemical or physical treatments, if appropriate, shall be undertaken using the gentlest means possible. Treatments that cause damage to historic materials shall not be used.
8. Archeological resources shall be protected and preserved in place. If such sources must be disturbed, mitigation measures shall be undertaken.
9. New additions, exterior alterations, or related new construction shall not destroy historic materials, features, and spatial relationships that characterize the property. The new work shall be differentiated from the old and shall be compatible with the historic materials, features, size, scale and proportion, and massing to protect the integrity of the property and its environment.
10. New additions and adjacent or related new construction shall be undertaken in such a manner that, if removed in the future, the essential form and integrity of the historic property and its environment would be unimpaired.

Table III-1
Standards for Treatment of Significant Architectural Resources
after the Secretary's Standards and Guidelines for Archeology and Historic Preservation [48 FR 44716]

Restoration is defined as the act or process of accurately depicting the form, features, and character of a property as is appeared at a particular period of time by means of the removal of features from other periods in its history and reconstruction of missing features from the restoration period. The limited and sensitive upgrading of mechanical, electrical, and plumbing systems and other code required work to make properties functional is appropriate within a restoration project.

Standards for Restoration

1. A property shall be used as it was historically or be given a new use, which interprets the property and its restoration period.
2. Materials and features from the restoration period shall be retained and preserved. The removal of materials or alteration of features, spaces, and spatial relationships that characterize the period shall not be undertaken..
3. Each property shall be recognized as a physical record of its time, place, and use. Work needed to stabilize, consolidate, and conserve materials and features from the restoration period shall be physically and visually compatible, identifiable upon close inspection, and property documented for future research.
4. Materials, features, spaces, and finishes that characterize other historical periods shall be documented prior to their alteration or removal.
5. Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize the restoration period shall be preserved.
6. Deteriorated features from the restoration period shall be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature shall match the old in design, color, texture, and, where possible, materials.
7. Replacement of missing features from the restoration period shall be substantiated by documentary and physical evidence. A false sense of history shall not be created by adding conjectural features, features from other properties, or by combining features that never existed together historically.
8. Chemical or physical treatments, if appropriate, shall be undertaken using the gentlest means possible. Treatments that cause damage to historic materials shall not be used.
9. Archeological resources shall be protected and preserved in place. If such resources must be disturbed, mitigation measures shall be undertaken.
10. Designs that were never executed historically shall not be constructed.

Reconstruction is defined as the act of process of depicting, by means of new construction, the form, features, and detailing of a non-surviving site, landscape, building, structure, or object of the purpose of replicating its appearance at a specific period of time and in its historic location.

Standards for Reconstruction

1. Reconstruction shall be used to depict vanished or non-surviving portions of a properly when documentary and physical evidence is available to permit accurate reconstruction with minimal conjecture, and such reconstruction is essential to the public understanding of the property.
2. Reconstruction of a landscape, building, structure, or object in its historic location shall be preceded by a thorough archeological investigation to identify and evaluate those features and artifacts, which are essential to an accurate reconstruction. If such resources must be disturbed, mitigation measures shall be undertaken.
3. Reconstruction shall include measures to preserve any remaining historic materials, features, and spatial relationships.
4. Reconstruction shall be based on the accurate duplication of historic features and elements substantiated by documentary or physical evidence rather than on conjectural designs or the availability of different features from other historic properties. A reconstructed properly shall re-create the appearance of the non-surviving historic property in materials, design, color, and texture.
5. A reconstruction shall be clearly identified as a contemporary re-creation.
6. Designs that were never executed historically shall not be constructed.

TAB C

JEFFERSON PROVING GROUND: DU SAMPLING
GROUNDWATER MONITORING WELLS

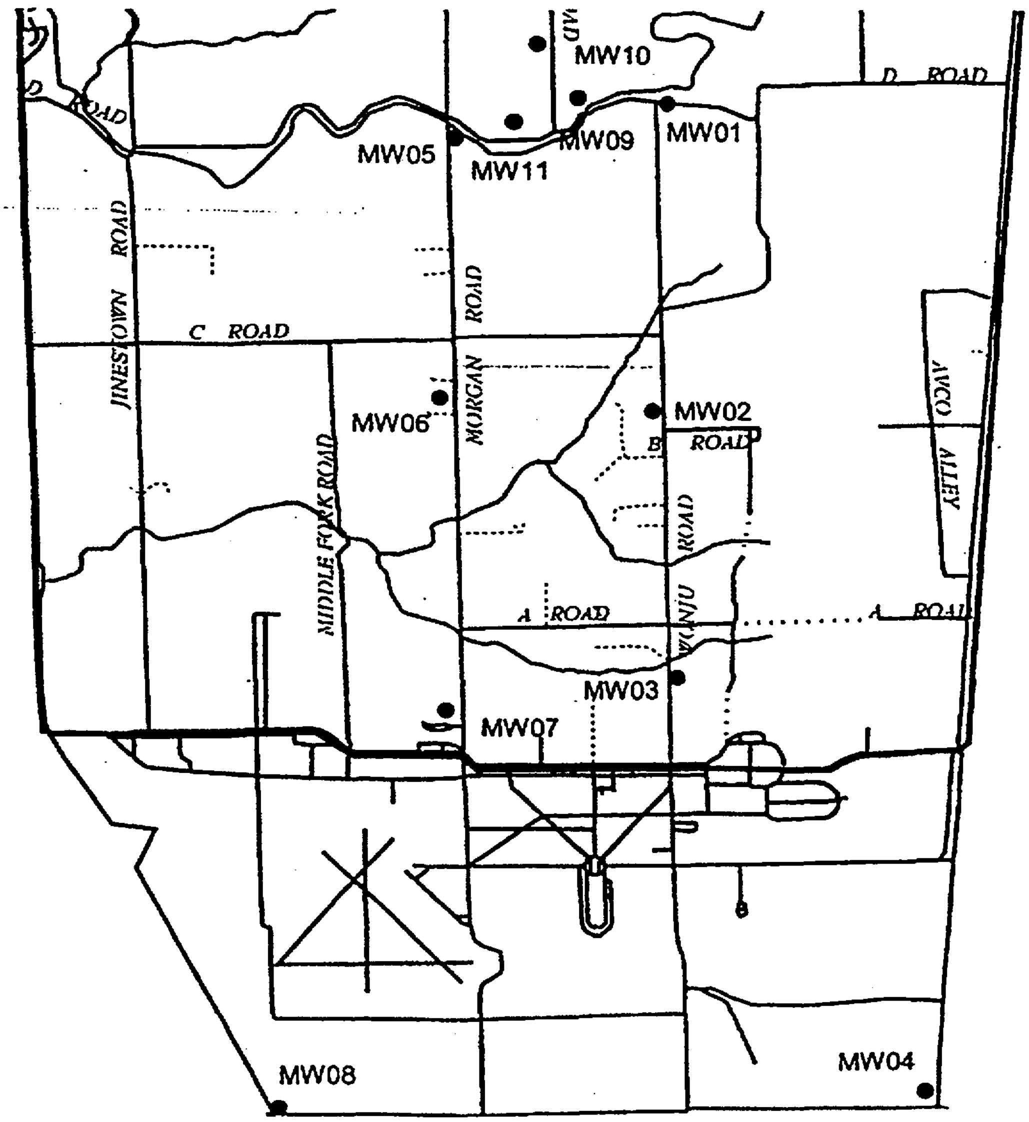


EXHIBIT C. JEFFERSON RANGE ACCESS PLAN

JEFFERSON RANGE ACCESS PLAN

(Revised 12 Apr 00)

Prepared by:
Air National Guard

MK 20 Apr 00

Major William Nolen
Commander
Jefferson Range

Reviewed by:
U.S. Fish and Wildlife Service

Lee Herzberger
Refuge Manager
Muscatatuck National Wildlife Refuge

Approved by:
U.S. Army

Major Mark Welch
Commander
Jefferson Proving Ground

EXHIBIT C

JEFFERSON RANGE ACCESS PLAN

This Operating Instruction will provide access procedures onto Jefferson Range. All access onto Jefferson Range and Old Timbers Lodge will be coordinated through Jefferson Range Operations Center (JROC).

Jefferson Range Operations Center (JROC) describes the range primary operations area. This area encompasses those buildings located at the intersection of Bomb Field and K roads. All access to the JROC is through Big Oaks National Wildlife Refuge.

Jefferson Range consists of 983 acres used as the primary training range. Geographical boundaries for this area illustrated in Attachment 1.

A 50 acre Precision Guided Munitions (PGM) target is located approximately 6nm south of the primary range. Geographical boundaries for this target are illustrated in Attachment 2.

Old Timbers Lodge and approximately 5 acres surrounding the lodge will be considered part of Jefferson Range for the purposes of this access plan.

Four gates allow access to the primary range. These gates are located as follows:

Intersection of Machine Gun and K roads
Intersection of Shape Charge and K roads
Intersection of Bethel Hole and J roads
Intersection of Cottrell and J roads

Range Personnel. All assigned personnel will be issued one key for perimeter gates and one key for range gates. Entry/Exit will be made through the gate most advantageous to their needs. Upon entry/exit the perimeter gate will be closed and locked.

Visitors. All visitors will coordinate range visits through the JROC. Visitors will be met at the appropriate perimeter gate and escorted to the JROC. Upon completion of visit, visitors will be escorted to appropriate gate for departure. There will be no unescorted visitors to and from Jefferson Range.

Contractors. Prior to any contractor performing duties on JPG real estate, coordination will be made through JROC and FWS office on all planned activities. Those contractors scheduled per Air Force (AF) requirements will be assigned a specific key for the duration of their activity. This key will be to an exclusive use lock located on the perimeter gate/interior gate nearest the planned activity and will only be utilized during duty hours.

Gate. All locks presently on all perimeter gates will be replaced by AF to ensure access by FWS, Army and AF personnel only. All locks will be changed prior to the issuance of a real estate license.

Fence. AF personnel and/or contractors will maintain the perimeter. Range personnel/contractors will perform weekly inspections of entire perimeter fence. All discrepancies will be reported so that any necessary repair action may be taken. FWS personnel are required to report any fence discrepancies to Jefferson Range NCOIC so the appropriate action may be taken. AF personnel or the designated contractor will perform fence repairs. Inspection documentation will include 1) date of inspection, 2) name of inspector, 3) description of damage, and 4) the location of the damage. Holes in the fence large enough to permit human access, damaged gates and missing " windchimes" of the creek barriers will be repaired within 72 hours of being documented. For every incident of damage a record shall be maintained documenting the action taken to make repairs. If any repairs take more than 72 hours, the Army shall be notified and milestones shall be given for completion of the repair.

Barricades. To ensure no trespass of the PGM target safety footprint and the interior of JPG, gate style barricades will be placed on all access roads into the footprint and interior areas. These barricades will be located at the point where all interior roads leave the East and West Perimeter Roads. Other than during the limited deer and turkey hunt, these barricade gates will remain closed and locked at all times. Only AF, Army and FWS personnel or required contractors will be allowed access to the footprint and interior areas of JPG. During the annual turkey and deer hunt, FWS will control access into these areas.

Key Control. All range personnel will be assigned 4 keys for range access. These keys include the perimeter gate keys, PGM target/interior road gate keys, range keys and building keys. Spare keys for these four series of keys will be kept in the JROC. All keys will be signed for on the Jefferson Range key control log. The FWS will be assigned the appropriate number of keys for distribution to FWS personnel. The FWS will be responsible for the control of these keys. The FWS will distribute the local law enforcement units perimeter gate keys from the FWS key allotment. The Army site staff will be issued 2 sets of keys and will be responsible for the control of these keys. Quarterly lock and key inventories will be made of all issued keys. In the event of a lost or missing key, the individual responsible for that key shall bear the cost for re-coring of applicable locks. Lock and Key Control guidance will be from 181st FW Instruction 32-1003. The Jefferson Range Commander has the ultimate responsibility for lock and key control on the range and refuge.

Safety Signs. The appropriate UXO safety signs will be maintained on the perimeter fence and gates. Gate numbers will be posted on all gates. Range and footprint gates will be posted with both Bombing Range and Laser Range danger signs. Radiation hazard signs will be maintained on DU field perimeter. Safety signs will be maintained on the west side of Machine Gun Road from K Road to Little Otter Creek.

Safety Brief. All visitors and contractors will receive a safety briefing from Jefferson Range Safety NCO. The safety brief will cover UXO, DU, driving hazards, flying operations and FWS operations. At no time will visitors or contractors be permitted to leave the JROC without first receiving an initial safety briefing.

Communications. Good communications between range, Army site staff and FWS personnel are a must to ensure a safe working environment for all concerned. The Range Operations Officer (ROO) will furnish FWS with a monthly flying schedule. The ROO will also inform FWS of any scheduled use of the PGM target. Use of this target will preclude any activity inside the safety footprint. All maintenance of the facilities will be coordinated with the Refuge Manager. At a minimum, monthly meetings will be conducted between the Refuge Manager and the Range Operations Officer to better facilitate a smooth work environment.

Weapons Safety Footprint. Two composite weapons safety footprints are associated with Jefferson Range. A composite footprint of approximately 5,100 acres supports the primary target area and a composite footprint of approximately 14,860 acres supports the PGM target area. During flight operations no personnel other than AF personnel will be allowed access inside the weapons footprints. The use of both footprints will be coordinated with the Refuge Manager through monthly scheduling or as necessary to meet mission requirements. When not in use, FWS personnel will have access to the safety footprints.

Emergency Response. Any emergency requiring an immediate response will be accomplished through the Ripley County Communication Supervisor. Emergency response personnel will be directed to Gate 8 for entrance and directions to the location of the emergency. AF personnel will provide escort to the incident location. Emergency response personnel will be informed of any hazards associated with the emergency. The Army site and staff and FWS will be notified of all needs for emergency response.

Aircraft Accident. In the event of an aircraft accident, the Range Control Officer (RCO) will be the on-scene commander until relieved by the appropriate authority. Emergency response will be through the Ripley County Communication Supervisor. Fire and medical support will be directed to the perimeter gate most advantageous to the crash site. Due to the dangers posed by military aircraft, no persons will be allowed access to a crash site until deemed appropriate by the on-scene commander. Access to an aircraft or pilot in a designated restricted area will be accomplished by the appropriate Jefferson Range vehicle. Only the necessary rescue personnel will be permitted access to any restricted area. Access to aircraft or pilot outside of a restricted area will be made by the appropriate vehicle for the situation. The Army site staff and FWS will be notified immediately of any aircraft mishap.

Fire Response. Request for fire response will be made through the Ripley County Communication Supervisor. Fire fighters will be directed to Gate 8 for entrance and directions to the fire. Fire fighters will not leave any roadway to fight fires per US Army directives. In the event of a need for fire department response after duty hours, the local fire department will be instructed to cut the lock on the gate most advantageous to their response. In this case, fire department response will only occur if it is apparent that the fire will cause life or property damage outside JPG. A complete list of AF and FWS contacts will be provided all local fire departments in the area. Attachment 4 lists the Jefferson Range contacts available on a 24 hour basis.

Law Enforcement Response . Request for law enforcement response will be made through the Ripley County Communication Supervisor or the appropriate law enforcement agency. Caller will state the nature of the emergency, location of the emergency and the most accessible gate to respond to the emergency. Local law enforcement units will have perimeter gate keys issued to them from the FWS key allotment. All local law enforcement units will be issued a 24 hour contact list of Jefferson Range personnel.

Old Timbers Lodge. Access to Old Timbers Lodge will be through Gate 1B. The sponsor that has reserved the lodge will contact Jefferson Range to arrange a time for key sign out and the required safety briefing. The sponsor and all guests will be required this safety brief. A single key to Gate 1B will be assigned the sponsor. The sponsor is responsible for the behavior and safe conduct of his/her guests. If the sponsor and/or guests wish to take part in recreational activities of Big Oaks NWR, those activities will fall under the rules and guidelines of the refuge. Use of Old Timbers Lodge does not guarantee hunting and fishing activities on the refuge. Attachment 3 depicts that area around the lodge to be maintained by the AF.

Attachment 4

24 Hour Contact List

Major Bill Nolen
Jefferson Range Commander
Office: 812-689-7295
Home: 317-738-2719
Cell Phone: 317-441-3653

Major Matt Sweeney
Jefferson Range Operations Officer
Office: 812-689-7295
Home: 812-988-6787
Cell Phone: 812-528-0974

Senior Master Sergeant Jim Bergdoll
Jefferson Range NCOIC
Office: 812-689-7295
Home: 812-265-2372

Master Sergeant Kerry Brinson
Jefferson Range Asst NCOIC
Office: 812-689-7295
Home: 812-839-3557

Master Sergeant Todd Bass
Jefferson Range Safety NCOIC
Office: 812-689-7295
Home: 812-265-2153

APPENDIX B

NRC LICENSE SUB-1435

MATERIALS LICENSE

Pursuant to the Atomic Enemy Act of 1954, as amended, the Energy Reorganization Act of 1974 (Public Law 93-438) and Title 10, Code of Federal Regulations, Chapter I, Parts 30, 31, 32, 33, 34, 35, 36, 39, 40, and 70, and in reliance on statements and representations heretofore made by the licensee, a license is hereby issued authorizing the licensee to receive, acquire, possess, and transfer byproduct, source, and special nuclear material designated below; to use such material for the purpose(s) and at the place(s) designated below: to deliver or transfer such material to persons authorized to receive it in accordance with the regulations of the applicable Part(s). This license shall be deemed to contain the conditions specified in Section 183 of the Atomic Enemy Act of 1954, as amended, and is subject to all applicable rules, regulations, and orders of the Nuclear Regulatory Commission now or hereafter in effect and to any conditions specified below.

Licensee		
1. U.S. Department of the Army 2. U.S. Army Soldier and Biological Chemical Command Aberdeen Proving Ground, MD 21010-5424	3. License Number	SUB-1435 Amendment No. 10
	4. Expiration Date	The license is deemed in effect in accordance with 10 CFR 40.42(c)*
	5. Docket or Reference No.	040-08838

6. Byproduct, Source, and/or Special Nuclear Material	7. Chemical and/or Physical Form	8. Maximum Amount that Licensee May Possess at Any One Time Under This License
Uranium	Depleted uranium metal, alloy, and/or other forms	80,000 kilograms

*The license is deemed in effect in accordance with 10 CFR 40.42(c) until NRC notification of its termination.

9. Authorized use: For possession only for decommissioning. License renewal applications dated August 29, 1994.

CONDITIONS

10. Authorized place of use:

A. The licensed material shall be kept onsite, for the purpose of decommissioning, in the restricted area known as the "Depleted Uranium Impact Area. This area is located north of the firing line, at the Jefferson Proving Ground, in Madison, Indiana 47250.

B. This license has been transferred from the "The U.S. Department of the Army, U.S. Army Test and Evaluation Command, Aberdeen Proving Ground, Maryland 21005-5055" to "The U.S. Department of the Army, U.S. Army Soldier and Biological Chemical Command, Aberdeen Proving Ground, Maryland 21010-5424."

11. A. Licensed materials shall be kept under the supervision of the Radiation Safety Officer, who shall have the following education, training, and experience:

1. Education: A bachelor's degree in the physical sciences, industrial hygiene, or engineering from an accredited college or university or an equivalent combination of training and relevant experience in radiological protection. Two years of relevant experience are generally considered equivalent to 1 year of academic study.

MATERIALS LICENSE SUPPLEMENTARY SHEET	License Number SUB-1435
	Docket or Reference Number 040-08838
	Amendment No. 10

2. Health physics experience: At least 1 year of work experience in applied health physics, industrial hygiene, or similar work relevant to radiological hazards associated with site remediation. This experience should involve actually working with radiation detection and measurement equipment, not strictly administrative or "desk" work.

3. Specialized knowledge: A thorough knowledge of the proper application and use of all health physics equipment used for depleted uranium and its daughters, the chemical and analytical procedures used for radiological sampling and monitoring, methodologies used to calculate personnel exposure to depleted uranium and its daughters, and a thorough understanding of how the depleted uranium was used at the location and how the hazards are generated and controlled

B. The licensee without prior NRC approval may appoint a RSO provided a) the licensee maintain documentation demonstrating that the requirements of condition 11A are met and b) the NRC is informed of the name of the new RSO by letter to the Regional Administrator, Region II, within 30 days of the appointment.

12. Except as specifically provided otherwise in this license, the licensee shall conduct its program in accordance with the statements, representations, and procedures contained in the documents, including any enclosures, listed below. The NRC's regulations shall govern unless the statements, representations, and procedures in the licensee's application and correspondence are more restrictive than the regulation. .

A. Letter and attachments for license renewal dated August 29, 1994,

B. Letter dated May 25, 1995,

C. Application with attachments dated September 29, 1995, and

D. JPG Security Plan included with the letter dated February 15, 2000.

13. Deleted.

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

Date: 6/8/2000 By: [signature]

Robert A. Nelson, Acting Chief
Decommissioning Branch
Division of Waste Management
Office of Nuclear Material Safety and Safeguards

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APPENDIX C

RISK ANALYSIS

Dose Assessment in Support of Decommissioning Plan for Jefferson Proving Ground

Michael H. Ebinger
Environmental Dynamics and Spatial Analysis Group
Los Alamos National Laboratory
Los Alamos, NM

20 June 2002

CONTENTS

FIGURES

TABLES

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ACRONYMS

ALARA	as low as reasonably achievable
BRAC	Base Realignment and Closure Act
CFR	*Code of Federal Regulations*
cm	centimeter
CSM	conceptual site model
D&D	decontamination and decommissioning
DGCL	derived concentration guidance level
DOE	U.S. Department of Energy
DU	depleted uranium
ft	foot or feet
FWS	U.S. Fish and Wildlife Service
g	gram
in.	inch or inches
JPG	Jefferson Proving Ground, Indiana
kg	kilogram
L	liter
mrem/y	millirem per year
m	meter
NRC	Nuclear Regulatory Commission
NWR	National Wildlife Refuge
pCi	picocurie
RESRAD	Residual Radioactivity
SBCCOM	Soldier and Biological Chemical Command
TEDE	total effective dose equivalent
U	uranium
USACHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
USDA	U.S. Department of Agriculture
UXO	unexploded ordnance

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1.0 INTRODUCTION

Jefferson Proving Ground (JPG), Indiana, was used by the U.S. Army as one of several locations for testing various munitions used in combat. One of the main activities at JPG was lot-acceptance testing of depleted uranium (DU) penetrator munitions. Testing of DU munitions began about 1984 and was terminated in 1994. JPG was closed under the Base Realignment and Closure Act of 1988 (BRAC) in September 1995. As part of base closure, the U.S. Army was interested in transferring available JPG land to private or public interests, as appropriate. The section of JPG south of the former firing line is being transferred to private/public ownership after extensive removal of hazardous components left over from previous missions. Transfer of lands north of the firing line, however, is not planned because of significant hazards that include not only the DU Impact Area, but also millions of unexploded ordnance (UXO) items that remain. Much of the northern part of JPG has been converted to a managed wildlife area, the Big Oaks National Wildlife Refuge (NWR), which is intended for restricted/limited public use with controlled access.

In this section, the purpose, objectives, scope, and problem definition are discussed. Section 2.0 provides background information on the environmental monitoring program and previous dose assessments. The dose estimation methodology and results are presented in Section 3.0 and provide the basis for conclusions addressed in Section 4.0. References are detailed in Section 5.0.

1.1 PURPOSE AND OBJECTIVES

The U.S. Army is seeking a termination of its radioactive materials license (license number SUB-1435, Amendment 10) and release of the lands for restricted use as defined in 10 *Code of Federal Regulations* (*CFR*) Part 20, Section 1403. The purpose of this report is to provide an analysis of the potential exposure of site users to DU fragments under a variety of land-use scenarios. The assessment approach and the data used for the assessment area are also documented in this report. Specifically, the following objectives are addressed in this report:

- estimate potential doses from DU fragments in the soil to humans in a critical group as defined by the exposure scenario; and
- evaluate if the expected doses to a member of the appropriate critical group are less than 25 mrem y^{-1} if institutional controls are in place, or the doses are less than 100 mrem y^{-1} if institutional controls fail as stipulated in 10 *CFR* Part 20, Section 1403.

1.2 SCOPE AND PROBLEM DEFINITION

The purpose of the analyses presented in this report is to evaluate potential doses to users of the DU Impact Area after the U.S. Army has released the site for restricted access.

There are two dose limits that govern release of lands for restricted use. First, as long as institutional controls are in place, the total effective dose equivalent (TEDE) to the average member of a critical group cannot exceed 25 mrem y^{-1} and must be kept as low as reasonably achievable (ALARA). The second limit takes effect if institutional controls at the site fail and is a TEDE to the average member of the critical group that is less than 100 mrem y^{-1}, less than 500 mrem y^{-1} if reduction of contamination is technically unachievable, or ALARA. Doses from various scenarios are compared to both limits and are developed below. Termination of the JPG DU license and release of the JPG DU Impact Area for restricted use are recommended if estimated doses are less than the release criteria. Release is not recommended if estimated doses exceed or approach the release criteria.

The main difficulties in estimating the doses to members of critical groups are: (1) the uncertainty in the amount and distribution of DU in the soils at the DU Impact Area; (2) the scarcity of site-specific data required by the dose modeling program; and (3) the need to use default values or estimates for many of the environmental parameters required to run the assessment model. These difficulties are addressed below. The effects of the approximations on the predicted doses also are addressed.

2.0 BACKGROUND: ENVIRONMENTAL MONITORING AND RISK ASSESSMENT AT JPG

In this section environmental monitoring data are reviewed (Section 2.1). Previous dose assessments are summarized in Section 2.2.

2.1 ENVIRONMENTAL MONITORING DATA

An environmental monitoring plan was developed for the JPG DU Impact Area before the initial DU munitions were fired in 1984 (Abbott 1983), and this plan guided sample collection and analysis through 1995. 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. Twice each year, samples were collected and analyzed for total uranium (U) and, often, the isotopic composition of U in samples. The environmental sampling data are reported elsewhere (Abbott 1983) and summarized for the 1984–1994 period (Ebinger and Hansen 1996a). Concentrations of DU in soil samples collected in the DU Impact Area from 1984–2000 are skewed left with a mean value of 18.8 picocuries (pCi) g^{-1} and a median value of 1.5 pCi g^{-1}; the standard deviation of these samples is almost 200 pCi g^{-1} (Table 1; Figure 1). Of nearly 400 soil samples analyzed since 1984, most total U concentrations are less than 2 pCi g^{-1}, which is no different than the average background soil concentration of U at JPG. Similar distributions for DU concentrations in groundwater and surface water were obtained for the same period (Table 1; Figures 2 and 3). The summary of the environmental data indicates that the expected concentrations of U or DU are significantly less than the derived concentration guideline of 35 pCi g^{-1} for soil and 150 pCi L^{-1} for surface water and groundwater developed in an earlier study at JPG (U.S. Army 1996).

Table 1. Descriptive Statistics of DU Concentrations in Soil, Groundwater, and Surface Water Samples Calculated from Environmental Monitoring Samples Collected 1984 through 2000

	Soil (pCi g^{-1})	Groundwater (pCi L^{-1})	Surface Water (pCi L^{-1})
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 1996a.
g = gram.
pCi = picocurie.
L = liter.

The hydrology of JPG lands south of the firing line was evaluated during remediation efforts associated with BRAC and land transfer by the Army (Rust 1994, 1998). The groundwater hydrology at JPG is complicated because of the karst terrain, but the overall flow was thought to be generally from northeast to the southwest and parallel to the flow of streams that cross the DU area, namely Big Creek.

