DEPARTMENT OF THE ARMY
United States Army Garrison – Rock Island Arsenal
1 ROCK ISLAND ARSENAL
ROCK ISLAND, ILLINOIS 61299-5000

REPLY TO
ATTENTION OF

May 25, 2005

Office of the Garrison Manager

SUBJECT: Jefferson Proving Ground (License SUB-1435)

Dr. Tom McLaughlin
Materials Decommissioning Branch
Division of Waste Management and Environmental Protection
Office of Nuclear Material Safety and Safeguards
Two White Flint North
11545 Rockville Pike
Rockville, MD 20852-2738

Dear Dr. McLaughlin:

As requested in your letter of March 22, 2005, and in furtherance of the information provided in my letter to you of March 25, 2005, it is the purpose of this letter to clarify the intent of the Army with regard to licensing actions at Jefferson Proving Ground (JPG).

It is the intent and request of the Army to continue with its Possession Only License for JPG, under which it currently operates, but without the contingency of five-year renewable periods attached. In support of that request, the Army is proposing a plan and strategy for site characterization, as outlined in the attachments hereto, to be conducted within 5 years of approval and commencement of plan execution. The intention of the Army is then at the end of the 5 year period to present to the Nuclear Regulatory Commission (NRC) a Decommissioning Plan. Under the current proposal, the Decommissioning Plan to be presented at that time will propose license termination under restricted release, as authorized by the NRC regulations, Title 10 of the Code of Federal Regulations, part 20. Therefore, the Army is requesting only an alternative schedule for submittal of a Decommissioning Plan for the JPG license SUB-1435 in accordance with 10 CFR 40.42 (g)(2) as supported by the details in the enclosed plans ("Field Sampling Plan for Depleted Uranium (DU) Impact Area Site Characterization, Jefferson Proving Ground, Indiana" and the "Health and Safety Plan for DU Impact Area Site Characterization, Jefferson Proving Ground, Indiana"). Also enclosed is a Technical Memorandum, "Identification of Key Site-Specific Data to enhance the accuracy and reliability of the RESRAD Modeling of the Depleted Uranium Impact Area, Jefferson Proving Ground, Indiana". The technical memorandum provides the details on how the parameters were defined as being the most significant for offsite transport modeling.

There is still risk to human health and safety in placing the wells and engaging in the gathering of site specific data in the areas with unexploded ordnance. However, monitoring and information gathering processes employed to date have left gaps in the information gathered, and the Army will have to now assume those risks in order to fill in the gaps in information to ensure that its future decommissioning plan provides the maximum safety to the local populace. The reasons that 5 years will be needed for execution of the efforts under the plan are set forth in the Field Sampling Plan. Table 4-1 of the Field Sampling Plan sets forth the Work Breakdown Structure (WBS) and the deliverables for the Depleted Uranium area project. In summary, a tiered, time phased approach has been designed for site characterization, which permits decisions to be made at intermediate milestones regarding the need for collection of additional data. The objectives of the plan are to enhance the understanding of the nature and extent of contamination in the Depleted Uranium (DU) area, to enhance understanding of the fate and transport of DU in the environment, to define and verify the Conceptual Site Model, and to provide the basis for modifying the current monitoring program within the next 2 to 3 years and for completing a revised Decommissioning Plan in 5 years. The plan also addresses gaps in data identified by the Army and NRC in prior correspondence. All actions under the plan are subject to funding of course. The Army does not believe, based upon all information available, that there is an undue risk from radiation to the public health and safety that will be caused by the extended time proposed, and that it is in fact in the public interest to take the time to ensure that monitoring deficiencies are adequately addressed and more specific information be gathered concerning the condition of the site Lastly, the Army requests that following the receipt and review of the attached plans by the NRC staff, that a meeting between the NRC and Army staffs be scheduled for July, 2005 at which time any questions, comments and/or clarifications regarding the Army's proposal may be discussed.

If you have any questions, please contact either Ms. Joyce Kuykendall, US Army Research, Development and Engineering Command (RDECOM), at (410) 435-7118, E-mail address joyce.kuykendall@us.army.mil, or Mr. John Welling, Chief Counsel, US Army Garrison-Rock Island Arsenal, at (309) 782-8433, E-mail address wellingj@ria.army.mil.

Sincerely,

Alan G. Wilson
Garrison Manager

Enclosures

Copies Furnished:

Mr. Paul Cloud
Ms. Joyce Kuykendall

TECHNICAL MEMORANDUM

IDENTIFICATION OF KEY SITE-SPECIFIC DATA TO ENHANCE THE ACCURACY AND RELIABILITY OF THE RESRAD MODELING OF THE DEPLETED URANIUM IMPACT AREA, JEFFERSON PROVING GROUND, INDIANA

Prepared for

U.S. Army
Army Chief of Staff for Installation Management
Installation Support Management Activity
OSD BTC for JPG
Aberdeen Proving Ground, Maryland 21010-5424

Prepared by

From Science to Solutions™

Science Applications International Corporation
11251 Roger Bacon Drive
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September 8, 2004

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1. INTRODUCTION

This memorandum summarizes the results of an analysis of the parameters impacting the dose assessment completed using residual radiation (RESRAD) computer model at Jefferson Proving Ground (JPG), Indiana. Science Applications International Corporation (SAIC) completed this assessment for the U.S. Army under Contract F44650-99-D-0007, Task Order CY02.

2. BACKGROUND

The U.S. Department of the Army performed dose assessments in support of license termination for the Depleted Uranium (DU) Impact Area at JPG (U.S. Army 2002). The dose assessment was conducted to determine compliance with the criteria for termination of its license SUB-1435 under restricted release conditions. The dose assessment was conducted using RESRAD Version 6.1 for nine different receptors under two sets of exposures. The results of the assessment demonstrated that the onsite resident farmer received the maximum dose because of DU contamination in soil. Appendix C of the Decommissioning Plan (U.S. Army 2002) presents the methodology and results of this dose assessment.

3. PURPOSE AND SCOPE

The purpose of this paper is to evaluate the dose assessment procedure documented in the Decommissioning Plan (U.S. Army 2002) for the DU Impact Area and to determine the impact of site-specific physical and exposure parameters on the total dose. The scope of this analysis included completion of a sensitivity analysis to identify the impact of site-specific data on the total dose and an analysis of the impact of U.S. Environmental Protection Agency (EPA) and Nuclear Regulatory Commission (NRC) exposure parameters and a comparison of these results to the RESRAD default values on the maximum dose.

4. METHODOLOGY AND RESULTS

Two technical evaluations were completed based on the dose assessment information provided in Appendix C of the Decommissioning Plan (U.S. Army 2002) and the application of RESRAD Version 6.22. Since the onsite resident farmer was the most limiting receptor, this scenario was used as the basis for these evaluations. The evaluations included:

- Sensitivity analysis to determine the impact of site-related data to the total dose
- Impact of EPA and NRC assigned values for the most sensitive exposure parameters to maximum dose against RESRAD default values.

In addition, this report also identified three major areas of concern regarding the dose assessment process used as a part of the Decommissioning Plan (U.S. Army 2002). The following sections of the report summarize each of the evaluations.

4.1 SENSITIVITY ANALYSIS

A sensitivity analysis was conducted to determine the impact of site-specific data on the total dose. Each analysis was conducted in two steps. For each site-specific parameter, the evaluation identified upper and lower values as listed in NUREG/CR-6697 (NRC 2000). The RESRAD sensitivity utility then was used to calculate the sensitivity index (SI) for the site-specific parameters provided in the Decommissioning Plan (U.S. Army 2002).

The utility operates by reducing and increasing the selected input parameter by a common factor. The dose was calculated for each perturbed parameter value. The output, including dose with the parameter unperturbed, dose with parameter reduced, and dose with parameter increased, was graphically displayed with time as the independent variable. The SI was calculated at the year when the maximum dose occurred by using the following formula:

$$SI = 1 - (f(p)_{min} / f(p)_{max})$$

where:

f(p) is the maximum dose associated with the upper and lower parameter values.

A positive value of the SI indicates that the dose is directly proportional to the parameter of interest, whereas a negative value indicates the dose is inversely proportional to the parameter of interest. A value less than 0.01 indicates that the dose is independent of the parameter. The further the value of SI is from zero (0), the more sensitive the parameter is.

During the sensitivity analyses, the common factor was selected in such a way that the maximum and minimum value related to the parameter included the upper and/or lower value associated with the parameter. For parameters for which there is no upper and lower value available, a common factor of two was used. However, for the area of contamination and thickness of contamination parameters, the sensitivity analyses were conducted based on the upper values for those parameters provided in the plan. The results of the sensitivity analysis are summarized in **Table 1.**

The results of the sensitivity analyses demonstrate that radionuclide concentrations and the thickness of the contaminated zone are the two most sensitive parameters affecting the total dose. The results also indicate that the other physical site parameters are not sensitive to the total dose.

4.2 IMPACT OF EPA AND NRC ASSIGNED VALUES FOR EXPOSURE PARAMETERS AND COMPARISON TO RESRAD DEFAULT VALUES

This evaluation was conducted in two steps. First, the most sensitive exposure parameters were identified. Although the dose assessment methodology documented in the Decommissioning Plan (U.S. Army 2002) used RESRAD default values for the sensitive exposure parameters, both EPA and NRC provide different, yet acceptable, values for those same exposure parameters.

Next, a dose assessment was conducted using both EPA and NRC values to determine the impact to the total dose. These values were compared to the total dose using the RESRAD default values. Each step is summarized below:

Step 1: Identification of Most Sensitive Exposure Parameters—RESRAD 6.22 was used to conduct a deterministic dose assessment for the resident farmer scenario based on the exposure pathways and the assigned values for RESRAD input parameters as presented in Appendix C of the Decommissioning Plan (U.S. Army 2002). The objectives of the assessment were to:

- Determine the most sensitive exposure pathway
- Identify the exposure parameters for the most sensitive analysis.

The results of the assessment showed that the maximum dose due to contamination of 225 picocuries per gram (pCi/g) of DU was 26.9 millirem per year (mrem/yr). This maximum dose occurred at year 0. **Table 2** presents the dose assessment results for each exposure pathway.

The results presented in Table 2 demonstrate that the external gamma exposure pathway is the most sensitive pathway for the onsite resident farmer. Since the maximum dose occurred at year 0, there is no dose contribution from drinking water.

Table 1. Sensitivity Indices for Site-specific Parameters
Jefferson Proving Ground, DU Impact Area, Madison, Indiana

Parameter	Value	Units	Limit	Values	SI	Additional Comments
Area of contaminated zone	5.0 E 06 to 1.2 E 06	m^2	Upper	1.2 E 06	0.02	Low sensitivity for areas >1,000 m^2
			Lower	5.0 E 05		
Thickness of contaminated zone	0.15	m	Upper	1	0.38	Highly sensitive. However, low sensitivity for thickness >1 m.
			Lower	0.15		
Radionuclide concentrations	225	pCi/g	Upper	225	0.58	Highly sensitive
			Lower	94		
Density of contaminated zone	1.4	g/m^3	Upper	2.1	0.07	Less sensitive
Contaminated zone total porosity	0.45	—	Upper	0.697	0	Not sensitive
Contaminated zone erosion rate	0.001	m/yr	Upper	0.00339	0	Not sensitive
Contaminated zone hydraulic conductivity	30	m/yr	Upper	960	0	Not sensitive
Saturated zone field capacity	0.3	—	Common factor	2	0	Not sensitive
Unsaturated zone thicknesses	0.3,0.38,0.59,0.68,1.5	m	Common factor	2	0	Not sensitive
Evapotranspiration coefficient	0.5	—	Upper	0.75	0	Not sensitive
			Lower	0.5		
Runoff coefficient	0.2	—	Upper	0.8	0	Not sensitive
			Lower	0.1		

Table 2. Pathway-Specific Doses Using RESRAD Version 6.22
Jefferson Proving Ground, DU Impact Area, Madison, Indiana

Exposure Pathways	Dose (mrem/yr)	Percentage Contribution of Dose for Each Pathway
External gamma	17.64	65.6%
Inhalation	2.48	9.2%
Plant ingestion	2.4	8.8%
Meat ingestion	0.6	2%
Milk ingestion	2.2	8%
Soil ingestion	1.6	6%

Dose from the external gamma pathway is dependent on the radionuclide concentration, exposure duration, indoor and outdoor time fraction, gamma shielding factor, and transport factor parameters. The exposure duration, indoor and outdoor time fraction, and gamma shielding factor were identified as the most sensitive exposure parameters during this evaluation.

Step 2: Impact of EPA and NRC Assigned Values for Most Sensitive Exposure Parameter to Total Dose—EPA's *Exposure Factor Handbook* (EPA 1997) and *Soil Screening Guidance for Radionuclides: User's Guide* (EPA 2000) provide recommended values for the most sensitive exposure parameters. Volume 4 of NUREG/CR 5512 lists recommended values for exposure parameters for the onsite resident farmer (NRC 1999). The assigned value for exposure duration is the same for all three sources. **Table 3** identifies the recommended values for the remaining most sensitive exposure parameters.

Table 3. NRC and EPA Recommended Exposure Parameter (Unitless) Values Jefferson Proving Ground, DU Impact Area, Madison, Indiana

Exposure Parameter	RESRAD Default	NRC		EPA	
		Value	Source	Value	Source
External gamma shielding factor	0.7	0.5512	NRC 1999	0.4	EPA 2000
Indoor time fraction	0.50	0.6571	NRC 1999	0.683	EPA 1997
Outdoor time fraction	0.25	0.1181	NRC 1999	0.073	EPA 1997

Using the recommended values listed in Table 3 and other assigned values presented in Appendix C, two additional dose assessments were conducted using RESRAD 6.22. **Table 4** presents the dose results using the RESRAD, NRC, and EPA default values. These results indicate that use of EPA's recommended values for those sensitive exposure parameters would result in the smaller maximum dose.

Table 4. Maximum Dose (mrem/yr) Using RESRAD, NRC, and EPA Values Jefferson Proving Ground, DU Impact Area, Madison, Indiana

RESRAD Default Value	NRC Value	EPA Value
26.9	23.03	18.9

5. IMPLICATIONS

This evaluation identified three major areas that should be revisited if RESRAD analyses are conducted in the future to support the decommissioning planning at JPG. These areas are identified and discussed below:

- *Factor Groundwater Contamination into RESRAD Analyses*—The dose assessment was conducted based on the presence of DU-contaminated soil in the DU Impact Area. The assessment did not include the potential dose associated with groundwater contamination. Section 4.3.6 of the Decommissioning Plan (U.S. Army 2002) concludes that the groundwater at the site may be affected by DU. Therefore, the total dose should include that attributable to both groundwater and soil contamination.
- *Apply a Less Conservative Approach to Determining the Source Term*—The average concentration of DU fragments in the soil was used as the source term during the dose assessment. Using the average concentration verses the exposure point concentration results in

a lower dose to the receptor. EPA encourages the use of exposure point concentrations instead of average concentrations during the dose assessment process. EPA's *Supplemental Guidance to the Risk Assessment Guidance for Superfund (RAGS): Calculating the Concentration Term* (EPA 1992) can be used to determine the exposure point concentration for DU in soil. According to this guidance document, for radionuclides, the exposure point concentration is defined as the smaller of the 95th percentile upper concentration limit (UCL_{95}) and the maximum detected concentration, minus the average background concentration.

- ***Apply a Less Conservative Value for the Thickness of the Contaminated Zone***—A value of 0.15 meters was assigned as the thickness of the contaminated zone. However, concentrations of total uranium greater than the background levels were detected at a depth below 0.15 meters (see Table 4-7 in U.S. Army 2002). Consequently, the value assigned for the thickness of the contaminated zone is not appropriate. In addition, the sensitivity analyses on the thickness of contamination indicated that this parameter is directly proportional to the total dose. Therefore, the thickness of the contaminated zone, when set to 0.15 meters, will result in a lower dose and will be less protective to the exposed receptor.

6. REFERENCES

EPA (U.S. Environmental Protection Agency). 1992. *Supplemental Guidance to the Risk Assessment Guidance for Superfund (RAGS): Calculating the Concentration Term.* Office of Solid Waste and Emergency Response. Publication 9285-081. May.

EPA. 1997. *Exposure Factors Handbook, Volumes 1, 2, and 3,* EPA/600/P-95/002Fa, b, and c, EPA, Office of Research and Development, Washington, D.C. August.

EPA. 2000. *Soil Screening Guidance for Radionuclides: User's Guide,* EPA/540-R-00-007. October.

NRC (Nuclear Regulatory Commission). 1999. *Comparison of the Models and Assumptions used in DandD 1.0, RESRAD 5.61, and RESRAD-Build 1.50 Computer Codes with Respect to the Residual Farmer and Industrial Occupant Scenarios,* Draft, Volume 4, NUREG/CR-5512, SAND99-2147. October.

NRC. 2000. *Development of Probabilistic RESRAD 6.0 and RESRAD-BUILD 3.0 Computer Codes,* NUREG/CR-6697, ANL/EAD/TM-98. November.

U.S. Army. 2002. *Final Decommissioning Plan for License SUB-1435: JPG, Indiana.* June.

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FIELD SAMPLING PLAN

Depleted Uranium Impact Area Site Characterization
Jefferson Proving Ground, Madison, Indiana

Final

Prepared for:

U.S. Department of Army
Installation Support Management Activity
5183 Blackhawk Road
Aberdeen Proving Ground, Maryland 21010-5424

and

U.S. Army Corps of Engineers
Louisville District
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Submitted by:

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From Science to Solutions

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Contract No: F44650-99-D0007
Task Order: CY02

May 2005

FIELD SAMPLING PLAN

Depleted Uranium Impact Area Site Characterization
Jefferson Proving Ground, Madison, Indiana

Final

Prepared for:

U.S. Department of Army
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Task Order: CY02

May 2005

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FIELD SAMPLING PLAN
Depleted Uranium Impact Area Site Characterization
Jefferson Proving Ground, Madison, Indiana

Contract No: F44650-99-D0007
Task Order: CY02

Nuclear Regulatory Commission License SUB-1435

May 2005

Final

COMMITMENT TO IMPLEMENT THE ABOVE FIELD SAMPLING PLAN

	Phone	Date
Corinne M. Shia Project Manager	(703) 318-6993	5/24/05
Joseph E. Peters Quality Assurance Officer	(703) 318-4763	5/24/05
Randy C. Hansen Health and Safety Officer	(314) 770-3027	5/24/05
Michael W. Lambert Radiation Protection Manager	(314) 770-3000	5/24/05
Seth T. Stephenson Field Manager	(765) 278-3520	5/24/05

The approved Field Safety Plan (FSP) will be provided to subcontractors (i.e., drillers, surveyors, and laboratories) at the time of subcontract execution.

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CERTIFICATION 4

CONTRACTOR STATEMENT OF INDEPENDENT TECHNICAL REVIEW

Science Applications International Corporation (SAIC) has prepared this Field Sampling Plan (FSP) for performing site characterization at Jefferson Proving Ground's Depleted Uranium Impact Area, located in Madison, Indiana. Notice is hereby given that an independent technical review has been conducted that is appropriate to the level of risk and complexity inherent in the project, as defined in the Quality Control Plan (QCP). During the independent technical review, compliance with established policy principles and procedures, utilizing justified and valid assumptions was verified. This included review of assumptions; methods, procedures, and material used in analyses; alternatives evaluated; the appropriateness of data used and level of data obtained; and reasonableness of the results, including whether the product meets the customer's needs consistent with law and existing Corps policy.

Corinne Shia

Corinne Shia
Project Manager
Science Applications International Corporation

5/24/05
Date

Joseph Peters

Joseph Peters
Quality Assurance Officer
Science Applications International Corporation

5/24/05
Date

Corinne Shia

Corinne Shia
Independent Technical Review Team Leader
Science Applications International Corporation

5/24/05
Date

Significant concerns and explanation of the resolutions are documented within the project file.

As noted above, all concerns resulting from independent technical review of the project have been considered.