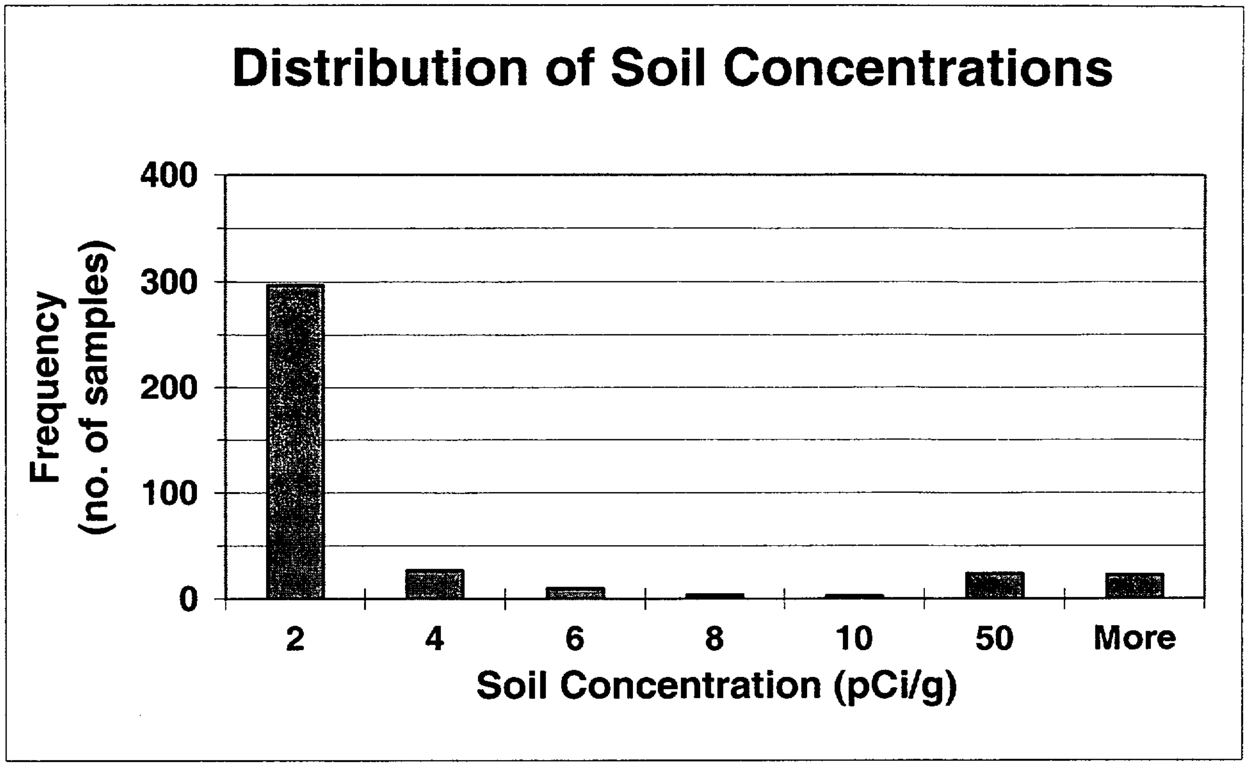

Figure 1. Frequency Distribution of Soil Samples Collected from 1984 through 2000
"More" refers to samples with concentrations greater than 50 pCi/g (Ebinger and Hansen 1996a).

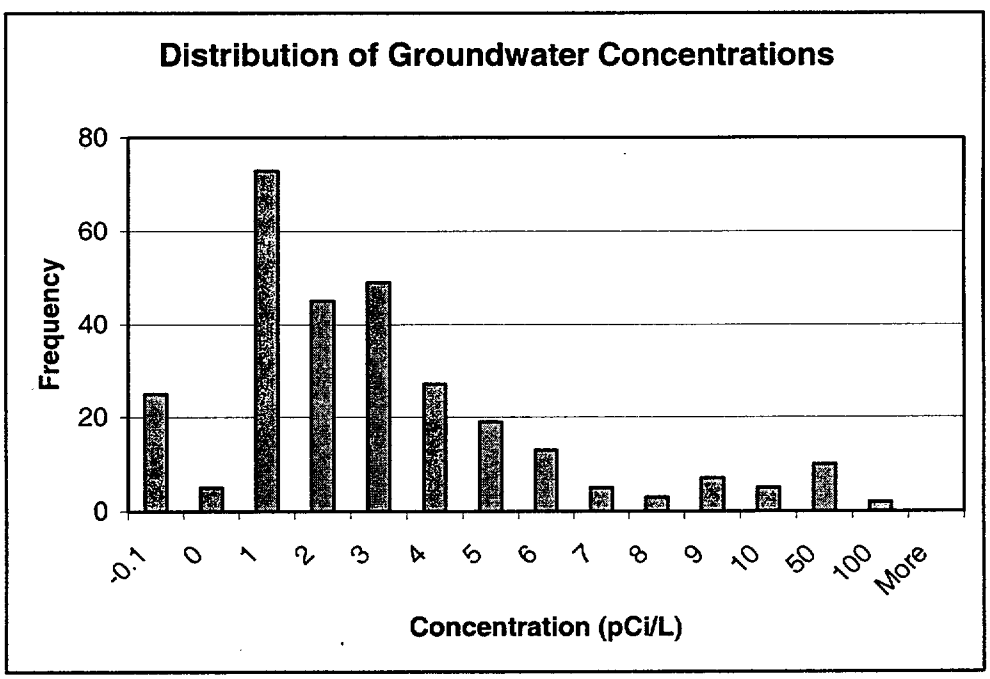

Figure 2. Frequency Distribution of Groundwater Samples Collected from 1984 through 2000 (Ebinger and Hansen 1996a)

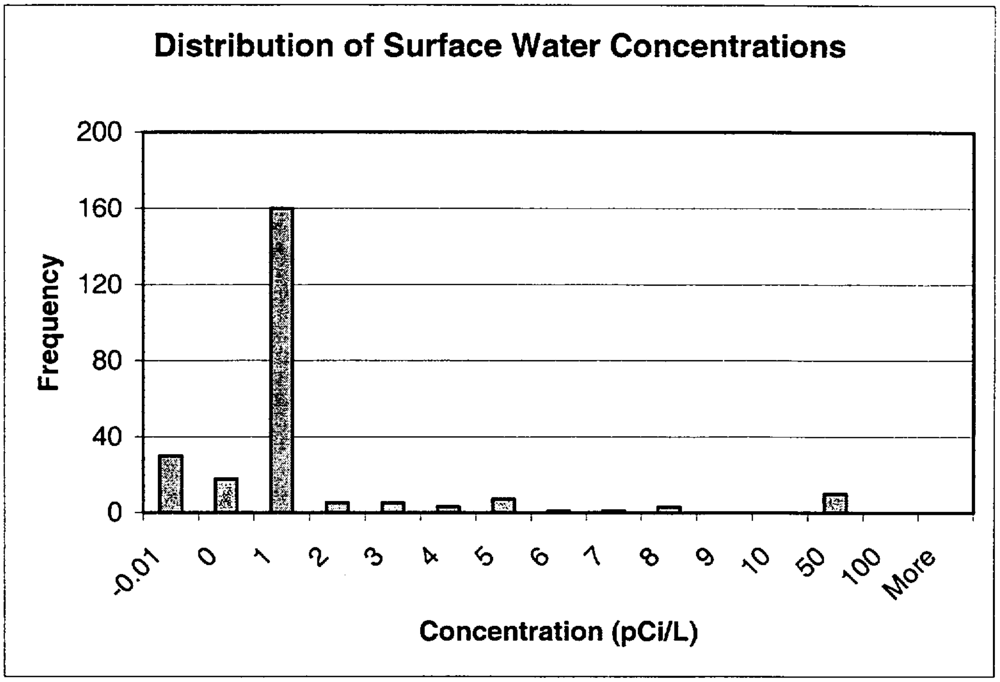

Figure 3. Frequency Distribution of Surface Water Samples Collected from 1984 through 2000 (Ebinger and Hansen 1996a)

Establishing the regional hydrology was not within the scope of the Rust reports, nor was characterization of the deeper groundwater hydrology at the site. Therefore, detailed descriptions of the overall hydrologicsetting cannot be made at this time.

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 feet (ft) from the surface [well logs, personal communication with Richard Herring, JPG, retired; personal communication with Soldier and Biological Chemical Command (SBCCOM) and U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) staff, Aberdeen Proving Ground; and SEC Donohue 1992]. The groundwater data show some variation in the concentration of U in wells between 1984 and 2000 (Figure 2), the largest of which was attributed to error in sample handling at the analytical laboratories (Ebinger and Hansen 1996a). Overall, the data indicate that no DU contamination has moved to the groundwater or surface water from the DU Impact Area. This conclusion was further supported by the isotopic composition of U in the groundwater samples (Ebinger and Hansen 1996a).

Surface water samples from monitoring locations on Big Creek upstream and downstream from the DU Impact Area varied in U 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 could be due to U incidentally applied as a trace constituent of phosphate fertilizer used throughout the farming community that surrounds JPG (Klement 1980; Eisenbud 1987). Isotopic ratios of these samples support that most of the observed variation was due to a natural U in surface water and not DU. The summary data suggest that the main source of U in surface waters has been natural in origin, that is, from fertilizers or derived from geologic deposits, and transported via water or erosion. Whether from natural sources or agricultural fertilizer, the concentrations are well below the Army derived concentration guidance levels (DGCLs) [U.S. Army 1996] and low enough to be of little concern.

2.2 PREVIOUS DOSE ASSESSMENTS

Several dose estimates for the potential effects of DU on members of appropriate critical groups have been conducted at JPG (Ebinger and Hansen 1994, 1996a,b, and 1998), and the predicted doses depended largely on the assumptions made about exposure pathways. In the earliest assessments, it was demonstrated that drinking water was the largest contributor to the overall dose to humans. Since the first estimates were completed, however, refinements have been made concerning DU transport to groundwater and surface water, and more realistic exposure scenarios have been developed. The most recent assessment assumed that the soil and geologic media that control groundwater recharge and DU transport were characterized well enough to use as modeling scenarios. This assumption is optimistic given that the hydrologic data (Rust 1994, 1998) were obtained from an area about 5 miles southwest of the DU Impact Area and may not be completely relevant to the hydrology of the DU Impact Area. The approach adopted for this report is to model the transport of DU at JPG relying on site-specific data as much as possible.

Refinements in the distribution and concentration of DU in the DU Impact Area were made in 1995 and 1996 (SEG 1995, 1996). These reports show that the size of the affected area could be more reliably estimated after radiological surveys were completed along a grid through the DU Impact Area. These survey data were used to map exposure rates at the surface of the soil, and for contaminated area delineation. However, the data were difficult to use to estimate source term concentrations because they were radiation rate measurements from all radionuclides present at the surface of the soil, not actual DU concentrations. The source terms for DU are the result of a refined estimate of the affected area from the SEG (1995, 1996) data and use of maximum and average concentration estimates from survey data.

3.0 DOSE ESTIMATION METHODOLOGY

The dose estimation methodology is described in Sections 3.1 to 3.9. The RESRAD results are detailed in Section 3.10. This section concludes with a discussion on the effects of uncertainty in parameter values (Section 3.11).

3.1 INTRODUCTION

Termination of the U.S. Army radioactive materials license (SUB-1435, Amendment 10) and release of the DU Impact Area for restricted use depends on demonstrating that estimated radiological doses to humans using the lands are less than 25 mrem y^{-1} if institutional controls remain in place or less than 100 mrem y^{-1} if institutional controls fail as set forth in 10 *CFR* Part 20, Section 1403. In order to estimate potential doses from residual DU at JPG, the following dose assessment methodology was designed. First, a conceptual site model (CSM) was developed that included potential exposure from a variety of environmental pathways. These pathways included DU contaminated soil, drinking water and irrigation water supplies potentially contaminated by DU leaching from the soils, DU transferred to the food chain via plant and animal (livestock, fish, and poultry) consumption, and transfer of DU via inhaled dust and soil ingestion. A set of exposure scenarios was developed according to the CSM. The exposure scenarios included various land uses, and the potential for exposure to DU via environmental pathways relevant to those land uses was evaluated. Exposures for on-site and off-site receptors were evaluated using the CSM and appropriate environmental pathways.

Next, the magnitude of the source term was estimated. Historical information of the amount of DU fired at JPG was used to estimate the upper bound of the total DU that remains in the DU Impact Area, and data from environmental sampling was used to refine the distribution of DU and the concentrations that characterize the affected area. The area considered affected by residual DU fragments is defined as the contaminated zone for dose assessment modeling and was delineated using radiological characterization surveys conducted after DU firing missions at JPG ceased. Two different contaminated zones with two associated DU concentrations were derived and serve as separate source terms.

Exposures were estimated for the average member of critical groups relevant to each tested scenario. Since the critical groups were different for the various scenarios, a separate critical group was identified for each. Thus, critical groups for on-site and off-site exposures, as well as exposures that varied with each scenario, were identified.

Next, the set of scenarios was screened to reduce the amount of repetition in dose estimate calculations. The scenarios selected for simulation represent a range of potential exposures from incidental doses by occasional site users to doses expected from a farming operation located in the contaminated zone. The tested scenarios were meant to be as realistic as possible; however, intense land uses, such as farming, omitted the potential injury or death of farmers from encounters with UXO.

Finally, the selected scenarios were used to formulate does estimates using the U.S. Department of Energy (DOE) Residual Radiation (RESRAD) program (Yu et al. 2001), and site-specific data were included in the model simulations. The sensitivity of the RESRAD simulations was evaluated to variation in input parameters, and the uncertainty of the predicted doses was estimated using probabilistic information for the sensitive parameters. The resulting dose estimates were used to evaluate if the JPG DU Impact Area could be released for restricted use within the stipulations of 10 *CFR* Part 20, Section 1403.

3.2 DEFINITIONS: "ON-SITE," "OFF-SITE," "CONTAMINATED ZONE," AND "DU IMPACT AREA"

Four terms used in the dose estimation assessments below refer to specific sections of the JPG area. The area under institutional control is that area north of the former firing line and enclosed by the current JPG boundary on the north, east, and west with a 7-foot (2.1 m) high chain link fence topped with V-shaped three-strand barbed wire (Figure 4). The DU Impact Area lies within the area under institutional control and has been marked with radiation contamination signs and secured by a locked swing gates on all access roads to the area. The area south of the firing line does not contain DU test areas. Contaminants from portions of this area are being removed, and transfer to the public or local businesses is under way or scheduled. In the following descriptions of the potential exposure scenarios, "on-site" refers to being within the area under institutional control, "off-site" refers to areas outside the institutional control fence, and "DU Impact Area" refers to the area within the northern part of JPG where DU munitions impacted the ground, and the "contaminated zone" is the area of highest concentration of DU from within the DU Impact Area (Figure 4). Appropriate interpretation of the conclusions of the exposure modeling effort below depends on these definitions.

3.3 JPG CONCEPTUAL MODEL

A site description is provided in Section 3.3.1. This discussion is followed by a presentation of the conceptual site model (Section 3.3.2).

3.3.1 Site Description

The area enclosed by JPG is considered ideal farming land because of the favorable temperature during the growing season, a relatively long growing season, and adequate moisture to grow a variety of crops without added irrigation and without danger, in most years, of crop loss from drought [U.S. Department

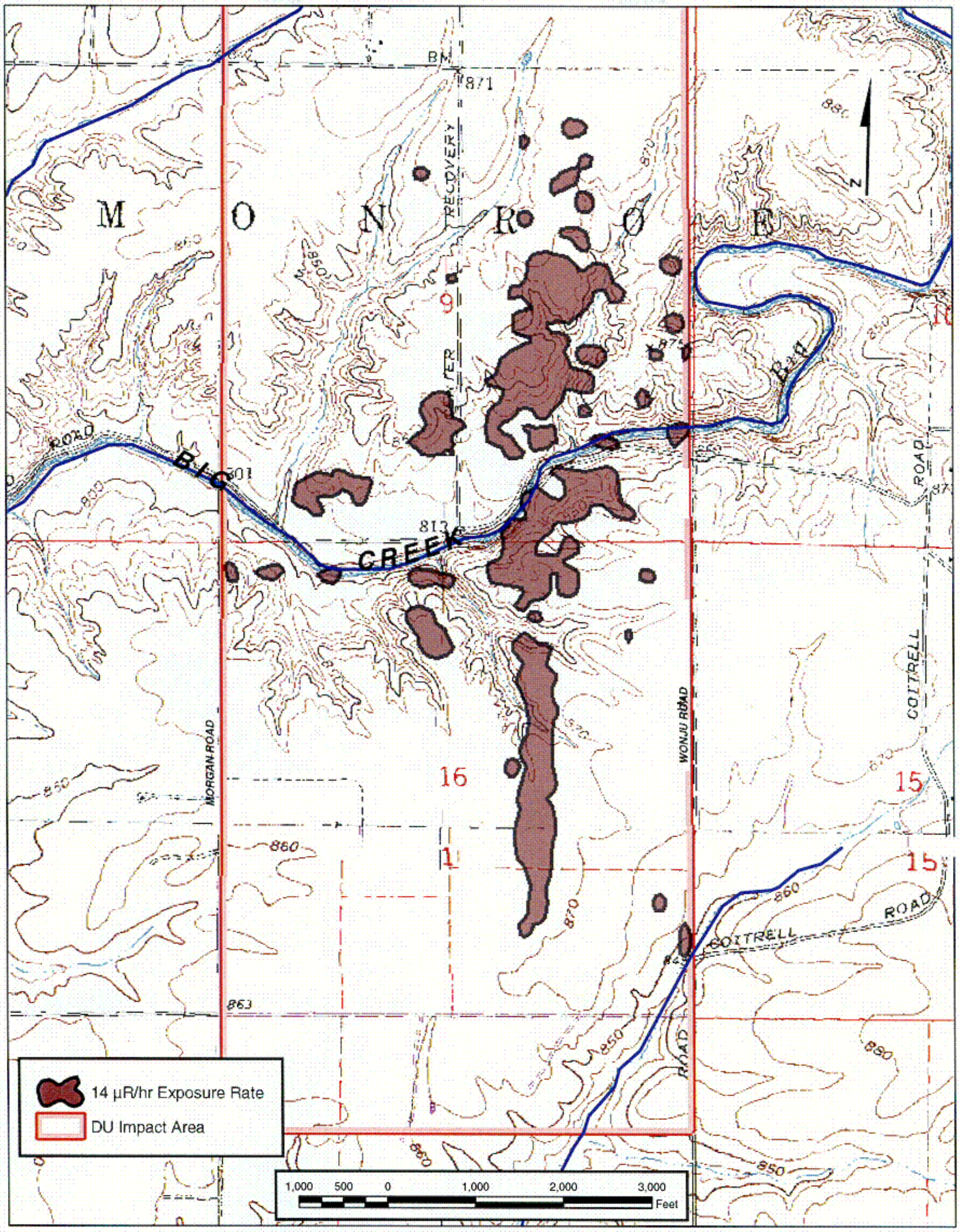

Figure 4. Map Showing the DU Impact Area and Two Areas Used as the Contaminated Zone for RESRAD Simulations

(The DU Impact Area lies within the red boundaries; the contaminated zone of 1.2×10^6 m^2 lies within the polygon outlined by the black lines; and the contaminated zone of 5×10^5 m^2 is the sum of the area within the irregular gray shapes. The scale bar on the bottom of the map is 1000 ft.)

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of Agriculture (USDA) 1997]. Adequate surface and groundwater resources ensure a regular water supply, including the Ohio River, which flows within 20 km (10 miles) of the south boundary of JPG. The JPG area is now forested with various hardwoods, herbaceous cover, and grasses, and supports a large population of game animals, non-game mammals, aquatic life, and reptiles. Between the late 1800s and 1943, JPG lands were cleared of timber and farmed extensively, but returned to a forest ecosystem after the U.S. Government took control of the area in World War II. The JPG reservation is cut from east to west by several rivers, notably Big Creek that flows through the DU Impact Area. Trenches were carved from south to north by munitions impacts that removed trees. The trenches or firing lines are enclosed within the DU Impact Area.

Soils of the area are derived mainly from glacial till covered by up to one meter (m) of loess (Nickell 1985). Strongly indurated horizons or fragipans can form as a result of the combination of loess over till and the annual precipitation of 1 m [40 inches (in.)] or more. Low permeability and conductivity of fragipans restrict water movement through these horizons, and ponding is a common occurrence in wet seasons on the site. The major soil series of the DU Impact Area at JPG is Cobbsfork silt loam (fine-silty, mixed, mesic Typic Ochraqualf), located on nearly flat plains with co-occurrence of Cincinnati silt loam, Avonburg silt loam, Grayford silt loam, and Ryker silt loam as the slope of the landscape becomes steeper (Nickell 1985). The Cobbsfork series poses only slight erosion hazard due to the mainly flat slope, and is good for pond construction due to the relatively low permeability of the fragipans. However, Cobbsfork silt loam is severely limited for septic applications and building sites because of the poor drainage, and these soils are difficult to develop for recreational purposes for the same reason (Nickell 1985). These soils are at least a meter deep on average, and unsaturated subsoils extend to a maximum of 6 to 7 m in depth in some cases. Shallow bedrock formations include limestone with interbeds of pyritic shale, and these are commonly observed in stream sediments, bank cuts, and road cuts in and around JPG. Water movement into and through the soil and deeper geologic media is assumed to be parallel to the flow of the main streams (e.g., Big Creek). Detailed hydrologic studies have not been conducted, but previous work showed that subsurface water flow is in the direction of the streams (Rust 1994, 1998). Soil properties important for dose estimation are discussed below.

3.3.2 Conceptual Site Model

As indicated above, JPG is undergoing reforestation after approximately 50 years of intense agriculture. The maturing woodland supports a variety of terrestrial and aquatic wildlife, and previous munitions testing at JPG has clearly resulted in deposition of large amounts of DU fragments. Exposure to DU of the many resources within the DU Impact Area can occur by several pathways. Figure 5 is a summary of the processes that control DU transport and migration at JPG and a list of potential exposure pathways.

In principal, DU transports and migrates by a variety of processes after deposition in soil (Figure 5). DU can dissolve within the soil and leach to groundwater; the dissolved DU can react with soil minerals that slow its transport to groundwater; and soluble DU can be taken up by plant roots and incorporated into various plants. Since plants grow in the soils that are contaminated, ingestion of plants by animals necessarily includes incidental ingestion of DU-contaminated soil. In addition, soils are also susceptible to wind and water erosion and transport (Whicker et al. 2002); thus, DU could be transported through the air or moved into surface waters by various erosion processes, and Williams et al. (1998) discuss transport of contaminants by smoke from fires. Finally, DU may transport with groundwater to drinking water supplies, or be used as well-derived irrigation water. Irrigation water is, thus, a mechanism by which some of the transported DU is recycled to the soil as well as a source for DU to plants that are irrigated. Doses to humans and ecosystem receptors can come from any number of exposure pathways beginning when the munitions are tested and lasting until DU is removed from the system. Thus, the dose to humans from DU must be assessed for a variety of pathways, and for a relatively long time due to slow transport through soils.

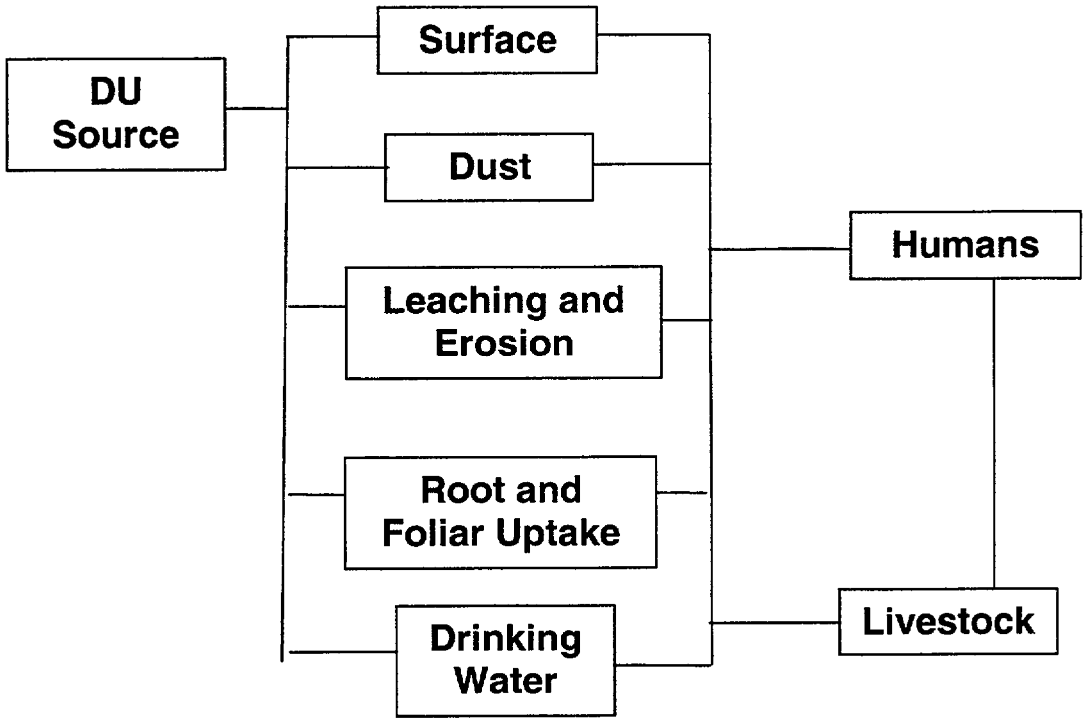

Figure 5. Conceptual Model of DU Transport Through Environmental Compartments to Humans (after Yu et al. 2001)

3.4 SOURCE TERM CHARACTERIZATION

Source term characterization is addressed in this section. Section 3.4.1 to 3.4.3 present the contaminated zone, DU soil concentrations, and the source term for off site exposure estimates, respectively.

3.4.1 Contaminated Zone Delineation

The source term for RESRAD simulations is assumed to be located in a specific area within a given depth of soil and is of uniform concentration throughout the area. For JPG, the contaminated zone is the area within the DU Impact Area (Figure 4) that contains DU concentrations greater than background concentrations as defined by scoping and characterization survey data (SEG 1995, 1996a,b). The DU Impact Area is located in the south–central part of the JPG reservation north of the firing line and covers approximately 2,080 acres (8.4 km^2)(Figure 4). The scoping and characterization survey data indicate that the actual area contaminated by DU fragments is considerably smaller than the entire impact area. Field observations throughout the period of 1984 through 1999 also indicate that DU contamination is restricted mainly to the main firing corridors and areas surrounding the trenches that formed on the main firing lines as a result of DU testing. Two estimates of the contaminated zone were derived from the characterization survey data (SEG 1995, 1996a) and range from 5×10^5 m^2 to 1.2×10^6 m^2. The smaller area, 5×10^5 m^2, was based on radiation survey data from a grid of sampling points within the DU Impact Area. Most of the survey measurements were not significantly different from uncontaminated areas, but about 5 percent (%) of the samples exceeded 13.3 μR hr^{-1} and were assumed to be the result of residual radiation from DU fragments. In addition to the survey measurements and the determination that 95% of the area surveyed was less than the 13.3 μR hr^{-1} value, a guideline of 35 pCi g^{-1} of soil was used to delineate the contaminated zone. This value was established as a guideline in the JPG license agreement and is based on a 1961 Nuclear Regulatory Commission (NRC) Notice (*Federal Register* Vol. 48, No. 25, Oct. 23, 1961). The guideline value corresponds to approximately 14.4 $\mu R\ hr^{-1}$ (SEG 1996a); thus, the 13.3 $\mu R\ hr^{-1}$ estimate for the area contaminated by DU fragments includes those areas that would also exceed 35 pCi g^{-1} for remediation purposes. The area greater than 13.3 $\mu R\ hr^{-1}$ criterion is approximately $5 \times 10^5\ m^2$ (SEG 1996a). For the purposes of the RESRAD simulations, this contaminated zone is described by a polygon that extends about 1,000 m north to south and 500 m east to west (Figure 4). This rectangle eliminates some of the areas that are less than 13.3 $\mu R\ hr^{-1}$ and may be unrealistically shaped for the RESRAD simulations. The result of using this size and shape for the contaminated zone, though, should over-estimate the potential exposure to humans by increasing the average soil concentration throughout the contaminated zone. This contaminated area falls mainly along the firing corridors as shown by SEG maps (Figure 4; SEG 1996a, Figure 5-2).

The SEG surveys (SEG 1996a) indicate that areas with measured rates less than 13.3 $\mu R\ hr^{-1}$ separated those areas along the firing corridors that exceeded the 13.3 $\mu R\ hr^{-1}$ criterion. Thus, a more realistic contaminated area was estimated by including these areas and increasing the size of the polygon that describes the contaminated zone (Figure 4). Because of this, an upper bound of $1.2 \times 10^6\ m^2$ was estimated for the contaminated zone. Each of the contaminated zone areas was incorporated into the RESRAD simulations to provide exposure estimates under a range of realistic initial conditions.

3.4.2 DU Concentration in Soil

The average concentration of DU fragments in the soil was estimated from (1) environmental monitoring data collected between 1984 and 1995; (2) data collected during the 1995 and 1996 surveys (SEG 1995, 1996a); and (3) by assuming an inventory of 70,000 kilograms (kg) of DU fragments remains in the impact area after the testing program was completed and JPG was closed. The latter estimate of DU inventory was derived from accounts of the amount of DU fired at the site adjusted for DU fragments that were collected and disposed of before base closure occurred in 1995. Based on these data and the analyses conducted by SEG (1995, 1996a), the soil concentrations of DU within the contaminated zone are bounded by 94 pCi g^{-1} from a contaminated zone of $1.2 \times 10^6\ m^2$ to 225 pCi g^{-1} from a contaminated zone of $5 \times 10^5\ m^2$ (Table 2).

Table 2. Estimated Areas of the Contaminated Zone and Corresponding Average Concentrations of DU in Soil

Area of Contaminated Zone (m^2)	Average Soil Concentration (pCi g^{-1})
5×10^5	225
1.2×10^6	94
2.8×10^6	40

Note: Average soil concentration assumes an inventory of 70,000 kg of depleted uranium is uniformly distributed in the top 15 centimeters of the soil.
g = gram.
m^2 = square meters.
pCi = picocurie.

The 70,000-kg inventory is the upper limit of soil concentrations of DU for the RESRAD simulations. Using this inventory, a fixed depth of the contaminated zone soil, and a specific soil bulk density, the area of the contaminated zone can be calculated. Use of this approach, however, may not account for the actual distribution of DU fragments along the firing lines and the variation of soil bulk density and other soil properties across a site. Using a bulk density of 1.6 grams per cubic centimeter (g/cm^3) and depth of 15 centimeters (cm), a range of contaminated zone areas could be calculated for a variety of soil concentrations. The relationship between the size of the contaminated zone and average soil concentration is shown in Table 3.

Table 3. Effect of Average Soil Concentration on Size of the Contaminated Zone for RESRAD Simulation

Average Concentration ($pCi\ g^{-1}$)	Contaminated Zone Area (m^2)
10	1.1×10^7
20	5.6×10^6
35	3.2×10^6
100	1.1×10^6
240	4.7×10^5

Note: The contaminated zone area is determined by (1) total DU inventory of 70,000 kg remaining in the impact area and (2) a contaminated zone that is 15 cm thick.
g = gram.
m^2 = square meters.
pCi = picocurie.

The depth of the contaminated zone has been difficult to establish, but two estimates support a depth of 15 cm. Previous data of DU concentrations with depth from Aberdeen Proving Ground and Yuma Proving Ground (Ebinger et al. 1995) show that DU was detected to about 20 cm, and at 20 cm the concentrations were nearly at background levels. In a separate analysis of DU activity with depth, SEG (1996a) showed that the 35 $pCi\ g^{-1}$ concentration was achieved if approximately 11 cm of contaminated soil were removed from the contaminated area. Additional analysis of the DU concentrations in soil under penetrators lying on the surface indicates that 97% of the total DU in the top 60 cm of the soil is found between the surface and 15 cm depth (Table 4). Data from random locations within the DU Impact Area indicate that little, if any, DU is detected outside the firing corridor at any depth, and the concentration of the U that is detected at these locations does not vary significantly with depth (Table 5). It is noted, though, that DU concentrations in some locations are at least greater than the detection limit, and this information supports the idea that a fraction of the deposited DU fragments leach into the soils (SEG 1996a). Also, penetrator fragments at depths below 45 cm have been observed and result from deep impacts within the DU Impact Area. These occurrences, however, are the exception to what is usually observed in the field and in the data from soil samples. Thus, from the analyses of DU concentration data, the 15 cm depth appears to contain most of the DU deposited during testing at JPG and was selected as the contaminated zone depth for these tests.

Table 4. DU Concentrations in Soil Beneath Penetrators on the Surface

Sampled Depth (cm)	Average Concentration ($pCi\ g^{-1}$)	Minimum Value ($pCi\ g^{-1}$)	Maximum Value ($pCi\ g^{-1}$)	Standard Deviation ($pCi\ g^{-1}$)	Percent of Total DU
0 to 15	2,881	2.9	12,318	3,470	96.7
15 to 30	79.5	1.5	547	131	2.7
30 to 45	12.7	1.8	63	16.4	0.4
45 to 60	4.6	1.4	11.5	3.4	0.2

Note: See SEG 1996a for raw data.
cm = centimeter.
DU = depleted uranium.
g = gram.
pCi = picocurie.

Table 5. DU Concentrations in Soil at Random Locations Within the DU Impact Area

Sampled Depth (cm)	Average Concentration (pCi g^{-1})	Minimum Value (pCi g^{-1})	Maximum Value (pCi g^{-1})	Standard Deviation (pCi g^{-1})
0 to 15	2.6	1.46	4.73	0.9
15 to 30	2.4	1.51	6.94	1.21
30 to 45	2.0	1.34	4.21	0.68

Note: See SEG 1996a for raw data.
cm = centimeter.
DU = depleted uranium.
g = gram.
pCi = picocurie.

3.4.3 Source Term for Off-Site Exposure Estimates

A modified source term also is needed for estimation of doses associated with off-site exposures. The initial source term, as defined above, was used, and transport of this source material via wind, surface water (i.e., sediment deposition during flooding), and groundwater to off-site locations was considered the source term for off-site exposures. Sediment eroded from the contaminated zone can be transported by surface water (e.g., Big Creek) and deposited downstream. Simulation of sediment transport during floods was conducted in order to evaluate the magnitude of this process and integrate the results into dose assessments of off-site receptors. Attachment 1 is the flood analysis and sediment yield estimates for the western boundary of JPG. Concentrations of uranium in Big Creek water were estimated using surface water flow rates and erosion rates estimated in the flood analysis. Contamination of off-site soil was assumed to occur via use of water from Big Creek for irrigation.

3.5 ENVIRONMENTAL PATHWAYS

The CSM (Figure 4) shows the processes that control DU transport and migration from soil to groundwater, surface water, and different biotic receptors. Figure 6 identifies specific environmental pathways from DU source to humans. Exposure can occur through external radiation of humans; inhalation of airborne, DU-containing dust; and/or ingestion of DU via the human food chain or drinking water.

Direct exposure results from radiation received via DU fragments in the soil as the uranium isotopes and daughter products decay to stable isotopes (Shelien 1992). Much of the radiation is absorbed by soil minerals, soil water, and within the media through which the decay products travel. The small fraction of radiation that reaches human receptors can be absorbed by the skin and results in external doses to humans. Inhalation of DU can occur when DU-containing soil is lifted from the soil surface and remains airborne long enough to enter the lungs of a receptor. For this environmental pathway to be effective, the receptors must be close enough to the contaminated zone during the time when DU-containing dust is airborne. Also, the dose is proportional to the distance from the source so more dose is expected from on-site exposure than from off-site. Both external exposure and exposure from inhalation affect on-site and off-site receptors. However, since both depend on the time spent at the source area and the distance from the source area, on-site receptors will be more affected than off-site receptors by this pathway.

Ingestion of DU can occur through a variety of environmental pathways (Figure 6). Uptake by plants through roots and foliar deposition are the main mechanisms of transfer to plant material. Contaminated plants can be fed to livestock as fodder; contaminated beef, poultry, or dairy products could then be consumed by humans. Also, contaminated plants, such as vegetables from a summer garden or a subsistence farm, can be directly consumed by humans. Thus, the DU source-plant-livestock-human and

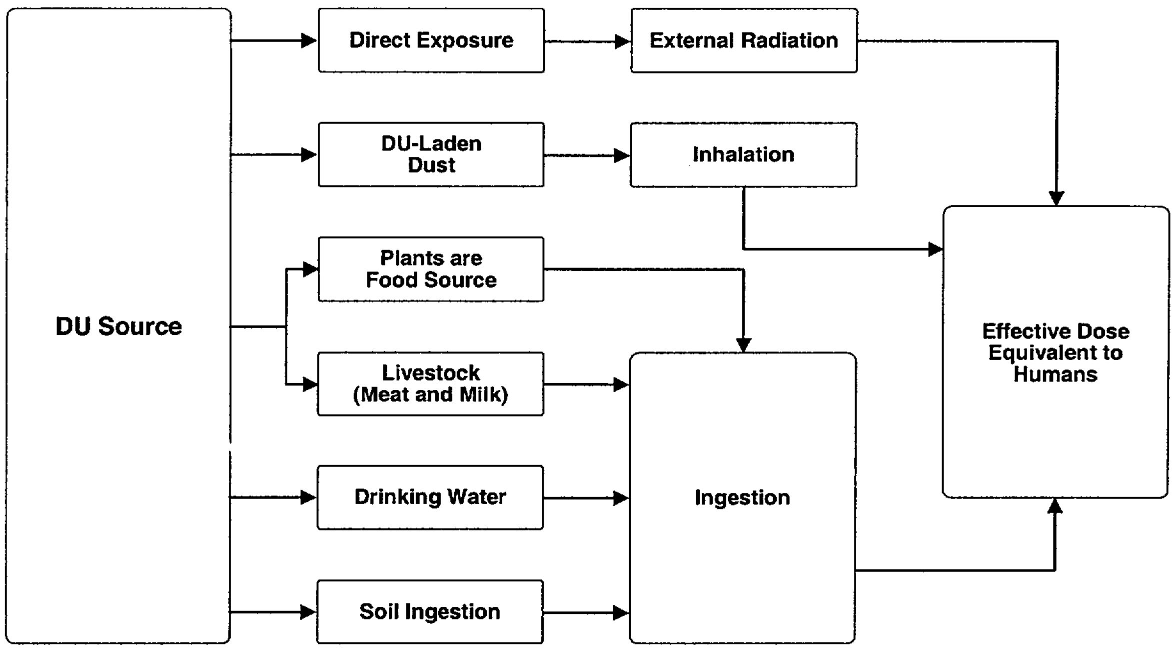

Figure 6. Schematic Diagram of RESRAD Program Illustrating Environmental Pathways of Exposures

DU source-plant-human pathways are important to consider in risk estimates. These pathways are particularly important to the farming and domestic scenario described below.

Soil ingestion can also be a significant environmental pathway with regard to dose estimates. Humans can be exposed by this pathway directly by incidental ingestion of DU-containing soil on vegetables or other food products that contact contaminated soil. Indirectly, contaminated soil can be ingested by livestock and passed to humans via poultry, beef, and dairy product consumption. Because of the potentially large contribution to total dose from direct and indirect soil ingestion, these pathways are modeled below.

Contamination of drinking water by DU leaching through soil to aquifers is an environmental pathway that could affect humans off-site and on-site for considerable periods. DU transport by physical means, such as erosion of soils and deposition away from the contaminated zone by streams, is a pathway considered. Also considered is dissolution of DU from fragments and transport via soil water to aquifers used for irrigation, drinking water, or both. Effects of this pathway could show up early in the dose estimations or many years in the future depending on the hydrologic characteristics of the soils of the contaminated zone and underlying geology. The effects of the contaminated groundwater pathways include ingestion of water by livestock, then passing the DU to humans through beef, poultry, and dairy products. A second effect is the direct exposure of humans through drinking water. Both types of environmental pathways are included in the dose modeling below. While the drinking water pathway is included in the dose modeling, the quality of water from shallow groundwater wells was not considered. Some data (Rust 1994, 1998) indicate that the quality of water is below drinking water standards because of sediment or other contaminants not related to DU, and these low-quality waters occur at the depths included in the modeling. Low-quality water would mean that deeper wells are required, and this would also decrease the amount of DU in drinking water and decrease the potential dose to receptors at JPG.

Surface water can also be contaminated by DU transported by water erosion as well as contaminated groundwater flowing into ponds or streams that are used by humans. Contaminated surface water can enter the human food chain indirectly as livestock drinking water or directly through the drinking water supply as discussed above for groundwater. In addition, fish raised in ponds that contain contaminated water represent an additional pathway to humans. The DU-surface water-fish-human pathway is included in the dose modeling presented below.

Environmental pathways for on-site and off-site receptors differ mainly in the source term used for the calculations. On-site receptors are assumed to be in proximity to the contaminated zone, either occasionally as hikers, hunters, or fisherman, or daily as resident farmers. Off-site receptors are exposed to similar environmental pathways as on-site receptors, but because the source term has been reduced by transport processes (Figures 4 and 5), the magnitude of the expected doses will be proportionally less. Thus, the amount of DU contamination in the external, inhalation, and ingestion pathways would be considerably less than the same pathways for on-site exposure. Because of the contact with the contaminated zone, via multiple pathways in some of the scenarios, the potential exposure of on-site receptors would be greater than exposure of off-site receptors.

3.6 CRITICAL GROUPS

The various human receptors mentioned above depend on exposure of the average member of the hypothetical critical group. For this report, the critical group is defined as a group of individuals that is expected to receive the largest exposure to DU within the DU Impact Area. The average member of that group is a person expected to receive the dose from an ordinary use of the site based on the exposure scenario. Since each scenario developed is different and the critical group for a particular scenario varies accordingly, a more specific average member of the critical group is given in the scenario descriptions. For example, the average member of the critical group might be an individual worker who spends half of his or her work days on-site and the other half inside a building, or the average member of the critical group might be the farmer who is involved in the daily operations of a working subsistence farm located within the contaminated zone. Each critical group, then, is defined for each scenario, and the average member, to which the dose estimates apply, is specified in the description tables.

3.7 EXPOSURE SCENARIOS FOR JPG DOSE ESTIMATES

The risk of adverse effects to human health from inhalation, ingestion, or external radiation from DU fragments depends on credible exposure scenarios from the DU source through the environment to human receptors. Several potential exposure scenarios were considered, and from these a subset was developed to simulate the most reasonable exposures of humans using the lands surrounding the DU firing at JPG. Two sets of scenarios are developed: (1) those in effect while institutional controls are in place (Section 3.7.1), and (2) those in effect if institutional controls fail (Section 3.7.2). Two radiation dose limits are also in effect for the types of scenarios: 25 mrem y^{-1} is imposed in Section 1403 of 10 *CFR* Part 20 when institutional controls are in place, whereas the dose limit is 100 mrem y^{-1} if institutional controls fail. These dose limits do not replace the ALARA concept, that is, that radiation exposure will be kept as low as reasonably achievable and will be no more than the specified dose limit. Potential exposure scenarios are listed in Table 6 (institutional controls in place) and Table 7 (institutional controls failed), and each is considered for inclusion in the set of scenarios selected for analysis.

3.7.1 Institutional Controls in Effect

Institutional controls are methods to restrict access to specific areas. Physical controls in place at JPG consist of 7 ft (2.1 m) high, chain-link fence topped with V-shaped three-strand barbed wire around the perimeter of the site north of the former firing line and locked swing gates on all roads providing access to the DU Impact Area. In addition to these physical controls, administrative access control will be maintained by U.S. Fish and Wildlife (FWS) personnel in charge of the Big Oaks NWR. Physical controls will minimize the amount of contact the general public has with JPG lands, whereas the administrative controls will provide the forum needed to address safety and health issues related to site use. The scenarios described below are consistent with this concept of institutional controls at JPG.

The main characteristics of the exposure scenarios when institutional controls are in place are that exposures are limited because site use and site access are limited. In these scenarios, one of the more plausible receptors is the FWS personnel who work access control points regularly. With limited access beyond the site boundary (i.e., the fence that begins north of the former firing line and encloses the north end of JPG), scenarios that account for periodic exposure were developed and are described below. These scenarios include periodic hunting of deer and/or turkey within the institutionally controlled area and then consuming these game animals, and periodic fishing with consumption of the fish. Hunting is currently allowed on-site twice each year, and a similar arrangement for fishing is not unreasonable. Exposure of hikers, bicyclists, bird watchers, and other participants in outdoor activities has also been described below. Also included are potential exposures for farmers and homeowners who live at the site boundary and are considered off-site.

Table 6. Potential Exposure Scenarios with Institutional Controls in Place[a]

Scenario Number	Scenario Name	Description and Critical Group Identification	Exposure Pathways	Analyzed in DP?	Justification if not analyzed
1	On-site Worker	The critical group spends up to 4 days each month in the vicinity of the DU Impact Area for activities related to operation of the site.	External exposure: DU in soil. Inhalation: Resuspension of DU-containing dust. Ingestion: (1), (2) incidental ingestion of DU-containing soil; and (3) no pathways from drinking water, crops, or livestock.	Yes	
2	On-site Hunter	The critical group spends a limited amount of time on-site for hunting. Hunting period is two 1-week periods per year, and game consumed replaces all dietary meat each year. Hunting does not occur in the DU Impact Area. Game is either deer or turkey.	Ingestion: (1) Consumption (off-site) of game animals that feed in contaminated area is the only exposure pathway	Yes	
3	Off-site Fisherman	The critical group spends a limited amount of time off-site for fishing in Big Creek. Fishing period is 32 hours per month (4 days) for 3 months, or 12 days each year. Fish taken on-site will replace all dietary fish.	Ingestion: (1) Consumption (off-site) of fish obtained from water of Big Creek contaminated by (2) no pathways from drinking water, crops, or livestock.	Yes	

Table 6. Potential Exposure Scenarios with Institutional Controls in Place (Continued)

Scenario Number	Scenario Name	Description and Critical Group Identification	Exposure Pathways	Analyzed in DP?	Justification if not analyzed
4	Off-site Resident Farmer	The critical group is a family that lives on a farm at the institutional boundary of JPG. This farm is approximately 2.5 km (1.5 mi) from the DU Impact Area. Family raises all crops and livestock for consumption with minimal sources of commercial food products. Family lives near Big Creek, uses water from Big Creek for irrigation and drinks well water down-gradient of JPG. Location of farm is Node 13 in Figure 1 of Attachment 1.	External exposure: DU in soil deposited from irrigation with water from Big Creek. Inhalation: Resuspension of DU-containing dust. Ingestion: (1) Crops, meat, and milk from livestock raised on soils contaminated by irrigation; (2) fish from stream or pond contaminated by DU leaching through soil and transporting from JPG; (3) incidental ingestion of DU-contaminated soil; and (4) use of drinking water that contains DU from JPG.	Yes	
5	Off-site Boundary Recreationist	The critical group spends a limited amount of time at the JPG boundary but remains off-site. Activities could include hiking, camping, hunting, or other outdoor activities. Recreationists would not have access to JPG area under institutional control.	Ingestion: Consumption of game animals or fish that grazed, browsed, or lived in contaminated area at JPG; incidental ingestion of DU-containing soil deposited from irrigation; and no pathways from drinking water, crops, or livestock.	No	Scenarios 2 and 3 (Hunting and Fishing) are equivalent to this exposure scenario

Table 6. Potential Exposure Scenarios with Institutional Controls in Place (Continued)

Scenario Number	Scenario Name	Description and Critical Group Identification	Exposure Pathways	Analyzed in DP?	Justification if not analyzed
6	Off-site Boundary Recreationist (Hunter)[b]	The critical group spends a limited amount of time near the site boundary for hunting. Hunting period is two 1-week periods per year, and game consumed replaces all dietary meat each year. Game is either deer or turkey. Game assumed contaminated by grazing on-site and migrating off-site.	Ingestion: (1) Consumption (off-site) of game animals that grazed from contaminated area; and (2) no pathways from drinking water, crops, or livestock.	No	Exposure to this group already bounded by exposures evaluated in Scenario 2.
7	Off-site Part-time Resident	The critical group lives in a cabin or vacation home up to 50% of the year. All food is assumed uncontaminated and comes from off-site; drinking water from municipal source.	External exposure: DU in soil deposited by irrigation with water from Big Creek. Inhalation: Resuspension of DU-containing dust. Ingestion: Incidental ingestion of DU-contaminated soil deposited by irrigation.	No	Bounded by Scenario 4.

Table 6. Potential Exposure Scenarios with Institutional Controls in Place (Continued)

Scenario Number	Scenario Name	Description and Critical Group Identification	Exposure Pathways	Analyzed in DP?	Justification if not analyzed
8	Off-site Part-time Resident, Mod. 1	The critical group visits a home site periodically each year and lives in a cabin or vacation home up to 4 months each year. All food assumed uncontaminated and comes from off-site; drinking water from municipal source. Residents grow vegetables in small garden that is irrigated with water from a well at the site boundary or approximately 2.5 km (1.5 mi) from DU-contaminated area.	External exposure: DU in soil contaminated by irrigation with water from Big Creek. Inhalation: Resuspension of DU-containing dust. Ingestion: Incidental ingestion of DU-contaminated soil; and irrigated vegetable crops in season.	No	Bounded by Scenario 4, Table 7.
9	Off-site Industrial Worker	Critical group works indoors in a building at the site boundary. Drinking water supplied by a well that could be affected by contaminated zone leaching. Work ranges from office jobs to heavy industrial jobs. Scenario covers exposure to U.S. Fish and Wildlife Service personnel or other administrators.	External exposure: DU in soil deposited by irrigation with water from Big Creek. Inhalation: Resuspension of DU-containing dust. Ingestion: (1) Incidental ingestion of DU-contaminated soil deposited by irrigation; and (2) drinking water from well.	Yes	

Table 6. Potential Exposure Scenarios with Institutional Controls in Place (Continued)

Scenario Number	Scenario Name	Description and Critical Group Identification	Exposure Pathways	Analyzed in DP?	Justification if not analyzed
10	Off-site Industrial Worker	People who work indoors at the site boundary (e.g., in the cantonment area), JPG. Drinking water from well that is 5 mile from JPG. Work ranges from office jobs to heavy industrial jobs.	External exposure: DU in soil deposited by irrigation with water from Big Creek. Inhalation: Resuspension of DU-containing dust. Ingestion: (1) Incidental ingestion of DU-contaminated soil deposited by irrigation; and (2) consumption of DU-containing water from well.	No	Bounded by Scenario 9.
11	City Resident	People who live in Bedford, IN and use water originating from Big Creek.	Ingestion: (1) Consumption of drinking water-contaminated by soil eroded from the DU Impact Area	Yes	

[a]RESRAD input and output data are available on CD upon request to the U.S. Army SBCCOM.
[b]Replacement of meat with game follows Ferenbaugh et al. (2002).
Note: Dose limit is 25 mrem y^{-1}.
DU = depleted uranium.
JPG = Jefferson Proving Ground.

Table 7. Potential Exposure Scenarios Following Loss of Institutional Control[a]

Scenario Number	Name	Description	Exposure Pathways	Analyzed in DP	Reason not analyzed
1	Resident Farmer, without irrigation[b]	Critical group is a family who moves onto site after institutional controls fail. They have their home on-site and raise crops and livestock for family consumption. This scenario represents the maximum likely exposure to the person outside the most, often tending the farm.	External exposure: DU in soil. Inhalation: DU-containing dust. Ingestion: (1) Crops, meat, and milk from livestock raised on DU-contaminated soil; (2) fish from stream or pond contaminated by DU leaching through soil; (3) incidental ingestion of DU-contaminated soil; and (4) drinking water that contains DU.	Yes	
2	Resident Farmer, with irrigation[b,cb]	Scenario is same as #1, but the crops require irrigation.	External exposure: DU in soil. Inhalation: DU-containing dust Ingestion: (1) Crops, meat, and milk from livestock raised on DU-contaminated soil; (2) fish from stream or pond contaminated by DU leaching through soil; (3) incidental ingestion of DU-contaminated soil; (4) drinking water that contains DU; and (5) crops, meat, and milk depend on contaminated irrigation water.	Yes	

Table 7. Potential Exposure Scenarios Following Loss of Institutional Control (Continued)

Scenario Number	Name	Description	Exposure Pathways	Analyzed in DP	Reason not analyzed
3	On-site Hunter	People who spend a limited amount of time on-site for hunting. Hunting period is two 1-week periods per year, and game consumed replaces 50% of dietary meat each year. Game is either deer or turkey. Assume hunting occurs in DU Impact Area.	External exposure: DU in soil. Inhalation: DU-containing dust. Ingestion: (1) Consumption (off-site) of game animals obtained from contaminated area; (2) incidental ingestion of DU-containing soil; and (3) no pathways from drinking water, crops, or livestock.	Yes	
4	On-site Fisherman	People who spend a limited amount of time on-site for fishing. Fishing period is 32 hours per month (4 days) for three months, or 12 days total. Fish taken on-site will replace all dietary fish. Assumes fishing occurs in DU Impact Area	External exposure: DU in soil. Inhalation: DU-containing dust Ingestion: (1) Consumption (off-site) of fish obtained from contaminated stream or pond; (2) incidental ingestion of DU-containing soil; and (3) no pathways from drinking water, crops, or livestock.	No	Exposure identical with Scenario 3 (Table 6). This scenario and Scenario 3 (Table 6) represent more likely exposures to DU than from farming in Scenario 1.
5	Domestic[b]	Critical group lives in houses within area formerly under access control and grows vegetables for home consumption in summers. Water from well located at DU-contaminated area boundary.	External exposure: DU in soil. Inhalation: DU-containing dust. Ingestion: Consumption of fish obtained from contaminated stream or pond; incidental ingestion of DU-containing soil; drinking water and vegetables; and no pathway from livestock.	Yes	

Table 7. Potential Exposure Scenarios Following Loss of Institutional Control (Continued)

Scenario Number	Name	Description	Exposure Pathways	Analyzed in DP	Reason not analyzed
6	Part-Time Domestic[b]	The critical group visits a home site periodically each year and lives in a cabin or vacation home up to 4 months each year. All food assumed uncontaminated and comes from off-site; drinking water from municipal source. Residents grow vegetables in small garden that is irrigated with water from a well at the site boundary or approximately 2.5 km (1.5 mi) from DU-contaminated area.	External exposure: DU in soil. Inhalation: DU-containing dust. Ingestion: Incidental ingestion of DU-contaminated soil; and irrigated vegetable crops in season.	Yes	

[a]RESRAD input and output data are available on CD upon request to the U.S. Army SBCCOM.
[b]Scenario is unlikely because of significant risk of injury to farmer from unexploded ordnance.
[c]Irrigation of farms in southern Indiana is rare (U.S. Department of Agriculture Stats.) but is included in this scenario for completeness.
Note: Dose limit is 100 mrem y^{-1}.
DP = Decommissioning Plan.
DU = depleted uranium.

The scenarios listed in Tables 6 and 7, while representative of a wide range of potential exposures, contain common pathways. The following scenarios from Table 6 were not included in the RESRAD simulations, and reasons for elimination are given. Scenario 5 was eliminated because doses from off-site recreationists are covered by Scenario 2 (hunters) and Scenario 3 (fisherman). Scenario 6 was eliminated because it is bounded by analysis of Scenario 2. Scenarios 7 and 8 were eliminated mainly because the two are variations of the same exposure scenario, with potentially larger exposure to receptors in Scenario 4. Scenario 10 was eliminated because Scenario 9 accounts for exposures from the same environmental pathways but at higher doses in Scenario 9. Scenario 12 was included to provide an estimate of population dose due to consumption of drinking water potentially contaminated by erosion of the DU Impact Area.

There are concerns about DU transport in the smoke that occurs during controlled burning at JPG and subsequent doses to receptors via this pathway. The RESRAD modeling program does not specifically address inhalation of DU-containing smoke as an environmental pathway. Nonetheless, such a pathway could be approximated via the inhaled dust pathway and altering the mass loading for foliar deposition, but at the cost of increasing uncertainty in the estimated doses. As a preface to such modifications and to evaluate if the added uncertainty was justified, exposure to radionuclides (including DU in smoke from fires) was reviewed. There is some evidence that DU and other natural and anthropogenic radionuclides could transport considerable distances and result in small doses to receptors as a result of physical disturbances (Kerekes et al. 2001; Royal Society 2002a, 2002b). Total radioactivity increased in smoke from fires related to battle (Royal Society 2002b), controlled burns, and wildfires (Williams et al. 1998; Johansen et al. 2001; Kraig et al. 2001a,b), but the increased radionuclide concentrations did not result in significant doses to receptors. For example, Kraig et al. (2001a,b) showed that estimated doses to firefighters at the scene of a fire that lasted several days was approximately 0.2 mrem, whereas to people away from the fire scene, the estimated dose was approximately 0.06 mrem. These small increases in doses to various receptors were dominated by naturally occurring radioactive materials such as U in soils and/or worldwide fallout (Kraig et al. 2001a; Kerekes et al. 2001; Royal Society 2002b). While transport by smoke is a possible mechanism of DU transport, the small increase in expected dose to humans and the uncertainty introduced from modifications of the modeling program do not justify including this pathway in the present dose assessment. Thus, doses from DU transported by smoke during fires was not evaluated.