Ilisa D. Jones-Bateman
Vice President
Science Applications International Corporation

5/24/05
Date

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TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

APPENDICES

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

µR/hr	Microroentgen per Hour
µrad/hr	Microrad per Hour
ACHP	Advisory Council on Historic Preservation
ADA	Americans with Disabilities Act
ALARA	As Low as Reasonably Achievable
ANG	Air National Guard
ANS	American National Standard
ANSI	American National Standards Institute
APFSDS-T	Armor-Piercing, Fin-Stabilized, Discarding Sabots with Tracer Element
AR	Army Regulation
ARPA	Archaeological Resources Protection Act
ASTM	American Society for Testing and Materials
BGS	Below Ground Surface
BRAC	Base Realignment and Closure
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
CHPPM	Center for Health Promotion and Preventive Medicine
CIH	Certified Industrial Hygienist
CO	Contracting Officer
CoC	Chain-of-Custody
COR	Contracting Officer's Representative
cpm	Counts per Minute
CQA	Certified Quality Auditor
CQC	Contractor Quality Control
CSM	Conceptual Site Model
CSP	Certified Safety Professional
DGPS	Digital Global Positioning System
DO	Dissolved Oxygen
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DP	Decommissioning Plan
DQO	Data Quality Objective
DU	Depleted Uranium
EA	Environmental Assessment
EC&HS	Environmental Compliance and Health and Safety
EG&G	EG&G Mound Applied Technologies Corporation
EI	Electrical Imaging
EM	Engineer Manual
EO	Executive Order
EOD	Explosive Ordnance Disposal
EPA	U.S. Environmental Protection Agency
ER	Engineer Regulation
ERM	Environmental Radiation Monitoring
FCR	Field Change Request
FMP	Fire Management Plan
FONSI	Finding of No Significant Impact
FSP	Field Sampling Plan
FUDS	Formerly Used Defense Site

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

FY	Fiscal Year
GPS	Global Positioning System
GSA	Geological Society of America
H&S	Health and Safety
HASP	Health and Safety Plan
HTRW	Hazardous, Toxic, and Radiological Waste
I.D.	Identification
IDW	Investigation-derived Waste
ISMA	Installation Support Management Activity
ISPCS	Indiana State Plane Coordinate System
ITR	Independent Technical Review
JPG	Jefferson Proving Ground
K_d	Distribution Coefficient
KPA	Kinetic Phosphorescence Analysis
LCS	Laboratory Control Sample
LOR	Letter of Receipt
LTP	License Termination Plan
MDC	Minimum Detectable Concentration
Mn	Manganese
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
mrem	Millirem
MS/MSD	Matrix Spike/Matrix Spike Duplicate
mSv	Millisievert (1 mSv = 100 mrem)
NaI	Sodium Iodide
NA	Not Applicable
NAGPRA	Native American Graves Protection and Repatriation Act
NCR	Nonconformance Report
NCSHPO	National Conference of State Historic Preservation Officers
NCSS	National Cooperative Soil Survey
NEPA	National Environmental Policy Act
NGB	National Guard Bureau
NGVD	National Geodetic Vertical Datum
NHPA	National Historic Preservation Act
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
NRHP	National Register of Historic Places
NTU	Nephelometric Turbidity Unit
NWR	National Wildlife Refuge
PC	Personal Computer
pCi/g	Picocuries per Gram
pCi/L	Picocuries per Liter
PG	Professional Geologist
POC	Point of Contact
PPE	Personal Protection Equipment
PVC	Polyvinyl Chloride
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

QAPP	Quality Assurance Project Plan
QC	Quality Control
QCP	Quality Control Plan
QCR	Quality Control Report
QCSR	Quality Control Summary Report
RPPT	Registered Radiation Protection Technologist
RAI	Request for Additional Information
RCRA	Resource Conservation and Recovery Act of 1976
R_d	Distribution Ratio
RDECOM	Research, Development, and Engineering Command
redox	Reduction/Oxidation
RESRAD	RESidual RADiation
RI/FS/RD	Remedial Investigation/Feasibility Study/Remedial Design
RPD	Relative Percent Difference
S&H	Safety and Health
SAIC	Science Applications International Corporation
SCS	Soil Conservation Service
SEG	Scientific Ecology Group
SHPO	State Historic Preservation Officer
SOP	Standard Operating Procedure
SOW	Statement of Work
SRP	Standard Review Plan
TECOM	Test and Evaluation Command
TEDE	Total Effective Dose Equivalent
TO	Task Order
USACE	U.S. Army Corps of Engineers
USAF	U.S. Air Force
USCS	U.S. Soil Classification
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UXO	Unexploded Ordnance
WBS	Work Breakdown Structure
XPS	X-Ray Photodetection Spectroscopy
XRD	X-Ray Diffraction

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1. INTRODUCTION

This Field Sampling Plan (FSP) documents and describes the Jefferson Proving Ground (JPG) Depleted Uranium (DU) Impact Area site characterization project background; identifies the project team organization, members, and responsibilities; describes specific procedures for conducting and documenting field activities for this project; and presents the project deliverables and schedules. Science Applications International Corporation (SAIC) has prepared this plan in accordance with the statement of work (SOW) requirements under the U.S. Army Corps of Engineers (USACE) Contract No. F44650-99-D0007, Task Order (TO) CY02.

This plan is organized into the following sections:

- *Section 1. Introduction*—This section summarizes the organization and contents of the FSP.
- *Section 2. Project Background*—This section provides information about the site, including site history, site contaminants, and existing data, and defines the problem that the site characterization is intended to resolve.
- *Section 3. Project Organization and Responsibilities*—The organization for this project and the roles and responsibilities of key project personnel are identified in this section. Additional information about the project organization, responsibilities, and management approach is included in the Quality Control Plan (QCP) (SAIC 2005a).
- *Section 4. Project Scope and Objectives*—An overview of the purpose and scope of this site characterization project is provided in this section and includes a description of project tasks, applicable regulations and standards, and the project schedule.
- *Section 5. Nonmeasurement Data Acquisition*—This section defines how nonmeasurement data (e.g., fracture trace analysis data) to support the site characterization will be acquired.
- *Section 6. Field Activities*—This section identifies planned activities to be completed over the next 5 years. These activities include electrical imaging (EI); groundwater, soil, sediment, surface water, and biological tissue (biota) sampling; and corrosion and dissolution data collection. Details are provided for activities planned to occur in fiscal years (FYs) 2005 and 2006.
- *Section 7. Field Operations Documentation*—This section identifies requirements for documenting field operations. It includes requirements for developing, managing, and retaining daily quality control reports (QCR), field logbooks and/or sample field sheets, photographic records, sampling documentation, and field analytical records. It also summarizes the system for documenting potential variances from sampling procedures, the quality assurance project plan (QAPP), and/or the health and safety plan (HASP).
- *Section 8. Sample Packaging and Shipping Requirements*—This section identifies the requirements for packaging and shipping samples that will be collected during the field activities described in Section 6.
- *Section 9. Investigation Derived Waste*—This section documents the requirements for managing investigation-derived waste (IDW) and non-IDW (e.g., litter, household garbage) collected during the field activities described in Section 6.
- *Section 10. Field Assessment/Three-Phase Inspection Procedures*—This section summarizes the activities needed to ensure that quality is maintained throughout the entire project through a three-phase control process and includes checklists for sampling apparatus and field instruments.

- *Section 11. Nonconformance/Corrective Actions*—This section specifies procedures for identifying, correcting, and documenting significant conditions adverse to quality at the project site, laboratory, or subcontractor locations.
- *Section 12. References*—This section identifies the documents used to support development of this FSP.
- *Appendix A. Quality Assurance Project Plan*—This appendix presents the QAPP for the JPG DU Impact Area site characterization project.
- *Appendix B. Field Procedure: Electrical Imaging*—This appendix includes the field procedures for the electrical imaging (EI) geophysical survey.
- *Appendix C. Methodology for Scan Detection of Depleted Uranium Fragments Using 2-Inch by 2-Inch Sodium Iodide (NA) Detector*—This appendix describes the procedures for scanning DU fragments.

2. PROJECT BACKGROUND

The site history and the contaminant (i.e., DU) are discussed in Section 2.1. Existing site data are summarized in Section 2.2 and Section 2.3 includes a site-specific summary of the problem that this FSP addresses.

2.1 SITE HISTORY AND CONTAMINANT

JPG was established in 1941 as a proving ground for the test firing of a wide variety of ordnance. The facility is approximately 55,264 acres (224 square kilometers) and is located in Jefferson, Jennings, and Ripley Counties in southeastern Indiana (**Figure 2-1**). A firing line with 268 gun positions used for testing ordnance separates JPG into two areas: a 4,000-acre (16.1-square kilometer) southern portion and a 51,000-acre (206-square kilometer) northern portion (SAIC 1997). An east-west fence separates the area north of the firing line from the cantonment area. The firing line demarcates the ordnance impact area to the north from the cantonment area to the south. The cantonment area housed the support facilities that were used for administrative ammunition assembly and testing, vehicle maintenance, and residential housing. The area north of the firing line consists of 51,000 acres (206 square kilometers) of undeveloped and heavily wooded land and contains the Nuclear Regulatory Commission (NRC)-licensed area (SAIC 1997). The DU Impact Area is in the south-central portion of this area, as shown in **Figure 2-2.**

The U.S. Army used JPG as a proving ground from 1941 to 1994. During this time, more than 24 million rounds of conventional explosive ammunition were fired. Approximately 1.5 million rounds did not detonate upon impact, remaining as unexploded ordnance (UXO) either on, or beneath, the ground surface. This remaining UXO and its hazard has been a major factor in decisions about managing the area north of the firing line (SAIC 1997).

The Army test fired DU projectiles as part of its munitions testing program. The possession and test firing of DU penetrators were conducted under a license issued by the NRC (License SUB-1435, Docket 040-08838). The test firing of DU projectiles occurred between 1983 and 1994 in an area known as the DU Impact Area, in the northern portion of the installation.

The DU projectiles were fired from three fixed-gun positions on the firing line at soft (cloth) targets placed at intervals of 3,280 feet (1,000 meters), starting at 3,280 feet (1,000 meters) from the gun position and continuing to 13,123 feet (4,000 meters). Because of the type of testing conducted, the DU projectiles would impact at approximately the same location each time on their respective lines of fire. This firing protocol, with repeated impacts in the same area, resulted in the formation of a trench approximately 3.4 feet (1 meter) deep by 16.4 to 26.3 feet (5 to 8 meters) wide, extending for approximately 3,937 feet (1,200 meters) at the most frequently used gun position (SEG 1996). These tests were nondestructive (i.e., no aerosolization occurred), although the rounds may have fragmented upon impact.

The primary impact location was the trench. Secondary impact locations developed when the projectile skipped, either whole or in fragments. A similar pattern was repeated at each of the other two firing positions, but to a lesser extent because a smaller quantity of DU was fired from each location (SEG 1996).

Approximately 220,462 pounds (100,000 kilograms) of DU projectiles were fired at soft targets in a 2,080-acre (8.4-square kilometer) DU Impact Area. Approximately 66,139 pounds (30,000 kilograms) of DU projectiles and projectile fragments were recovered on or near the surface periodically to ensure that the total 100,000-kilogram license limit was not exceeded. Approximately 154,323 pounds (70,000 kilograms) of DU remain in the DU Impact Area (SEG 1995 and 1996).

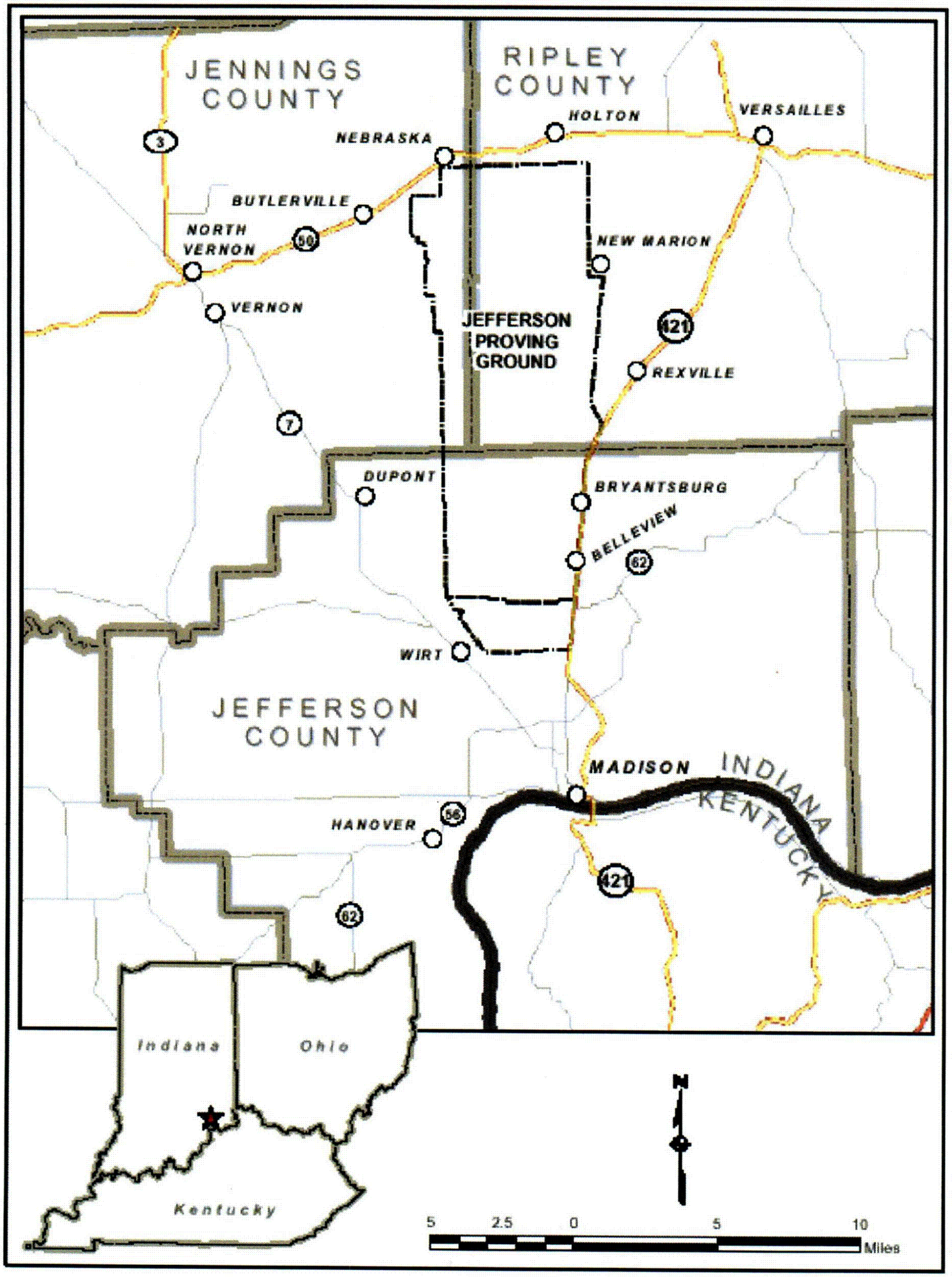


Figure 2-1. Regional Location of Jefferson Proving Ground

C01

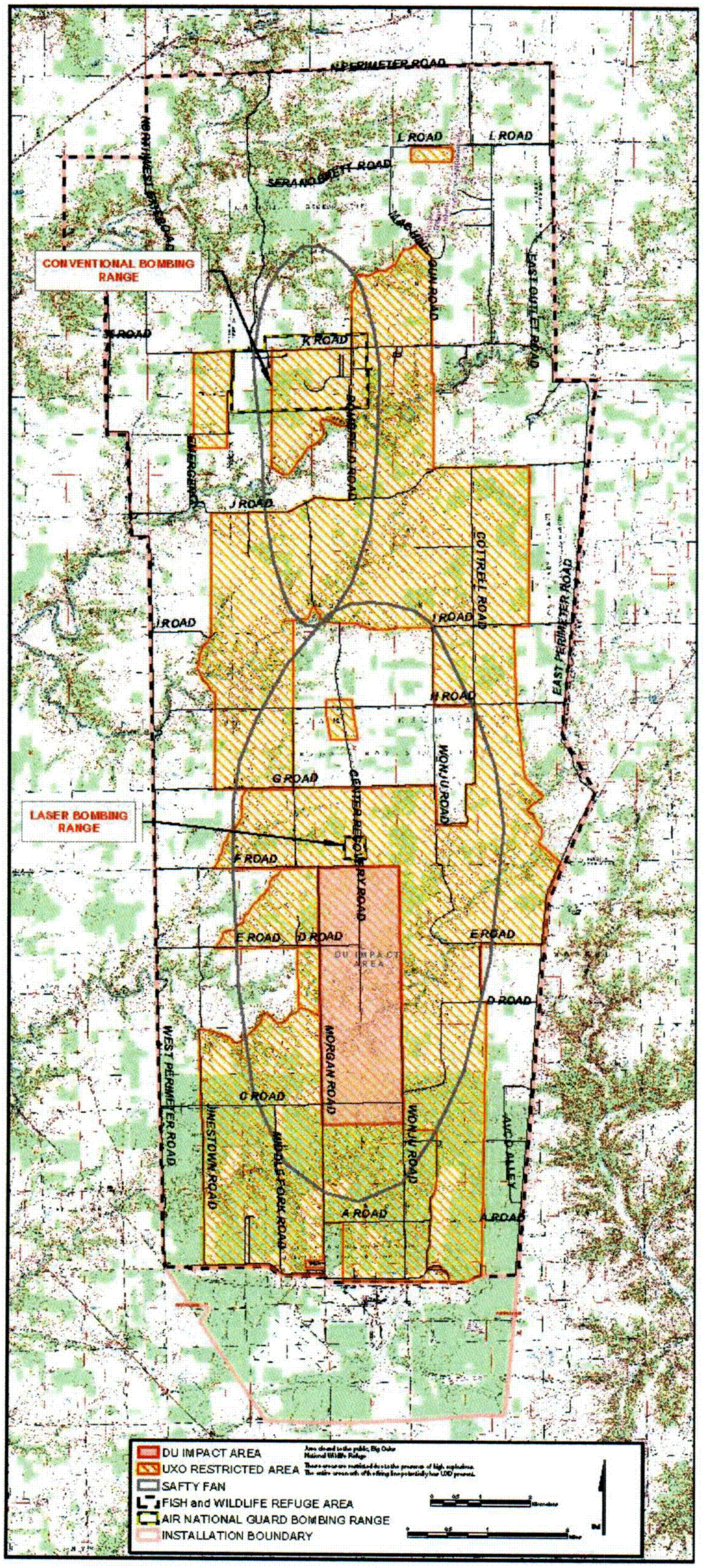


Figure 2-2. Jefferson Proving Ground, Madison, Indiana

C02

JPG was closed in September 1995 under the Defense Authorization Amendments and Base Realignment and Closure (BRAC) Act of 1988. At that time, the area south of the firing line where DU was stored was surveyed to determine the extent of DU contamination. Any contaminated areas were decontaminated, and the total area south of the firing line was released for unrestricted use in 1996. The NRC license for the area north of the firing line was amended for possession of DU only in May 1996. Site access to the area north of the firing line and to the DU Impact Area at JPG is controlled by the U.S. Army via the Army/Air Force/U.S. Fish and Wildlife Service (USFWS) Memorandum of Understanding (MOU) of 2000 (Section 4.2.2.1).

Decommissioning Plans were submitted by the Army in December 1999 and June 2001 in support of license termination (U.S. Army 1999 and 2001). The NRC discontinued review of the 1999 Decommissioning Plan with the release of the 2001 Decommissioning Plan (U.S. Army 2001). The NRC rejected the 2001 Decommissioning Plan during an expanded acceptance review, noting the need for additional information, including off site transport modeling. In a revised Decommissioning Plan dated June 27, 2002 (U.S. Army 2002a), the Army addressed the deficiencies noted with respect to the 2001 Decommissioning Plan and proposed to decommission JPG under restricted release conditions in compliance with Title 10, Code of Federal Regulations (CFR), Part 20.1403 (10 CFR 20.1403). After completing an expanded acceptance review, the NRC accepted the 2002 Decommissioning Plan for technical review.

In February 2003, the Army made a contingent request for an alternate schedule for submittal of a Decommissioning Plan (U.S. Army 2003a). The amendment would withdraw the 2002 Decommissioning Plan and create a 5-year possession-only renewable license, subject to fulfillment of NRC requirements articulated in a letter dated April 8, 2003 (NRC 2003). To clarify matters, the Army currently is pursuing an alternate schedule for submittal of a Decommissioning Plan only.