Scenarios included for analysis while institutional controls are in place are: (1) on-site worker, (2) on-site hunter, (3) off-site fisherman, (4) off-site resident farmer, (5) off-site industrial worker and (6) off-site member of the population. Table 6 shows the potential exposures that could affect the critical group of each scenario and the environmental pathways by which this exposures could occur.

3.7.2 Loss of Institutional Controls

Loss of institutional control implies failure of physical and administrative access control to the JPG lands north of the firing line. Site characteristics are such that the land could be farmed, developed, or used as habitat for wildlife or to support outdoor activities similar to those permitted at JPG as discussed above. However, even though institutional controls are assumed to fail, removal of UXO scattered throughout the JPG lands is not assumed. Thus, estimating all risks involved with using the JPG lands must include potential exposure to DU fragments in soil and water as well as potential injury and death from UXO-related encounters. The former risks will be estimated in this report, but the latter are beyond the scope of this work and are not be assessed as part of this Decommissioning Plan.

Because of the presence of millions of UXO items and with no plans to remove the UXO from JPG lands north of the firing line, intense activities, such as farming or development for residential homes or industry, are not realistic land uses. However, farming and development are considered as potential DU exposure pathways and are included in the tested scenarios. Transport of DU by groundwater, surface water, soil erosion, and uptake by plants and animals is similar to that discussed above when institutional controls are in place. The main difference in the scenarios considered if institutional controls fail, besides probable exposure to UXO, is the proximity to the DU Impact Area where farming, residential development, or recreational use can take place. The farming scenarios described below assume that a resident farmer lives all year in a house built on the DU Impact Area and supports a family on produce and livestock on-site. Part-time residential scenarios assume that residents live part of the year in houses built on the DU Impact Area and grow vegetables during the summer (4 months) for consumption at home. Recreational uses of the lands are similar to those listed above (Table 6) except that the DU Impact Area is accessible. Table 7 lists the scenarios, potential exposure pathways, and if the scenario is included in risk estimates, or if not, why the scenario was eliminated from the dose estimates.

Scenarios selected for analysis when institutional controls fail are listed in Table 7. All scenarios were included for RESRAD analysis because they represent potential exposure to humans under scenarios not included when institutional controls are in place. Resident farmers, without and with irrigated crops, were one such scenario and are analyzed as Scenarios 1 and 2, respectively (Table 7). The on-site hunter encounters more exposure pathways in the case of loss of institutional controls than in the case of effective institutional controls. Domestic residents and part-time residents (i.e., summer vacationers) were also included for further analysis (Scenarios 5 and 6, Table 7). These scenarios cover exposure by the same environmental pathways as in Table 6, but with different magnitudes from the source term.

Developing the entire list of scenarios, then screening the list for the unique cases, simplified the RESRAD modeling process considerably. In addition, the lower bound and upper bound of potential exposure were estimated for the two dose limits so that release of the JPG site for restricted use can be evaluated.

3.8 METHODOLOGY

In this section, the methodology is discussed. Sections 3.8.1 to 3.8.7 address RESRAD codes and applications, general and scenario-specific parameter values, and common properties. Sections 3.8.8 to 3.8.16 address potential receptors, while Sections 3.8.17 and 3.8.18 discuss data for ingestion pathways.

3.8.1 RESRAD Codes and Applications

The DOE program, RESRAD 6.1 (Yu et al. 2001) was used for assessment of on-site and off-site dose assessments. The program is flexible enough to accommodate site-specific information for many of the parameters required in an assessment. This flexibility is extremely important when diverse pathways and complex exposure routes need to be modeled. RESRAD was developed by DOE specifically to evaluate the risk of residual radioactive material in soils and water under different land uses. Earlier versions of RESRAD have been used in previous assessments at JPG (Ebinger and Hansen 1994, 1996a,b, and 1998). Finally, the present version of RESRAD has been developed to include widely accepted values of many default parameters (i.e., not site-specific values but values required to run the program) as discussed by Kennedy and Strenge (1992), Beyeler et al. (1996, 1998), NRC (1998a), Meyer and Gee (1999), and Meyer and Taira (2001). Use of RESRAD was intended to support the decommissioning and license termination process at JPG by incorporating a widely accepted assessment program.

Off-site deposition of DU-containing soils eroded from the contaminated zone provides the source term for off-site exposure scenarios. Attachment 1 is an analysis of potential floodwater flow through Big Creek with use of surface water for irrigation on farms downstream and off-site. Floodwater generation was estimated for various return periods using meteorological data from stations near JPG and digital elevation maps of the JPG area. In addition, soil erosion information was derived from soil surveys of JPG (Nickell 1985) and previous erosion research.

RESRAD 6.1simulates transport of DU (or other radionuclides) in soils to various crops and plants for use by a farmer and groundwater used for drinking. RESRAD also can account for external exposure of receptors (Figure 6). The program requires input concentrations of radionuclides in the soil of the affected area. The soil concentration of DU, or source term, is assumed to be uniformly distributed over a defined affected area and is diminished only by radioactive decay, leaching, wind and water erosion, and uptake from soils, water, and air. The leaching model depends on several soil properties, including permeability, texture, and the distribution coefficient between soluble (i.e., mobile) DU and insoluble DU that remains in the soil and is not leached. Groundwater flow depends on the permeability of the geologic strata through which it flows as well as the structure of the underlying bedrock. The depth through which the DU migrates depends, again, on the underlying geologic formations and the depth of the water table. In general, DU and other contaminants simulated with RESRAD move more quickly in saturated, porous materials that are relatively thin in depth, whereas transport is slowed when the materials are less porous, deeper, react with the contaminant, or a combination of these.

3.8.2 Parameter Values for Exposure Modeling

The RESRAD program requires values for several dozen parameters in order to simulate contaminant flow from the source through the unsaturated and saturated media to groundwater or surface water. A general set of default parameters is built into RESRAD (Yu et al. 2001; NRC 1998a) and is based on "average" agricultural characteristics reported in the technical literature, or recently, on accepted default values (e.g., NRC 1998a). Default values more specific to license termination and/or decommissioning, hereafter called the NUREG/CR-5512 default values, have been integrated into NRC guidance (Kennedy and Strenge 1993; Beyeler et al. 1996; NRC 1998a). A comparison of the RESRAD and an NRC program, decontamination and decommissioning (D&D), is made in NRC (NRC 1998a), and the two sets of general default values are also compared. Default and site-specific input values for RESRAD simulations are given for each scenario tested as Attachment 2.

3.8.3 Parameter Values for RESRAD Simulations

A large array of values is entered into each RESRAD simulation; in order to distinguish between default values and site-specific values for each scenario that was tested, a data catalog was designed (Table 8).

Table 8. Default and Selected Values for Various Parameters Used in RESRAD Simulations

Parameter	Default Value	JPG Value	Reference
Radionuclide Concentrations and Transport Parameters			
Depleted Uranium[a] (pCi g^{-1})	0	94 or 225	
Basic Radiation Dose Limit (mrem y^{-1})	25	25 or 100	
Uranium Distribution Coefficient[b]	50	50	Yu et al. 2001; Sheppard and Thibault 1992
Contaminated Zone Parameters			
Contaminated Zone Area (m^2)	10,000	5×10^5 or 1.2×10^6	SEG 1996a
Contaminated Zone Thickness (m)	2	0.15	SEG 1996a; Ebinger et al. 1995
Length Parallel to Aquifer Flow (m)	100	100	
Depth of Cover (m)	0	0	
Bulk Density of Contaminated Zone (g cm^{-3})	1.5	1.4	Saxton et al. 1986; Meyer and Gee 1999
Contaminated Zone Erosion Rate (m y^{-1})	0.001	.001	
Contaminated Zone Total Porosity	0.4	0.45	Saxton et al. 1986; Meyer and Gee 1999
Contaminated Zone Field Capacity	0.2	0.3	Saxton et al. 1986; Meyer and Gee 1999
Contaminated Zone Hydraulic Conductivity (m y^{-1})	30	30	Meyer and Gee 1999
Contaminated Zone b Parameter	5.3	5.3	
Evapotranspiration Coefficient	0.5	0.5	
Wind Speed (m s^{-1})	2	2	
Precipitation (m y^{-1})	1	1	
Irrigation (m y^{-1})	0.1	0.1 or 0	
Irrigation Mode	Overhead	Overhead	
Runoff Coefficient	0.2	0.2	
Watershed Area for Nearby Pond or Stream (m^2)	1×10^6	1×10^6	
Accuracy for Computations	0.001	.001	
Saturated Zone Parameters			
Bulk Density of Saturated Zone (g cm^{-3})	1.5	1.5	
Saturated Zone Total Porosity	0.4	.4	
Saturated Zone Field Capacity	0.2	.2	
Saturated Zone Hydraulic Conductivity (m y^{-1})	100	100	
Saturated Zone Hydraulic Gradient	0.2	.2	
Saturated Zone b Parameter	5.3	5.3	
Water Table Drop Rate (m y^{-1})	0.001	.001	
Well Pump Intake Depth (m) below water table	10	10	
Model for Water Transport	Nondispersive	Nondispersive	
Well Pumping Rate (m^3 y^{-1})	250	250	
Unsaturated Zone Parameters[c]			
Number of Zones	1	5[c]	
Thickness (for each zone) [m]	4	0.3 (total thickness of 3.6 m for unsaturated zone)	Nickell 1985; SEC Donohue 1992

Table 8. Default and Selected Values for Various Parameters Used in RESRAD Simulations (Continued)

Parameter	Default Value	JPG Value	Reference
Bulk Density of Unsaturated Zone (g cm^{-3})	1.5	1.35	Saxton et al. 1986; Meyer and Gee 1999
Unsaturated Zone Total Porosity	0.4	.45	Saxton et al. 1986
Unsaturated Zone Effective Porosity	0.2	.3	Saxton et al. 1986
Unsaturated Zone Field Capacity	0.2	.3	Saxton et al. 1986
Unsaturated Zone Hydraulic Conductivity (m y^{-1})	10	30	Meyer and Gee 1999
Unsaturated Zone b Parameter	5.3	5.3	
Occupancy, Inhalation, and Gamma Parameters			
Inhalation Rate (m^3 y^{-1})	8,400	8,400	Yu et al. 2001; Beyeler et al. 1998
Mass Loading for Inhalation (g m^{-3})	0.001	.001	
Exposure Duration (y)	30	30	
Inhalation Shielding Factor	0.4	.4	
External Gamma Shielding Factor	0.7	.7	
Indoor Time Fraction	0.5	.5	
Outdoor Time Fraction	0.25	.25	
Shape of Contaminated Zone	Circular	Circular	
Ingestion Pathways, Dietary Data			
Fruit, Vegetable, and Grain Consumption (kg y^{-1})	160	80	
Leafy Vegetable Consumption (kg y^{-1})	14	15 ± 6.0	Beyeler et al. 1998
Milk Consumption (L y^{-1})	92	78 ± 17.7	Beyeler et al. 1998
Meat and Poultry Consumption (kg y^{-1})	63	52 ± 7.4	Beyeler et al. 1998
Fish Consumption (kg y^{-1})	5.4	16 ± 7	Beyeler et al. 1998
Seafood Consumption (kg y^{-1})	0.9	0.9	
Soil Ingestion (g y^{-1})	36.5	36.5	
Drinking Water Intake (L y^{-1})	510	510	
Contaminated Fraction			
Drinking Water	1	1	
Livestock Water	1	1	
Irrigation Water	1	1	
Aquatic Food	0.5	1	
Plant Food	−1	1	
Meat	−1	1	
Milk	−1	1	
Ingestion Pathways, Non-Dietary Data			
Livestock Fodder Intake for Meat (kg d^{-1})	68	68	
Livestock Fodder Intake for Milk (kg d^{-1})	55	55	
Livestock Water Intake for Meat (L d^{-1})	50	50	Beyeler et al. 1998; also default
Livestock Water Intake for Milk (L d^{-1})	160	160	
Livestock Soil Ingestion (kg d^{-1})	0.5	0.5	
Mass Loading for Foliar Deposition (g m^{-3})	0.0001	0.0001	
Depth of Soil Mixing Layer (m)	0.15	0.15	
Root Depth (m)	0.9	0.9	
Groundwater Use Fractions			
Drinking Water	1	1	
Livestock Water	1	1	

Table 8. Default and Selected Values for Various Parameters Used in RESRAD Simulations (Continued)

Parameter	Default Value	JPG Value	Reference
Irrigation Water	1	1	
	Plant Transfer Factors		
Wet Weight, Non-leafy Yield	0.7 kg m^{-2}	0.7 kg m^{-2}	
Wet Weight, Leafy Yield	1.5 kg m^{-2}	1.5 kg m^{-2}	
Wet Weight, Fodder Yield	1.1 kg m^{-2}	1.1 kg m^{-2}	
Translocation Factor, Non-Leafy	0.1 y	0.1 y	
Translocation Factor, Leafy and Fodder	1 y	1 y	
Weathering Removal Constant	20 y^{-1}	20 y^{-1}	
Wet Foliar Interception Fraction	0.25	0.25	
Dry Foliar Interception Fraction	0.25	0.25	

[a]Nominal isotopic composition of depleted uranium is from Schlieren (1992).
[b]A separate distribution coefficient is required for the contaminated zone, each unsaturated zone, and the saturated zone.
[c]Properties for each of the five horizons are entered in forms in Appendix A; data shown only for the first horizon in Table 8.
Note: See Attachment 2 for a complete listing of parameters.
JPG = Jefferson Proving Ground.
RESRAD = Residual Radioactivity.

Site-specific values are indicated in the center column of the catalog form, and each set of site-specific values will be discussed. The complete set of data catalog forms is included as Attachment 2.

The basic configuration for the RESRAD simulations consists of a contaminated zone of 0.15 m (15 cm) in thickness, an unsaturated zone of five soil horizons and based on site soil surveys (Nickell 1985), and an underlying saturated zone. The DU source term is included in the 0.15-m-thick contaminated zone, and the entire concentration is evenly distributed across the contaminated zone area. The various hydrologic, physical, and chemical parameters common to each exposure scenario are discussed below, then parameter values specific to each scenario are listed. In this way, the unique characteristics of the different scenarios can be illustrated separately from the common parameters.

3.8.4 Common Properties: Contaminated Zone

The contaminated zone is a single soil horizon of 0.15-m thickness that is of the same physical and chemical properties as the surface horizon of the local soils. The permeability of the contaminated zone soil is determined by the bulk density of the soil; soil porosity, field capacity, and effective porosity; the hydraulic conductivity; and infiltration of precipitation or irrigation that is affected by runoff, evapotranspiration, and precipitation amount. These values were estimated from soil texture using a hydraulic property calculator (Saxton et al. 1986). Hydraulic conductivity values from the calculator tend to be about a factor of 10 greater than the RESRAD default value of 10 m y^{-1}. Meyer and Gee (1999) report a distribution of conductivities that ranges from 9.8×10^{-2} m y^{-1} to 980 m y^{-1} with mean of 29.4 m y^{-1} and standard deviation of 69 m y^{-1} for silt loam soils. This distribution was used to estimate the conductivities of the various soil horizons including the contaminated zone. Soil total porosity, field capacity, effective porosity, and bulk density from the calculator were similar to measure values of Meyer and Gee (1999). From these data, the average conductivity of 30 m y^{-1} was used with bulk density of 1.4 g cm^{-3}, total porosity of 0.45, effective porosity of 0.3, and field capacity of 0.3. Annual precipitation was estimated from JPG records and other sources (see Attachment 1), and default values for evapotranspiration, runoff, and applied irrigation were used because no better data from JPG were available. The default value for a watershed to support a pond on the contaminated zone soils was used since a pond the size of the contaminated zone is reasonable based on poor drainage and ponding on the soils at JPG.

Transport of DU through the soil is controlled mainly by the distribution coefficient, K_d, in addition to the permeability of the soil. There are several values in the literature that are applicable to uranium transport in soils, and selecting values without measurements from JPG soils is uncertain (e.g., Baes and Sharp 1983; Clapp and Hornberger 1978; Isherwood 1981; Sheppard and Thibault 1990; Yu et al. 2001). However, the various studies can be used to bound a value selected for these simulations, then the selected value can be subjected to sensitivity and/or uncertainty analyses to estimate the effect on risk estimates of varying the K_ds. Experimental values of K_ds are subject to various chemical properties such as pH and ionic strength of solutions within which the values are measured. The 15 cm of soil that makes up the contaminated zone is reportedly slightly acidic, potentially about pH 5 to 6 (Nickell 1985). Eliminating K_d values that apply outside this range gives several values that range from about 10 to over 200. K_ds less than 100 are the more commonly measured (see Yu et al. 2001, Table E-7; Sheppard and Thibault 1990), and the mean is near the RESRAD default value of 50. With no additional data from JPG soils, the default K_d was used and sensitivity analysis covering a factor of 10 (K_d from 5 to 500) was implemented (Figure 7). From previous studies, the K_d value is the parameter that most affects dose estimates after variation in the source concentration.

3.8.5 Common Properties: Unsaturated Zone (Soil Zone)

The predominant soil type within the DU Impact Area is Cobbsfork silt loam, although a variety of soils occur near where the Big Creek dissects the loess-over-glacial till landscape (Nickell 1985). All soils within the DU Impact Area are represented by similar chemical and physical properties that include poor to somewhat poorly drained soils (i.e., soils that are wet and could pond); textures of mainly silt loam and clay loam; the presence of a fragic horizon or a thick soil horizon that is very impermeable to water; and all are relatively non-erosive except on steeper slopes leading to the Big Creek drainage. Cobbsfork silt loam will be considered the soil of the contaminated zone for the RESRAD simulations. A typical soil profile description is shown in Table 9, and this general description is the basis for the unsaturated, uncontaminated zone that separates the contaminated zone from the aquifer. Values for the top horizon were entered into the data catalog (Table 8 and Appendix A), and the values in Table 9 for each of the other horizons were input but not shown in Table 8. The thickness of the unsaturated zone was estimated from the average depth to groundwater from wells located in the DU Impact Area (SEC Donohue 1992). The average of 9 wells was 3.6 m (± 1.8 m). The thickness of the lowest soil horizon (i.e., unsaturated zone 5 in Table 2-1) was adjusted to give a total unsaturated zone thickness of 3.6 m.

Table 9. Profile Description and Characteristics of Cobbsfork Silt Loam

Horizon Depth (cm)	Texture (USDA)	Field Capacity	Saturation	Saturated Hydraulic Conductivity ($m\ y^{-1}$)[a]	Bulk Density ($g\ cm^{-3}$)[b]
0–30	Silt loam	0.3	0.45 to 0.5	148 to 290	1.33 to 1.37
30–68	Silt loam	0.3	0.45 to 0.5	148 to 290	1.33 to 1.46
68–127	Silt loam	0.3	0.45 to 0.5	52 to 148	1.33 to 1.37
127–195	Silt loam	0.3	0.45 to 0.5	52 to 148	1.33 to 1.37
195–203	Silt loam	0.32	0.52	46 to 52	1.27 to 1.33

[a]Range from Nickell (1985) and Saxton et al. 1986. Values increase with increasing sand. Estimated average value for Cobbsfork silt loam shown. Meyer and Gee (1999) show a log normal distribution with mean of 29.4 $m\ y^{-1}$, standard deviation of 69 $m\ y^{-1}$, and range from 0.098 $m\ y^{-1}$ to 980 $m\ y^{-1}$.
[b]Calculated from texture using Saxton et al. 1986; Meyer and Gee (1999) bulk density estimates also similar.
Source: Data from Nickell (1985) and estimates from Saxton et al. (1986).
cm = centimeter.
g = gram.
m = meter.
USDA = U.S. Department of Agriculture.

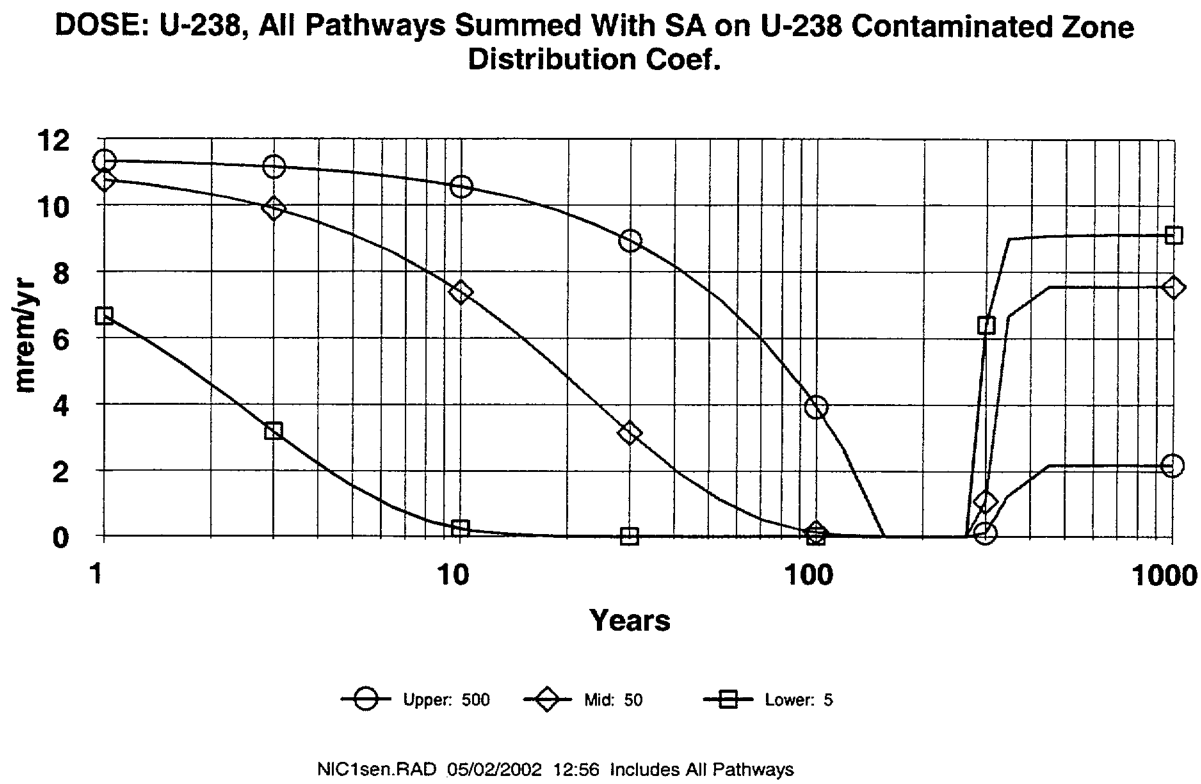

Figure 7. Results of RESRAD Sensitivity Analysis on the K_d of the Contaminated Zone Soil (Values for K_d varied between 5 and 500.)

3.8.6 Common Properties: Saturated Zone

Default values were used for the saturated zone since there were no site-specific data that could be used in place of defaults. The exception was the K_d value, which was estimated from literature values at 50 and varied by a factor of 10 in sensitivity tests. Table 2-1 (Attachment 2) lists the parameter values for those properties that are common throughout the RESRAD analyses. Scenario-Specific Parameters

The scenarios discussed above require different parameter values than the common properties listed in the last section. These parameters are scenario dependent and, thus, change to reflect the relevant exposure assessment. The scenario-dependent parameters are discussed here for each scenario, first for the simulations that evaluate exposures when institutional controls are in place, then for the simulations that evaluate exposures after loss of institutional control.

3.8.7 On-Site Worker

The average member of the critical group for this scenario spends the equivalent of 4 days each month involved in outdoor activities on the border of or within the DU Impact Area of JPG (Scenario 1, Table 6). Exposure pathways include external exposure, dust inhalation, and incidental soil ingestion, and no contribution from food or water produced on-site. Parameters of importance to this scenario are mainly the occupancy, inhalation, and gamma parameters of Table 8 and in Attachment 2 (Table 2-1, Table 2-2). Default parameters for the inhalation rate and mass loading of dust for inhalation were used because they were reasonable for moderate activity outdoors. Work hours spent indoors were approximately 0.2 yr, and the 4 days per month spent near the DU Impact Area was approximately 0.05 yr. Default soil ingestion was used since there are no data or other indications of potential to increase soil ingestion significantly. Table 2-2 (Attachment 2) shows input data for this scenario.

3.8.8 On-site Hunters

Two versions of this scenario are evaluated: the first for the case of effective institutional controls (Scenario 2, Table 6) and the second for the case of failed institutional controls (Scenario 3, Table 7). In each case, the average member of the critical group spends eight hours per day for up to two weeks each year (approximately 0.01 yr) hunting game that fed within the DU Impact Area of JPG and replaces up to 50% of dietary meat with turkey or deer hunted at JPG. In the first case, the hunter does not enter the DU Impact Area and receives exposure only through the meat ingestion pathway. In the second case, the hunter enters the DU Impact Area and is exposed to external radiation from soil, and DU-containing dust can be inhaled. Ingestion of DU is through meat consumption and soil ingestion, but consumption of potentially contaminated drinking water was not included. Occupancy, inhalation, and gamma parameters were default values except for indoor and outdoor times. Ingestion pathways included soil ingestion at a default value of 36.5 g y^{-1} and up to half of the meat consumed came from contaminated sources. Human consumption of contaminated drinking water was not part of the scenario, but it was assumed that the hunted deer only drank from contaminated sources, and contaminated water was used to grow the fodder for the deer. Consumption of vegetables, fruits, and grains grown on the contaminated site was not included in this scenario, neither was consumption of fish or dairy products produced on-site. Table 2-3 (Attachement 2) shows input data for the loss of institutional control version of this scenario.

3.8.9 Off-Site Fisherman

The average member of the critical group for this scenario spends up to four days for three months each year fishing in Big Creek downstream of the access-controlled area of JPG and replaces all dietary fish with fish caught at JPG (Scenario 3, Table 7). Concentration of uranium in surface water was estimated using uranium concentration in soil, erosion rate and surface water flow rate modeled in Attachment 1 for Node 13. Dose was estimated using

$$D_{fish} = C_{W,DU} * BCF * CR * DCF \quad (1)$$

Where D_{fish} is the dose from fish consumption (mrem y^{-1}), BCF is the concentration factor for U-238 in fish (10 L kg^{-1}; Yu et al, 2001), CR is the rate at which humans consume fish (15 kg y^{-1}; Beyeler, 1998), and DCF is the dose conversion factor for ingestion of U-238 (Yu et al, 2001), and $C_{w'DU}$ is the concentration of DU in stream water after it erodes from the DU Impact Area (pCi/g) and is estimated from

$$C_{W,DU} = C_{sed} / Kd \quad (2)$$

Where C_{sed} is the concentration of DU in the sediment eroded from the DU impact area (pCi g^{-1}) and K_d is the distribution coefficient (50 cm^3 g^{-1}; Yu et al., 2001). C_{sed} is the estimated amount of DU in the sediment eroded from the DU impact area each year (pCi y^{-1}) and is estimated by

$$C_{sed} = C_{erode} / Sed \quad (3)$$

where C_{erode} is the amount of DU eroding from the Impact Area (pCi y^{-1}) and Sed is the total amount of sediment at Node 13 (28,830 metric ton or 2.88×10^{10} g y^{-1}; Attachment 1, Fig. 1, Table 1) outside the JPG boundary. The Sed value was taken as the two-year return period as this value should more closely approximate the average sediment yield in Big Creek. C_{erode} is estimated from the fraction of the Big Creek watershed (90 km^2; Attachment 1, Fig. 1, Table 1) covered by the DU Impact area (5×10^5 m^2, or 0.5 km^2); the value of the fraction is 5.6×10^{-3}. Thus,

$$C_{erode} = 5.6 \times 10^{-3} * Sed * 225 \text{ pCi g}^{-1} \quad (4)$$

and C_{sed} = 1.25 pCi g^{-1}, and $C_{W,DU} = 2 \times 10^{-2}$ pCi mL^{-1}. Thus, the dose to humans consuming about 15 kg of fish from Big Creek each year is approximately 8×10^{-1} mrem y^{-1}. Values used in these calculations are shown in Table 2-4.

3.8.10 Off-Site Resident Farmer

The critical group is a family that lives on a farm at the institutional boundary of JPG. This farm is approximately 2.5 km (1.5 mi) from the DU Impact Area (Node 13; Attachment 1, Fig. 1). The family raises all crops and livestock for consumption with minimal sources from commercial food products. The family lives near Big Creek, uses water from Big Creek for irrigation, and drinks well water down-gradient of JPG. Soil contamination for the farm was assumed to be sediment deposited from Big Creek floods, thus the source of DU for the farm is the sediment eroded from the DU Impact Area and its estimated concentration is 1.25 pCi g^{-1} (see section 3.8.9). Water contamination is the DU that dissolves into Big Creek from the eroded sediment, and is 2×10^{-2} pmCi l^{-1} as in Section 3.8.9. Using these inputs and all available pathways in RESRAD v. 6.1, doses to farmers at this site were estimated. Table 2-5 shows the input values for these estimates.

3.8.11 Off-Site Industrial Worker

The average member of the critical group for this scenario works in a building at the JPG boundary and spends work time indoors (Scenario 9, Table 6). No site access is allowed in this scenario, but the building water supply is derived from a well that is near the building which is near the DU Impact Area. Thus, the exposure pathway that exists for this scenario is from drinking water.

3.8.12 City Resident

The average member of the critical group for this Scenario (Scenario 11, Table 6) is a user of surface water located at the nearest municipal water take-up point downstream of the JPG. This point is located at Bedford, IN on the East Fork White River. Concentration of uranium in surface water is derived from the concentration of uranium in soil in the DU Impact Area and the estimate of erosion rate of soil. Dose was estimated using hand calculation as the product of concentration of uranium in surface water, water ingestion rate and dose conversion factor. Table 2-4 shows relevant values used in these calculations. The water concentration is estimated as in Section 3.8.9, using the amount of DU in sediments and water in Big Creek, then using the estimated volume flow of the East Fork of the White River (3.74 x 10 9 m3 y^{-1}; http://waterdata.usgs.gov/nwis/qwdata, Accessed 6/14/2002). Using Equations 2 and 3, the concentration of DU in water is approximately 9.6 pCi m^3, and if water consumption is 510 L y^{-1} (or 0.51 m3 y^{-1}) and the DCF is as listed in Table 2-4, the dose to a city resident using White River water as drinking water is approximately 1.3×10^{-3} mrem y^{-1}. If Big Creek water is used at Node 13 as drinking water, the resulting dose is slightly larger, 2.7×10^{-3} mrem y^{-1}.

3.8.13 Resident Farmer, no Irrigation

This scenario occurs only after loss of institutional control to the area of the contaminated zone. The average member of the critical group for this scenario farms year-round on a location centered on the contaminated zone (Scenario 1, Table 7), and replaces up to all vegetables, meat, poultry, dairy products, and fish with farm-raised products. The resident farmer is exposed to external radiation from soil, and DU-containing dust can be inhaled. Ingestion of DU is through consumption of vegetables, beef and poultry, milk and other dairy products, and fish, and consumption of potentially contaminated drinking water. Occupancy, inhalation, and gamma parameters were default values. Table 2-7 shows input data for this scenario.

3.8.14 Resident Farmer, Irrigation Allowed

This scenario also occurs only after loss of institutional control to the area of the contaminated zone. The average member of the critical group for this scenario farms year-round on a location centered on the contaminated zone, uses irrigation from streams or ponds that contain water from the contaminated zone, and replaces up to all vegetables, meat, poultry, dairy products, and fish with farm-raised products (Scenario 2, Table 7). The resident farmer is exposed to external radiation from soil, and DU-containing dust can be inhaled. Ingestion of DU is through consumption of vegetables, beef and poultry, milk and other dairy products, and fish, and consumption of potentially contaminated drinking water. Occupancy, inhalation, and gamma parameters were default values. Table 2-8 shows input data for this scenario.

3.8.15 Domestic Resident

This scenario also occurs only after loss of institutional control to the area of the contaminated zone. The average member of the critical group for this scenario lives year-round on a location built on the contaminated zone, uses irrigation from streams or ponds that contain water from the contaminated zone, replaces up to 33 % of vegetables with products raised in a home garden in the summers and 33% of fish consumed annually with fish from contaminated waters, but does not produce farm-raised meat, poultry, or dairy products (Scenario 5, Table 7). The domestic resident is exposed to external radiation from soil, and DU-containing dust can be inhaled. Ingestion of DU is through consumption of vegetables and fish, but not beef or poultry, milk, or other dairy products. Occupancy, inhalation, and gamma parameters were default values. Table 2-9 shows input data for this scenario.

3.8.16 Part-Time Domestic Resident

This scenario is similar to the previous one except that the resident and average member of the critical group only live in the house for 4 months each year, in the summer. The part-time resident raises all of the vegetables used for the 4-month period (0.33 y) in the garden located in the contaminated zone and replaces all fish consumed with fish caught in contaminated waters at JPG. The part-time resident is exposed to external radiation from soil, and DU-containing dust can be inhaled. Ingestion of DU is through consumption of vegetables and fish, but not beef or poultry, milk, or other dairy products (Scenario 6, Table 7). Occupancy, inhalation, and gamma parameters were default values. Table 2-10 shows input data for this scenario.

3.8.17 Ingestion Pathways and Human Dietary Data

Several compilations of data on the amount of food consumed by humans show relatively large variation. The larger values were selected to ensure conservatism in the risk estimates from exposure to DU via food pathways. Where distributions of values were given (e.g., Beyeler et al. 1998), the standard deviation or variance was used to vary the parameter value, or the distribution was used in simulations if variation of the parameter affected the dose estimate by more than about 10%. Where values of RESRAD parameters were not given and could not be derived without uncertainty, the RESRAD defaults were used.

3.8.18 Ingestion Pathways and non-Human Dietary Data

As with human dietary data, the more conservative values for needed parameters were selected from compilations of data or RESRAD defaults were used. The values chosen were subjected to sensitivity and/or uncertainty analyses to test which of the parameter values affected the dose estimates the most. Default values for plant transfer factors were used throughout the analyses as variation in these factors produced changes of less than 1% in predicted doses to humans. Contaminated fractions of drinking water, water for irrigation and livestock, aquatic, plant, beef, and milk products were selected as "1" if a pathway was allowed in a scenario or "0" if that pathway was not allowed.

3.9 SENSITIVITY AND UNCERTAINTY ANALYSES

The output of the RESRAD program depends on the various values of the input parameters used; thus, it is important to evaluate which of the input parameters most affects the output doses. The resident farmer scenario (Table 7, Scenarios 1 and 2) evaluated doses to the farmer through all of the environmental pathways available to RESRAD for these simulations and provided the initial evaluation of model sensitivity. RESRAD was run as a deterministic model for these evaluations, that is, set parameter values were used and varied, then the dose to humans was monitored. The changes in the parameters that caused the largest magnitude of change in estimated doses were considered sensitive parameters. Conversely, those parameters that could be changed with little to no effect on the output doses were considered insensitive parameters. Changes in parameter values of a factor of 5 to 10 that caused changes in output of 10% or greater were considered highly sensitive parameters; those parameters that resulted in 1 to 10% change in the output doses were considered medium-sensitivity parameters, and parameters of low sensitivity caused less than 1% difference in output doses. Table 10 shows the parameters evaluated and the results of the sensitivity analysis.

Table 10. Results of Sensitivity Analyses for Several RESRAD Parameters

High Sensitivity	Medium Sensitivity	Low Sensitivity
K_d of Contaminated Zone	K_d of Unsaturated and Saturated Zones	Porosity and hydraulic conductivities of Contaminated and Unsaturated Zones
Mass Loading for Inhalation (g m^{-3})	Bulk Density of All Zones	Porosities of all Zones
Drinking Water Intake Rate (l d^{-1}).	Hydraulic Conductivity of Saturated Zone Indoor and Outdoor fractions Inhalation Rate of Receptor Soil Ingestion Rate Food Ingestion Parameters (milk intake rate, amount of fruit, vegetables, and grain ingested, etc.)	

Three parameters were most sensitive in the analysis, the distribution coefficient of the contaminated zone soil, the mass loading value for inhalation pathways, and the drinking water ingested by the receptors. Food ingestion rates were also considered of high interest to the dose results, although these values proved to be less sensitive than the distribution coefficient, mass loading, and drinking water intake. Most of the parameters tested were of medium sensitivity. These parameters included the distribution coefficients of the saturated and unsaturated zones; the physical parameters of the unsaturated and saturated zones, including hydraulic conductivities, bulk densities, and porosities of the various layers; the fraction of time spent indoors and out; and the food ingestion rates. Of low sensitivity were additional hydrologic properties in the unsaturated zones. Scenarios that included multiple pathways for exposure of receptors, like the farming scenarios, naturally resulted in larger doses received by the receptors. Conversely, those scenarios with relatively uncomplicated exposure pathways resulted in smaller doses.

Uncertainty analysis is a means by which the distribution of output values is estimated, that is, the degree of error in estimated values is established. Uncertainty analysis uses distributions of parameter values for each parameter in the analysis. A value for each parameter is selected at random from the distribution, the dose is calculated for that set of parameter values, then the process begins again. Value selection can either be completely at random from the distribution, or selected at random from individual segments of the entire distribution. The latter method is the Latin hypercube sampling method (McKay et al. 1979; Inman et al. 1981; Helton and Inman 1982) and forces sampling of the tails of the parameter distribution. This method tends to increase the average value in some cases and ensures that the largest and smallest values of a distribution are included in the analysis. Three hundred iterations of the model are run during an uncertainty analysis, so each distribution is sampled 300 times (Yu et al. 1993; Yu et al. 2001, Appendix M; Kamboj et al. 2000; LePoire et al. 2000). In this way, a set of 300 output values is derived that can be described statistically.

Uncertainty analysis using all the parameters in the RESRAD model for each scenario is a large task that is extremely inefficient because the contributions of all the parameters would be included for each estimated dose for each scenario. However, the set of parameters included in the analysis can be refined using the information from the sensitivity analysis described above. Using the sensitivity information, the distribution coefficient for the contaminated zone, the drinking water intake rate, and the mass loading for inhalation were used in the uncertainty analysis. Also included were the food ingestion factors for the scenarios that included food pathways. This reduced list of variables for the uncertainty analysis was a much smaller set of calculations to perform, and interpretation of the resulting data was a less daunting task.

Selecting probability distributions for the parameters used for the uncertainty analysis was relatively difficult and is the source of error itself in the analysis. Clearly, variation in source term concentrations, area of the contaminated zone, and depth of the contamination are directly related to the input values: an increase in one results in a proportional increase in the estimated dose. Instead of including distributions for the soil concentration of DU, contaminated zone size, and depth of the contamination, two sets of values for the source term (94 pCi g^{-1} and 225 pCi g^{-1}) were used, two contaminated zone areas were used, and the depth of contamination was set at 15 cm based on previous data (see also discussions above on source term and contaminated zone area). No site-specific data were available for the other parameters chosen for the uncertainty analysis even though these parameters were the main source of variation in the estimated doses. Instead, various literature sources were used to estimate probability distributions for these and variables, and the food ingestion rates. The probability distributions, the values used for the uncertainty analyses, and the source of the values are given in the tables of Attachment 2, whereas results are discussed in the next section.

In addition to the sensitivity to values of parameters, the sensitivity of dose to the presence of trace contaminants in DU was investigated. Dose due to the presence of Pu-238/239/240 and Tc-99 was estimated for the on-site residential farmer scenario. Concentration levels of plutonium and technetium in DU armor were those reported in Section 4.0, 5 and 540 pCi/g for Pu-238/239/240 and Tc-99, respectively.

3.10 RESRAD RESULTS

The parameter distributions used for the uncertainty analysis require some discussion since all were estimated from the literature and not from site-specific measurements. The distribution coefficient, K_d, for the contaminated zone was estimated at 50 milliliters per gram (mL/g) using various literature values (Yu et al. 1993; Yu et al. 2001), and the sensitivity analysis showed that smaller values of K_d affected the dose more than values larger than 50 (Figure 6). To capture the larger changes in doses from smaller values of K_d, a triangular distribution was selected for K_d. The minimum value was 5, the maximum was 60, and the median was 50. Thus, more values between 5 and 50 were selected in the uncertainty iterations than between 50 and 60. Literature and site-specific data on mass loading for inhalation, or the amount of DU-containing dust in the air, were sparse. The distribution selected follows that reported by Beyeler et al. (1998) and is a uniform distribution between 0.0001 and 0.001. The upper value is the largest reported in the literature (Baes and Sharp 1993; Meyer and Gee 1999; Yu et al. 2001) and is slightly larger than the maximum value reported by Beyeler et al. (1998). The uniform distribution ensured that all values in the distribution were selected with equal probability.

Drinking water intake rates varied over a relatively wide range (Yu et al. 1993; Beyeler et al. 1998). Several values near 440 L y^{-1} were suggested, and the largest reasonable rate listed was about 660 L y^{-1}. With a wide distribution of values, the uniform distribution was a conservative choice, and the distribution was constructed between 440 and 660 L y^{-1}. The food ingestion rates were also variable depending on the source. Lognormal distributions of values were chosen from Beyeler et al. (1998) as the most likely.

Results of the probabilistic dose estimates are presented in Table 11 for all scenarios. The average largest dose and standard deviation of that dose were estimated in the uncertainty analyses and presented in the results tables along with the range of the largest dose values predicted. Inhalation and external exposure were the major dose components in all scenarios, and they were the dominant components of scenarios that were not affected by drinking water or food ingestion pathways that depended on water use. Figure 8 shows the estimated dose with time for the On-Site Worker and illustrates the dominance of the external exposure and inhalation pathways. Figure 9 shows the dose with time for the On-Site Hunter and the effects of ingestion of game.

Table 11. Results from RESRAD Simulations of all Scenarios

Scenario (Table)	Concentration (pCi g^{-1})	Average Dose (mrem y^{-1})	S.D.	Minimum Dose (mrem y^{-1})	Maximum Dose (mrem y^{-1})	Time at Average Dose (y)
1 (6)	94	1.2	0.3	0.7	1.7	0
	225	2.9	0.7	1.6	4.1	0
2 (6)	94	0.8	0.03	0.7	0.9	0
	225	2.0	0.08	1.7	2.2	0
3 (6)	225[a]	8.1×10^{-1}				
4 (6)	1.25[b]	0.2	0.04	0.1	0.3	0
9 (6)	94	2.7	0.5	1.9	3.5	0
	225	6.4	1.1	4.5	8.4	0
11 (6)	225[a]	1.3×10^{-3}		(Bedford, IN)		
	225[a]	2.7×10^{-3}		(Big Creek)		
1 (7)	94	15.5	2.8	10.0	20.5	1000[c]
	225	37.0	6.8	24.5	49.1	1000[c]
	0.3[d]	0.1	0.01	0.07	0.2	0
	0.03[e]	0.05	0.02	8×10^{-3}	0.09	0
2 (7)	94	15.4	2.7	10.4	20.4	1000[c]
	225	26.8	6.7	23.6	48.9	1000[c]
3 (7)	94	1.49	0.3	0.9	2.1	0
	225	3.6	0.8	2.2	4.9	0
5 (7)	94	14.4	2.6	9.58	19.4	1000[c]
	225	34.5	6.3	22.9	46.4	1000[c]
6 (7)	94	10.7	1.4	7.5	14.7	1000[c]
	225	35.3	3.4	17.9	35.3	1000[c]

[a]Dose to human receptor calculated by hand, and no probabilistic results were possible with this program.
[b] Dose to human receptor calculated by RESRAD v. 6.1, and soil concentration estimated to be 1.25 pCi g-1 from erosion and sediment modeling (Attachment 1).
[c]Dose at 1,000 years due to fish and plant ingestion pathways.
[d] dose from Tc-99 residue in DU alloy.
[e] dose from Pu-239 residue in DU alloy.
Note: Values are from uncertainty analyses.
S.D. = Standard Deviation.

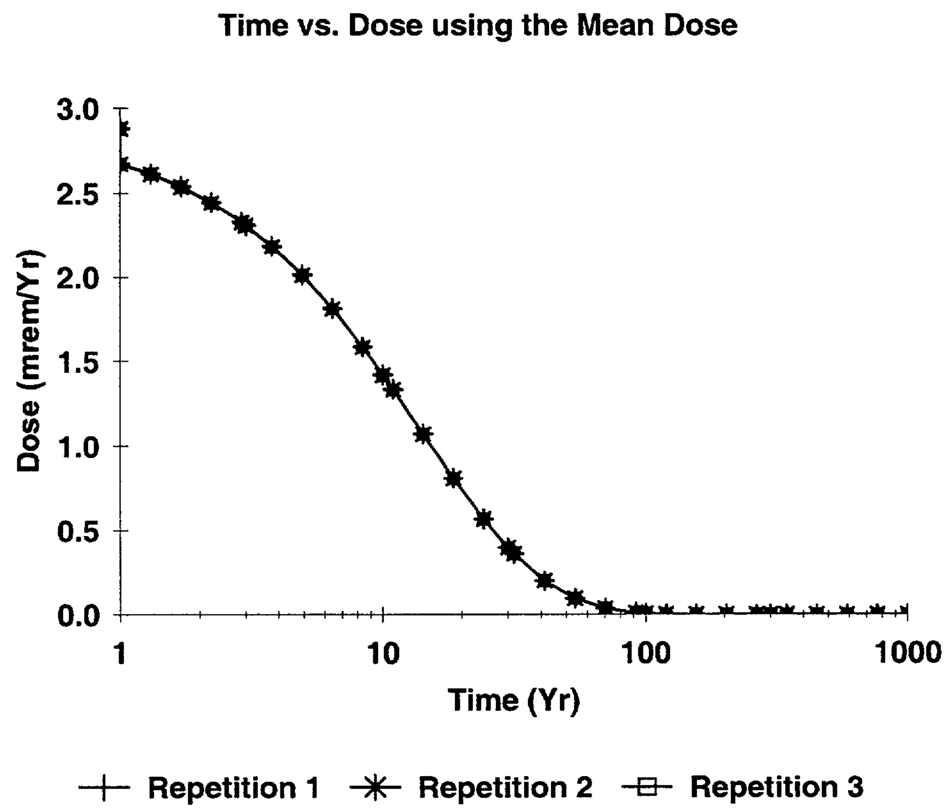

Figure 8. Plot of predicted dose vs. time for On-Site Worker (Scenario 1, Table 6). Data shown for soil concentration of 225 pCi g-1 and three repetitions of probabilistic risk assessment in RESRAD 6.1. Estimated dose prior to year 100 from external and inhalation pathways.

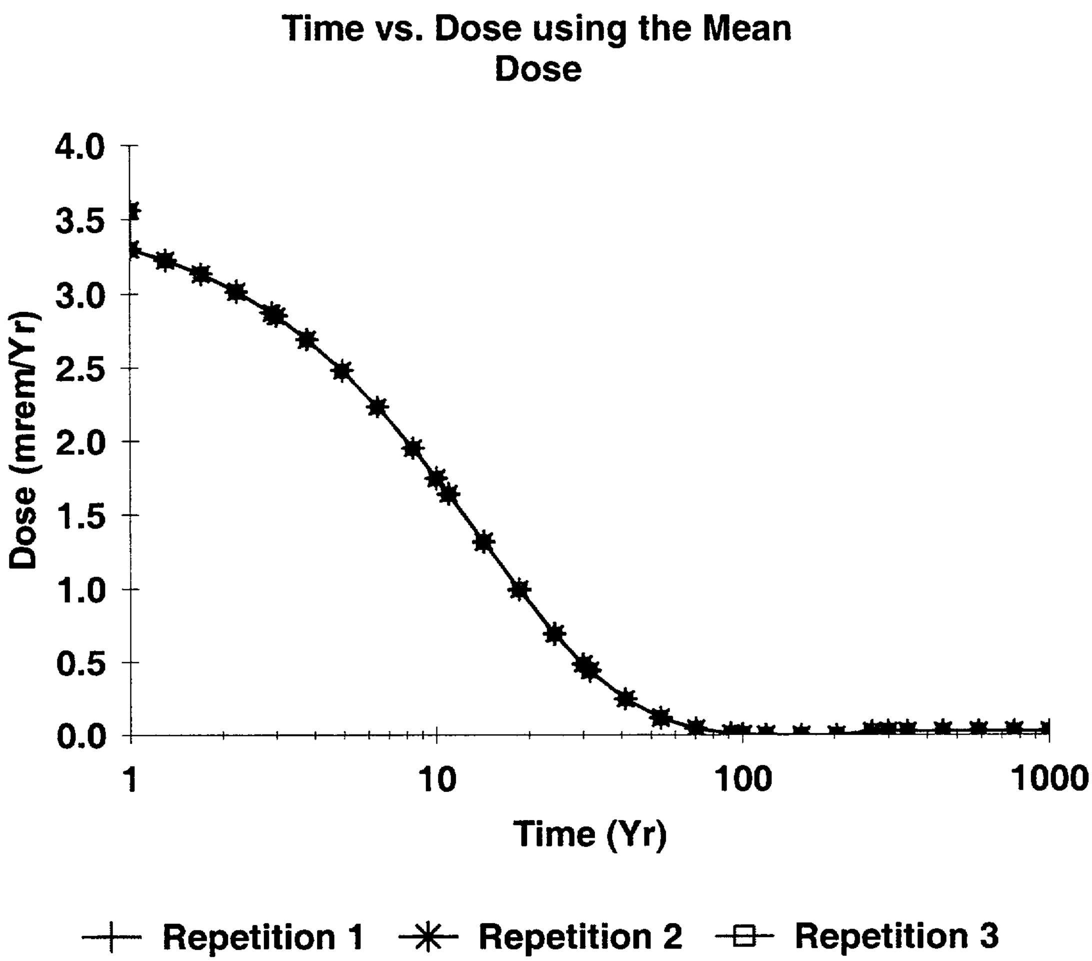

Figure 9. Plot of predicted dose vs. time for On-Site Hunter (Scenario 3, Table 7). Data shown for soil concentration of 225 pCi g-1 and three repetitions of probabilistic risk assessment in RESRAD 6.1. Estimated dose prior to year 100 from external and inhalation pathways, with little to no contribution from ingested meat.

The dose occurs after the initial dose from inhalation and external exposure because of the time to transport the DU 100 m from the contaminated zone.

Figure 10 shows dose with time for the Resident Farmer after loss of institutional controls and reflects the dose due to all food ingestion pathways after the DU transports to surface water sources used for raising fish, irrigating crops and livestock, and drinking water. The increased importance of the external and inhalation pathways is due to the significant amount of time spent outside in the contaminated area where the farm is located. The overall dose increased compared to doses shown in Table 11 and Figures 8 and 9, due to the increased amount of DU in food items and from external and inhalation exposure increases. Dose to the resident farmer from trace concentrations of Tc-99 and Pu-239 are included in Table 11 as additions to Scenario 1(7). Data for this analysis was taken from Section 4; the concentration for Tc-99 was 0.3 pCi g^{-1}-soil, and for Pu-239 was 0.03 pCi g^{-1}-soil. The resulting doses were small compared to overall doses from DU.

Exposure of off-site farmers while institutional controls are in place (Scenario 4, Table 6) indicates that minimal exposure (e.g., about 1 mrem y^{-1}) occurs based on erosion of soil containing DU to Big Creek and use of water from Big Creek for irrigation at the off-site location Floodwater and sediment yield modeling (Attachment 1) support the idea of only slightly increased exposure to DU eroded from the contaminated zone. The estimate of the DU concentration in the sediment delivered to this location takes the sediment yield (Table 12, Attachment 1) from the contaminated zone area, then the amount of DU is calculated based on the soil concentration used in RESRAD simulations (either 94 pCi g^{-1} or 225 pCi g^{-1}). The total activity of DU is then divided by the estimated flow rate of Big Creek to calculate the concentration of uranium in Big Creek exiting JPG. The concentration of uranium in soil at off-site location was estimated based on use of water from Big Creek for irrigation and partitioning of the uranium onto the soil.

3.11 EFFECTS OF UNCERTAINTY IN PARAMETER VALUES

Many of the parameters used for the RESRAD modeling and the flood and sediment modeling were determined from literature values of these parameters, not from actual field measurements. There are clear changes in predicted doses if DU concentrations change or if the size of the contaminated zone changes; these possibilities were controlled by adjusting the model simulations for high or low concentrations from large or small, contaminated zones. While field measurements and empirical estimates of the parameter values are ideal, the imminent personnel safety hazard due to the presence of UXO, the ecological impact of obtaining additional field measurements and the cost to produce such a catalog is prohibitive and extremely time-intensive. However, use of the best values for various parameters based on measurements from other locations, then using distributions of those values for sensitive parameters in the models, can account for some of the uncertainty in estimated doses.

The dose calculations presented above represent use of as much site-specific information as possible coupled with literature values for similar parameters in determining the values and distributions of the values used in the models. Presentation of the distributions of the estimated doses also provides an evaluation of variation in the estimates and allows for better decisions on if the site can be released for restricted use.

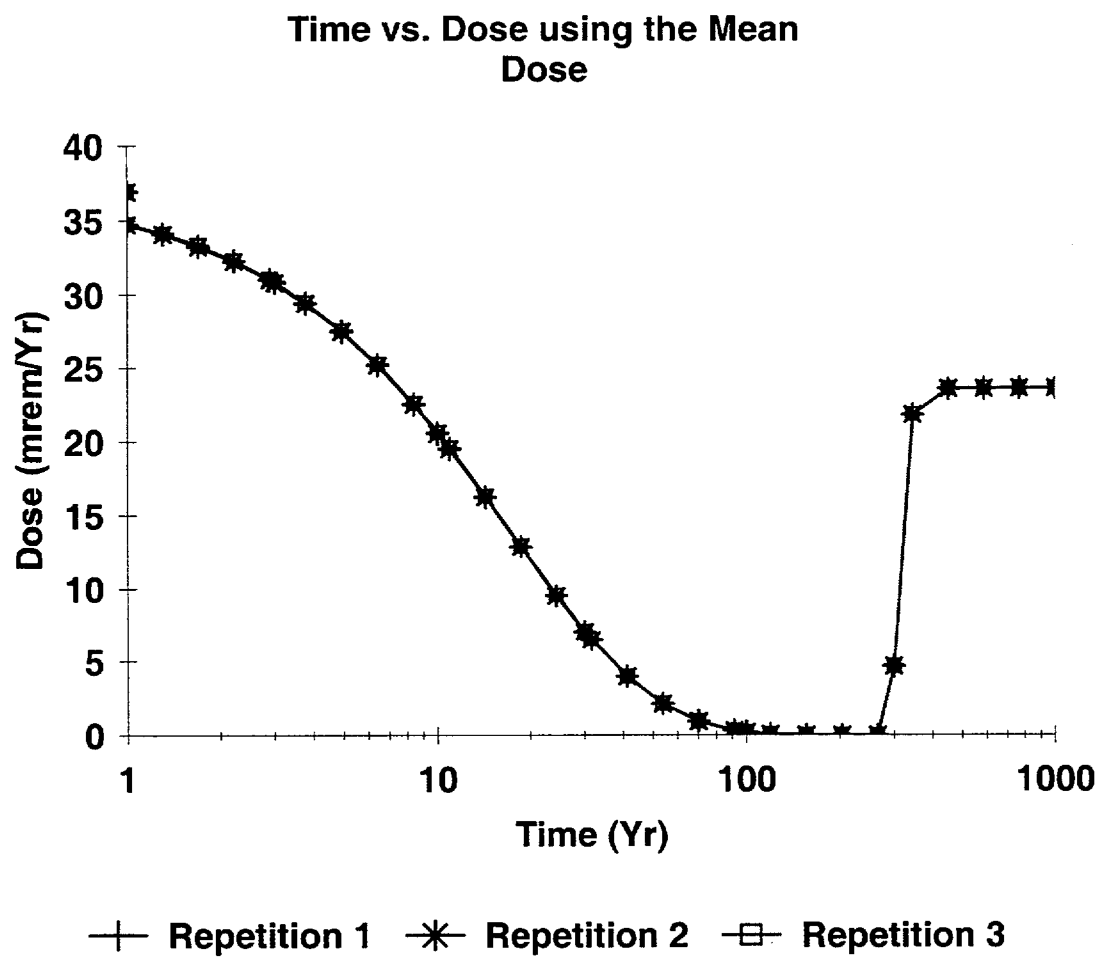

Figure 10. Plot of expected dose vs. time to Resident Farmer (Scenario 1, Table 7). Estimated dose prior to year 100 due to external and inhalation pathways. Estimated dose after year 300 due to ingestion of fish, vegetables, meat, dairy products, and drinking water contaminated with DU transported from the DU Impact Area. Data shown for soil concentration of 225 pCi g-1 and three repetitions of probabilistic risk assessment in RESRAD 6.1.