Based on the April 2003 NRC request (NRC 2003), the Army submitted a revised Environmental Radiation Monitoring (ERM) Plan (U.S. Army 2003b and 2004b), which would update the current monitoring program (U.S. Army 2000a). The NRC issued a request for additional information (RAI) to support evaluation of this ERM Plan (NRC 2004a). The Army submitted its response to the RAIs in November 2004 (U.S. Army 2004a). These responses pointed to incomplete understanding of the conceptual site model (CSM) and gaps in the current set of site characterization data. In a January 2005 letter to the NRC (U.S. Army 2005c), the Army outlined its strategy for site characterization, including its plans to collect data to support offsite transport modeling (NRC 2004b).

This FSP, the HASP (SAIC 2005a), and QCP (SAIC 2005b) define the strategy and plans for the site characterization project. Data derived from this project will be used to establish a solid foundation to support decommissioning in 5 years. This information will be used to support NRC's evaluation and approval of the Army's plans.

2.2 SUMMARY OF EXISTING SITE DATA

Both radiological and nonradiological investigations have been completed at JPG. Section 2.2.1 summarizes the existing radiological studies conducted at the DU Impact Area and Sections 2.2.2 through 2.2.4 summarize analytical results from several of the data collection studies conducted for DU.

2.2.1 Summary of Existing Studies

A number of studies evaluating potential environmental impacts associated with the DU testing program have been conducted since DU was first used at JPG in 1983. The following bullets summarize several key documents that include existing site data:

- *Review of the Environmental Quality Aspects of the U.S. Army Test and Evaluation Command (TECOM) DU Program at JPG, Indiana (Monsanto 1984)*—This document introduced the concept of the DU program before it began at JPG in terms of the anticipated environmental consequences of accuracy testing. This document included a description of the planned DU range safety systems and pollution controls. It also included an overview of the physical and environmental characteristics of JPG before DU was used and summarized the results of environmental monitoring data collected at JPG to establish the environmental baseline. Finally, it established an environmental monitoring program related to the use of DU at JPG that continues in a similar form today.

- *A Review of the Radiological Environmental Monitoring Data at the U.S. Army JPG, Madison, Indiana (EG&G 1988)*—This document describes sampling of various environmental media and biological tissues conducted by EG&G Mound Applied Technologies Corporation (EG&G) after the DU testing program had been initiated. This report examined potential correlations of field investigation data with the use of DU and, in all cases except surface water, the concentration trends appeared to be steady or decreasing. However, the concentrations of DU in surface water appeared to increase steadily. The authors postulated that the increasing concentration trend was potentially due to the lower volume of water available during the summer sampling event and that the overall quantity of DU was probably the same.
- *Environmental Assessment (EA) for Renewal of NRC License for Testing DU at JPG (U.S. Army 1988)*—This document proposed the renewal of the NRC license under the auspices of the National Environmental Policy Act (NEPA) and discussed the effects that testing DU munitions has had at JPG. This EA did not include new DU data collection from the DU Impact Area, but it included a description of the environmental setting, summary of radiological characteristics of DU, and an evaluation of the environmental impacts from the following four alternatives: no action, build and fire into a sand/earthen backstop, program 100 percent recovery, and continue testing DU.
- *JPG DU Impact Area, Scoping Survey, Report, Volumes 1-3 (SEG 1995)*—The scoping survey was conducted by Scientific Ecology Group (SEG) in 1995 to determine the boundaries of the DU Impact Area. This survey evaluated areas to the north and east of the DU Impact Area as well as radiation surveys along the three affected trajectories from the firing line. The survey included gamma radiation measurements and environmental sampling (soil, groundwater, surface water, sediment, and vegetation samples).
- *JPG DU Impact Area Characterization Survey Report, Volume 1 (SEG 1996)*—A characterization survey of the DU Impact Area was conducted to confirm the amount and extent of activity in the area as determined by the scoping survey. The impacted area was defined as that area that contained radioactivity in excess of 35 picocuries per gram (pCi/g) of DU in soil. In addition, the characterization survey provided estimates of remedial costs, waste volumes, and techniques for DU decontamination.
- *JPG Data Summary and Risk Assessment (Ebinger and Hansen 1996a)*—This report summarizes the environmental monitoring data from JPG from 1983 through 1994 and assesses the risk of adverse health effects to humans and the environment due to exposure to DU fragments. This report did not include new DU data collection from the DU Impact Area, but it concluded that recreational use of the DU Impact Area presents immeasurable increases in risk of cancer incidence or death due to cancer and that intensive farming on the impact area could result in significant doses to humans consuming drinking water from the site.
- *DU Risk Assessment for JPG using Data from Environmental Monitoring and Site Characterization (Ebinger and Hansen 1996b)*—This report documents the third risk assessment completed for the DU munitions testing range at JPG. This report did not include new DU data collection from the DU Impact Area, but it integrates information obtained from site characterization surveys at JPG with environmental monitoring data collected from 1983 through 1994 during DU testing. Three exposure scenarios were evaluated for potential adverse effects to

human health: an occasional use scenario and two farming scenarios. Human exposure was minimal from occasional use, but significant risks were predicted from the farming scenarios when contaminated groundwater was used by site occupants. Exposures of white-tailed deer to DU also were estimated in this study, and exposure rates resulted in no significant increase in either toxicological or radiological risks. The results of this study indicated that remediation of the DU Impact Area would not substantially reduce already low risks to humans and the ecosystem, and that managed access to JPG is a reasonable model for future land use options.

- *Decommissioning Plan and Environmental Report for DU Impact Area, JPG, Indiana (U.S. Army 1999)*—This plan provided TECOM with the information necessary to develop a decommissioning plan to be submitted to the NRC. This plan did not include new DU data collection from the DU Impact Area, but it included a description of planned decommissioning activities, evaluation of unrestricted and restricted use scenarios, analysis of the site survey and characterization results, and examination of UXO remediation.
- *License SUB-1435 Termination Standard Review Plan No. 26-MA-5970-01, JPG, Madison, Indiana (U.S. Army 2001)*—This License Termination Standard Review Plan (SRP) was developed to support NRC license SUB-1435 termination under restricted release conditions for JPG and to describe institutional controls to support the License Termination Plan (LTP). This plan did not include new DU data collection from the DU Impact Area.
- *Evaluation of JPG for Restricted Release: Risk Assessment Supporting NRC License Termination (Ebinger 2001)*—This document included a risk assessment conducted to support the termination of its radioactive materials license under a restricted release scenario. This plan did not include new DU data collection from the DU Impact Area, but it analyzed risk using existing data to represent the range of potential exposures of humans to DU at JPG under NRC industrial occupant and resident farmer scenarios.
- *Decommissioning Plan for License SUB-1435, JPG, Madison, Indiana (U.S. Army 2002a)*—The Decommissioning Plan (DP) presented the Army's request to terminate license SUB-1435 for possession of DU at JPG under restricted conditions. This plan did not include new DU data collection from the DU Impact Area, but it included additional data analyses and evaluations (e.g., dose modeling, as low as reasonably achievable [ALARA] analysis) to support the license termination request.
- *Environmental Report, JPG, Madison, Indiana (U.S. Army 2002b)*—The Environmental Report summarized information derived from numerous source documents related to the Army's Proposed Action to terminate its NRC license at JPG. It summarized DU monitoring data that existed at the time the report was prepared and introduced the proposed action (i.e., license termination under restricted conditions) and two alternative actions (i.e., no action and license termination for unrestricted use).
- *Regional Range Study (CHPPM 2003)*—This study was a limited focus investigation of the potential chemical impacts of munition constituents from live-fire training operations at JPG. Sampling of soils, surface water, sediment, groundwater, vegetation, and the sperm of a limited number of small mammals was conducted to support screening-level human and ecological risk assessments. Sampling locations for groundwater and soil included the DU Impact Area. Surface water and sediment sampling was conducted at the entrance and exits points of the installation. Among the analytes assessed in the study was uranium in groundwater, soil, surface water, and sediment.
- *Environmental Radiation Monitoring Program Plan For License SUB-1435 JPG (U.S. Army 2003b) and ERM Program Plan for License SUB-1435 JPG Addendum (U.S. Army 2004b)*—An environmental monitoring plan was developed for the JPG DU Impact Area before the initial DU munitions were fired in 1984 (Monsanto 1984), and this plan guided sample collection and analysis through 1995. This sampling plan and protocol were updated in 1996 (U.S.

Army 1996) and 2000 (U.S. Army 2000a). The ERM Program Plan and Addendum defined the strategy and associated procedures for biannual sampling of environmental media within and surrounding the DU Impact Area at JPG and provided the basis for determining if onsite and offsite receptors are or will be at risk from exposure to DU. The scopes of these plans were limited to the DU Impact Area at JPG and its immediate environs and to sampling media to determine the presence or absence of DU. The overall goals of the ERM Program at JPG are to provide a historical and current perspective of contaminant levels in various media, an indication of the magnitude and extent of any DU release or migration from past operations, and a timely indication of DU contaminant release and migration.

- *ERM Reports for License SUB-1435 JPG (SAIC 2004, 2005d)*—These reports summarize the methodology, results, and conclusions of the April and December 2004 sampling events based on the procedures established in the ERM Program Plan (U.S. Army 2003b) and Addendum (U.S. Army 2004b). These are the two sampling events in 2004 for the biannual ERM program that is scheduled to continue until license termination is complete.

2.2.2 Summary of Scoping Survey Results

To characterize the nature and extent of DU contamination, scoping and characterization surveys were conducted within the DU Impact Area. The scoping survey consisted of a radiation survey of the DU Impact Area, a radiation survey of the trajectories from the firing line into the DU Impact Area, and environmental sampling and analysis (**Figure 2-3**). Samples of all media were obtained both within and exterior to the 2,080-acre (8.4-square kilometer) DU Impact Area.

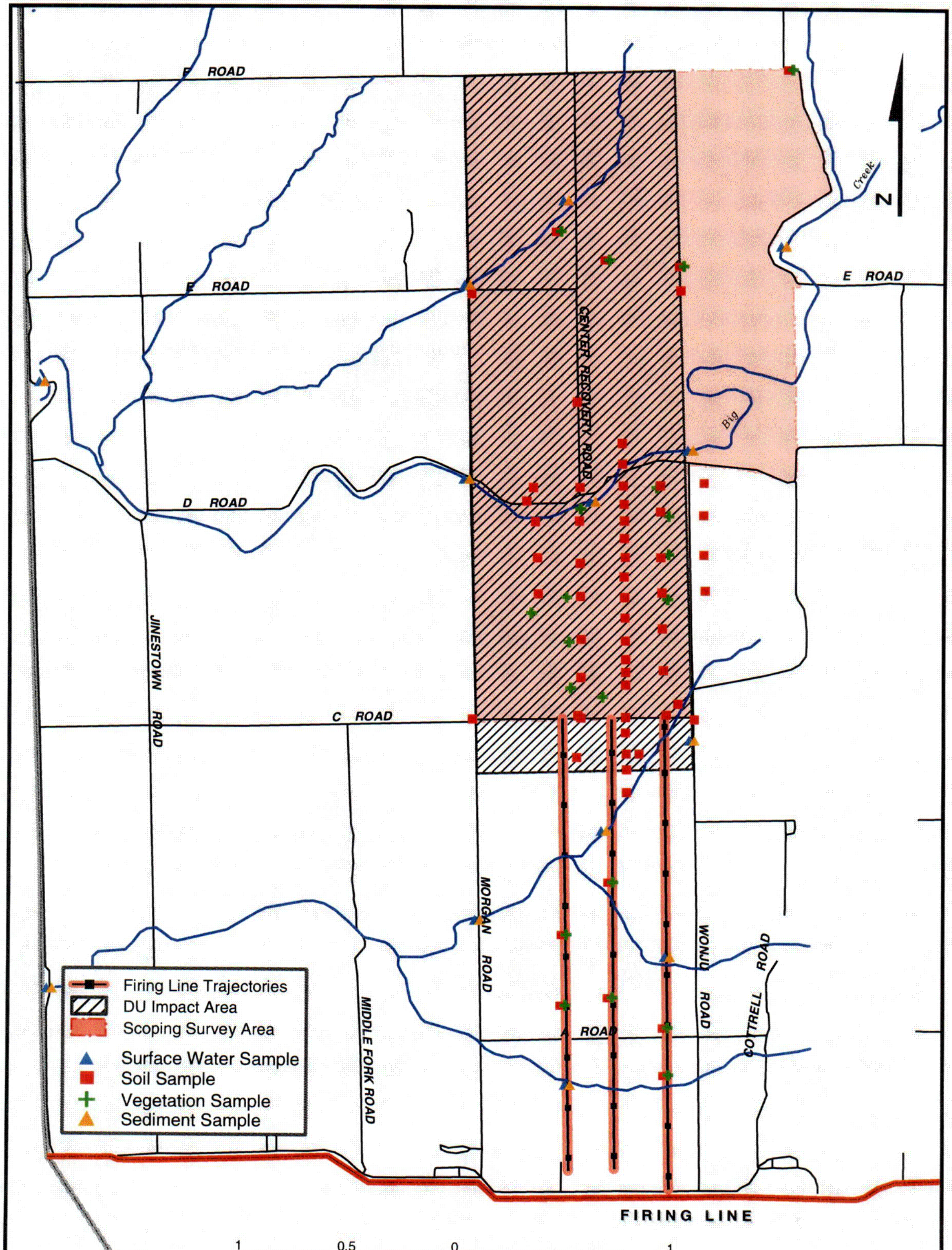
The radiation survey of the DU Impact Area was based on an unbiased, gridded survey with grid lines established at intervals of 164 feet (50 meters) from north to south on the eastern and western boundaries (SEG 1995). Soil, groundwater, surface water, sediment, and vegetation samples were collected prior to the radiation survey. **Table 2-1** summarizes the sampling results from the scoping survey. Detailed results are provided in the scoping survey report (SEG 1995).

2.2.3 Summary of Characterization Study Results

The characterization survey was completed after the scoping survey and it included the collection of exposure rate and in situ gamma spectroscopy measurements and soil, groundwater, surface water, sediment, vegetation, and biological samples. Background sampling was completed for surface and subsurface soil (10 locations), groundwater (6 locations), surface water (3 locations), and sediment (3 locations). All samples were analyzed by alpha spectroscopy for U-234, U-235, and U-238. **Table 2-2** summarizes the sampling results from the characterization survey. Detailed results are provided in the characterization survey report (SEG 1996). **Figure 2-4** shows the sampling locations for environmental media collected in support of site characterization.

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

At each location, a single in situ gamma spectroscopy measurement yielded the total inventory of activity for each nuclide presented as an area of activity concentration at the surface. Using these results, the concentrations of thorium-234 and polonium-234m were calculated for depth ranges of 0 to 5.9 inches (0 to 15 centimeters), 5.9 to 11.8 inches (15 to 30 centimeters), and 11.8 to 17.7 inches (30 to 45 centimeters) below ground surface (BGS). The specific assumptions used to determine this relationship are presented in SEG (1996). The exposure rate corresponding to a DU concentration of 35 pCi/g is 14.4 μR/hr. The contour map showing areas with an exposure rate greater than 14.4 μR/hr is shown in **Figure 2-5**.



Source: SEG 1995.

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

C03

Table 2-1. Scoping Survey Sample Results
Jefferson Proving Ground, Madison, Indiana

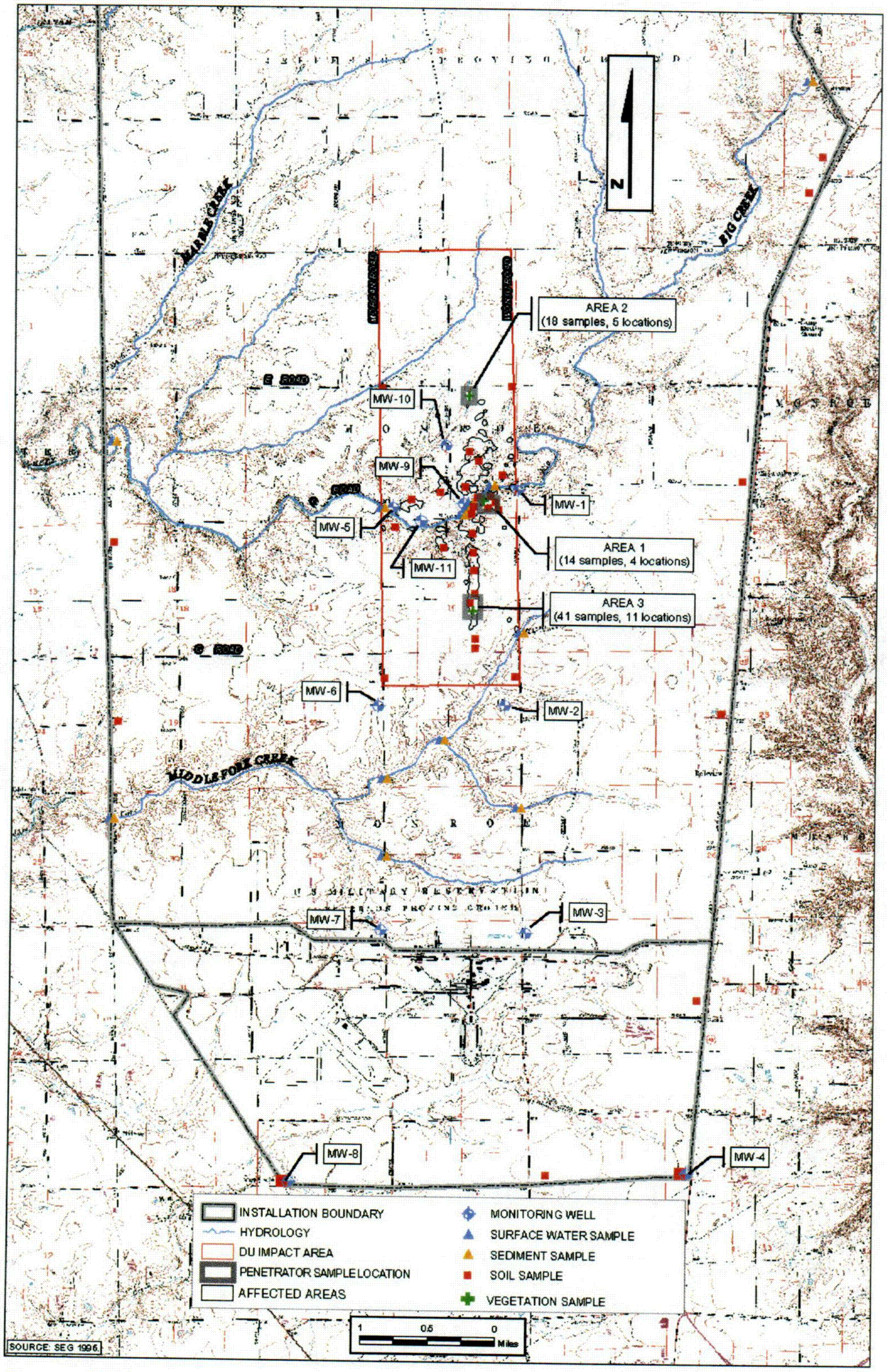
Sample Location	Number of Samples	Total Uranium Range in Concentration
DU Impact Area and Environs		
Soil	50	1.35–201 pCi/g
Sediment	11	0.42–1.9 pCi/g
Surface Water	12	0.21–3.6 pCi/L
Vegetation	14	0.01–0.50 pCi/g
Trajectory Locations		
Soil	12	1.42–1.87 pCi/g
Sediment	2	2.03–3.08 pCi/g
Surface Water	2	0.35–0.88 pCi/L
Groundwater	11	0.43–3.6 pCi/L
Vegetation	6	0.06–0.65 pCi/g

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

Table 2-2. Summary of Characterization Survey Results
Jefferson Proving Ground, Madison, Indiana