4.0 CONCLUSIONS

The doses to average members of specific critical groups using JPG lands were predicted with the RESRAD program for a variety of exposure scenarios. The means, standard deviations, and ranges for all predictions were less than the dose limits for restricted release when institutional controls were in place (25 mrem y^{-1}) or when institutional controls failed (100 mrem y^{-1}). These dose estimates are based on a combination of site-specific parameter values used in RESRAD, values and their distributions estimated from literature on the parameters, and default values that are required to run the program.

Sensitivity analyses on many of the parameters indicate that variations in K_d of the contaminated zone soils, mass loading for inhalation, and drinking water intake rates caused changes of 10% or more in the predicted doses, whereas variations in other parameters do not result in significant changes in the predicted doses. Means, standard deviations, and ranges of estimated doses were calculated by probabilistic methods integrated into the RESRAD program, and none of the values exceeds the dose limits for any of the scenarios tested.

Overall, the results suggest that exposures to residual DU at JPG are well below the dose limits of 25 mrem y^{-1} or 100 mrem y^{-1} established for restricted release when institutional controls are in place or after loss of institutional control, respectively, as specified in 10 *CFR* 20, Section 1403. However, since the restricted release guidelines are specific to radiological doses to human receptors, these dose estimates do not address the potential effects of chemical toxicity to humans exposed to DU through these scenarios, the radiological toxicity of DU to ecosystem receptors, or the risk of injury or death to the members of the critical groups due to UXO accidents. Risk of adverse health effects in humans due to radiation from DU is low, based on the analyses in this report, and is potentially the smallest of the various risk factors regarding JPG site use.

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ATTACHMENT 1 – FLOOD AND SEDIMENT ANALYSES OF BIG CREEK WATERSHED, JEFFERSON PROVING GROUNDS, INDIANA

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Introduction

This report presents the development and analysis of flood flows and suspended sediment transport and yield from the Big Creek watershed that flows through the Jefferson Proving Grounds (JPG) in southeastern Indiana. The objective of this study is to provide flood flows for given return periods and associated sediment transport and yield for environmental analyses. Data and parameters for this effort were obtained from reports, maps, and web-based routines to support modeling estimates of erosion rate.

Watershed Delineation

Digital Elevation Model (DEM) data for the Big Creek watershed were downloaded from the following web site: http://data.geocomm.com/catalog/US/61066/sublist.html. These data were provided in U.S. Geological Service (USGS) Spatial Data Transfer Standard (SDTS) format. The following sections were necessary to cover the JPG and Big Creek watershed: Volga, Clifty Falls, Vernon, San Jacinto, and Rexville. Data in the SDTS format cannot be used by the ESRI ArcGIS™ system used in this study; however, ESRI does provide a data translator that takes SDTS raster data and coverts it into grids usable by ArcGIS. After converting the data, grid cell size was checked for consistency, converting 10- by 10-meter grids to 30- by 30-meter grids as necessary. All data were in the same projection [North American Datum (NAD) 1927 Universal Transverse Mercator (UTM) zone 16N]. A single ArcGIS™ grid was generated using the mosaic function. This grid was checked for sinks or missing data with those cells being filled using values calculated from the adjacent cells. After obtaining a filled grid, a flow direction grid was determined based on elevation values and then a flow accumulation grid was calculated. Using these grids, sub-basin outlines and areas, channel lengths, and elevation changes were calculated. Outlines of the JPG and depleted uranium (DU) impact areas were used from data provided by Science Applications International Corporation (SAIC). Figure C1-1 presents the results of these processing and location of nodes used later in the flood analyses.

Flood Analyses

Flood analyses used the U.S. Army Corp of Engineers (USACE) Hydrologic Engineering Center (HEC) model, known as HEC-1, as implemented on a Microsoft Windows™-based system by Haestad Methods (HEC 1990). This code is commonly used to provide flood information. The analysis only predicts flood hydrographs at various nodes through the watershed as described in the previous section. The results presented do not include floodplain definition that would be performed using HEC-2 or HEC-River Analysis System (HEC-RAS). Floodplain mapping (see McLin et al. 2001 for an example) requires more detailed analysis of channel conditions and time than was available.

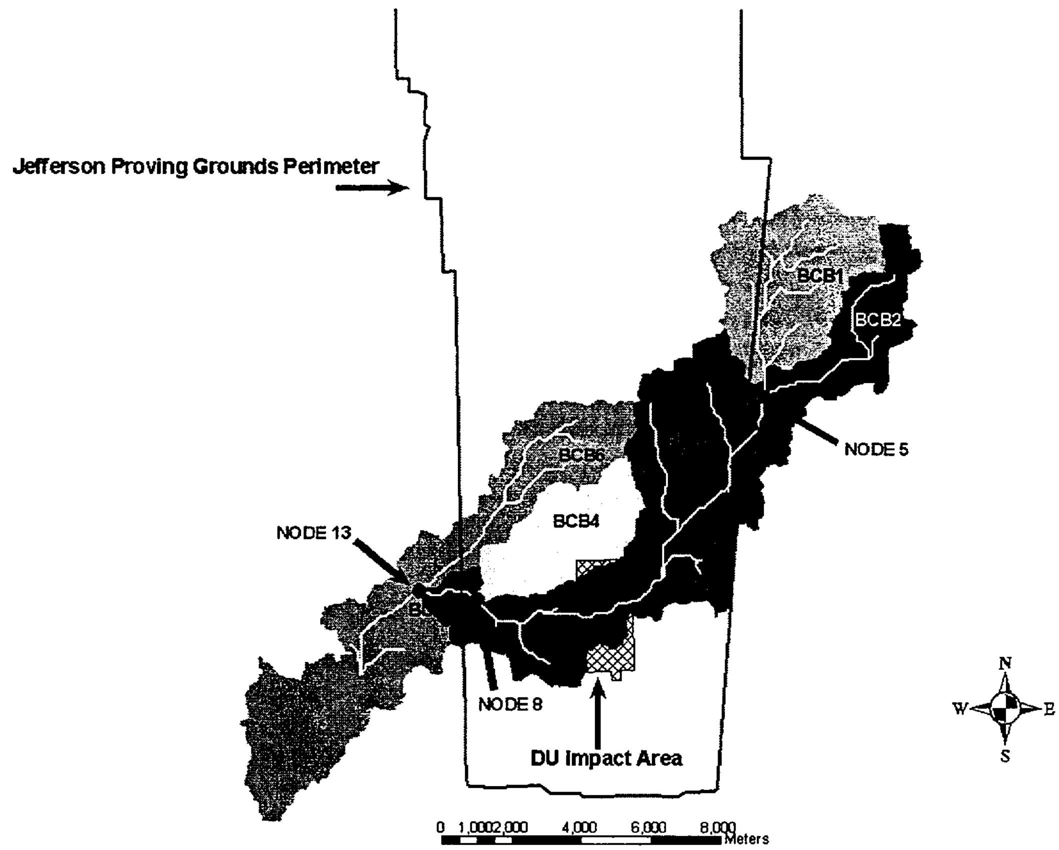

Figure C1-1. Big Creek Watershed with Identified Sub-basins and Nodes used in the HEC-1 Modeling of Flood Flows

The analysis proceeds by developing the flood estimates for the 2-, 10-, 25-, 50-, and 100-year, 24-hour duration rainfall event and using the resulting hydrologic data to estimate sediment discharge at two locations on Big Creek. The computational interval for both rainfall input and runoff was one hour. This section will present the watershed network, parameter estimates, and results used by HEC-1 for the flood analysis of Big Creek, and the next section will examine suspended sediment discharge and yield.

Watershed network – The first step is to create a network based on the watershed information presented in the previous section. The HEC-1 network representation is presented in Figure C1-2. A description of the network follows. The icons with BCB1 (Big Creek Basin 1), BCB2, BCB3, BCB4, BCB5, and BCB6 are computed runoff nodes, which represent upland areas that generate runoff from rainfall events. Icons that are designated Node 5, Node 8, and Node 13 are confluence points where two or more hydrographs are combined. Water is routed through the watershed using routing nodes (Node 6 and Node 10). The computed runoff and routing nodes have different methods for making calculations that will be described in the following section. Confluence nodes combine hydrographs and these nodes do not have any options.

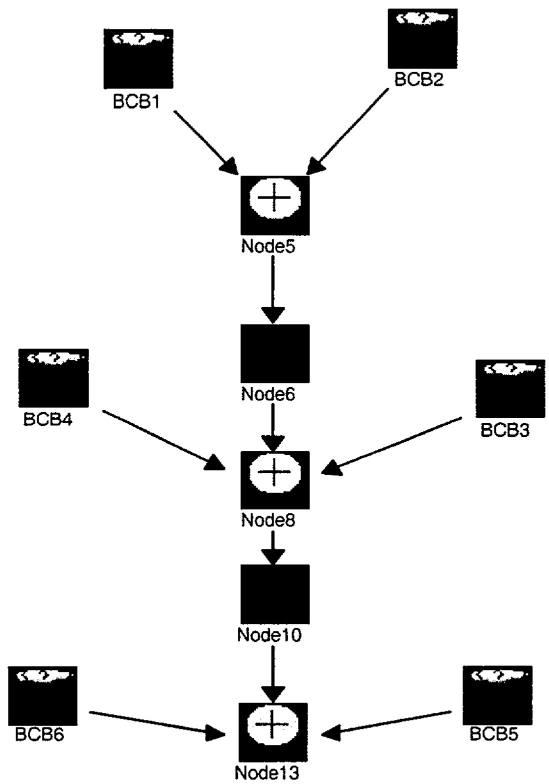

Figure C1-2. HEC-1 Network Diagram for Flood Flow Estimates for Big Creek

Using the information from the watershed delineation, the properties for each node are given in Table C1-1. The confluence nodes represent that area upstream from the locations. Node 6 and Node 10 route flow through BCB3 and BCB5, and all other basin input at their outlets. Flood and sediment discharges are given for Node 8 and Node 13. Data are available for each node if needed.

Rainfall amounts and distribution – Flood flows were estimated for 2-, 10-, 25-, 50-, and 100-year return periods and a 24-hour duration rainfall event. Rainfall amounts for these return periods were determined using a web-based procedure located at the URL http://pasture.ecn.purdue.edu/~sedspec/ for Jefferson County, Indiana. By selecting the "Database Frontend" button, rainfall amounts can be estimated for selected durations and return periods for various counties in the United States using either the U.S. Weather Bureau Report TP-40 or the Midwestern Climate Center analysis. We used the Midwestern Climate Center for our calculations. The rainfall amounts appear in Table C1-2.

Rainfall distribution assumed the Soil Conservation Service (SCS) Type II storm from Kent (1973). This rainfall distribution is suggested for areas of the United States other than the west coast and Alaska. Values of the Type II distribution by hour are given in Table C1-3.

Table C1-1. Area, Length, and Elevation Change for Sub-basins, Routing Channels, and Confluences for Big Creek used in Flood Analyses

Node	Area (km^2)	Length (m)	Elevation Change (m)
BCB1	16.87	5006.3	38.0
BCB2	9.69	6813.1	41.0
Node 5	26.56	NA	NA
Node 6	NA	13154.40	51.0
BCB3	37.65	13154.40	51.0
BCB4	10.86	5450.24	40.0
Node 8	75.07	NA	NA
Node 10	NA	1884.36	27
BCB5	2.03	1884.36	27
BCB6	13.02	7421.44	41
Node 13	90.12	NA	NA

km^2 = square kilometers.
m = meter.
NA = Not applicable.

Table C1-2. Rainfall Amounts for 24-hour Duration Event for Selected Return Periods from Midwestern Climate Center Data Located at http://pasture.ecn.purdue.edu/~sedspec/

Return Period (Years)	Rainfall Amount (mm)
2	76.96
10	112.27
25	136.91
50	157.48
100	180.85

mm = millimeters.

<u>Runoff parameters</u> – The SCS Curve Number (CN) method was selected to partition rainfall into runoff for each of the compute runoff nodes (the BCB#). Estimates for CNs depend on selecting the hydrologic soil group and land cover condition. The hydrologic soil groups were selected based on information in Table C1-19 of Nickell (1985). The soils were all essentially hydrologic soil group D, which means they have high potential runoff. The surface condition qualifier varied between on- and off-site of the JPG. Land use off-site was assumed to be more agriculture so a "fair" condition was assigned and for the JPG, the condition was "good" because basically the land was allowed to recover from any previous anthropogenic disturbance, except for certain locations such as the DU Impact Area. Sub-basins BCB1 and BCB2 were assumed to be impacted by agriculture more than the rest of the watershed with row crops as the land cover for those basins. Approximately 25% of BCB1 was located in the JPG so BCB1 had a weighted CN based on wood-grassland (25%) and row crop agriculture (75%). The CNs were estimated using the same web site as the rainfall, http://pasture.ecn.purdue.edu/~sedspec/, and selecting the TR-55 button. The menu will lead one through the selection process, and the CN value will be generated. For all calculations, the initial abstraction (Ia) for the SCS CN method was set to 0.2, and no impervious area was assumed. The CNs for each sub-basin are given in Table C1-4.

Table C1-3. SCS Type II Rainfall Distribution for 24-hour Duration Event

Time (hours)	Cumulative Rainfall
0	0.0
1	0.011
2	0.022
3	0.035
4	0.048
5	0.064
6	0.080
7	0.100
8	0.120
9	0.147
10	0.181
11	0.235
12	0.663
13	0.772
14	0.820
15	0.850
16	0.880
17	0.898
18	0.916
19	0.930
20	0.952
21	0.964
22	0.976
23	0.988
24	1.0

Source: Kent 1973.
SCS = Soil Conservation Service.

Table C1-4. Runoff Curve Numbers and Lag Times Used in Flood Estimation for Big Creek for Each Sub-basin

Sub-basin	CN	Lag Time (hours)
BCB1	84	0.90
BCB2	85	1.25
BCB3	79	2.45
BCB4	79	0.97
BCB5	82	0.33
BCB6	79	1.38

CN = curve number.

Runoff for the computed runoff nodes was routed to the basin outlet using the SCS unit hydrograph method. This requires an estimate of the lag time (t_l) for each basin. The lag time can be related to the time of concentration (t_c) by the following formula (Kent 1973)

$$t_l = 0.6 * t_c \ , \qquad (1)$$

where t_l is lag time (hours) and t_c is time of concentration in hours. The t_c was estimated using the Kirpich formula (Maidment 1993):

$$t_c = 0.0078 * L^{0.77} * S^{-0.385} , \quad (2)$$

where t_c is time of concentration in minutes, L is the length of watershed from divide to outlet (ft), and S is the channel slope (ft/ft). Values for L and S were obtained from Table C1-1 and converted to English units for use in Equation 2. The lag time for each sub-basin is given in Table C1-4.

Stream routing – The Muskingham method was used for routing water in Node 6 and Node 10. Data on inflow and outflow hydrographs that can be used to support parameter estimation for the Muskingham method were not readily available. There are two parameters that require estimation for the Muskingham method, which provides the relative contribution of the inflow hydrograph (X) and K, which is the travel time through the reach. Values for X are $0 \leq x \leq 0.5$, and a value of 0.2 was used. The parameter K was estimated assuming a flow velocity of 1.52 m/s and dividing this velocity into the channel length in Table C1-1. The values for K are 2.4 for Node 6 and 0.3 for Node 10. The number of reaches for both Node 6 and Node 10 were set to 1.

Results of flood calculations - Data are presented for two nodes that can be seen in Figures 1 and 2. Node 8 is near the outlet of JPG so that estimates of flood flows and sediment discharge at that location can be identified, and Node 13 provides the flood flow and sediment transport from the entire JPG. The lack of data from Big Creek meant that data from other nearby locations are needed to test consistency of the model results. Two major drainages are Brush Creek near Nebraska, Indiana (USGS Station ID 03368000; see URL http://waterdata.usgs.gov/nwis/peak/?site_no=03368000) and Indian-Kentuck Creek near Canaan, Indiana (USGS Station ID 03291780; see URL http://waterdata.usgs.gov/nwis/peak/?site_no=03291780). Brush Creek has a drainage area of 29.53 km^2 (11.4 mi^2) and a record length of 46 years. It is located north of JPG. Indian-Kentuck Creek has a drainage area of 71.22 km^2 (27.5 mi^2) and a record length of 32 years. Indian-Kentuck Creek is located east of the JPG. Annual peak flow data from these steams allow comparison with the model-generated values for Big Creek to establish that the simulated values are reasonable.

The peak flow values estimated using the parameters values in HEC-1 for Node 8 and Node 13 are presented in Table C1-5. The frequency distribution is an approach to compare flood between watersheds. The return periods in Table C1-5 provide the frequencies for Big Creek. Using the annual peak flows obtained for Brush Creek and Indian-Kentuck Creek and the Weibull plotting position formula (Maidment 1993) a comparison of the flood frequencies are given in Figure C1-3. A logarithmic scale is used for the y-axis because floods have been shown to have a skewed distribution. The HEC predicted peak flows are greater than those observed from either Brush or Indian-Kentuck Creeks. This is somewhat expected because the record of observed flows is short and the difference in area between Big Creek and the other two watersheds. Figure C1-4 shows the probability plot with the flood peak flows on a unit area basis (km^2) to account for the difference in area between the various watersheds. In Figure C1-4, the predicted Big Creek peaks are less than those from Brush Creek and Indian-Kentuck. This is expected because the Big Creek watershed through the Jefferson Proving Grounds is in forested conditions leading to less runoff generation than the other two watersheds where more agriculture is practiced. The peak flow values in Figure C1-4 for Big Creek HEC simulations are also given in Table C1-5.

Table C1-5. Peak Flow Values for Given Return Periods for Big Creek at Selected Locations

Return Period	Node 8 (m^3/s)	Node 13 (m^3/s)	Node 8 ($m^3/s\text{-}km^2$)	Node 13 ($m^3/s\text{-}km^2$)
2	80.59	107.04	1.07	1.19
10	148.09	193.40	1.94	2.14
25	195.19	258.08	2.60	2.86
50	237.49	313.72	3.16	3.48
100	286.48	378.14	3.81	4.19

km^2 = square kilometers.
m^3/s = cubic meters per second.

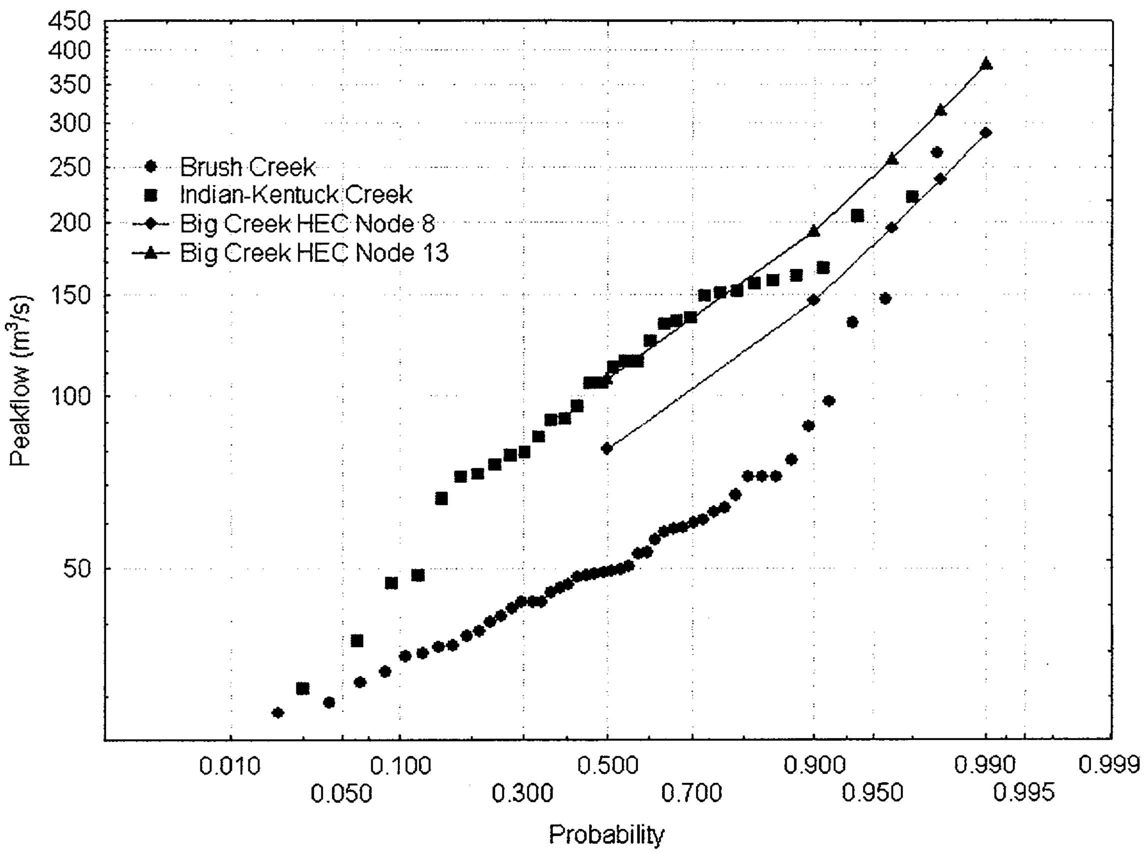

Figure C1-3. Frequency Plot of Peak Flows For Observed Data from Brush and Indian-Kentuck Creeks and HEC Predicted Peak Flows for Big Creek from Node 8 and Node 13

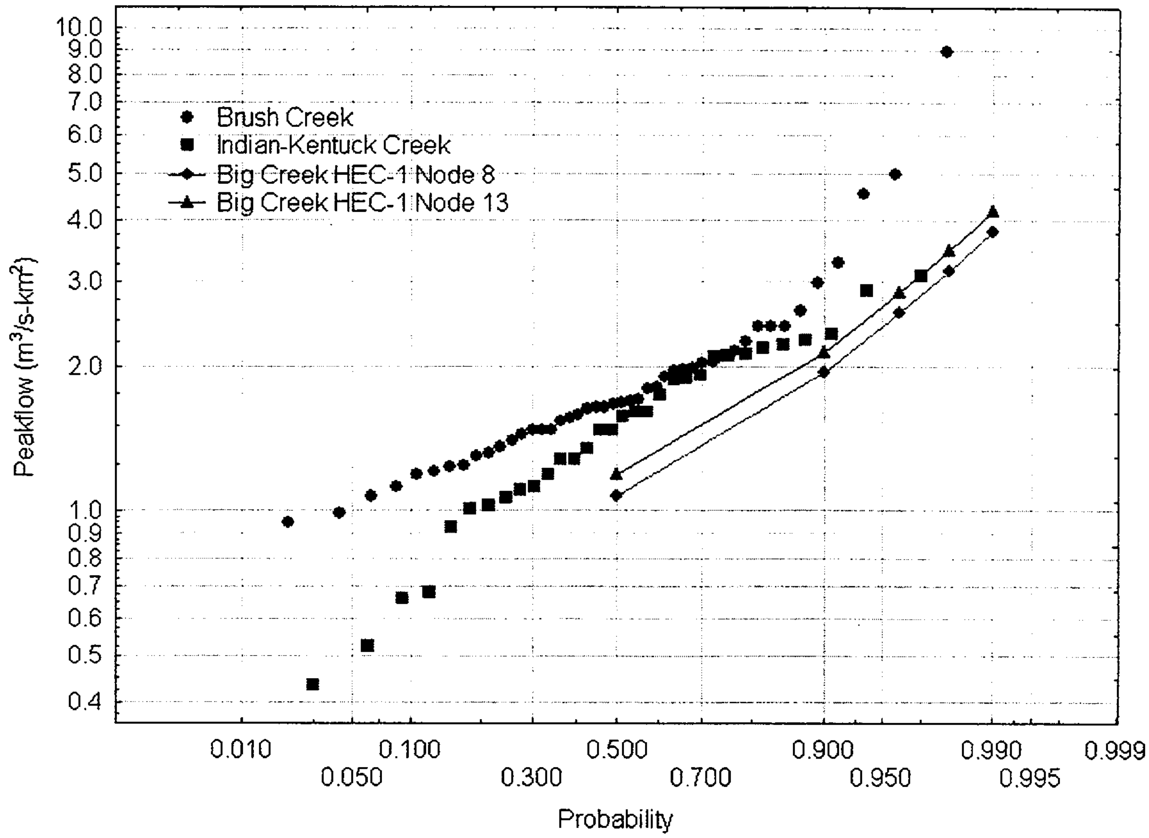

Figure C1-4. Frequency Plot of Peak Flows on a Unit Area Basis for Observed Data from Brush Creek and Indian-Kentuck Creeks and HEC Predicted Peak Flows on a Unit Area Basis for Big Creek from Node 8 and Node 13

Overall, the simulation by HEC on Big Creek appears to be reasonable for the area given the data from Brush and Indian-Kentuck Creeks. From Figure C1-4, it can be seen how the smaller watersheds have a larger peak flow per unit area, which is an observed trend with other data. One inconsistency is the higher peak flow per unit area (Figure C1-4) for Node 13 over Node 8. This is most likely due to the Muskingham routing between these two nodes. The computational time interval was set at 1 hour, and the travel time through the reach was estimated to be 0.3 hour. So basically the hydrograph from Node 8 is routed to Node 13 in the same time interval. In reviewing the hydrographs the peak flow occurs at the same time for both Nodes 8 and 13, which will not happen in the watershed. To support a more detailed simulation, data on channel characteristics must be available to make a better estimate of routing parameters.

Suspended Sediment Transport and Yield

__Water discharge vs. sediment concentration and discharge__ – Statistical analyses were performed for average discharge rates (m^3/s) vs. sediment concentration (mg/L) and sediment discharge (t/d) using 20 samples from 1977–1980 at Indian-Kentuck Creek near Cannan, Indiana, using 43 samples from 1964–1968 at Brush Creek near Nebraska, Indiana, and using 25 samples from 1969–1983 at South Hogan Creek near Dillsboro, Indiana. These USGS data were obtained from the web site, http://waterdata.usgs.gov/nwis/qwdata, and are summarized in Table C1-6.

Table C1-6. Summary of Water and Sediment Data for Indian-Kentuck Creek, Brush Creek, and South Hogan Creek USGS Gauging Sites near JPG

Site	Mean Discharge (m^3/s) Range in ( )	Std Dev of Discharge (m^3/s)	Mean Suspended Sediment Concentration (mg/L) Range in ( )	Std Dev of Suspended Sediment Concentration (mg/L)	Mean Sediment Discharge (t/d) Range in ( )	Std Dev Sediment Discharge (t/d)
03291780 Indian-Kentuck Creek near Cannan, Indiana A = 27.5 sq mi N = 20	1.68 (19.6)	4.45	49.1 (224)	68.6	22.9 (398)	88.6
03368000 Brush Creek near Nebraska, Indiana A = 11.4 sq mi N = 43	0.997 (18.7)	3.26	112. (2690)	426.	122. (4345)	671.
03276700 South Hogan Creek near Dillsboro, Indiana A = 38.1 sq mi N = 25	2.29 (23.5)	5.23	66.4 (323)	85.3	47.3 (669)	143.

Note: The 8-digit codes shown for each site are the USGS site numbers.
JPG = Jefferson Proving Ground.
USGS = U.S. Geological Service.

Linear and log-transform regressions were run on these data. The results (i.e. the best water discharge predictor equation for suspended sediment concentration or sediment discharge) showed that the log-transform was inappropriate and the results were inconclusive.