Environmental Medium/ Tissue Type	Number of Samples	Total Uranium Range in Concentration (pCi/g)	Average Concentration (pCi/g)
Background:			
0–15	10	1.52–2.53	1.97
15–30	10	1.33–2.59	1.84
30–45	10	1.33–2.76	1.95
Penetrator Soil Samples:			
0–15	20	2.9–12,318	2,881
15–30	20	1.5–547	79.5
30–45	20	1.8–63	12.7
45–60	13	1.4–11.5	4.50
Random Soil Samples:			
0–15	20	1.46–4.73	2.60
15–30	20	1.51–6.91	2.40
30–45	20	1.34–4.21	2.00
Other Media:			
Surface Water	10	0.62–25.02	3.55
Sediment	10	0.75–6.20	2.5
Vegetation	10	17.0–3,447	627.5
Vegetation Root Wash	10	46.1–14,258	2,868.8
Deer Liver	1	0.091	—
Deer Kidney	1	0.151	—
Deer Bone	1	0.416	—
Freshwater Clams	1	0.774	—
Freshwater Clams	1	0.334	—
Fish	1	0.150	—
Fish	1	0.282	—
Soft Shelled Turtle	1	0.245	—

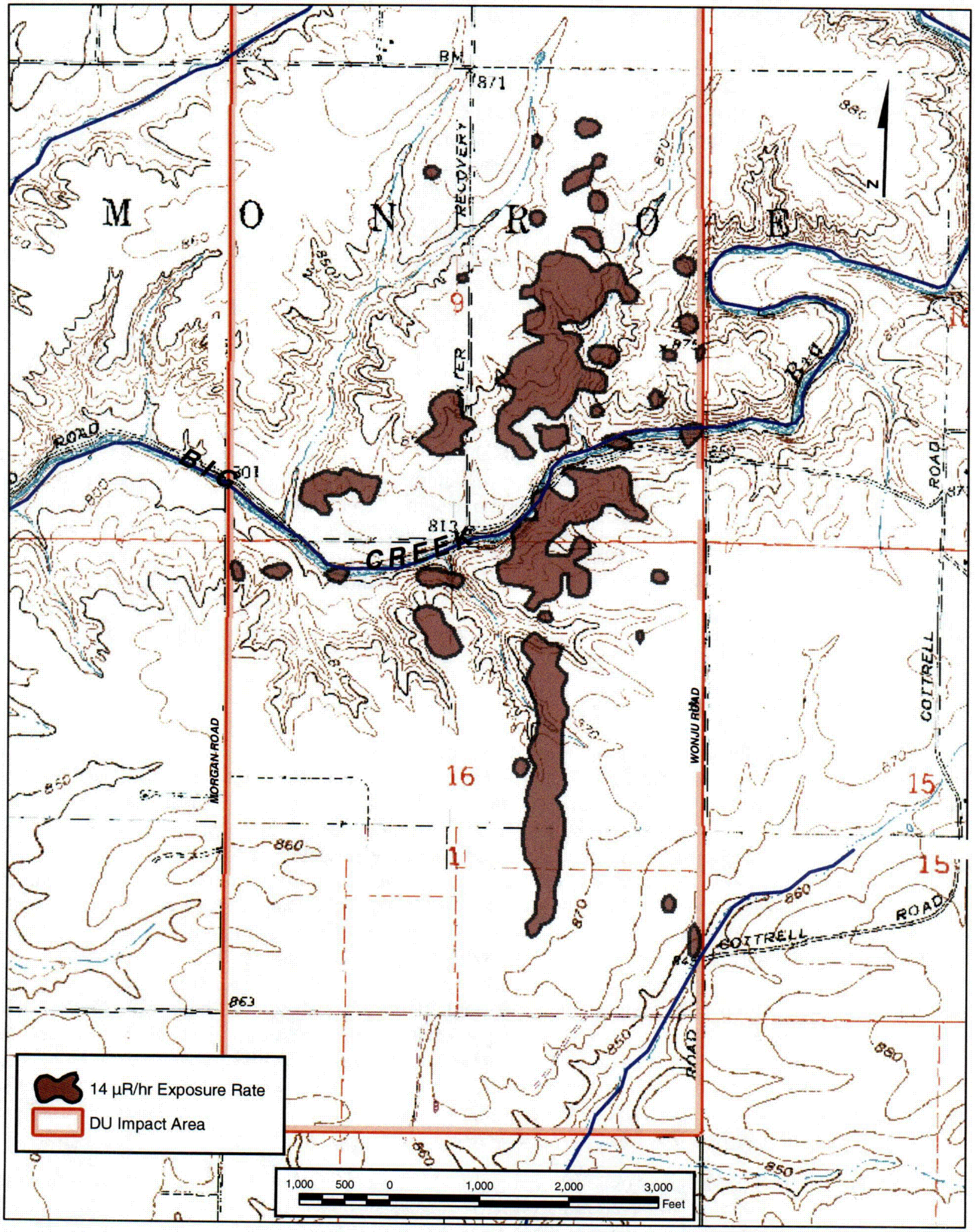
Source: Compiled from SEG 1996
— = Average not calculated for single sample result
BGS = below ground surface
pCi/g = picocuries per gram



Source: SEG 1996

Figure 2-4. Characterization Survey Sample Locations
Jefferson Proving Ground, Madison, Indiana

C04



Source: SEG 1996

Figure 2-5. Exposure Rate of 14 µR/hr from Soil Jefferson Proving Ground, Madison, Indiana

C05

2.2.4 Annual Environmental Monitoring Program

Sampling locations for soils, surface water, and groundwater are shown in **Figure 2-6** from the environmental monitoring plan (U.S. Army 2000a). Samples were collected and analyzed semiannually for total uranium and, often, the isotopic composition of uranium in samples. The environmental sampling data are summarized for the 1984 - 1994 period (Ebinger and Hansen 1996a) (**Table 2-3**). Sampling conducted since 2000 yielded similar results; no increasing or decreasing trends were identified and all results are below action levels (CHPPM 2001, 2002a, 2002b, and 2003; SAIC 2004 and 2005d).

The environmental data indicate that the expected concentrations of uranium or DU are significantly less than the derived concentration guideline of 35 pCi/g for soil and 150 pCi/L for surface water and groundwater (U. S. Army 1996). Of nearly 400 soil samples analyzed since 1984, most are less than 2 pCi/g, which is identical to the average background soil concentration of uranium at JPG. Similar distributions for DU concentrations in groundwater and surface water were obtained for the same period (**Table 2-3**).

2.3 SITE-SPECIFIC DEFINITION OF PROBLEM

There is an estimated 154,323 pounds (70,000 kilograms) of DU in the DU Impact Area. The distribution of this DU is nonhomogeneous because of the variability in the projectile trajectory and projectile fragmentation. The initial nonhomogeneous deposition of DU as metal remains nonhomogeneous as the DU metal oxidizes with time. The highest concentrations of DU in the soil have been from samples collected directly under projectiles or projectile fragments. In these cases, the DU concentration in the soil in the top 5.9 inches (15 centimeters) under a penetrator or penetrator fragment can be thousands of pCi/g. The DU concentrations decrease with depth, and at depths greater than approximately 24 inches (61 centimeters), DU concentrations are comparable to background (SEG 1995 and 1996).

2.3.1 Overview of DU in Munitions

DU results from the enrichment of natural uranium for use in nuclear reactors and nuclear weapons. It is defined as uranium that has less than 0.711 percent of the isotope uranium-235. DU consists principally of uranium-238, with trace amounts of uranium-235. Although 0.7 times as radioactive as natural uranium, DU metal is pyrophoric (able to ignite spontaneously) in powdered or finely divided metallic forms (e.g., saw turnings and chips, sawdust, abrasive saw sludge), but the DU penetrators at JPG are not expected to ignite spontaneously because they are in a more stable metallic alloy form. In addition, DU is extremely dense (Ebinger and Hansen 1996). U.S. Department of Defense (DOD) military specifications require that DU must have 0.335 percent or less uranium-235, and DU actually used by DOD has only 0.2 percent uranium-235. When manufactured as 105 and 120 mm DU rounds, each 105 mm DU projectile contains approximately 7.5 to 7.9 pounds (3.4 to 3.6 kilograms) and each 120 mm DU projectile contains approximately 8.6 to 10.1 pounds (3.9 to 4.6 kilograms) (U.S. Marine Corps 2003) of extruded DU, alloyed with 0.754 percent by weight titanium. The DU penetrators are armor-piercing, fin-stabilized, discarding sabots with tracer element (APFSDS-T) projectiles, which means that the DU penetrators are long, narrow cylinders (23.75 inches [603 millimeters] × 0.91 inches [23 millimeters]) encased in lightweight, clamshell-like devices that are discarded shortly after being fired while the penetrator is propelled toward the target (ORDATA Online 2005).

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

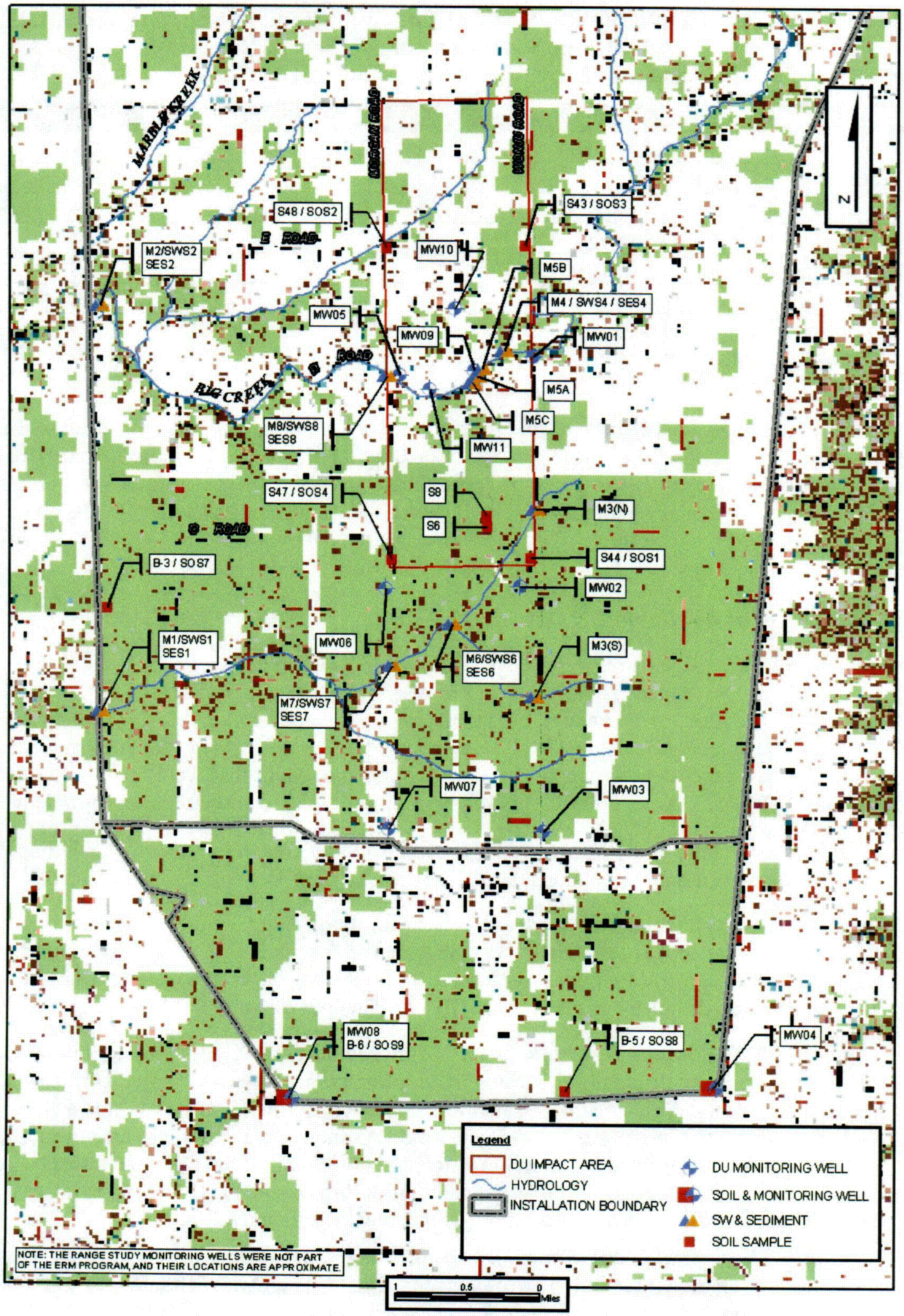


Figure 2-6. Sampling Locations Under the ERM Program (U.S. Army 2000) Jefferson Proving Ground, Madison, Indiana

E06

Table 2-3. Descriptive Statistics of DU Concentrations in Soil, Groundwater, and Surface Water Samples (1984 - 2000) Jefferson Proving Ground, Madison, Indiana

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

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

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

2.3.2 Limitations of Available DU Data at JPG

Although none of the existing reports provides conclusive evidence of elevated levels of DU migrating outside the DU Impact Area, the Army's responses (U.S. Army 2004a) to the NRC-issued RAIs (NRC 2004a and 2004b) pointed to an incomplete understanding of the CSM and gaps in the current set of site characterization data. This FSP augments the Army's strategy for site characterization, including its plans to collect data to support offsite transport modeling, that were included in a January 2005 letter to the NRC (U.S. Army 2005). This FSP will provide data to address the key problems:

- Limited understanding of the present nature and extent of contamination in the DU Impact Area
- Limited understanding of the potential fate and transport of DU outside the DU Impact Area.

This enhanced understanding will serve as the basis for modifying the current ERM program within the next 2 to 3 years with a longer-term goal of establishing the foundation to initiate decommissioning in October 2010. NRC issued the following RAIs and the comment on groundwater action level (NRC 2004a). This information details the data needs that this FSP addresses:

- *Question 1, Conceptual Site Model*—The Army should provide additional information on the CSM that was used originally to locate the sampling points for groundwater, surface water, and stream sediments. The CSM of the hydrologic system for the DU Impact Area should include all potential water-bearing units, surface water systems, caves, springs, and the unsaturated zone that may be impacted by the degradation and movement of the DU penetrators. The Army should provide information on the interrelationship between DU concentrations in the groundwater, surface water, caves, springs, and stream sediments.
- *Question 2, Groundwater Flow and Well Placement*—There appears to be conflicting information on the direction of groundwater flow. The Army should provide additional information on the adequacy of the placement (and screened interval), number, and spacing of the current 11 monitoring wells to detect DU in groundwater.
- *Question 3, Well Construction Details*—The Army should provide additional information on the construction, development, and maintenance of the current 11 monitoring wells.

- *Question 4, Groundwater and Surface Water Relationships*—The Army should provide additional information on the relationship between stream flow in Big and Middle Fork Creeks, and DU concentrations in surface water and stream sediments. The Army should describe how DU concentration in the surface water and stream sediments vary during high, average, and low stream flow conditions. The Army also should state if its corrective measures first proposed in 1984, to be taken if the surface water action level is exceeded, are still current.
- *Question 5, Penetrator Dissolution Rate and DU Solubility*—The Army should provide additional information on the rate of dissolution of the penetrators. The Army also should provide data on the solubility of DU.
- *Question 6, Groundwater Corrective Measures*—The Army should state if its corrective measures first proposed in 1984, to be taken if the groundwater action level is exceeded, are still current.
- *Question 7, Uranium Concentrations in Deer*—The Army should provide additional information on the apparent trend of increasing uranium concentration in deer kidneys and bone, and how this relates to the potential for DU in deer meat that is consumed by humans.
- *Cover Letter Comment on Groundwater Action Level*—The staff has discussed the groundwater action level proposed in the ERM with the Army and the Army has indicated that the action level for DU in groundwater in the impact area should be changed. Please include this modification to the action level with your response to the requests for additional information.

The Army submitted responses to the RAIs in November 2004 (U.S. Army 2004a) and addressed the Army's revised position on the subject action level.

A central concept to understanding the site-specific problem was articulated in the dose assessment in support of the *Decommissioning Plan for License SUB-1435* (U.S. Army 2002a) that indicated, "Doses to humans and ecosystem receptors can come from any number of exposure pathways beginning when the munitions are tested and lasting until the 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 the soils." **Figure 2-7** is the CSM that is a graphical representation of the DU sources, transport mechanisms, potential exposure pathways, and potential receptors.

The basis of the CSM is the DU that has been deposited on, or immediately below, the ground surface and/or within the surface water (streams). Once the DU has been deposited within the soil or surface water, it could be transported through the environment by several different processes. DU in the soil or surface water can be subject to physical movement by erosion, flooding/high-water conditions, and dust movement by wind or fire and leaching. Processes of erosion could cause migration and transport of DU penetrators or fragments (during floods and high runoff events) along the ground surface and along surface water drainageways. Leached DU from the penetrators and/or fragments in the soil and in the surface water could be transported to groundwater and surface water. Soluble DU could be absorbed by plants and incorporated within the plant matter. The simplest and most direct exposure pathway to wildlife and humans would be from direct contact with the penetrators and/or fragments and incidental ingestion of DU or DU-impacted soils. Impacted surface water and groundwater could migrate to drinking water sources. The drinking water and surface water could be ingested by humans, livestock, and wildlife. Meat and/or animal products from animals ingesting DU-impacted water could be ingested by humans. Humans could have contacts with, and incidental ingestions of, impacted surface waters during recreational activities such as fishing and hunting.

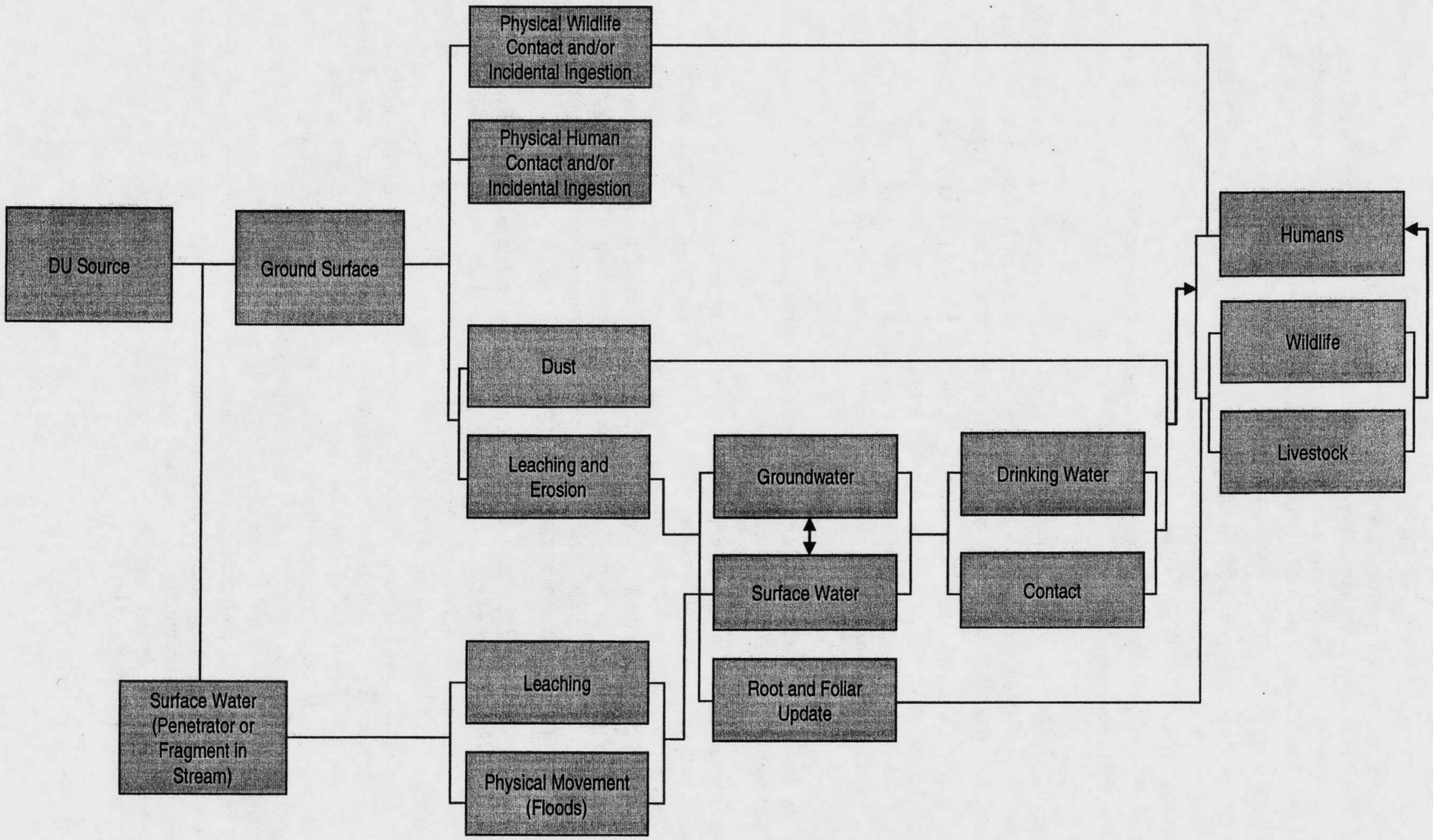


Figure 2-7. Conceptual Site Model of DU Transport Through the Environment at and Around the JPG DU Impact Area Jefferson Proving Ground, Madison, Indiana

3. PROJECT ORGANIZATION AND RESPONSIBILITIES

SAIC's management approach to the JPG DU Impact Area site characterization project is detailed in this section. Specific elements of this approach are addressed in Sections 3.1 through 3.3 and include the management structure; qualifications, responsibilities, and authorities of personnel; management approach; and project communications.

3.1 PROJECT ORGANIZATION AND MANAGEMENT APPROACH

The organization for this project, shown in **Figure 3-1**, indicates the reporting lines of key project personnel to the Project Manager. The Field Manager, Mr. Seth Stephenson, and his support staff for site characterization, Mr. Mike Barta and Mr. Todd Eaby, report to Ms. Corinne Shia, the Project Manager. The project Quality Assurance (QA) Officer, Health and Safety (H&S) Officer, and Radiation Protection Manager each report independently to their corporate counterparts, Mr. Glenn Cowart, Certified Quality Auditor (C.Q.A), Corporate QA Manager and Mr. Steve Davis, Certified Industrial Hygienist (CIH), certified safety professional (CSP), Corporate H&S Manager. Section 3.2 outlines the responsibilities and authorities and qualifications of those personnel assigned to the JPG site characterization project.

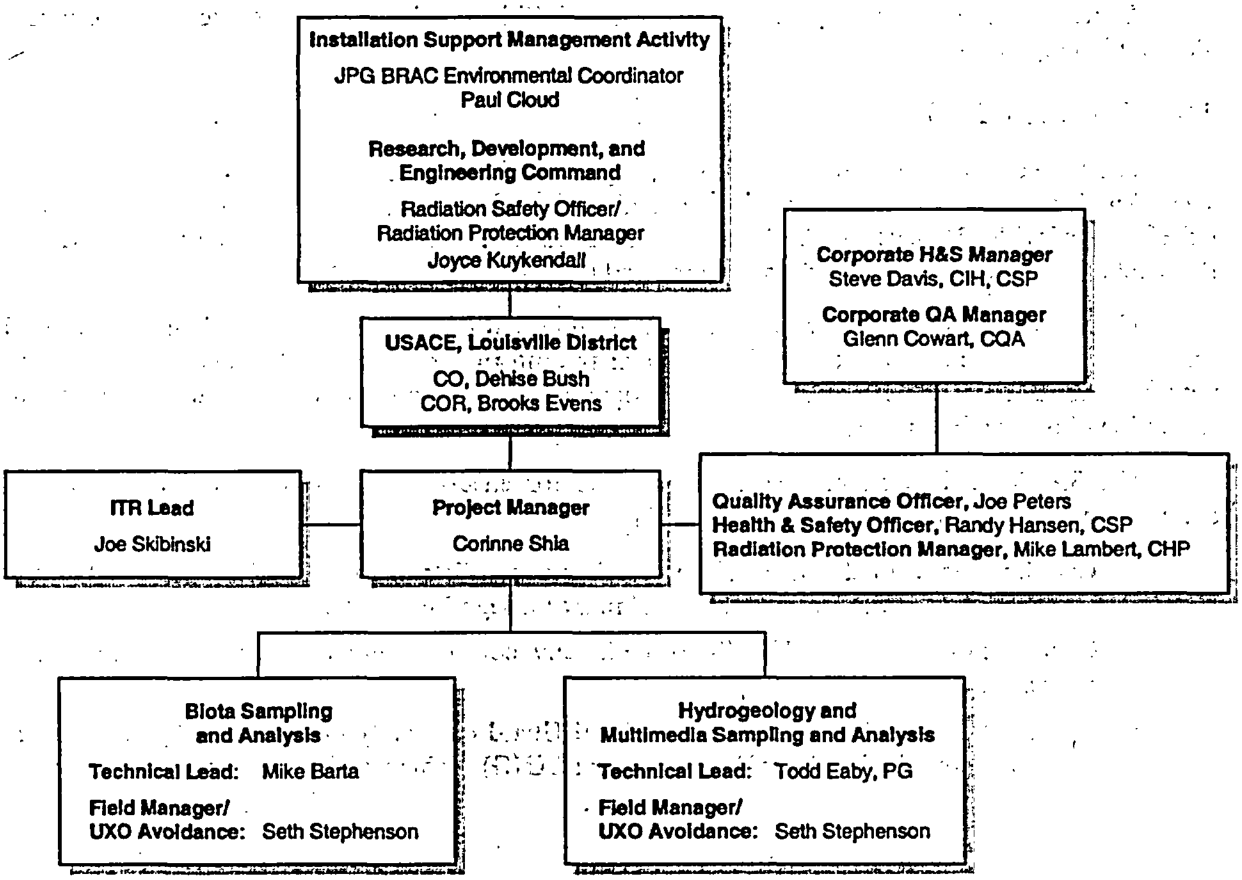


Figure 3-1. Project Organization for the DU Impact Area Site Characterization Project Jefferson Proving Ground, Madison, Indiana

As the single point-of-contact for the JPG site characterization project, the Project Manager, Ms. Shia, is responsible for ensuring the project meets the technical, schedule, and cost requirements outlined in the TO scope, contractual documents, and project plans. The Project Manager will be assisted by her team in managing staff and subcontractors to ensure project performance goals are achieved. Ms. Shia will use

SAIC's integrated schedule/cost/technical performance management system to support planning, budgeting, and performance assessment functions for the JPG site characterization project.

SAIC's performance management system is the corporate management tool used to control project progress, manage contract requirements within cost and on schedule, and provide communications within the project to senior management and to the client, the U.S. Army. Integrated scheduling and time-phased budgeting, according to the work breakdown structure (WBS), provides the baseline for performance measurement. This system integrates the scope of work, budget, WBS, and schedule to the work planned, thereby providing an efficient and effective approach to managing this project.

Cost, schedule, risk analysis, and performance reports are generated by this system to support the needs of project management and the Army. Planned budget and schedule data are entered into this system when each work package is defined and approved. Schedule and earned value information is updated at least weekly, and cost information is updated biweekly.

3.2 QUALIFICATIONS, RESPONSIBILITIES, AND AUTHORITIES OF QUALITY CONTROL PERSONNEL

Table 3-1 identifies the qualifications, responsibilities, and authorities of key project personnel identified in Figure 3-1.

3.3 PROJECT COORDINATION

The Project Manager is directly responsible for the direction of all assigned SAIC technical staff. The SAIC Project Manager will serve as the single point of contact (POC) for communications with the USACE Louisville District, U.S. Army's Installation Support Management Activity (ISMA), and Research, Development and Engineering Command (RDECOM).

The Project Manager will oversee the scheduling and conduct of project meetings and briefings (including conference calls) and reporting. Formal and informal periodic reviews also will be scheduled, within SAIC and with the client, to status progress against plans, adjust schedules, and coordinate resolution of outstanding issues.

The SAIC Field Manager will be responsible for ensuring the following coordination prior to commencing field work at the JPG DU Impact Area:

- Coordination with the USFWS to avoid any conflicts with USFWS-prescribed burns (i.e., USFWS burns normally occur from February through March of any given year).
- Coordination with the USFWS to avoid any conflicts with any scheduled public hunting programs.
- Coordination with the Indiana Air National Guard on a daily or as-needed basis to avoid any conflicts with scheduled Air National Guard (ANG) flights/training.

Table 3-1. Qualifications, Responsibilities, and Authorities of Key Project Personnel for the DU Impact Area Site Characterization Project Jefferson Proving Ground, Madison, Indiana

Name/Title	Qualifications	Responsibilities	Authorities
Corinne Shia *Project Manager*	**Highest Degree:** M.S., Mechanical Engineering **Total Years Experience:** 33 **Experience Highlights:** Managed JPG BRAC and NRC licensing support activities since 1995 Directed more than 100 HTRW RI/FS/RDs tasks for the U.S. Army, DOE, and other DOD organizations	Serves as single POC for TO Manages work, approved plans Coordinates TO performance with USACE, including monthly progress and financial reports Directs resources to ensure safe, quality execution of TO within budget and schedule Oversees subcontractor services Ensures Administrative Record is updated and maintained	Approves budgets and expenditures Approves work plans Certifies invoices Assigns staff Negotiates subcontract agreements and directs subcontractors Stops work for H&S and quality issues
Joe Skibinski, *ITR Lead*	**Highest Degree:** B.S., Chemistry **Total Years Experience:** 16 **Experience Highlights:** Risk Assessor and Chemist on HTRW and UXO projects for U.S. Army and Navy Superfund, BRAC, and FUDS Supported and led multimedia characterization studies	Oversees and coordinates implementation of the independent reviews of all deliverables Tracks deficient items to ensure corrective actions are implemented Ensures QC records are maintained	Approves document review plans and corrective actions in consultation with the Project Manager
Glen Cowart CQA *Corporate QA Officer*	**Highest Degree:** M.S., Library Science **Total Years Experience:** 29 **Experience Highlights:** QA Manager with overall responsibility for development and implementation of SAIC's Corporate Quality Management Program used on more than 30 programs (700 projects in last 5 years) Establishes and maintains QA/QC programs at military installations	Oversees corporate QA program, reporting independently to the Program Manager on the TO Conducts periodic assessments of projects for compliance with corporate and project-specific QA/QC requirements Monitors corrective actions based on Corporate-level reviews	Enforces corporate QA program requirements Has stop work authority for quality issues

Table 3-1. Qualifications, Responsibilities, and Authorities of Key Project Personnel for the DU Impact Area Site Characterization Project Jefferson Proving Ground, Madison, Indiana (Continued)

Name/Title	Qualifications	Responsibilities	Authorities
Steve Davis, CIH, CSP *Corporate S&H Officer*	**Highest Degree:** B.S., Zoology **Total Years Experience:** 28 **Experience Highlights:** Responsible CIH at more than 500 engineering and environmental management projects for Air Force, Air and Army National Guards, Army, and USACE Experience spans facility engineering, design, construction, asbestos and lead abatement, and in toxic atmospheres, confined spaces requiring air monitoring, respiratory protection, and personnel protection through Level A	Oversees corporate S&H program, reporting independently to the Program Manager on the TO Conducts periodic assessments of projects for compliance with Corporate and project-specific S&H requirements Monitors corrective actions based on Corporate-level reviews	Enforces Corporate S&H program requirements Has stop work authority for unsafe conditions
Joe Peters *QA Officer*	**Highest Degree:** B.A., Chemistry **Total Years Experience:** 21 **Experience Highlights:** Chemical QC Manager for USACE, NGB, and DOE contracts Oversaw QA program for more than 50 projects, inclusive of onsite and offsite analytical programs Extensive experience in working with laboratories and validating chemical and radiological data	Ensures all chemistry-related goals of TO are met Participates in project reviews Conducts/oversees onsite analytical testing, including field screening tests Reviews offsite contractor analytical testing Reviews and verifies chemical data for hazardous waste manifests Designs and implements audits/surveillances Prepares data validation reports or reviews reports prepared by subcontractors	Approves FSPs Approves chemical-related reports Approves audit and surveillance reports
Randy Hansen, CSP, RPPT *H&S Officer*	**Highest Degree:** B.S., Radiation Protection Science **Total Years Experience:** 15 **Experience Highlights:** Supervisor for environmental H&S program and radiation protection program on St. Louis remedial action for radiological contamination Developed and approved 30 Site Safety and Health Plans	Reviews, approves, maintains, and ensures compliance with Corporate H&S program and HASP Delegates responsibilities to and oversees Field Safety and Health Officer activities Participates in project reviews Maintains project documentation on HASP, training, briefings, corrective actions, and other H&S reporting requirements	Enforces compliance with HASP Has stop work authority if unsafe conditions are present Authorizes resumption of field activities Upgrades protective measures

Table 3-1. Qualifications, Responsibilities, and Authorities of Key Project Personnel for the DU Impact Area Site Characterization Project Jefferson Proving Ground, Madison, Indiana (Continued)

Name/Title	Qualifications	Responsibilities	Authorities
Mike Lambert, CHP *Radiation Protection Manager*	**Highest Degree:** B.S., Biology **Total Years Experience:** 25 **Experience Highlights:** Health physicist specializing in environmental compliance, industrial hygiene, occupational safety, and radiation protection Led and supported radiation protection programs for operations and decommissioning at Rocky Flats, Paducah Gaseous Diffusion Plant, Savannah River Site, and various commercial nuclear power facilities	Reviews radiological hazards associated with the project, including: Reviews radiation portions of the HASP Conducts site training and audits, as needed Assesses radiological exposure measurements Reviews and approves H&S work permits, if applicable	Approves radiological protection portions of the HASP in consultation with the H&S Officer
Seth Stephenson *Field Manager/UXO Avoidance*	**Highest Degree:** High School Diploma **Total Years Experience:** 15 **Experience Highlights:** Graduate of EOD School, Indian Head, Maryland, serving as UXO Team Member or UXO Supervisor on survey and removal actions at DOD sites Serving as Field Manager and Site Supervisor for site monitoring and remediation activities at Newport Chemical Depot, Indiana	Implements and enforces compliance with the project HASP under the direction of the Health and Safety Officer Coordinates and manages onsite operations in accordance with the FSP, including subcontractor activities Provides UXO avoidance support Documents and reports field changes Coordinates and controls any emergency response actions Conducts and documents daily safety inspection Maintains current copies of the project HASP, SAIC EC&HS Manual, training, environmental and personal exposure monitoring results, and other project documentation onsite	Enforces compliance with FSP and HASP Has no-dig authority if UXO is present Has stop work authority if unsafe conditions are present Authorizes resumption of field activities Upgrades protective measures

Table 3-1. Qualifications, Responsibilities, and Authorities of Key Project Personnel for the DU Impact Area Site Characterization Project Jefferson Proving Ground, Madison, Indiana (Continued)

Name/Title	Qualifications	Responsibilities	Authorities
Mike Barta *Biota Sampling and Analysis Technical Lead*	**Highest Degree:** M.S., Zoology **Total Years Experience:** 13 **Experience Highlights:** Supports aquatic receptors and terrestrial wildlife assessments for CERCLA and RCRA sites Designs and implements field sampling programs in support of baseline surveys and ecological risk assessments	Develops plans for biota sampling Ensures compliance with applicable USACE requirements for field sampling programs Coordinates with Field Manager and crew on biota sampling protocol Complies with USFWS protocol with the Big Oaks National Wildlife Refuge at JPG	Approves staffing plans and changes to the FSP
Todd Eaby, P.G. *Hydrogeology and Multimedia Sampling and Analysis Lead*	**Highest Degree:** B.S., Geology **Total Years Experience:** 14 **Experience Highlights:** Serves as Field Manager/Geologist for well installation, sampling, and monitoring for site characterization and remediation projects Develops FSPs, develops protocol, analyzes results, and develops reports for a variety of hydrogeologic regimes, including karst geology	Develops plans for hydrogeology and multimedia sampling Ensures compliance with applicable USACE requirements for field sampling programs Coordinates with Field Manager and crew on sampling, well drilling, and other related activities	Approves staffing plans and changes to the FSP

4. PROJECT SCOPE AND OBJECTIVES

The objectives of the JPG site characterization project are three-fold:

- Enhance the understanding of the nature and extent of contamination in the DU Impact Area and the fate and transport of DU in the environment
- Define and verify the CSM
- Provide the basis for modifying the current monitoring program within the next 2 to 3 years and for completing a revised Decommissioning Plan in 5 years.

By implementing this project, the Army will establish a solid foundation to support decommissioning in 5 years. The project is structured and phased to address the data gaps outlined in Army and NRC documentation (i.e., U.S. Army 2004a; NRC 2004a and 2004b) subject to funding availability. The scope of the project is defined below:

- The site characterization project will be developed and implemented in accordance with the data needs defined in the Army's Response to NRC's RAI (U.S. Army 2004a) and in its letter to NRC in January 2005 regarding data to be collected for offsite modeling (U.S. Army 2005).
- NRC's 5-year timeframe begins on October 1, 2005 (FY 06) and includes a 5-year implementation timeframe; schedule accelerations are desirable and possible technically if there are no budget constraints on an annual basis. For instance, acceleration of the planned schedule would allow time before the end of the 5-year timeframe to address additional regulatory requirements.
- Investigations are planned for all media (i.e., soil, sediment, surface water, groundwater, and biota, except air) (SAIC 2005c).
- The presence of UXO and DU penetrators presents a potential H&S risk to field personnel. Site investigation plans will be adjusted, as appropriate and necessary, to ensure that the H&S of all field personnel are always protected.

4.1 TASK DESCRIPTION

A tiered, time-phased approach for site characterization has been defined to allow decisions at intermediate milestones regarding the need for collecting additional site data. **Table 4-1** shows the WBS structure and deliverables for the DU site characterization project. In accordance with the SOW included in the QCP (SAIC 2005b), plans for this project are defined in detail in this FSP and the HASP (SAIC 2005a) for the first year (FY 2005 - 2006) of the project. Subsequent year tasks and associated activities will be planned and detailed as addenda to the FSP and HASP.

4.2 APPLICABLE REGULATIONS/STANDARDS

This section describes the general (Section 4.2.1) and site-specific (Section 4.2.2) applicable regulations and standards for the field investigation activities and related documentation included in this FSP.