Therefore, linear regression results for data from the sites listed in Table C1-6 are summarized in Table C1-7. The suspended sediment concentration, C, is in mg/L, sediment discharge, Qs, is in t/d, and water discharge, Q, is in m^3/s. Notice that Indian-Kentuck and South Hogan Creek have similar results (i.e. the sign of the intercepts are the same and the values of the coefficients are similar) in Table C1-7. However, the regression intercepts for Brush Creek are quite different (for suspended sediment concentration, the intercept for Brush Creek is negative while the intercepts are positive for the other two locations) and the regression coefficients (the b or slope values) are about an order of magnitude larger for the Brush Creek data.

The differences in the regression results in Table C1-7 can be partially explained by the ranges of the data shown in parentheses in Table C1-6. The ranges of the water discharge values in Table C1-6 are comparable, but the range of suspended sediment concentrations and sediment discharge is about an order of magnitude larger for the Brush Creek data. Given similar water discharge and higher suspended sediment concentration, then the suspended sediment discharge, as their product, must also be larger.

Prediction equations of the form $C = a + bQ$ with $a < 0$, can produce spurious results (i.e. negative suspended sediment concentrations) as the discharge, Q, approaches zero. Therefore, we performed regression analyses with the intercept set at zero (called regression through the origin) for each of the data sets and the results are summarized in Table C1-8. The results are prediction equations of the form $C = bQ$

and Qs = bQ. Again, notice that the b values for the data from Brush Creek are about an order of magnitude larger than at the other two sites. Also, notice that except for C vs. Q at Indian-Kentuck Creek, there was little reduction in R^2 values when going from regression with an intercept to regression through the origin.

Table C1-7. Summary of Linear Regression Results for the Gauging Stations Listed in Table C1-6

Site	Linear Regression C = a + bQ			Linear Regression Qs = a + bQ		
	Intercept a	**Coefficient b**	**R^2**	**Intercept a**	**Coefficient b**	**R^2**
03291780 Indian-Kentuck Creek near Cannan, Indiana N = 20	32.8	9.71	0.40	-9.25	19.2	0.93
03368000 Brush Creek near Nebraska, Indiana N = 43	−13.6	126.	0.93	-66.8	190.	0.85
03276700 South Hogan Creek near Dillsboro, Indiana N = 25	32.0	15.0	0.84	−15.1	27.1	0.98

Table C1-8. Summary of Linear Regression Through the Origin Results for the Gauging Stations Listed in Table C1-6

Site	Regression Through the Origin C = bQ		Regression Through the Origin Qs = bQ	
	Coefficient b	**R^2**	**Coefficient b**	**R^2**
03291780 Indian-Kentuck Creek near Cannan, Indiana N = 20	12.3	0.19	18.5	0.92
03368000 Brush Creek near Nebraska, Indiana N = 43	125.	0.93	184.	0.85
03276700 South Hogan Creek near Dillsboro, Indiana N = 25	17.3	0.72	26.0	0.97

__Procedure for estimating sediment yields for flood events on Big Creek__ – The longer period of record at Brush Creek and the greater range in observed suspended sediment concentration there suggest that we should use it to estimate the water discharge – suspended sediment concentration relationship for Big Creek. This estimating equation is:

$$C\ (mg/L) = 125 \times Q\ (m^3/s)\ , \qquad (3)$$

where Q is the HEC-1 computed water discharge rate at any given time A discharge rate of 28.32 m^3/s would produce an estimated suspended sediment concentration of 3,540 mg/L, which is 0.354% by weight, and a peak discharge of 142 m^3/s would produce a suspended sediment concentration of 17,750 mg/L, which is equal to 1.775% by weight.

The regression through the origin relationship for the Brush Creek data is shown in Figure C1-5. Notice that the maximum observed discharge rate is 18.7 m^3/s, which produced a suspended sediment concentration of 2,690 mg/L = 0.269% by weight. The premise of Equation 3 as an estimating equation for Big Creek is that the water discharge – suspended sediment concentration relationship can be transposed from Brush Creek to Big Creek and will produce reasonable estimates of suspended sediment concentration. As shown in Table C1-8, the coefficient in the equation relating water discharge to sediment discharge can vary by about a factor of 10 for streams in the JPG area. The error in transposing Equation 3 from Brush Creek to Big Creek depends upon a number of factors including: (1) length of record, (2) number of larger storms sampled, (3) the degree of hydrologic similarity between Big Creek and surrounding streams, and (4) the stationarity in time and uniformity in space of the data used to determine Equation 3.

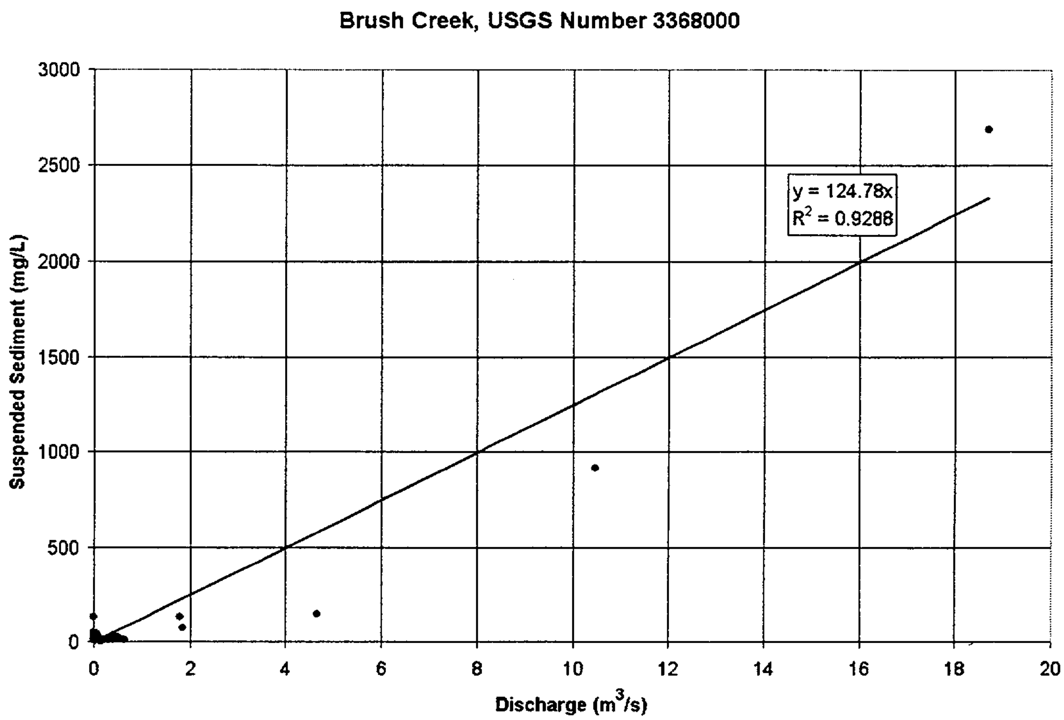

Figure C1-5. Regression Through the Origin for the USGS Measured Data at Brush Creek near Nebraska, Indiana

(These data were obtained from the U.S. Geological Survey web site: http://waterdata.usgs.gov/nwis/qwdata.)

<u>Estimating sediment yields for simulated flood events on Big Creek</u> – Flood hydrographs (water discharge as a function of time, starting at zero flow, rising to the peak flow, and then receding back to zero flow or zero flow above base flow) simulated by the HEC-1 were used to calculate suspended sediment concentration (using Equation 3). Suspended sediment discharge was calculated as the product of water discharge and suspended sediment concentration throughout the duration of the flood. Water and

suspended sediment yield were then calculated by numerically integrating the rates of water and suspended sediment discharge throughout the flood hydrographs. These calculations produced estimates of peak discharge, water yield, and suspended sediment yield for each flood event. These estimated data for Big Creek at two locations are summarized in Table C1-9 in customary English units (cubic feet per second, cfs, acre feet, AF, and English short tons, t). The data in Table C1-10 are in customary metric units (cubic meters per second, m^3/s, megaliters, ML, and metric tons, t).

Table C1-9. Results for Suspended Sediment Yield Estimates at Nodes 8 and 13, HEC-1 Analyses for Big Creek, at the JPG

Return Period (y)	Node 8			Node 13		
	Peak (cfs)	Volume (AF)	Sediment Yield (t)	Peak (cfs)	Volume (AF)	Sediment Yield (t)
2	2846.	2393.	21,593.	3780.	2850.	31,780.
10	5159.	4189.	66,973.	6830.	4999.	99,168.
25	6893.	5519.	116,643.	9114.	6592.	173,203.
50	8387.	6660.	170,045.	11,079.	7957.	252,955.
100	10,117.	7978.	244,134.	13,354.	9538.	363,808.

Note: Results are in English units.
HEC = Hydrologic Engineering Center.
JPG = Jefferson Proving Ground.

Table C1-10. Results for Suspended Sediment Yield Estimates at Nodes 8 and 13, HEC-1 Analyses for Big Creek, at the JPG

Return Period (y)	Node 8			Node 13		
	Peak (m^3/s)	Volume mL	Sediment Yield (t)	Peak (m^3/s)	Volume (ML)	Sediment Yield (t)
2	80.6	2952.	19,589.	107.	3515.	28,830.
10	146.	5167.	60,757.	193.	6166.	89.963.
25	195.	6808.	105,816.	258.	8131.	157,126.
50	238.	8215.	154,261.	314.	9815.	229,476.
100	287.	9841.	221,473.	378.	11,765.	330,039.

Note: Results are in English units.
HEC = Hydrologic Engineering Center.
JPG = Jefferson Proving Ground.

Often, it is easier to compare results when they are normalized per unit area. Normalized English units of inches, in., inches per hour, in./hr, and tons per acre, t/a, are used in Table C1-11. Normalized metric units of millimeters, mm, millimeters per hour, mm/h, and metric tons per hectare, t/ha, are used in Table C1-12.

Table C1-11. Results for Runoff and Suspended Sediment per Unit Area at Nodes 8 and 13

Return Period (y)	Node 8			Node 13		
	Peak (in./hr)	Volume (in.)	Sediment Yield (t/a)	Peak (in./hr)	Volume (in.)	Sediment Yield (t/a)
2	0.152	1.55	1.16	0.168	1.54	1.43
10	0.276	2.71	3.61	0.304	2.69	4.45
25	0.369	3.57	6.29	0.406	3.55	7.79
50	0.448	4.31	9.17	0.493	4.29	11.36
100	0.541	5.16	13.16	0.595	5.14	16.34

Note: Results are in English units.

Notice that runoff peak rates and suspended sediment yields increase at a greater rate with increasing return periods than does runoff volume. This is the usual case in simulated and observed data per unit area. Also, notice that all of the data presented herein (Tables 9 to 11) are simulated. Therefore, it is necessary to examine them in the context of measured data. We used long-term, annual sediment yield data from reservoir sedimentation studies (e.g. Chow, 1964, Chapter 17, Table C1-17-I-7, pp. 17-28 to 17-29). Finally, notice that the simulated data are for flood events with return periods from 2 to 100 years, whereas the reservoir sedimentation data are long-term average annual values. Direct comparisons cannot be made between individual simulated flood events and measured average annual data. However, the average annual sediment yields should be roughly comparable in magnitude to the values of the 2- and 10-year suspended sediment yields.

Table C1-12. Results for Runoff and Suspended Sediment per unit area at Nodes 8 and 13

Return Period (y)	Node 8			Node 13		
	Peak (mm/h)	Volume (mm)	Sediment Yield (t/ha)	Peak (mm/h)	Volume (mm)	Sediment Yield (t/ha)
2	3.86	39.4	2.60	4.27	39.1	3.21
10	7.01	68.8	8.09	7.72	68.3	9.98
25	9.37	90.7	14.10	10.31	90.2	17.47
50	11.4	109.5	20.56	12.55	109.0	25.47
100	13.7	131.1	29.50	15.11	130.6	36.63

Note: Results are in metric units.

Chow (1964) presented annual sediment yield (from reservoir sedimentation rates) from seven small watersheds in the Midwest ranging in size from 2.59 km^2 to 156 km^2. These results for average annual sediment yield in t/ha are summarized in Table C1-13.

Table C1-13. Summary of Average Annual Sediment Yields from Seven Small Watersheds in the Midwest

Name/Location	Drainage Area (km^2)	Record Length (y)	Annual Sediment Yield (t/ha)
Caldwell, Waverly, Ohio	2.59	12	1.16
Decker, Piqua, Ohio	5.96	10	3.61
Shepard Mountain, Ironton, Missouri	10.1	10	1.65
Westville, Alliance, Ohio	21.3	37	1.01
Upper Pine, Eldora, Iowa	35.7	13.3	5.22
Carlinville, Carlinville, Illinois	66.8	10.4	3.57
Bloomington, Bloomington, Illinois	156.	22.7	1.80

Source: Adapted from Chow (1964).

The average annual sediment yield for these seven reservoirs ranged from about 1 to 5 t/ha. The 2-year floods (Table C1-S 7) had suspended sediment yields of 2.60 and 3.21 t/ha, respectively, for Nodes 8 and 13. The corresponding flood yields for the 10-year flood were 8.09 and 9.98 t/ha. Therefore, the average annual sediment yields from the reservoir surveys ranged from less than the simulated 2-year suspended sediment yields to about midway between the simulated 2-year and 10-year suspended sediment yields. Again, while average annual sediment yield cannot be directly compared with simulated suspended sediment yields from the 2- and 10-year floods, their values are comparable in magnitude. This provides empirical support for the general order of magnitude of the simulated suspended sediment yields from this study.

References

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ATTACHMENT 2 – DATA CATALOG

The following tables are a data catalog of the input parameters, default values, and justifications for selection of various values used in the Residual Radioactivity (RESRAD) analyses. The distributions of values selected for uncertainty analyses are also listed. Jefferson Proving Ground (JPG) values that are identical with values in the default values column were used without additional references; other selected values were referenced.

Table C2-1. Values for Parameters Common to all Exposure Scenarios

Parameter	Default Value	JPG Value	Probabilistic Values (Distribution)	Reference
Radionuclide Concentrations and Transport Parameters				
Depleted Uranium[a] (pCi g^{-1})	0	94 or 225		Problem Definition
Basic Radiation Dose Limit (mrem y^{-1})	25	25 or 100		Regulatory Limits
Uranium Distribution Coefficient[b]	50	50	50 (min. 5, max 60, Triangular)	Yu et al. (2001); Sheppard and Thibault (1992)
Contaminated Zone Parameters				
Contaminated Zone Area (m^2)	10,000	5×10^5 or 1.2×10^6		SEG 1996a
Contaminated Zone Thickness (m)	2	0.15		SEG 1996a; Ebinger et al. 1995
Length Parallel to Aquifer Flow (m)	100	100		
Depth of Cover (m)	0	0		
Bulk Density of Contaminated Zone (g cm^{-3})	1.5	1.4		Saxton et al. 1986; Meyer and Gee (1999)
Contaminated Zone Erosion Rate (m y^{-1})	0.001	.001		
Contaminated Zone Total Porosity	0.4	0.45		Saxton et al. 1986; Meyer and Gee (1999)
Contaminated Zone Field Capacity	0.2	0.3		Saxton et al. 1986; Meyer and Gee (1999)
Contaminated Zone Hydraulic Conductivity (m y^{-1})	10	30		Meyer and Gee (1999)
Contaminated Zone b Parameter	5.3	5.3		
Evapotranspiration Coefficient	0.5	0.5		
Wind Speed (m s^{-1})	2	2		
Precipitation (m y^{-1})	1	1		
Irrigation (m y^{-1})	0.1	0.1 or 0		
Irrigation Mode	Overhead	Overhead		
Runoff Coefficient	0.2	0.2		
Watershed Area for Nearby Pond or Stream (m^2)	1×10^6	1×10^6		
Accuracy for Computations	0.001	.001		
Saturated Zone Parameters				
Bulk Density of Saturated Zone (g cm^{-3})	1.5	1.5		
Saturated Zone Total Porosity	0.4	.4		
Saturated Zone Field Capacity	0.2	.2		
Saturated Zone Hydraulic Conductivity (m y^{-1})	100	100		
Saturated Zone Hydraulic Gradient	0.2	.2		

Table C2-1. Values for Parameters Common to all Exposure Scenarios (Continued)

Parameter	Default Value	JPG Value	Probabilistic Values (Distribution)	Reference
Saturated Zone b Parameter	5.3	5.3		
Water Table Drop Rate (m y^{-1})	0.001	.001		
Well Pump Intake Depth (m) below water table	10	10		
Model for Water Transport	Non-dispersive	Non-dispersive		
Well Pumping Rate (m^3 y^{-1})	250	250		
		Unsaturated Zone Parameters[c]		
Number of Zones	1	5^3		
Thickness (for each zone) [m]	4	0.3		Nickell 1985; SEC Donohue 1992
Bulk Density of Unsaturated Zone (g cm^{-3})	1.5	1.35		Saxton et al. 1986; Meyer and Gee (1999)
Unsaturated Zone Total Porosity	0.4	.45		Saxton et al. 1986
Unsaturated Zone Effective Porosity	0.2	.3		Saxton et al. 1986
Unsaturated Zone Field Capacity	0.2	.3		Saxton et al. 1986
Unsaturated Zone Hydraulic Conductivity (m y^{-1})	10	30		Meyer and Gee (1999)
Unsaturated Zone b Parameter	5.3	5.3		
		Zone 2		
Thickness (for each zone) [m]	4	0.38		Nickell 1985; SEC Donohue 1992
Bulk Density of Unsaturated Zone (g cm^{-3})	1.5	1.4		Saxton et al. 1986; Meyer and Gee (1999)
Unsaturated Zone Total Porosity	0.4	0.45		Saxton et al. 1986
Unsaturated Zone Effective Porosity	0.2	0.2		Saxton et al. 1986
Unsaturated Zone Field Capacity	0.2	0.3		Saxton et al. 1986
Unsaturated Zone Hydraulic Conductivity (m y^{-1})	10	30		Meyer and Gee (1999)
Unsaturated Zone b Parameter	5.3	5.3		
		Zone 3		
Thickness (for each zone) [m]	4	0.59		Nickell 1985; SEC Donohue 1992
Bulk Density of Unsaturated Zone (g cm^{-3})	1.5	1.35		Saxton et al. 1986; Meyer and Gee (1999)
Unsaturated Zone Total Porosity	0.4	0.4		Saxton et al. 1986
Unsaturated Zone Effective Porosity	0.2	0.2		Saxton et al. 1986
Unsaturated Zone Field Capacity	0.2	0.3		Saxton et al. 1986
Unsaturated Zone Hydraulic Conductivity (m y^{-1})	10	10		Meyer and Gee (1999)
Unsaturated Zone b Parameter	5.3	5.3		
		Zone 4		
Thickness (for each zone) [m]	4	0.68		Nickell 1985; SEC Donohue 1992
Bulk Density of Unsaturated Zone (g cm^{-3})	1.5	1.35		Saxton et al. 1986; Meyer and Gee (1999)

Table C2-1. Values for Parameters Common to all Exposure Scenarios (Continued)

Parameter	Default Value	JPG Value	Probabilistic Values (Distribution)	Reference
Unsaturated Zone Total Porosity	0.4	0.4		Saxton et al. 1986
Unsaturated Zone Effective Porosity	0.2	0.2		Saxton et al. 1986
Unsaturated Zone Field Capacity	0.2	0.3		Saxton et al. 1986
Unsaturated Zone Hydraulic Conductivity (m y^{-1})	10	10		Meyer and Gee (1999)
Unsaturated Zone b Parameter	5.3	5.3		
Zone 5				
Thickness (for each zone) [m]	4	1.5		Nickell, 1985; SEC Donohue 1992
Bulk Density of Unsaturated Zone (g cm^{-3})	1.5	1.3		Saxton et al. 1986; Meyer and Gee (1999)
Unsaturated Zone Total Porosity	0.4	0.45		Saxton et al. 1986
Unsaturated Zone Effective Porosity	0.2	0.2		Saxton et al. 1986
Unsaturated Zone Field Capacity	0.2	0.3		Saxton et al. 1986
Unsaturated Zone Hydraulic Conductivity (m y^{-1})	10	30		Meyer and Gee (1999)
Unsaturated Zone b Parameter	5.3	5.3		

[a]Nominal isotopic composition of depleted uranium is from Shleien (1992).
[b]A separate distribution coefficient is required for the contaminated zone, each unsaturated zone, and the saturated zone.
[c]Properties for each horizon entered from top (zone 1) to bottom (zone 5) of the soil profile. Total thickness of unsaturated zone is 3.6 m.

Table C2-2. Parameter Values for On-Site Worker (Table 6, Scenario 1)

Parameter	Default Value	Scenario Value	Probabilistic Values (Distribution)	Reference
Occupancy, Inhalation, and Gamma Parameters				
Inhalation Rate (m^3 y^{-1})	8,400	8,400		Yu et al. 2001; Beyeler et al. 1998
Mass Loading for Inhalation (g m^{-3})	0.001	.001	0.001 to 0.0001 (uniform)	Beyeler et al. 1998
Exposure Duration (y)	30	30		
Inhalation Shielding Factor	0.4	.4		
External Gamma Shielding Factor	0.7	.7		
Indoor Time Fraction	0.5	0.2		Scenario definition
Outdoor Time Fraction	0.25	0.05		Scenario definition
Shape of Contaminated Zone	Circular	Circular		
Ingestion Pathways, Dietary Data				
Fruit, Vegetable, and Grain Consumption (kg y^{-1})	160	NA		
Leafy Vegetable Consumption (kg y^{-1})	14	NA		
Milk Consumption (L y^{-1})	92	NA		
Meat and Poultry Consumption (kg y^{-1})	63	NA		
Fish Consumption (kg y^{-1})	5.4	NA		

Table C2-2. Parameter Values for On-Site Worker (Table 6, Scenario 1) [Continued]

Parameter	Default Value	Scenario Value	Probabilistic Values (Distribution)	Reference
Seafood Consumption (kg y^{-1})	0.9	NA		
Soil Ingestion (g y^{-1})	36.5	36.5		
Drinking Water Intake (L y^{-1})	510	NA		
Contaminated Fraction				
Drinking Water	1	NA		
Livestock Water	1	NA		
Irrigation Water	1	NA		
Aquatic Food	0.5	NA		
Plant Food	−1	NA		
Meat	−1	NA		
Milk	−1	NA		
Ingestion Pathways, Non-Dietary Data				
Livestock Fodder Intake for Meat (kg d^{-1})	68	NA		
Livestock Fodder Intake for Milk (kg d^{-1})	55	NA		
Livestock Water Intake for Meat (L d^{-1})	50	NA		
Livestock Water Intake for Milk (L d^{-1})	160	NA		
Livestock Soil Ingestion (kg d^{-1})	0.5	NA		
Mass Loading for Foliar Deposition (g m^{-3})	0.0001	NA		
Depth of Soil Mixing Layer (m)	0.15	NA		
Root Depth (m)	0.9	NA		
Groundwater Use Fractions				
Drinking Water	1	1		
Livestock Water	1	1		
Irrigation Water	1	1		
Plant Transfer Factors				
Wet Weight, Non-leafy Yield ()	0.7 kg m^{-2}	0.7 kg m^{-2}		
Wet Weight, Leafy Yield ()	1.5 kg m^{-2}	1.5 kg m^{-2}		
Wet Weight, Fodder Yield ()	1.1 kg m^{-2}	1.1 kg m^{-2}		
Translocation Factor, Non-Leafy ()	0.1 y	0.1 y		
Translocation Factor, Leafy and Fodder ()	1 y	1 y		
Weathering Removal Constant ()	20 y^{-1}	20 y^{-1}		
Wet Foliar Interception Fraction	0.25	0.25		
Dry Foliar Interception Fraction	0.25	0.25		

Table C2-3. Parameter Values for Off-Site Hunter (Table 6, Scenario 2) and On-Site Hunter (Table 7, Scenario 3). On-site Hunter includes an inhalation pathway and external exposure pathway, whereas Off-Site Hunter does not.

Parameter	Default Value	Scenario Value	Probabilistic Values (Distribution)	Reference
Occupancy, Inhalation, and Gamma Parameters				
Inhalation Rate ($m^3 y^{-1}$)	8,400	12,264		Yu et al. 2001; Beyeler et al. 1998
Mass Loading for Inhalation ($g m^{-3}$)	0.001	.001	0.001 to 0.0001 (uniform)	Beyeler et al. 1998
Exposure Duration (y)	30	30		
Inhalation Shielding Factor	0.4	.4		
External Gamma Shielding Factor	0.7	.7		
Indoor Time Fraction	0.5	0		Scenario definition
Outdoor Time Fraction	0.25	0.05		Scenario definition
Shape of Contaminated Zone	Circular	Circular		
Ingestion Pathways, Dietary Data				
Fruit, Vegetable, and Grain Consumption ($kg y^{-1}$)	160	NA		
Leafy Vegetable Consumption ($kg y^{-1}$)	14	NA		
Milk Consumption ($L y^{-1}$)	92	NA		
Meat and Poultry Consumption ($kg y^{-1}$)	63	52	52 ± 7 (normal)	Beyeler et al. 1998
Fish Consumption ($kg y^{-1}$)	5.4	NA		
Seafood Consumption ($kg y^{-1}$)	0.9	NA		
Soil Ingestion ($g y^{-1}$)	36.5	36.5		
Drinking Water Intake ($L y^{-1}$)	510	NA		
Contaminated Fraction				
Drinking Water	1	NA		
Livestock Water	1	1		
Irrigation Water	1	NA		
Aquatic Food	0.5	NA		
Plant Food	−1	NA		
Meat	−1	NA		
Milk	−1	NA		
Ingestion Pathways, Non-Dietary Data				
Livestock Fodder Intake for Meat ($kg d^{-1}$)	68	68		
Livestock Fodder Intake for Milk ($kg d^{-1}$)	55	NA		
Livestock Water Intake for Meat ($L d^{-1}$)	50	50		
Livestock Water Intake for Milk ($L d^{-1}$)	160	NA		
Livestock Soil Ingestion ($kg d^{-1}$)	0.5	NA		
Mass Loading for Foliar Deposition ($g m^{-3}$)	0.0001	NA		
Depth of Soil Mixing Layer (m)	0.15	NA		
Root Depth (m)	0.9	NA		

Table C2-3. [Continued]

Parameter	Default Value	Scenario Value	Probabilistic Values (Distribution)	Reference
Groundwater Use Fractions				
Drinking Water	1	NA		
Livestock Water	1	1		
Irrigation Water	1	NA		
Plant Transfer Factors				
Wet Weight, Non-leafy Yield ()	0.7 kg m^{-2}	0.7 kg m^{-2}		
Wet Weight, Leafy Yield ()	1.5 kg m^{-2}	1.5 kg m^{-2}		
Wet Weight, Fodder Yield ()	1.1 kg m^{-2}	1.1 kg m^{-2}		
Translocation Factor, Non-Leafy ()	0.1 y	0.1 y		
Translocation Factor, Leafy and Fodder ()	1 y	1 y		
Weathering Removal Constant ()	20 y^{-1}	20 y^{-1}		
Wet Foliar Interception Fraction	0.25	0.25		
Dry Foliar Interception Fraction	0.25	0.25		

Table C2-4. Values for Scenario 3, Table 6 and Scenario 11, Table 6.