Table 4-1. WBS Structure and Deliverables for the DU Impact Area Site Characterization Project Jefferson Proving Ground, Madison, Indiana

WBS	WBS Title	Description	Fiscal Year (FY)
1.0	Project Planning		
1.1	*QCP*	Draft and Final QCP	2005
1.2	*FSP (includes QAPP)*	Draft and Final FSP	2005
1.3	*HASP*	Draft and Final HASP	2005
1.4	*Service Provider License*	License	2005
1.5	*Meetings*	Quarterly Meetings, Abingdon, Maryland; biweekly telecons	2005 - 2010
1.6	*Progress Reports*	Monthly	2005 - 2010
2.0	Field Investigations		
2.1	*Biota Investigations*		
2.1.1	Deer Sampling	Collection and analysis of 30 to 40 deer (kidney, liver, bone, and muscle) from within and outside the DU Impact Area. USFWS will obtain permit and acquire deer for contractor. Laboratory analyses of samples for isotopic uranium are planned. Decision point, if DU is not an issue, no additional biota sampling is likely to be implemented.	2006
2.1.2	Deer and Other Biota Sampling	Second sampling event for deer is a validation activity. This is an optional task and depends on the results of the first deer sampling event. A second optional task involves other biota (plants, earthworms, birds, mammals, and fish) sampling and includes 10 samples each from the DU Impact Area and background locations. Laboratory analyses of samples for isotopic uranium are planned.	2008
2.1.3	Other Biota Sampling	Second sampling event for other biota is a validation activity. This is an optional task and depends on results of the first other biota sampling event.	2009
2.2	*Hydrogeology*		
2.2.1	Fracture Trace Analysis	A fracture trace analysis is planned based on stereo-paired aerial photographs. Mapped fracture traces will be given a quality ranking, and the lines will be transferred to an ArcView® shape file. Ground truth of fracture trace is planned.	2005
2.2.2	Electrical Imaging Survey	Survey, combined with the fracture trace analysis, will be used to identify preferential flow paths and karst features for groundwater. Survey will be conducted to identify entry and exit pathways.	2006
2.2.3	Well Location Assessment & Selection	Analysis will use fracture traces, electrical imaging, and media contamination profiles to select the locations of new well clusters.	2006
2.2.4	Well Installation	Installation of 10 multi-level well clusters located on preferential groundwater flow paths. Collection of groundwater monitoring data from new and 19 existing wells will result in characterization of groundwater gradients and chemistry.	2007

Table 4-1. WBS Structure and Deliverables for the DU Impact Area Site Characterization Project Jefferson Proving Ground, Madison, Indiana (Continued)

WBS	WBS Title	Description	Fiscal Year (FY)
2.2.5	Other Monitoring Equipment Installation (precipitation, cave streams, streams, and groundwater levels)	Installation and maintenance of automatic, continuous recorders for stream (Big Creek and Middle Fork), precipitation gauge, and three-cave stream/spring gauges, and groundwater level (monitoring wells). Possible USGS cooperation and assistance. Data will be used to evaluate and develop the CSM.	2007
2.3	***Media Sampling and Analysis***		
2.3.1	Groundwater Sampling	Four quarters of sampling for all wells for DU. Isotopic analyses of uranium are planned.	2008
2.3.2	Sediment/Surface Water Sampling	Four quarters of sampling of sediment and surface water for DU. Isotopic analyses of uranium are planned.	2008
2.3.3	Other Monitoring (precipitation, cave streams, and streams)	Four quarters of sampling for DU and other field parameters. Isotopic analyses of uranium are planned.	2008
2.3.4	Soil Sampling		
2.3.4.1	*Verification*	Field verification of soil mapping conditions.	2006
2.3.4.2	*Extent and Depth*	Approximately 380 soil samples (including QC samples) at 60 locations will be sampled at various depths. Isotopic analyses of uranium are planned.	2008
2.3.4.3	*K_d/Corrosion Parameters (Soil Sampling)*	Data help determine K_d and support MNTEQA2. Physical and chemical properties of Cincinnati and Cobbsfork soils, chemical properties of rainwater, and desorption/adsorption tests are planned.	2008
2.3.5	DU Penetrator Corrosion Analysis		
2.3.5.1	*Corrosion Field Measurements of DU Penetrators*	Collect 24 samples (penetrators) from the DU Impact Area and select the minimum number, based on field examination, for further laboratory analysis to determine a "theoretical" estimate of DU penetrator corrosion/dissolution rate. In addition, subject several new penetrators to laboratory test methods designed to validate the "theoretical" estimate. The objective will be to establish a corrosion/dissolution rate for the penetrators subject to the environmental conditions specific to JPG.	2008
2.3.5.2	*Modeling*	Geochemical speciation modeling using MINTEQA2 will be based on actual soil physical and geochemical properties and model based thermodynamic data.	2008
2.4	***Reporting***		
2.4.1	Interim Report 1	Each one of these four interim reports is a summary briefing of activities completed, results of analyses, and planned work. Each briefing will include ~100 slides and involve participation of 3 to 4 SAIC project personnel at Aberdeen Proving Ground, Maryland. These reports will serve as input to the Decommissioning Plan prepared in 2010.	2006
2.4.2	Interim Report 2	See above.	2007
2.4.3	Interim Report 3	See above.	2008
2.4.4	Interim Report 4	See above.	2009

Table 4-1. WBS Structure and Deliverables for the DU Impact Area Site Characterization Project Jefferson Proving Ground, Madison, Indiana (Continued)

WBS	WBS Title	Description	Fiscal Year (FY)
3.0	ERM Sampling		
3.1	*Event 1 (Fall FY 05)*	Based on current standard operating procedure (CHPPM 2000) and associated work plans. Includes sampling, laboratory analysis, and draft/final report (FY 05 - 09).	2005
3.2	*Event 2 (Spring FY 05)*	See above.	2005
3.3	*Event 3 (Fall FY 06)*	See above.	2006
3.4	*Event 4 (Spring FY 06)*	See above.	2006
3.5	*Event 5 (Fall FY 07)*	See above.	2007
3.6	*Event 6 (Spring FY 07)*	See above.	2007
3.7	*Event 7 (Fall FY 08)*	See above.	2008
3.8	*Event 8 (Spring FY 08)*	See above.	2008
3.9	*Event 9 (Fall FY 09)*	See above.	2009
3.10	*Event 10 (Spring FY 10)*	Sampling program based on Revised ERM Program Plan.	2010
3.11	*Recommendations for Revised ERM Program Plan*	Recommendations implemented in Event 10. Draft and final ERM Program Plan anticipated to revise the sampling program proposed in the Draft ERM Program Plan (U.S. Army 2003b).	2009
4.0	Decommissioning Plan		
4.1	*Complete Analysis and Modeling*	RESRAD modeling, sensitivity, and uncertainty analyses similar to those presented in the June 2002 Decommissioning Plan for JPG. Modeling will include site-specific data gathered during the site characterization of the DU Impact Area and be based on the updated CSM.	2010
4.2	*Prepare Decommissioning Plan*	Draft and Final Decommissioning Plan.	2010
5.0	Administrative Record	Maintenance of JPG Administrative Record with information developed during the site characterization program.	Present - 2010

4.2.1 General Requirements

The U.S. Environmental Protection Agency (EPA) and NRC recognized their mutual commitment to protect the public health and safety and the environment by entering into an MOU that continues a basic policy of EPA deferral to NRC decisionmaking in the decommissioning of NRC-licensed sites except in certain circumstances, and establishes the procedures to govern the relationship between the agencies in connection with the decommissioning of sites at which those circumstances arise (Whitman and Meserve 2002). NRC Regulations, Title 10, CFR, Part 20 – Standards For Protection Against Radiation (62 FR 39088, July 21, 1987, unless otherwise noted) include requirements for decommissioning NRC-licensed sites. This regulation includes the following subparts:

- Subpart A – General Provisions
- Subpart B – Radiation Protection Programs
- Subpart C – Occupational Dose Limits

- Subpart D – Radiation Dose Limits for Individual Members of the Public
- Subpart E – Radiological Criteria for License Termination
- Subpart F – Surveys and Monitoring
- Subpart G – Control of Exposure From External Sources in Restricted Areas
- Subpart H – Respiratory Protection and Controls to Restrict Internal Exposure in Restricted Areas
- Subpart I – Storage and Control of Licensed Material
- Subpart J – Precautionary Procedures
- Subpart K – Waste Disposal
- Subpart L – Records
- Subpart M – Reports
- Subpart N – Exemptions and Additional Requirements
- Subpart O – Enforcement.

Subpart E includes the following conditions for determining if a site will be considered acceptable for license termination under restricted release:

- The licensee can demonstrate that further reductions in residual radioactivity necessary to comply with the provisions of § 20.1402 would result in net public or environmental harm or were not being made because the residual levels associated with restricted conditions are ALARA. Determination of the levels that are ALARA must take into account consideration of any detriments, such as traffic accidents, expected to potentially result from decontamination and waste disposal.
- The licensee has made provisions for legally enforceable institutional controls that provide reasonable assurance that the total effective dose equivalent (TEDE) from residual radioactivity distinguishable from background to the average member of the critical group will not exceed 25 mrem (0.25 mSv) per year.
- The licensee has provided sufficient financial assurance to enable an independent third party, including a governmental custodian of a site, to assume and carry out responsibilities for any necessary control and maintenance of the site.
- The licensee has submitted a decommissioning plan or LTP to the Commission indicating the licensee's intent to decommission in accordance with §§ 30.36(d), 40.42(d), 50.82 (a) and (b), 70.38(d), or 72.54 of this chapter, and specifying that the licensee intends to decommission by restricting use of the site. The licensee will document in the LTP or decommissioning plan how the advice of individuals and institutions in the community who may be affected by the decommissioning has been sought and incorporated, as appropriate, following analysis of that advice.
- Residual radioactivity at the site has been reduced so that if the institutional controls were no longer in effect, there is reasonable assurance that the TEDE from residual radioactivity distinguishable from background to the average member of the critical group is as low as reasonably achievable and would not exceed either.

4.2.2 Site-specific Requirements

This section identifies agreements, consultations, and permits relating to the management of JPG, including the DU Impact Area. Table 4-2 summarizes the consultations completed in support of installation operations and BRAC closure.

Table 4-2. Consultations and Agreements Completed to Support Operations and BRAC Closure Jefferson Proving Ground, Madison, Indiana

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

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

4.2.2.1 Memorandum of Agreement

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

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

The USFWS is responsible for providing UXO, DU, and environmental contamination safety/awareness training to all personnel and visitors to the Big Oaks National Wildlife Refuge (NWR) and maintaining infrastructure elements not maintained by the USAF. The MOA includes an interim public access plan that identifies requirements and protocols for public access to the Big Oaks NWR. This plan also outlines USFWS-, Army-, and USAF-related responsibilities regarding safety briefings, entry procedures, types of public use and areas of accessibility, and monitoring and control procedures. Public use of the Big Oaks NWR is limited to hunting, fishing, wildlife observation, photography, and guided tours to selected areas north of the firing line not including the JPG DU Impact Area. The maximum one-time capacity on the refuge is limited to 423 people during deer hunting season in November. Visitors to the Big Oaks NWR must check in and check out and receive a safety briefing at the refuge office before being issued a public access permit. Public access to the refuge is controlled strictly at one gate and is limited to two areas: limited day use recreation and special controlled hunting zones. All of these recreational areas were used previously in the Army recreation program. Public use areas are delineated by maps and on signs placed at strategic locations within the Big Oaks NWR.

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

The USAF operates the Jefferson Range Operations Center within a demarcated area north of the firing line. The Jefferson Range consists of 983 acres (3.9 square kilometers) used as the primary training range, a 50-acre (0.2-square kilometer) precision-guided munitions target, and the Old Timbers Lodge and the surrounding 5 acres (0.02 square kilometers).

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

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

4.2.2.2 Section 16 Consultation

Cultural resources at JPG are addressed in the 1992 Amended BRAC preliminary assessment between the Army, Advisory Council on Historic Preservation (ACHP), and the National Conference of State Historic Preservation Officers (NCSHPO), as well as the MOA between the Army, ACHP, and the Indiana State Historic Preservation Officer (SHPO). All of the National Register of Historic Places

(NRHP)-listed or NRHP-eligible properties at JPG should be protected, preserved, or mitigated for loss if primary or secondary impact is unavoidable. The MOA indicates that properties of unknown NRHP eligibility must be considered potentially eligible and should be protected and preserved until the NRHP evaluation process is complete (SAIC 1997).

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

4.2.2.3 Other Permits

Prior to installation closure in 1995, JPG maintained various permits in support of mission operations. These permits included a Resource Conservation and Recovery Act of 1976 (RCRA) permit (Part A, "Interim," and Part B, "Application"), a National Pollutant Discharge Elimination System (NPDES) permit, a Fire Training Permit, an Open Burning/Open Detonation Permit, and an Air Permit. After installation closure, these permits were transferred or allowed to expire. Currently, there are no permits in effect at JPG (MWH 2002).

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

The U.S. Army was issued and maintains NRC license SUB-1435 pursuant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974, and 10 CFR Chapter I, Parts 30 - 40 and 70. Section 2 provides additional information on the history and status of this license.

4.3 PROJECT SCHEDULE

SAIC is proposing a tiered, time-phased approach with intermediate milestones to optimize data collection needs. While the overall project schedule is planned for 5 years, this FSP includes details only for the first 2 years. The following tables and figures present scheduling and schedule control; summarize the milestones for project deliverables; and present a detailed project schedule for planning, field investigations, ERM sampling, and the Decommissioning Plan. **Table 4-3** summarizes the major tasks planned for the next 5 years, subject to funding availability and regulatory reviews. The deliverables under the current SOW are identified in **Table 4-4**. As new task orders are issued for other tasks identified in **Table 4-4**, additional deliverables will be identified as addenda to this FSP.

Figure 4-1 identifies the project schedule and major project milestones throughout the 5-year site characterization project. Although the overall schedule for the 5-year project is presented, activities beyond the first 2 years of the project are subject to change based on assigned tasks and available funding.

Table 4-3. Summary of Major Tasks for the DU Impact Area Site Characterization Project Jefferson Proving Ground, Madison, Indiana

Fiscal Year	Major Tasks
2005	Planning Work Plan Fracture Trace Analysis
2006	Site Characterization Network Design Electrical Imaging Soils Verification Well Location Selection Initial Deer Sampling
2007	Monitoring Network Installation – Wells and Gauges Streams Cave Streams Groundwater Wells Precipitation
2008	Monitoring Network (Multi-Media) Data Collection DU Distribution In Soil (Extent and Depth and K_d Study) Corrosion Data Collection Deer/Other Biota Sampling
2009	Other Biota Sampling Recommendations Development
2010	Decommissioning Plan Development

Table 4-4. Task Order Deliverables for the DU Impact Area Site Characterization Project Jefferson Proving Ground, Madison, Indiana

Task	SOW*	Deliverable
Task 4	Work Plan Development	Draft and Final QCP, FSP, and HASP
Task 5	Fracture Trace Analysis	Final Fracture Trace Map in ArcView®
Task 6	Administrative Record	Host JPG web page for 18 months and upload electronic data formatted reports from Fiscal Year 05 - 06

* See the SOW in Appendix A of the QCP (SAIC 2005b).

Task Name	Duration	Start	Finish
WBS 1.0 Project Planning	**1466 days**	**Tue 2/1/05**	**Wed 9/15/10**
WBS 1.1 (QCP), 1.2 (FSP) and 1.3 (HASP)	**92 days**	**Fri 3/25/05**	**Mon 8/1/05**
Draft	**92 days**	**Fri 3/25/05**	**Mon 8/1/05**
SAIC Prepare	37 days	Fri 3/25/05	Mon 5/16/05
Army Review	4 days	Tue 5/17/05	Fri 5/20/05
Submission to NRC	1 day	Mon 5/23/05	Mon 5/23/05
NRC Review	30 days	Tue 5/24/05	Mon 7/4/05
Revisions	20 days	Tue 7/5/05	Mon 8/1/05
Final	0 edays	Mon 8/1/05	Mon 8/1/05
WBS 1.4 Service Provider License Application & Approval	90 days	Mon 5/2/05	Fri 9/2/05
WBS 1.5 Meetings (Quarterly)	**1304 days**	**Thu 9/15/05**	**Wed 9/15/10**
WBS 1.5 Meetings (Biweekly telecons)	**1310 days**	**Mon 9/5/05**	**Mon 9/13/10**
WBS 1.6 Progress Reports	**1456 days**	**Tue 2/1/05**	**Wed 9/1/10**
WBS 2.0 Field Investigations	**1155 days**	**Fri 3/25/05**	**Fri 8/28/09**
2.1 Biota Investigations (includes laboratory analyses)	**825 days**	**Sat 10/15/05**	**Sun 12/14/08**
WBS 2.1.1 Deer (Baseline)	60 edays	Sat 10/15/05	Wed 12/14/05
WBS 2.1.2 Deer (Optional)	60 edays	Mon 10/15/07	Fri 12/14/07
WBS 2.1.3 Biota (Baseline)	60 edays	Mon 10/15/07	Fri 12/14/07
WBS 2.1.4 Biota (Optional)	60 edays	Wed 10/15/08	Sun 12/14/08
2.2 Hydrogeology	**658 days**	**Fri 3/25/05**	**Wed 10/3/07**
WBS 2.2.1 Fracture Trace Study	70 days	Fri 3/25/05	Thu 6/30/05
WBS 2.2.2 Electrical Imaging Survey	110 edays	Mon 3/27/06	Sat 7/15/06
WBS 2.2.3 Well Location Assessment and Selection	90 edays	Sat 7/15/06	Fri 10/13/06
WBS 2.2.4 Well Installation	160 edays	Mon 4/9/07	Sun 9/16/07
WBS 2.2.5 Other Monitoring Equipment Installation	30 edays	Mon 9/3/07	Wed 10/3/07
2.3 Media Sampling and Analysis	**740 days**	**Mon 3/27/06**	**Fri 1/23/09**
WBS 2.3.1 Groundwater Sampling	**255 days**	**Mon 2/4/08**	**Fri 1/23/09**
WBS 2.3.2 Sediment/Surface Water Sampling	**255 days**	**Mon 2/4/08**	**Fri 1/23/09**
WBS 2.3.3 Other Monitoring	**255 days**	**Mon 2/4/08**	**Fri 1/23/09**
WBS 2.3.4 Soil Sampling	**710 days**	**Mon 3/27/06**	**Mon 12/15/08**
WBS 2.3.4.1 Verification	110 edays	Mon 3/27/06	Sat 7/15/06
WBS 2.3.4.2 Extent and Depth	60 edays	Thu 10/16/08	Mon 12/15/08
WBS 2.3.4.3 Kd.Corrosion Parameters (Soil Sampling)	60 edays	Thu 10/16/08	Mon 12/15/08
WBS 2.3.5 DU Penetrator Corrosion Analysis	**72 days**	**Thu 10/16/08**	**Fri 1/23/09**
WBS 2.3.5.1 Corrosion Field Measurements of DU Penetrators	60 edays	Thu 10/16/08	Mon 12/15/08
WBS 2.3.5.2 Modeling	30 days	Mon 12/15/08	Fri 1/23/09
WBS 2.4 Reporting	**785 days**	**Fri 8/25/06**	**Fri 8/28/09**
WBS 3.0 ERM Sampling	**1235 days**	**Mon 10/10/05**	**Fri 7/2/10**
WBS 3.1 to 3.10 ERM Sampling (Biannual)	**1235 days**	**Mon 10/10/05**	**Fri 7/2/10**
WBS3.11 Recommendations for Revised ERM Program Plan	30 days	Mon 1/11/10	Fri 2/19/10
WBS 4.0 Decommissioning Plan	**160 days**	**Mon 2/22/10**	**Fri 10/1/10**
WBS 4.1 Complete Analysis and Modelling	40 days	Mon 2/22/10	Fri 4/16/10
WBS 4.2 Prepare Draft and Final Decommissioning Plan	120 days	Mon 4/19/10	Fri 10/1/10

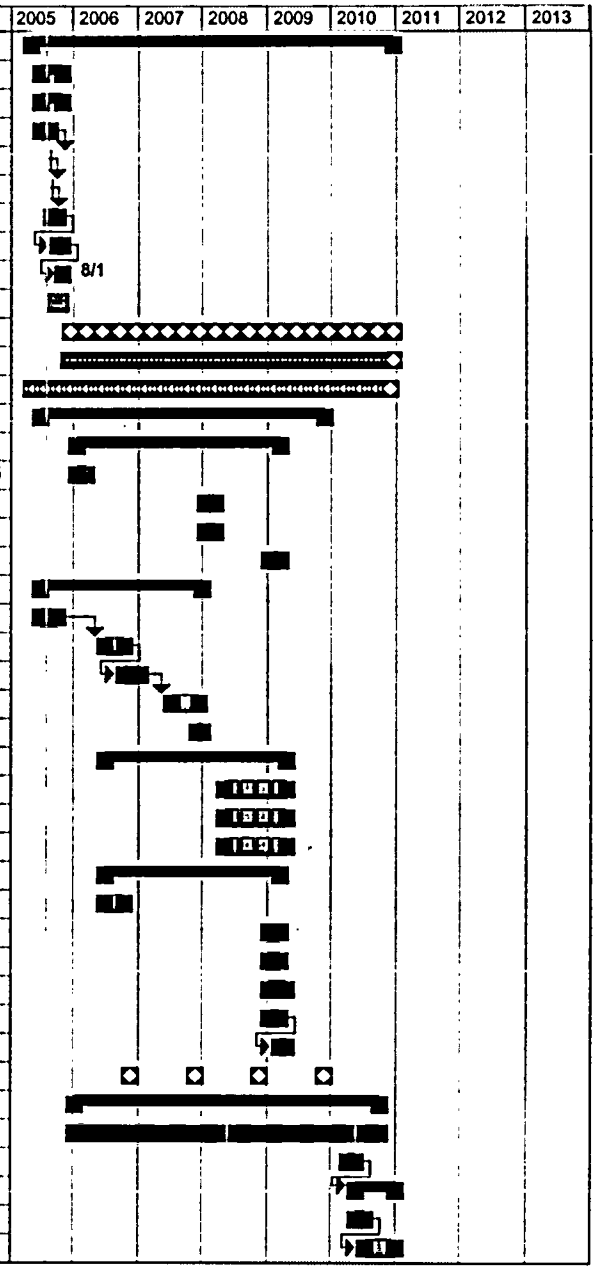


Figure 4-1. JPG DU Impact Area Site Characterization Project Schedule
Jefferson Proving Ground, Madison, Indiana

5. NONMEASUREMENT DATA ACQUISITION

Nonmeasurement data include information obtained to support the site characterization of the JPG DU Impact Area that will be obtained from databases, literature, handbooks, local planning authorities, and other specific organizations. In addition, nonmeasurement data include information collected from the site that is evaluated, but not measured using numerical standards or scales (e.g., visual evaluation of soil properties such as color).

This section discusses the acquisition and management of nonmeasurement data, including published information (Section 5.1), fracture trace analysis (Section 5.2), soil survey mapping and interpretations (Section 5.3), and onsite soil survey verification (Section 5.4).

5.1 PUBLISHED, HISTORICAL, SOIL, GEOLOGY, AND HYDROLOGY MATERIALS REVIEW

Available relative published materials consisting of geological reports, soil studies and mapping (U.S. Department of Agriculture [USDA], Soil Conservation Service [SCS]), and hydrogeological reports will be compiled and reviewed for relevant site information consisting of geology, bedrock structure, soil types, characteristics and locations, and groundwater and surface water flow information. The identification and review of this information will consist of contact with the USDA, SCS, and the U.S. Geological Survey (USGS). Included will be a visit to the USGS office in Indianapolis, Indiana, by an SAIC geologist for review and acquisition of published materials. The acquired information will be used in the planning, development, and verification of the fracture trace analysis, geophysical study, soil identification and verification, and conduit well location selection.

5.2 FRACTURE TRACE ANALYSIS

Water can be present in solid sedimentary rocks within voids. Movement of this water is trapped or generally slow unless the voids are connected. Fracturing of the bedrock (e.g., faulting, fracturing, and jointing) and enhancement of the fracture openings by dissolution of the bedrock interconnects and provides pathways (i.e., groundwater conduits) for the water to move. Groundwater will preferentially move through the network of interconnecting joints, fractures, and solution-enhanced channels. These groundwater conduits when oriented vertically also provide a pathway for migration of surface water or recharge to the bedrock aquifer. The permeability or capacity for fluid flow due to the presence of groundwater conduits is often several orders of magnitude greater than the permeability of the unaltered bedrock. Therefore, the majority of the flow through the aquifer occurs within the groundwater conduits. In order to accurately characterize groundwater flow characteristics in a fractured and solution-enhanced (karst) aquifer, these groundwater conduits need to be identified and targeted for the installation of monitoring wells.

SAIC will obtain stereo-paired historical aerial photographs from the U.S. National Archives for the study area, showing the site prior to construction of JPG and the DU testing range. Using the aerial photographs, a fracture trace analysis of the DU penetrator testing range and the immediate area will be conducted. Bedrock fracture locations and orientations are often able to be interpreted from linear or semi-linear features, which represent surface fracture traces visible in aerial photographs. Identified fracture traces will be mapped, given a quality ranking, and the fracture trace lines will be transferred to an ArcView® shape file, which can be presented overlain on a variety of base maps (e.g., USGS topographic maps, aerial photographs, site maps).

If available, the fracture trace work that was completed previously by the USGS and presented in the USGS Open File Report 81-1120 (Greeman 1981) will be reviewed and incorporated, to the extent possible, with the mapping conducted by SAIC. The USGS fracture trace study was conducted over a large area that included JPG, but was not specific to JPG or the DU penetrator testing range area; therefore, the results of the USGS study may be of limited use or relevance.

Following the completion of the fracture trace analysis and review of the published geological reports and USGS fracture trace analysis, an SAIC geologist will conduct a site walkover to field verify and evaluate the completed aerial photography analysis. The site walkover will be completed in one field day and the SAIC geologist will be escorted by a designated project EOD technician while north of the firing line. The completed fracture trace analysis will be used to further refine the areas or lines that will be completed as part of the geophysical investigation.

5.3 SOIL SURVEY MAPPING AND INTERPRETATIONS

The original purpose of the soil survey maps was to support agricultural uses of the land, but more recently, interpretations for other land uses are more common. The soil survey maps indicate areas of a similar soil body on the landscape that has a defined range of physical and chemical properties associated with the main soil series (soil type). These areas may have distinct boundaries on the landscape, such as an abrupt change in topography, or may be diffused with a gradational boundary between two or more soil mapping units.

Typical soil survey maps prepared by the National Cooperative Soil Survey (NCSS) are classified as Order 2 to Order 3, with a minimum soil mapping delineation area of approximately 1.4 to 10 acres (0.6 to 4.1 hectares). The size of these mapping units often includes areas of similar or contrasting soil types that may not be identified on the scale of the maps. These soil inclusions are recognized in the soil surveys in the discussion of the soil mapping unit properties; however, any particular site may include varying size areas and types of different soils.

In order to provide accurate interpretations of the site based on soil characteristics, the variability of the soils, both spatially and across the landscape and vertically through different soil horizons (layers), must be recognized and considered in any sampling plan and/or modeling of contaminant mobility. The range of physical, chemical, and biological properties associated with each soil type should be defined as detailed as possible and practical. Therefore, onsite verification of the soil mapping units is proposed to confirm the soil characteristics related to the mapped soils, as well as any inclusions of similar or contrasting soil types, that need to be considered in interpretations on the site.

5.4 ONSITE SOIL SURVEY VERIFICATION

In order to verify the onsite soil characteristics, along with the associated soil properties, the existing soil survey information will be reviewed and all of the soil series (types) will be identified with their range in characteristics. This would include all of the geographically associated soil series.

Different soils will have different soil properties that can influence water and contaminant migration through the soil and include:

- Physical properties include migration of water and contaminants based on soil structure, texture, consistence, pore sizes, and tortuosity.
- Chemical properties include chemical reactions and interactions affecting the mobility of such parameters as contaminants, pH, corrosivity, and dissolution rates.
- Any significant biological activities and processes associated with the site.

A list of physical and chemical criteria that can be recognized using limited field observations via hand-auger borings will be identified and compiled for the different soil series. Anticipated field characteristics include color, texture (to a relative degree), thickness of horizons or surface soil/loess characteristics, depth to glacial deposits (if encountered), and effervescence related to carbonate materials.

The site will be reviewed to identify appropriate transects across the site typically perpendicular to contours or topographic changes. Soil series will generally change at topographic discontinuities in the landscape. Soil mapping units also will follow topographic changes.

To view the soil characteristics, SAIC will conduct willow (up to 3 feet deep) hand-auger borings along transects to identify the field characteristics in order to confirm or identify the soil series. A review of the field confirmation of the soil survey mapping will result in a revised soil survey map for the site.

The soil survey map is anticipated to provide directions for any additional sampling and interpretations regarding the mobility of contaminants onsite. The range in soil properties associated with each soil type can be evaluated independently. Data points can be selected on the basis of the soil mapping units minimizing special variability across the landscape and to obtain statistically valid interpretations. Similarly, different soil mapping units can be used in site models, such as the RESRAD model (Yu et al. 2001) that is proposed for use at this site.

In summary, SAIC proposes to review and confirm the soil mapping for the site using published soil survey information and interpretations, along with a limited field hand-auger borings, to confirm soil characteristics and mapping units in order to provide a more accurate mapping of the site for use in modeling and/or additional sample analyses.

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6. FIELD ACTIVITIES

This section describes the field investigation activities for the characterization of DU in the JPG DU Impact Area. The field activities will be conducted using guidance such as USACE, NRC, and EPA. The standard operating procedures (SOPs) referenced in the following sections are included in appendices, as noted. The following sections are consistent with the requirements specified in Engineer Manual (EM) 200-1-3 (USAEC 2001) except that the media have been organized according to the scheduled activities occurring over the next 5 years.

As stated previously, this FSP includes details only for the first 2 years of the overall project schedule that is planned for 5 years. Details for the latter 3 years will be provided in addenda to this FSP. **Table 6-1** summarizes the characterization activities by fiscal year according to the applicable section of this document.

Table 6-1. Summary of Work Plan Activities by FSP Section Jefferson Proving Ground, Madison, Indiana

Fiscal Year	Activity	FSP Section
2005	Work Plan	Entire FSP
	Fracture Trace Analysis	5.2
2006	Electrical Imaging	6.1
	Soils Verification	5.4
	Well Location Selection	6.2
	Initial Deer Sampling	6.3
2007	Monitoring Network Installation	
	Streams	6.4
	Cave Streams	6.4
	Groundwater Wells	6.2
	Precipitation	6.4
2008	Monitoring Network (Multi-Media) Data Collection	6.4
	Streams	6.4
	Cave Streams	6.4
	Groundwater Wells	6.2
	Precipitation	6.4
	DU Distribution in Soil	
	Extent and Depth – Soil	6.5
	Extent and Depth – Sediment	6.6
	K_d Study	6.7
	Corrosion and Dissolution Data Collection	6.8
	Deer/Other Biota Sampling	6.3
2009	Other Biota Sampling	6.3
	Recommendations Development	NA
	Decommissioning Plan Development	NA

NA – not applicable

6.1 GEOPHYSICS (ELECTRICAL IMAGING)

Fracture trace analysis identifies the locations of potential preferential pathways or groundwater conduits (e.g., fractures, voids). EI conducted across previously identified fracture traces from fracture trace analysis will be used to refine the locations of the potential preferred groundwater flow pathways and to further characterize the subsurface features.

The final design, location, and orientation of the geophysical (EI) investigation lines will not be completed until the fracture trace analysis has been completed. The fracture trace analysis will identify possible areas of preferential flow pathways (groundwater conduits) that will be further investigated or verified with the EI study. The results from the fracture trace analysis and the EI study will be used in combination to further enhance the identification or verification of the locations of preferential flow pathways and the selection of the monitoring well drilling locations. Potential well sites will be selected where fracture traces and geophysical anomalies coincide, indicating the presence of a potential preferential flow pathway.

6.1.1 Rationale, Method, Study Area Definition, and Measurement Spacing

EI is a geophysical technique, which measures the electrical properties of the subsurface. EI involves measuring the resistivity of the earth along a series of profiles. Electrodes are planted in the earth with their separation being increased with successive measurements. Increasing electrode separation enables measurements of greater depth. Length of profile, depth of penetration, and resolution determine the electrode spacing, which can be anywhere from 3.3 feet to 164 feet (1 to 50 meters) or more. Resistivity measurements are made by placing a known current (measured in milli-amps) into the ground using two electrodes. The resulting potential (measured in milli-volts) is measured between two other electrodes. By changing relative spacing or locations between the potential and current electrodes, different resistivity measurements can be made using different electrode array configurations. Common arrays include Wenner, Schlumberger, and dipole-dipole.

The final design, location, and orientation of the geophysical investigation lines will not be completed until the fracture trace analysis has been completed.

Approximately 39,000 feet (11,887 meters) of traverse will be conducted with the EI, geophysical method. Areas to be tested are along Morgan Road, Center Recovery Road, and D Road. Another candidate area for an east-west oriented traverse is along C Road along the southern side of the DU penetrator impact area. Survey coordinates will be collected every fourth electrode of the EI traverse using global positioning system (GPS) equipment to an accuracy of 3.3 feet (1 meter).

6.1.2 Field Procedures

Sections 6.1.2.1 through 6.1.2.7 describe the field procedures and procedures for analyzing information obtained during the EI.

6.1.2.1 Equipment

In conducting the EI survey, SAIC will follow SAIC geophysical procedure *GP-011 Electrical Imaging Surveys* (Appendix B). SAIC will propose to use 84-, 96-, or 112-electrode arrays and a dipole-dipole array configuration. The data will be collected anticipating using a spacing of 13.1 feet (4 meters). The maximum depth of investigation is anticipated to be approximately 150 feet (45.7 meters); however, actual site conditions will determine the depth of investigation. EI base survey parameters will be optimized, given site conditions and electrical properties of the subsurface, to sufficiently attain the target depth of 150 feet (45.7 meters). Electrode rolls from the beginning end of the traverse to the end of the traverse will facilitate adequate coverage along the entire traverse distance.

The survey will utilize a SuperSting® automatic, multi-electrode system. At the present time, this unit represents the leading edge of current resistivity technology. The equipment has higher power, lower electrical signal-to-noise ratio, and collects data much faster than other similar systems. The data will be downloaded to a field computer for field evaluation and preliminary analysis. The locations of each traverse will be marked in the field with paint and/or labeled stakes on the ground surface for future reference.

6.1.2.2 Preliminary Method Testing and Early Termination Procedures

The data will be downloaded to a field computer for field evaluation and preliminary analysis. The field evaluation may recommend adjustment of acquisition parameters, or termination of the survey. This important data monitoring step will ensure an adequate data set for comprehensive analysis and evaluation.

6.1.2.3 Instrument Calibration and QC Procedures

In conducting the EI survey, SAIC will follow SAIC geophysical procedure *GP-011 Electrical Imaging Surveys* (Appendix B). Calibration and use of the instruments will be in accordance with the manufacturer's instructions. Calibration checks will be conducted daily to verify the equipment is functioning properly.

Once the cable setup is complete, the EI operator will check the SuperSting® for adequate function (calibration). This is completed by attaching a test box to the SuperSting® (while the cables are not connected), using a small current input, and completing a test box survey. This survey is a 10-minute test that checks the measurement components of the SuperSting® main unit. This test is recorded digitally within the main unit and is identified with a file name denoted as "test__" with "__" being the site survey identifier. The test file will be downloaded to a field personal computer (PC) at the end of the field day.

Following download, the SAIC Field Supervisor will conduct a preliminary inversion of the data to ensure the collected data are reasonable. At a minimum, this preliminary inversion should be performed daily.

The EI data will be checked for QA purposes and will be preliminarily processed during the field effort. The locations of all significant preliminary anomalies identified on the color cross-sections will be checked against the SuperSting® Field Data Sheet information and preliminary inversions; any indications of surface features that could contribute to the anomaly, may be identified.

6.1.2.4 Field Progress/Interpretation Reporting

The data will be downloaded to a field PC for evaluation and preliminary analysis in the field. The field evaluation may recommend adjustment of acquisition parameters, or termination of the survey.

6.1.2.5 Measurement Point/Grid Surveying

SAIC will utilize a digital global positioning system (DGPS) unit to identify the location of each traverse. The DGPS unit will provide sub-meter accuracy in locating the position of the traverses. SAIC will use the DGPS to identify prominent site features in order to present a reasonable and accurate base map of the geophysical survey.

6.1.2.6 Data Processing

Interpretation of the raw apparent resistivity data without modeling or inversion will result in a qualitative product that is affected by a large volume of subsurface area. Inversion or modeling of the data discrete subsurface segments, called model blocks, will provide modeled resistivity values that are more discrete. This discrete modeled resistivity leads to a more-quantitative interpretation of the data. The inversion of the data also will correct for effects of topography changes, which can cause misleading interpretations of the raw apparent resistivity data from the dipole-dipole data set. SAIC will utilize the resistivity inversion program RES2DINV (Geomoto Software 2004) to produce true resistivity models based on the apparent resistivity data.

During data analysis, SAIC will examine the apparent resistivity data for spurious values and remove invalid data caused by noise, cultural interference, or poor ground contact by the electrode. SAIC will examine the model block sensitivity to evaluate an appropriate depth of investigation based upon the electrical signal to noise ratio and model sensitivity to modeled variations in resistivity.

The modeled data will be imported into Surfer® for contouring, interpretation annotation, and presentation. Surfer® provides SAIC with a robust data contouring management tool that permits presentation of the modeled resistivities. This approach allows SAIC to emphasize subsurface features in the data while de-emphasizing residual information from the physical measurements or from the modeling process.

6.1.2.7 Potential Interpretation Techniques

Following data collection and inversion modeling, the EI electrostratigraphy information will be used to interpret the gross stratigraphy along the survey traverses. Dry materials have higher resistivity than similar wet materials because moisture increases their ability to conduct electricity. The resistivity difference between dry and wet material, if indicated in the observed electrostratigraphy, can represent water table depths. Beneath the water table and below the average bedrock depth, higher conductivity zones are indicative of karst solution channels.

6.2 GROUNDWATER

At the conclusion of the fracture trace analysis and EI study, SAIC will propose locations for the installation of test conduit wells. For planning purposes, it was estimated that 10 to 20 well pairs will be installed based on the results of the fracture trace analysis and EI study. The proposed locations will be field checked and ranked by the strength of the data. Monitoring well locations will be designated in areas most likely to be conduits of groundwater flow based on:

- The locations of fracture traces as determined by the aerial photography analysis
- Indications that specific fracture traces are discharging groundwater to surface water, to the extent that that information is made available
- Areas along EI traverses that indicate greater depth to bedrock and zones of weathered bedrock
- Areas identified during the EI survey as potential karst conduits.

The locations of monitoring wells will be staked in the field based on the position of the fracture trace and with reference to the surveyed endpoints of the EI traverse.

The anticipated depths of the conduit monitoring wells will be estimated following the fracture trace analysis and the EI study. The EI study results will assist in estimating the anticipated depths by providing information on the size and type of conduit feature. For estimating purposes, the total depths were assumed to be approximately 50 and 120 feet (15.2 to 36.6 meters) for each well pair. The individual wells within each pair will be located approximately 10 to 20 feet (3.0 to 6.1 meters) apart. The EI study results will most likely produce additional information that will assist in the estimation of proposed well depths. The final depths of each well will be determined from the observations of the subsurface conditions as determined by the rig geologist during drilling. The rig geologist will be in contact with the project hydrogeologist and the final decision on the well total depths and screen intervals will be made with concurrence from the project hydrogeologist.

6.2.1 Rationale, Sample Collection, and Field and Laboratory Analysis

Following the installation of the new conduit wells, a plan will be developed for the collection of groundwater samples. Onsite and offsite human and ecological receptors could be impacted by DU leaching through soil to the underlying aquifer. Contaminated groundwater can enter the human or ecological food chain indirectly (e.g., livestock drinking water) or directly (e.g., drinking water supply). Direct exposure of humans to drinking water is unlikely given that the aquifer is not a drinking water source and is of poor quality (Montgomery Watson Harza 2002).

Groundwater samples will be collected to determine if DU is migrating from the DU Impact Area into the groundwater and if the migration of DU is occurring with groundwater movement. The existing 19 wells (U.S. Army 2000a and CHPPM 2003) and the new conduit wells all will be considered for collection of groundwater samples. Variables that will be considered while deciding upon the wells and sample collection methods will consist of, but not be limited to, the following: integrity of well, location, connection to aquifer, connection or relative position with respect to preferential flow pathways, construction, well yields, and well screen (i.e., overburden versus bedrock). The final well selection may include a combination of the newly installed conduit wells and existing wells. The proposed groundwater sampling plan will consist of, at a minimum, quarterly sampling for a period of 1 year. The number of locations from which groundwater samples will be collected will be determined following the installation of the new conduit wells and based partially on the final number of new conduit well pairs that are installed. The final well selection will be documented in an addendum to this FSP.

6.2.2 Groundwater Stage Monitoring

In order to evaluate groundwater flow potentials, groundwater elevation fluctuations, and response to precipitation events, groundwater elevation recorders will be installed into select monitoring wells. It is assumed that six recorders will be installed.

When installation of the new conduit wells is complete, the new and existing wells will be evaluated and six wells will be selected for installation of continuous electronic data recorders. The wells selected for electronic stage monitoring could consist of a mixture of existing wells and conduit wells. The recorders will be operated for a minimum of one hydrologic year and will be downloaded quarterly. In addition to downloading the data recorders quarterly, a complete synoptic round of water levels will be collected from all of the wells including the 11 DU program wells (U.S. Army 2000a), 8 Range Study wells (CHPPM 2003), and the conduit wells at each event. The well selected for stage monitoring will be documented in an addendum to this FSP.

6.2.3 Upgradient, QA/QC, and Blank Samples and Frequency

Included within the final well selection will be the location(s) of upgradient well(s) to establish background levels of naturally occurring uranium in groundwater. The locations selected as upgradient well(s) will be documented in an addendum to this FSP.

Section 8.4 and Appendix A describe the requirements for collecting QC samples.

6.2.4 Monitoring Well Installation

Conduit monitoring well pairs will be installed as part of this scope will be 4-inch (10 centimeters), schedule 40 polyvinyl chloride (PVC) wells with 10-foot (3.0 meters) screen lengths and standard above grade completions. Specifications for drilling, installation, completion, and development of the conduit monitoring wells are contained in the following subsections.