Parameter	Value	Reference
BCF, concentration factor to fish from water	10 L kg^{-1}	Yu et al., 2001
DCF, dose conversion factor	2.69 x 10-4 mrem pCi^{-1}	Yu et al., 2001
Kd	50	Yu et al., 2001
Sed (Sediment yield)	28,830 metric Ton	Attachment 1, Table 10
Big Creek Watershed Area	90 km^2	Attachment 1; Fig.1, Table 1
Big Creek Flow Volume at Node 13 (2-year return)	3.5 x 10^9 L y^{-1}	Attachment 1, Table 10
Volume Flow, East Fork of White River	3.74 x 10^9 m^3 y^{-1}	http://waterdata.usgs.gov/nwis/qwdata

Table C2-5. Parameter Values for Off-Site Farmer (Table 6, Scenario 4)

Parameter	Default Value	Scenario Value	Probabilistic Values (Distribution)	Reference
Occupancy, Inhalation, and Gamma Parameters				
Inhalation Rate (m^3 y^{-1})	8,400	8,400		Yu et al. 2001; Beyeler et al. 1998
Mass Loading for Inhalation (g m^{-3})	0.001	.001	0.001 to 0.0001 (uniform)	Beyeler et al. 1998
Exposure Duration (y)	30	30		
Inhalation Shielding Factor	0.4	.4		
External Gamma Shielding Factor	0.7	.7		
Indoor Time Fraction	0.5	0.5		Scenario definition
Outdoor Time Fraction	0.25	0.25		Scenario definition
Shape of Contaminated Zone	Circular	Circular		
Ingestion Pathways, Dietary Data				
Fruit, Vegetable, and Grain Consumption (kg y^{-1})	160	80	80 ± 12 (normal)	Beyeler et al. 1998
Leafy Vegetable Consumption (kg y^{-1})	14	15	15 ± 6 (normal)	Beyeler et al. 1998
Milk Consumption (L y^{-1})	92	118	118 ± 7.7 (normal)	Beyeler et al. 1998
Meat and Poultry Consumption (kg y^{-1})	63	52	52 ± 7 (normal)	Beyeler et al. 1998
Fish Consumption (kg y^{-1})	5.4	15	15 ± 7 (normal)	Beyeler et al. 1998
Seafood Consumption (kg y^{-1})	0.9	.9		
Soil Ingestion (g y^{-1})	36.5	36.5		
Drinking Water Intake (L y^{-1})	510	440 to 660	(Uniform)	Beyeler et al. 1998
Contaminated Fraction				
Drinking Water	1	1		
Livestock Water	1	1		
Irrigation Water	1	1		
Aquatic Food	1	0.5		
Plant Food	−1	1		Scenario Definition
Meat	−1	1		Scenario Definition
Milk	−1	1		Scenario Definition
Ingestion Pathways, Non-Dietary Data				
Livestock Fodder Intake for Meat (kg d^{-1})	68	68		
Livestock Fodder Intake for Milk (kg d^{-1})	55	55		
Livestock Water Intake for Meat (L d^{-1})	50	50		
Livestock Water Intake for Milk (L d^{-1})	160	160		
Livestock Soil Ingestion (kg d^{-1})	0.5	0.5		
Mass Loading for Foliar Deposition (g m^{-3})	0.0001	0.0001		
Depth of Soil Mixing Layer (m)	0.15	0.15		

Table C2-5. Parameter Values for Off-Site Farmer (Table 6, Scenario 4) [Continued]

Parameter	Default Value	Scenario Value	Probabilistic Values (Distribution)	Reference
Root Depth (m)	0.9	0.9		
Groundwater Use Fractions				
Drinking Water	1	1		
Livestock Water	1	1		
Irrigation Water	1	1		
Plant Transfer Factors				
Wet Weight, Non-leafy Yield ()	0.7 kg m^{-2}	0.7 kg m^{-2}		
Wet Weight, Leafy Yield ()	1.5 kg m^{-2}	1.5 kg m^{-2}		
Wet Weight, Fodder Yield ()	1.1 kg m^{-2}	1.1 kg m^{-2}		
Translocation Factor, Non-Leafy ()	0.1 y	0.1 y		
Translocation Factor, Leafy and Fodder ()	1 y	1 y		
Weathering Removal Constant ()	20 y^{-1}	20 y^{-1}		
Wet Foliar Interception Fraction	0.25	0.25		
Dry Foliar Interception Fraction	0.25	0.25		

Table C2-6. Parameter Values for Industrial Worker (Table 6, Scenario 9)

Parameter	Default Value	Scenario Value	Probabilistic Values (Distribution)	Reference
Occupancy, Inhalation, and Gamma Parameters				
Inhalation Rate (m^3 y^{-1})	8,400	8,400		Yu et al. 2001; Beyeler et al. 1998
Mass Loading for Inhalation (g m^{-3})	0.001	.001	0.001 to 0.0001 (uniform)	Beyeler et al. 1998
Exposure Duration (y)	30	30		
Inhalation Shielding Factor	0.4	.4		
External Gamma Shielding Factor	0.7	.7		
Indoor Time Fraction	0.5	0.1		Scenario definition
Outdoor Time Fraction	0.25	0.1		Scenario definition
Shape of Contaminated Zone	Circular	Circular		

Table C2-6. Parameter Values for Industrial Worker (Table 6, Scenario 9) [Continued]

Parameter	Default Value	Scenario Value	Probabilistic Values (Distribution)	Reference
Ingestion Pathways, Dietary Data				
Fruit, Vegetable, and Grain Consumption (kg y^{-1})	160	NA		
Leafy Vegetable Consumption (kg y^{-1})	14	NA		
Milk Consumption (L y^{-1})	92	NA		
Meat and Poultry Consumption (kg y^{-1})	63	NA		
Fish Consumption (kg y^{-1})	5.4	NA		

Table C2-6. Parameter Values for Industrial Worker (Table 6, Scenario 9) [Continued]

Parameter	Default Value	Scenario Value	Probabilistic Values (Distribution)	Reference
Seafood Consumption (kg y^{-1})	0.9	NA		
Soil Ingestion (g y^{-1})	36.5	36.5		
Drinking Water Intake (L y^{-1})	510	NA		
Contaminated Fraction				
Drinking Water	1	NA		
Livestock Water	1	NA		
Irrigation Water	1	NA		
Aquatic Food	0.5	NA		
Plant Food	−1	NA		
Meat	−1	NA		
Milk	−1	NA		
Ingestion Pathways, Non-Dietary Data				
Livestock Fodder Intake for Meat (kg d^{-1})	68	NA		
Livestock Fodder Intake for Milk (kg d^{-1})	55	NA		
Livestock Water Intake for Meat (L d^{-1})	50	NA		
Livestock Water Intake for Milk (L d^{-1})	160	NA		
Livestock Soil Ingestion (kg d^{-1})	0.5	NA		
Mass Loading for Foliar Deposition (g m^{-3})	0.0001	NA		
Depth of Soil Mixing Layer (m)	0.15	NA		
Root Depth (m)	0.9	NA		
Groundwater Use Fractions				
Drinking Water	1	NA		
Livestock Water	1	NA		
Irrigation Water	1	NA		
Plant Transfer Factors				
Wet Weight, Non-leafy Yield ()	0.7 kg m^{-2}	0.7 kg m^{-2}		
Wet Weight, Leafy Yield ()	1.5 kg m^{-2}	1.5 kg m^{-2}		
Wet Weight, Fodder Yield ()	1.1 kg m^{-2}	1.1 kg m^{-2}		
Translocation Factor, Non-Leafy ()	0.1 y	0.1 y		
Translocation Factor, Leafy and Fodder ()	1 y	1 y		
Weathering Removal Constant	20 y^{-1}	20 y^{-1}		
Wet Foliar Interception Fraction	0.25	0.25		
Dry Foliar Interception Fraction	0.25	0.25		

Table C2-7. Parameter Values for Resident Farmer (Without Irrigation) After Loss of Institutional Controls (Table 7, Scenario 1)

Parameter	Default Value	Scenario Value	Probabilistic Values (Distribution)	Reference
		Occupancy, Inhalation, and Gamma Parameters		
Inhalation Rate ($m^3\ y^{-1}$)	8,400	8,400		Yu et al. 2001; Beyeler et al. 1998
Mass Loading for Inhalation ($g\ m^{-3}$)	0.001	.001	0.001 to 0.0001 (uniform)	Beyeler et al. 1998
Exposure Duration (y)	30	30		
Inhalation Shielding Factor	0.4	.4		
External Gamma Shielding Factor	0.7	.7		
Indoor Time Fraction	0.5	0.5		Scenario definition
Outdoor Time Fraction	0.25	0.25		Scenario definition
Shape of Contaminated Zone	Circular	Circular		
		Ingestion Pathways, Dietary Data		
Fruit, Vegetable, and Grain Consumption ($kg\ y^{-1}$)	160	80	80 ± 12 (normal)	Beyeler et al. 1998
Leafy Vegetable Consumption ($kg\ y^{-1}$)	14	15	15 ± 6 (normal)	Beyeler et al. 1998
Milk Consumption ($L\ y^{-1}$)	92	118	118 ± 7.7 (normal)	Beyeler et al. 1998
Meat and Poultry Consumption ($kg\ y^{-1}$)	63	52	52 ± 7 (normal)	Beyeler et al. 1998
Fish Consumption ($kg\ y^{-1}$)	5.4	15	15 ± 7 (normal)	Beyeler et al. 1998
Seafood Consumption ($kg\ y^{-1}$)	0.9	.9		
Soil Ingestion ($g\ y^{-1}$)	36.5	36.5		
Drinking Water Intake ($L\ y^{-1}$)	510	440 to 660	(Uniform)	Beyeler et al. 1998
		Contaminated Fraction		
Drinking Water	1	1		
Livestock Water	1	1		

Table C2-7. Parameter Values for Resident Farmer (Without Irrigation) After Loss of Institutional Controls (Table 7, Scenario 1) [Continued]

Parameter	Default Value	Scenario Value	Probabilistic Values (Distribution)	Reference
Irrigation Water	1	0		
Aquatic Food	1	1		
Plant Food	−1	1		Scenario Definition
Meat	−1	1		Scenario Definition
Milk	−1	1		Scenario Definition
Ingestion Pathways, Non-Dietary Data				
Livestock Fodder Intake for Meat (kg d^{-1})	68	68		
Livestock Fodder Intake for Milk (kg d^{-1})	55	55		
Livestock Water Intake for Meat (L d^{-1})	50	50		
Livestock Water Intake for Milk (L d^{-1})	160	160		
Livestock Soil Ingestion (kg d^{-1})	0.5	0.5		
Mass Loading for Foliar Deposition (g m^{-3})	0.0001	0.0001		
Depth of Soil Mixing Layer (m)	0.15	0.15		
Root Depth (m)	0.9	0.9		
Groundwater Use Fractions				
Drinking Water	1	1		
Livestock Water	1	1		
Irrigation Water	1	1		
Plant Transfer Factors				
Wet Weight, Non-leafy Yield ()	0.7 kg m^{-2}	0.7 kg m^{-2}		
Wet Weight, Leafy Yield ()	1.5 kg m^{-2}	1.5 kg m^{-2}		
Wet Weight, Fodder Yield ()	1.1 kg m^{-2}	1.1 kg m^{-2}		
Translocation Factor, Non-Leafy ()	0.1 y	0.1 y		
Translocation Factor, Leafy and Fodder ()	1 y	1 y		
Weathering Removal Constant ()	20 y^{-1}	20 y^{-1}		
Wet Foliar Interception Fraction	0.25	0.25		
Dry Foliar Interception Fraction	0.25	0.25		

Table C2-8. Parameter Values for Resident Farmer (With Irrigation) After Loss of Institutional Controls (Table 7, Scenario 2)

Parameter	Default Value	Scenario Value	Probabilistic Values (Distribution)	Reference
Occupancy, Inhalation, and Gamma Parameters				
Inhalation Rate (m^3 y^{-1})	8,400	8,400		Yu et al. 2001; Beyeler et al. 1998
Mass Loading for Inhalation (g m^{-3})	0.001	.001	0.001 to 0.0001 (uniform)	Beyeler et al. 1998
Exposure Duration (y)	30	30		
Inhalation Shielding Factor	0.4	.4		

Table C2-8. Parameter Values for Resident Farmer (With Irrigation) After Loss of Institutional Controls (Table 7, Scenario 2) [Continued]

Parameter	Default Value	Scenario Value	Probabilistic Values (Distribution)	Reference
External Gamma Shielding Factor	0.7	.7		
Indoor Time Fraction	0.5	0.5		Scenario definition
Outdoor Time Fraction	0.25	0.25		Scenario definition
Shape of Contaminated Zone	Circular	Circular		
Ingestion Pathways, Dietary Data				
Fruit, Vegetable, and Grain Consumption (kg y^{-1})	160	80	80 ± 12 (normal)	Beyeler et al. 1998
Leafy Vegetable Consumption (kg y^{-1})	14	15	15 ± 6 (normal)	Beyeler et al. 1998
Milk Consumption (L y^{-1})	92	118	118 ± 7.7 (normal)	Beyeler et al. 1998
Meat and Poultry Consumption (kg y^{-1})	63	52	52 ± 7 (normal)	Beyeler et al. 1998
Fish Consumption (kg y^{-1})	5.4	15	15 ± 7 (normal)	Beyeler et al. 1998
Seafood Consumption (kg y^{-1})	0.9	.9		
Soil Ingestion (g y^{-1})	36.5	36.5		
Drinking Water Intake (L y^{-1})	510	440 to 660	(Uniform)	Beyeler et al. 1998
Contaminated Fraction				
Drinking Water	1	1		
Livestock Water	1	1		
Irrigation Water	1	1		
Aquatic Food	1	1		
Plant Food	−1	1		Scenario Definition
Meat	−1	1		Scenario Definition
Milk	−1	1		Scenario Definition
Ingestion Pathways, Non-Dietary Data				
Livestock Fodder Intake for Meat (kg d^{-1})	68	68		
Livestock Fodder Intake for Milk (kg d^{-1})	55	55		
Livestock Water Intake for Meat (L d^{-1})	50	50		
Livestock Water Intake for Milk (L d^{-1})	160	160		
Livestock Soil Ingestion (kg d^{-1})	0.5	0.5		
Mass Loading for Foliar Deposition (g m^{-3})	0.0001	0.0001		
Depth of Soil Mixing Layer (m)	0.15	0.15		
Root Depth (m)	0.9	0.9		
Groundwater Use Fractions				
Drinking Water	1	1		
Livestock Water	1	1		
Irrigation Water	1	0		
Plant Transfer Factors				
Wet Weight, Non-leafy Yield ()	0.7 kg m^{-2}	0.7 kg m^{-2}		
Wet Weight, Leafy Yield ()	1.5 kg m^{-2}	1.5 kg m^{-2}		
Wet Weight, Fodder Yield ()	1.1 kg m^{-2}	1.1 kg m^{-2}		
Translocation Factor, Non-Leafy ()	0.1 y	0.1 y		

Table C2-8. Parameter Values for Resident Farmer (With Irrigation) After Loss of Institutional Controls (Table 7, Scenario 2) [Continued]

Parameter	Default Value	Scenario Value	Probabilistic Values (Distribution)	Reference
Translocation Factor, Leafy and Fodder	1 y	1 y		
Weathering Removal Constant	20 y^{-1}	20 y^{-1}		
Wet Foliar Interception Fraction	0.25	0.25		
Dry Foliar Interception Fraction	0.25	0.25		

Table C2-9. Parameter Values for Domestic Resident (Full Time) After Loss of Institutional Controls (Table 7, Scenario 5)

Parameter	Default Value	Scenario Value	Probabilistic Values (Distribution)	Reference
Occupancy, Inhalation, and Gamma Parameters				
Inhalation Rate (m^3 y^{-1})	8,400	8,400		Yu et al. 2001; Beyeler et al. 1998
Mass Loading for Inhalation (g m^{-3})	0.001	.001	0.001 to 0.0001 (uniform)	Beyeler et al. 1998
Exposure Duration (y)	30	30		
Inhalation Shielding Factor	0.4	.4		
External Gamma Shielding Factor	0.7	.7		
Indoor Time Fraction	0.5	0.5		Scenario definition
Outdoor Time Fraction	0.25	0.25		Scenario definition
Shape of Contaminated Zone	Circular	Circular		
Ingestion Pathways, Dietary Data				
Fruit, Vegetable, and Grain Consumption (kg y^{-1})	160	80	80 ± 12 (normal)	Beyeler et al. 1998
Leafy Vegetable Consumption (kg y^{-1})	14	15	15 ± 6 (normal)	Beyeler et al. 1998
Milk Consumption (L y^{-1})	92	NA		Beyeler et al. 1998
Meat and Poultry Consumption (kg y^{-1})	63	NA		Beyeler et al. 1998
Fish Consumption (kg y^{-1})	5.4	15	15 ± 7 (normal)	Beyeler et al. 1998
Seafood Consumption (kg y^{-1})	0.9	.9		
Soil Ingestion (g y^{-1})	36.5	36.5		
Drinking Water Intake (L y^{-1})	510	NA		Beyeler et al. 1998
Contaminated Fraction				
Drinking Water	1	0		
Livestock Water	1	1		
Irrigation Water	1	1		
Aquatic Food	1	1		
Plant Food	−1	.3		Scenario Definition
Meat	−1	0		Scenario Definition
Milk	−1	0		Scenario Definition
Ingestion Pathways, Non-Dietary Data				
Livestock Fodder Intake for Meat (kg d^{-1})	68	NA		
Livestock Fodder Intake for Milk (kg d^{-1})	55	NA		

Table C2-9. Parameter Values for Domestic Resident (Full Time) After Loss of Institutional Controls (Table 7, Scenario 5) [Continued]

Parameter	Default Value	Scenario Value	Probabilistic Values (Distribution)	Reference
Livestock Water Intake for Meat (L d^{-1})	50	NA		
Livestock Water Intake for Milk (L d^{-1})	160	NA		
Livestock Soil Ingestion (kg d^{-1})	0.5	NA		
Mass Loading for Foliar Deposition (g m^{-3})	0.0001	0.0001		
Depth of Soil Mixing Layer (m)	0.15	0.15		
Root Depth (m)	0.9	0.9		
Groundwater Use Fractions				
Drinking Water	1	0		
Livestock Water	1	0		
Irrigation Water	1	1		
Plant Transfer Factors				
Wet Weight, Non-leafy Yield ()	0.7 kg m^{-2}	0.7 kg m^{-2}		
Wet Weight, Leafy Yield ()	1.5 kg m^{-2}	1.5 kg m^{-2}		
Wet Weight, Fodder Yield ()	1.1 kg m^{-2}	1.1 kg m^{-2}		
Translocation Factor, Non-Leafy ()	0.1 y	0.1 y		
Translocation Factor, Leafy and Fodder ()	1 y	1 y		
Weathering Removal Constant ()	20 y^{-1}	20 y^{-1}		
Wet Foliar Interception Fraction	0.25	0.25		
Dry Foliar Interception Fraction	0.25	0.25		

Table C2-10. Parameter Values for Domestic Resident (Part Time) After Loss of Institutional Controls (Table 7, Scenario 6)

Parameter	Default Value	Scenario Value	Probabilistic Values (Distribution)	Reference
Occupancy, Inhalation, and Gamma Parameters				
Inhalation Rate (m^3 y^{-1})	8,400	8,400		Yu et al. 2001; Beyeler et al. 1998
Mass Loading for Inhalation (g m^{-3})	0.001	.001	0.001 to 0.0001 (uniform)	Beyeler et al. 1998
Exposure Duration (y)	30	30		
Inhalation Shielding Factor	0.4	.4		
External Gamma Shielding Factor	0.7	.7		
Indoor Time Fraction	0.5	0.15		Scenario definition
Outdoor Time Fraction	0.25	0.08		Scenario definition
Shape of Contaminated Zone	Circular	Circular		
Ingestion Pathways, Dietary Data				
Fruit, Vegetable, and Grain Consumption (kg y^{-1})	160	80	80 ± 12 (normal)	Beyeler et al. 1998
Leafy Vegetable Consumption (kg y^{-1})	14	15	15 ± 6 (normal)	Beyeler et al. 1998
Milk Consumption (L y^{-1})	92	NA		Beyeler et al. 1998

Table C2-10. Parameter Values for Domestic Resident (Part Time) After Loss of Institutional Controls (Table 7, Scenario 6) [Continued]

Parameter	Default Value	Scenario Value	Probabilistic Values (Distribution)	Reference
Meat and Poultry Consumption ($kg\ y^{-1}$)	63	NA		Beyeler et al. 1998
Fish Consumption ($kg\ y^{-1}$)	5.4	15	15 ± 7 (normal)	Beyeler et al. 1998
Seafood Consumption ($kg\ y^{-1}$)	0.9	.9		
Soil Ingestion ($g\ y^{-1}$)	36.5	36.5		
Drinking Water Intake ($L\ y^{-1}$)	510	NA		Beyeler et al. 1998
Contaminated Fraction				
Drinking Water	1	0		
Livestock Water	1	1		
Irrigation Water	1	1		
Aquatic Food	1	1		
Plant Food	−1	.3		Scenario Definition
Meat	−1	0		Scenario Definition
Milk	−1	0		Scenario Definition
Ingestion Pathways, Non-Dietary Data				
Livestock Fodder Intake for Meat ($kg\ d^{-1}$)	68	NA		
Livestock Fodder Intake for Milk ($kg\ d^{-1}$)	55	NA		
Livestock Water Intake for Meat ($L\ d^{-1}$)	50	NA		
Livestock Water Intake for Milk ($L\ d^{-1}$)	160	NA		
Livestock Soil Ingestion ($kg\ d^{-1}$)	0.5	NA		
Mass Loading for Foliar Deposition ($g\ m^{-3}$)	0.0001	0.0001		
Depth of Soil Mixing Layer (m)	0.15	0.15		
Root Depth (m)	0.9	0.9		
Groundwater Use Fractions				
Drinking Water	1	0		
Livestock Water	1	0		
Irrigation Water	1	1		
Plant Transfer Factors				
Wet Weight, Non-leafy Yield ()	0.7 $kg\ m^{-2}$	0.7 $kg\ m^{-2}$		
Wet Weight, Leafy Yield ()	1.5 $kg\ m^{-2}$	1.5 $kg\ m^{-2}$		
Wet Weight, Fodder Yield ()	1.1 $kg\ m^{-2}$	1.1 $kg\ m^{-2}$		
Translocation Factor, Non-Leafy ()	0.1 y	0.1 y		
Translocation Factor, Leafy and Fodder ()	1 y	1 y		
Weathering Removal Constant ()	20 y^{-1}	20 y^{-1}		
Wet Foliar Interception Fraction	0.25	0.25		
Dry Foliar Interception Fraction	0.25	0.25		

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APPENDIX D

STATEMENT OF INTENT

DEPARTMENT OF THE ARMY
U.S. ARMY SOLDIER AND BIOLOGICAL CHEMICAL COMMAND
5183 BLACKHAWK ROAD
ABERDEEN PROVING GROUND, MARYLAND 21010-5424

REPLY TO ATTENTION OF

U.S. Nuclear Regulatory Commission
Washington, DC 20555

STATEMENT OF INTENT

As the Commander of the U.S. Army Soldier and Biological Chemical Command (SBCCOM) of Aberdeen Proving Ground, Maryland, and license holder and organization responsible for oversight, development and execution of the license termination process for the Jefferson Proving Ground (JPG), Madison, Indiana, I exercise express authority and responsibility to request from the Department of the Army adequate funds for decommissioning activities associated with operations authorized by U.S. Nuclear Regulatory Commission Material License No. SUB-1435. The authority and responsibility to request funds for JPG for this effort is established by the Permanent Orders 12-4 dated 12 January 1998 and Assumption of Command by Authority AR 600-20, Paragraph 2-3 dated 2 July 1998.

Within this authority, I intend to request funds be made available when necessary in the necessary amount for the maintenance and implementation of institutional controls necessary to support the license termination under the restricted release criteria for decommissioning the area known as the DU Impact Area located North of the firing line at JPG. I intend to request and obtain such funds sufficiently in advance of the need for implementation of any institutional controls by SBCCOM to prevent the lapse of these activities as required for JPG to insure compliance with the restricted release criteria as specified at 10 CFR 20-2403(b).

However, any requirement for this payment or obligation of funds established by this license termination plan shall be subject to the availability of funds, and no provision herein shall be interpreted to require payment of obligation of funds in violation of the Antideficiency Act, 31 United States Code Section 1341.

A copy of the Permanent Order 12-4 and the Assumption of Command by Authority is attached as evidence that I am authorized to represent SBCCOM in this transaction.

John C. Doesburg

JOHN C. DOESBURG
Major General, USA
Commanding
June 11, 2001

Attachment: As stated

DEPARTMENT OF THE ARMY
U.S. ARMY CHEMICAL AND BIOLOGICAL DEFENSE COMMAND
5222 FLEMMING ROAD
ABERDEEN PROVING GROUND, MARYLAND 21015-5423

REPLY TO
ATTENTION OF

AMSCB-CG

2 July 1998

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Assumption of Command by Authority AR 600-20. Paragraph 2-3

The undersigned assumes command of the U.S. Army Chemical and Biological Defense Command, Aberdeen Proving Ground, Maryland 21010-5423 (W4MLAA) effective 2 July1991.

DISTRIBUTION:
Each CBDCOM Element

JOHN C. DOESBURG
Major General, USA
Commanding

DEPARTMENT OF THE ARMY
HEADQUARTERS UNITED STATES ARMY MATERIEL COMMAND
5001 EISENHOWER AVENUE, ALEXANDRIA, VA 22333-0001

Mike Smith

PERMANENT ORDERS 12-4 | 12 January 1998

U.S. Army Soldier and Chemical Biological Command (SCBCOM)(Provisional), XA (W4MLAA), Aberdeen Proving Ground, MD 21010-5423

The following organization or unit action directed.

Action: Unit organized on a provisional basis.
Assigned to: U.S. Army Material Command (AMC), X2 (WOGWAA)
Mission: The mission SCBCOM is to develop, integrate, acquire, and sustain soldiers and related support systems to modernize, balance, and improve the soldier's warfighting capabilities, performance, and quality of life. Perform similar functions for other services and customers. To provide research, development and acquisition of nuclear, biological and chemical (NBC) equipment for U.S. Forces. Act as the Army NBC defense commodity command, to provide management of joint service NBC Defense material. To provide US chemical stockpile management and safe storage; prepare for and respond to chemical biological emergency events/accidents. Conduct remediation/restoration actions at chemical activities. To provide successful planning, management, and execution of treaty responsibilities. Provide demilitarization support.
Effective date: 15 January 1998
Military structure strength: NA
Military authorized strength: NA
Civilian structure strength: NA
Civilian authorized strength: NA
Accounting classification: NA
Authority: VOCG AMC
Additional instructions: a. These orders effect the provisional organization and realignment of The missions, functions and personnel from CBDCOM, XA (W4MLAA), GJ.A). (WIDGAA), WOLMAA), (WOMBAA), (WOMNAA), (WIFEAA), (W26FAA), (W38NAA), (W4UZAA), AMC Surety Field Activity, X3(W2EWAA) and Soldier Systems Command (SSCOM), XC (W038NAA), (WIDIAA).

b. Personnel will be detailed to the U.S. Army Soldier and Chemical Biological Command (Provisional) with baseline organizations responsible for the funding. CG, CBDCOM will assume operational control of the planning and transition process.

c. Permanent personnel actions towards implementation will not be taken until HQ AMC/HQ DA has approved the U.S. Army Soldier and Chemical Biological Command (Provisional) for permanent organizations and all affected personnel are provided due process in accordance with OPM guidelines.

d. There will be no change in physical location. All personnel will remain in place.

e. UCMJ authority will remain with existing commanders.

Format: 740

FOR THE COMMANDER

KATHLEEN M. BARNES.
Lieutenant Colonel, GS
Adjutant General

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1-Office, Secretary of the Army (OSA), Attn: SAAA-PF, Room 3E741, The Pentagon, Wash DC 20310-0101
9-HQDA (5-DALO-5M); (1-DAMO-FDF); (1-MOFD-FAS-F); (1-DAMO-FDO), (1-MOFD-FAS); Pentagon, Wash DC 20310-0101
1-Ch, U.S. Army Center of Military History, HQDA, ATTN: DAMH-HSO-U, 1099 14th Street N.W., Washington, DC 20005-3402
1-Civilian Personnel Center, ATTN:PECC-C1, Hoffman BLDG II, Alexandria, VA 22332-0400
1-Cdr, U.S. Army Training and Doctrine Command, ATTN : ATLOG-MAT-FM, Fort Monroe, VA 23561-7101 – Cdr. U.S. Army Management Analysis Agency, ATTN: MOFJ-SDC-A, Bldg 2588, Ft. Belvoir, VA 22060-5578
1-Cdr, U.S. Army Aviation and Missile Command: ATTN: AMSAM-RM-FD, Redstone Arsenal, AL 35815-5190
1-Cdr, U.S. Army Chemical and Biological Defense Command, Aberdeen Proving Ground, MD 21010-5423