6.2.4.1 Drilling Methods and Equipment

Monitoring wells will be drilled and installed in bedrock. It is anticipated that the wells will be installed using air rotary drilling techniques and an ODEX® or similar system for advancing the outer casing, but the appropriate drilling method/technique will be determined after additional information on the subsurface conditions is reviewed as a result of the EI study. Estimated well installation depths range from 50 to 120 feet (15.2 to 36.6 meters) and the top of bedrock is anticipated to be as shallow as 20 feet (6.1 meters) BGS. Permanent outer casing will be advanced through the unconsolidated materials above the bedrock and several feet into competent bedrock to prevent unconsolidated materials, weathered rock, and flowing or fluid materials from entering the borehole from the unconsolidated overburden during well installation activities. Soil and rock cuttings will be logged by the rig geologist from the materials returned to the surface by the air rotary drilling rig. Soil and rock cuttings and discharged groundwater from borehole advancement and well construction activities will be managed in accordance with the procedures specified in Section 9. Well screens will be placed across highly fractured rock zones and/or encountered voids below the water table to intercept possible conduits or preferred groundwater flow paths.

Equipment Condition and Cleaning

All drilling and support equipment used for monitoring well installation during performance of this scope will be in operable condition and free of leaks in the hydraulic, lubrication, fuel, and other fluid systems where fluid leakage would or could be detrimental to the project effort. All switches (including two functioning safety switches); gauges; and other electrical, mechanical, pneumatic, and hydraulic systems will be in safe and operable condition before arrival and during operation. The Drill Rig Operational Checklist presented in **Figure 6-1** will be completed before commencement of drilling at each monitoring well borehole location, typically once per week.

All drilling equipment will be cleaned with steam or pressurized hot water before arriving onsite. After arrival, but before commencement of drilling activities, all drilling equipment will be cleaned with steam or pressurized hot water using an approved water source at a decontamination pad.

Similar decontamination procedures will be conducted upon completion of each monitoring well borehole. However, only equipment used or soiled during the drilling at each borehole location will undergo decontamination.

The temporary decontamination pad to be used for equipment cleaning will be located, to the greatest extent possible, in an area surficially cross-gradient or down-gradient from the monitoring well borehole locations. The pad will be constructed in a manner to allow for containment and collection of decontamination solid and liquid wastes and to minimize loss of overspray water during decontamination activities. Solid and liquid wastes generated from the decontamination process (IDW) will be managed in accordance with procedures specified in Section 9.

6.2.4.2 Materials

The following discussion regarding materials to be used for construction of conduit monitoring wells will be 4 inches (10 centimeters) in diameter. General details regarding the installation of the wells are presented in Section 6.2.4.3 and final well construction details will be determined after additional information on the subsurface conditions are reviewed as a result of the EI study.

Site Name: ____________________

Rig Model: ____________________ Manufacturer: ____________________

Serial Number: ____________________ Rig Owner: ____________________

Inspection Performed by: ____

(Driller's Signature) (Date)

Checklist Reviewed and Emergency Shutdown Observed by: ____

(Signature) (Date)

Place an X in each appropriate ( )

1.0 GENERAL

1.1 Check all safety devices which are part of drill rig and which can be verified (see note). Is (are all) device(s) intact and operating as designed?

Emergency Interrupt System

A.	Kill Switch 1	Yes ( ) No ( ) NA ( )
B.	Kill Switch 2	Yes ( ) No ( ) NA ( )
C.	Kill Switch 3	Yes ( ) No ( ) NA ( )
D.	Kill Switch 4	Yes ( ) No ( ) NA ( )
E.	Kill Switch 5	Yes ( ) No ( ) NA ( )
F.	Other ____________	Yes ( ) No ( ) NA ( )
G.	Other ____________	Yes ( ) No ( ) NA ( )
H.	Other ____________	Yes ( ) No ( ) NA ( )

Note: All safety devices (not otherwise listed in this checklist) should be identified for each drill rig at the beginning of each project and subsequently checked at each inspection. Testing of all safety devices must be observed by health and safety personnel. List only safety devices which can be checked without disassembly or without rendering the device ineffective. This checklist does not cover United States Department of Transportation requirements.

1.2	Is the proper type and capacity of fire extinguisher(s) present, properly charged, and inspected?	Yes ( ) No ( ) NA ( )
1.3	Is rig properly grounded?	Yes ( ) No ( ) NA ( )
1.4	Are rig and mast a safe distance from electrical lines?	Yes ( ) No ( ) NA ( )
1.5	Can mast be raised without encountering overhead obstructions?	Yes ( ) No ( ) NA ( )
1.6	Have spill prevention materials been placed under rig (i.e., plastic sheeting)?	Yes ( ) No ( ) NA ( )

Figure 6-1. Drill Rig Operational Checklist

1.7	Is a spill kit present?	Yes ( ) No ( ) NA ( )
1.8	Is the safe operating zone/exclusion zone posted (minimum radius at least equal to height of raised drill mast)?	Yes ( ) No ( ) NA ( )
1.9	Do all modifications made to the drill rig permit it to operate in a safe manner and allow the drill to operate within the manufacturer's specifications?	Yes ( ) No ( ) NA ( )
1.10	Are moving parts (excluding cathead and other moving parts normally used during operations) properly guarded?	Yes ( ) No ( ) NA ( )
1.11	Are all exhaust pipes, which would come in contact with personnel during normal operation properly guarded?	Yes ( ) No ( ) NA ( )
1.12	Are tank(s) and lines free of leakage?	Yes ( ) No ( ) NA ( )
1.13	Are all normal or manufacturer-recommended maintenance activities or schedules performed at the required frequency?	Yes ( ) No ( ) NA ( )
1.14	Are walking and standing surfaces, steps, rungs, etc., free of excess grease, oil, or mud which could create a hazard?	Yes ( ) No ( ) NA ( )
2.0	**CONTROL MECHANISMS**	
	Are all control mechanisms and gauges on the drill rig functional and free of oil, grease, and ice (checked while running)?	Yes ( ) No ( ) NA ( )
3.0	**HYDRAULICS AND PNEUMATICS**	
	Note: The mast should be lowered during the completion of this section to allow inspection of portions of the lifting mechanisms normally out of reach during operation.	
3.1	Do all hydraulic reservoirs exhibit proper fluid levels?	Yes ( ) No ( ) NA ( )
3.2	Are hydraulic and/or pneumatic systems in good condition and functioning correctly (checked while running)?	Yes ( ) No ( ) NA ( )
4.0	**LIFTING MECHANISMS**	
	Note: The mast should be lowered during the completion of this section to allow inspection of portions of the lifting mechanisms normally out of reach during operation.	
4.1	Have all wires, ropes, cables, and lines that are kinked, worn, corroded, cracked, bent, crushed, frayed, stretched, birdcaged, or otherwise damaged been replaced and the defective equipment removed from the site?	Yes ( ) No ( ) NA ( )
4.2	Have all wires, ropes, cables, and lines been wrapped around winch drums without excessive pinching or binding?	Yes ( ) No ( ) NA ( )
4.3	Are all pulleys undamaged and functional?	Yes ( ) No ( ) NA ( )
4.4	Are all clips, clamps, clevises, hooks, and other hardware used to rig wires, ropes, cables, or lines undamaged and attached properly?	Yes ( ) No ( ) NA ( )

Figure 6-1. Drill Rig Operational Checklist (Continued)

4.5 Do all eyes formed in wires, ropes, cables, or lines attached to the rig use a thimble to retain the shape of the eye? Yes ( ) No ( ) NA ( )

4.6 Do all hooks having functioning safety gates/latches? Yes ( ) No ( ) NA ( )

5.0 NONCONFORMING ITEMS

5.1 When did the last operation checklist inspection take place for this drill rig at this site?

Date: ____________________

5.2 Have any nonconforming items been carried over from the last inspection? List any such items and dates or original nonconformance.

A. ____

Date: ____________________

B. ____

Date: ____________________

C. ____

Date: ____________________

D. ____

Date: ____________________

Any nonconforming items must be documented in the following remarks section and reported to the field operations manager for the project prior to operating the drill ring. Reference all remarks to the item numbers noted above.

Remarks:

____

____

____

____

Figure 6-1. Drill Rig Operational Checklist (Continued)

Casing/Screen/Centralizers

Final well construction materials selection and design will be completed following the review of additional information on the subsurface conditions as a result of the EI study. Generally, the casing, screen, and fitting materials will be composed of new, pre-cleaned, 4-inch (10.6-centimeter) schedule 40 PVC. Screen sections are anticipated to be commercially fabricated and slotted with openings equal to 0.010 inches (0.025 centimeters). Screen and casing sections will be flush threaded, and thermal or solvent welded couplings will not be used. Pop rivets and screws also will not be used during monitoring well construction. Pre-packed or u-pack screens will be used for intervals that can not be filter packed conventionally.

The well caps and centralizers to be used will be composed of new, pre-cleaned PVC. It is assumed that all wells will be completed with above-grade surface completions. The tops of the wells will be covered with slip caps or expandable plugs.

If deemed necessary, well centralizers will be used for construction of monitoring wells that are installed in open boreholes. They will be attached to well casings with stainless steel fasteners or strapping. The placement of centralizers will be determined in the field at the time of monitoring well installation based on total depth of well, borehole conditions, and well construction specifics. Centralizers will not be attached to the screen or any part of the well casings exposed to filter pack materials or bentonite seal. Centralizers, if used, will be oriented to allow for unrestricted passage of tremie pipes used for placement of well materials.

Filter Pack, Bentonite Seal, and Cement/Bentonite Grout

Final well construction materials selection and design will be completed following the review of additional information on the subsurface conditions as a result of the EI study and the actual observed subsurface conditions encountered during drilling. It is anticipated that based on the screen slot size of 0.010 inches (0.025 centimeters) to be used, the granular filter pack material will consist of Morie No. 1 pack or equivalent. The granular filter pack will be visually clean, free of material that would pass through a No. 200 mesh sieve, inert, siliceous, and composed of rounded grains. The filter material will be packaged by the supplier in bags or buckets.

Bentonite is anticipated to be used for one or more of the following purposes:

- Creation of an annular seal between the lower granular filter pack and the upper grout seal during monitoring well installation
- Additive in grout mixture used for creation of upper grout seal during monitoring well construction
- Additive in grout mixture used for abandonment of boreholes not converted into monitoring wells.

Bentonite material used will consist of compressed powdered bentonite pellets or chips generally measuring ¼- or ⅜-inch (0.64 to 0.95 centimeters) in size and will be used for annular seal applications. Powdered bentonite will be used for grout additive applications.

Grout used will be composed of Type I Portland cement, approximately 6 pounds (2.7 kilograms) dry-weight bentonite per 94-pound (42.6 kilograms) sack of dry Portland cement, and a maximum of 6 to 7 gallons (22.7 to 26.5 liters) of approved water per sack of cement. The amount of water used to prepare grout mixtures will be minimized to the greatest extent possible.

All grout materials will be combined in an above-ground, rigid container or mixer and mechanically blended onsite to produce a thick, lump free mixture throughout the mixing vessel. The grout will be placed using a tremie pipe of rigid construction for vertical control of pipe placement. The tremie pipe will be equipped with side discharge holes rather than an open end to help maintain the integrity of the underlying material onto which the grout is placed.

Surface Completion

The well protection assembly will be composed of new iron/steel protective casing. If it is determined that construction details require that permanent casing used for advancement of the borehole through the overburden needs to be left in place, the permanent casing can be used as the protective casing. All of the monitoring wells will be constructed with above grade surface completions. All protective casings will be equipped with locking covers and constructed to minimize the possibility of water leakage. The surface completions will be surrounded by a minimum of three new iron/steel guard posts filled with concrete to help in location and avoidance.

Water Source

Water will be used for the following purposes:

- Preparation of grout mixtures used for monitoring well construction and borehole abandonment
- Preparation of concrete mixture for construction of monitoring well surface completion
- Use for lubricating drill tools and facilitating movement of soil and rock cutting up and out of the borehole
- Decontamination of drilling and sampling equipment.

Evaluation of the water source will be accomplished by collecting a sample from each water source before starting field activities. The water sample will be submitted to the contracted laboratory for analysis of DU. The water source will be used only if the results indicate that the source is free from contaminants.

In the event an approved water supply is available and analytical documentation is available to document its suitability, this water source may be used without additional analysis.

The water source will be approved by the U.S. Army Project Manager before field activities commence. Field personnel will be responsible for transport and storage of the approved water in a manner to avoid the chemical contamination or degradation of the approved water once obtained.

Delivery, Storage, and Handling of Materials

All monitoring well construction materials will be supplied and delivered to the site by the subcontracted drilling company retained for the investigation. Upon delivery to the site, the Field Manager will inspect all of the materials to ensure that the required types of materials have been delivered and that the materials have not been damaged or contaminated during transport to the site. During the inspection the Field Manager will collect and file any material certification documentation attached to or accompanying the materials. All material certification documentation will be transferred to the project file. All materials will be stored in a dry and secure location until used. It is assumed that the Army will provide a storage/staging area for the well materials at JPG.

All well screens and well casings will be free of foreign matter (e.g., adhesive tape, labels, soil, grease) and will be washed with approved water before use. However, if the materials have been packaged by the manufacturer and the packaging is intact up to the time of installation, no pre-washing will be conducted. Pipe nomenclature stamped or stenciled directly on the well screens and/or solid casings to be located below the bentonite seal will be removed by sanding, unless removable by washing with approved water washing. Washed screens will be stored in plastic sheeting until immediately before insertion into the borehole. All well screens and casings will be free of unsecured couplings, ruptures, and other physical breakage and/or defects.

All protective casings will be free of extraneous openings and devoid of any asphaltic, bituminous encrusting, and/or coating materials (with the exception of black paint or primer applied by the manufacturer).

6.2.4.3 Installation

Monitoring wells installed as part of this investigation are anticipated to be constructed of above-grade installations. The wells are all anticipated to be constructed in bedrock and final well construction materials selection and design will be completed following the review of additional information on the subsurface conditions as a result of the EI study and the actual observed subsurface conditions encountered during drilling. A discussion of the anticipated installation process is presented below.

Test Holes

No test holes are anticipated at this time to be required prior to the installation of the conduit monitoring wells.

Soil Sampling and Rock Coring During Drilling

At this time, no soil sampling or rock coring activities are anticipated to be required during the installation of the conduit well installation activities. Section 6.5 discusses the field procedures associated with soil sampling.

Geophysical Logging

At this time, it is not anticipated that geophysical borehole logging will be required during the installation of the conduit wells.

Borehole Diameter and Depth

All of the wells are anticipated to be constructed in bedrock. Final well construction materials selection and design will be completed following the review of additional information on the subsurface conditions as a result of the EI study and the actual observed subsurface conditions encountered during drilling. It is anticipated that the conduit monitoring wells will be constructed using 4-inch (10.2-centimeter) PVC casing and screen, with the possibility of using pre-pack or U-pack screens. For monitoring wells of this diameter and construction materials it is anticipated that the boreholes will be advanced using an 8- or 9-inch (20- to 23-centimeter) diameter air rotary casing advancement system. This will allow adequate annulus between well construction materials and the borehole wall for placement of filter pack and sealing materials.

The depths of the wells will be determined based on EI results and subsurface conditions observed by the rig geologist during borehole advancement. It is anticipated that for each conduit well pair, two boreholes will be advanced separately and will have total depths of approximately 50 and 120 feet (15.2 and 36.6 meters) BGS. The anticipated depths will be determined partially based on targets as a result of the EI and fracture trace studies. Final depths will be determined by the conditions observed by the rig geologist during the borehole advance. If sufficient water to support a functional monitoring well is found to be present in the borehole, a monitoring well will be constructed. However, if insufficient groundwater is found to be present, the borehole will be abandoned unless additional drilling is authorized by the U.S. Army Project Manager.

Screen and Well Casing Placement

All screens will be installed such that the bottom of each well is placed no more than 3 feet (0.91 meters) above the bottom of the drilled borehole, unless the portion of the borehole greater than 3 feet (0.91 meters) below the screen is properly abandoned. The screen bottom will be securely fitted with a threaded PVC cap or plug. The cap/plug will be within 6 inches (15 centimeters) of the open portion of the screen. The standard length of the screen is anticipated to be 10 feet (3.0 meters). The casing used for the construction of above-grade well installations will be of sufficient length to allow for 2.5 feet (0.76 meters) of the casing to extend above the ground surface. The top of each installed well casing will be level so that the difference in elevation between the highest and lowest points on the top of the well casing is less than or equal to 0.2 inches (0.5 centimeters).

Filter Pack Placement

The granular filter pack will be placed within the annular space around the monitoring well screen by slowly pouring in from the surface. The sand pack will be monitored continually to ensure that the sand pack materials do not bridge and that the filter pack is placed without gaps or voids. After the sand pack is placed, a surge block will be placed inside the well and the filter pack will be surged to settle and seat the filter pack. The filter pack levels will be checked following the surging and if settling has occurred, additional sand pack will be added. The filter pack will extend from the bottom of the borehole to 3 to 5 feet (0.9 to 1.5 meters) above the top of the screen. The final depth of the top of the filter pack will be measured directly with a weighted tape and recorded.

If a pre-pack or U-pack is used, the filter pack either will be installed by the manufacturer or the U-pack will be filled with the specified filter pack material prior to placement into the borehole. The filter pack placed in the U-pack will be flushed with approved water for settling and seating the filter pack and additional filter pack materials will be added if settling occurs.

Bentonite Seal

The bentonite seal will be composed of commercially available pellets or chips. The bentonite seals will be from 3 to 5 feet (0.9 to 1.5 meters) thick as measured immediately after placement, without allowance for swelling. The bentonite materials will be placed in a manner to ensure that bridging does not occur. If pre-pack or U-pack screens are used, a shale catcher or grout basket will be placed above the screen and the seal will be suspended on the catcher.

A weighted tape will be used to measure and monitor the placement of the bentonite seal. If the bentonite seal is above the depth to groundwater, a small volume of approved water will be used to hydrate the pellets and the minimum hydration time for the pellets will be 1 hour. The final depth to the top of the bentonite seal will be measured directly with a weighted tape and recorded.

Cement/Bentonite Grout Placement

All grout materials will be combined in an above-ground, rigid container or mixer and mechanically blended onsite to produce a thick, lump-free mixture throughout the mixing vessel. The grout will be placed using a tremie pipe of rigid construction for vertical control of pipe placement. The tremie pipe will be equipped with side discharge holes rather than an open end to help maintain the integrity of the underlying material onto which the grout is placed.

Before exposing any portion of the borehole above the seal by removal of any surface casing, the annulus between the surface casing and the well casing will be filled with sufficient grout to allow for planned surface casing removal. If all of the surface casing is to be removed in one operation, the grout will be pumped through the grout pipe until diluted grout flows from the annulus at the ground surface.

During the surface casing removal, the grout pipe will be periodically re-inserted as needed for additional grouting.

If the surface casing is to be removed incrementally with intermittent grout addition, the grout will be pumped through the grout pipe until it reaches a level that will let at least 10 feet (3 meters) of grout to remain in the annulus after removing the selected length of surface casing. Using this method, the grout pipe will be re-inserted only to the base of the casing yet to be removed before repeating the process. After grouting has been completed to within approximately 10 feet (3 meters) of the ground surface, the remaining surface casing can be removed from the borehole and the remaining annulus can be grouted to 5 feet (1.5 meters) BGS.

Upon initiation of the grouting operation, the process will be conducted in one continuous operation; the process will be continued uninterrupted until all of the surface casing, if present, has been removed or pulled back to its final location; and all annular spaces are grouted to required levels, as noted. After 12 hours, the well will be checked for grout settlement and more grout will be added at that time to fill any depressions. This process will be repeated until firm grout remains within 5 feet (1.5 meters) of the ground surface. Incremental quantities of grout will be recorded on the well construction diagram.

Concrete/Gravel Pad Placement

Information regarding the placement of concrete pads around monitoring wells is presented in Section 6.2.4.2.

Protective Cover Placement

Protective steel/iron casing will be installed around each monitoring well. The exterior of the protective casing will be pre-primed prior to delivery to the site. The protective casing will be set approximately 5 feet (1.5 meters) below grade and will extend approximately 3 feet (0.91 meters) above ground surface. All protective casings will be installed so that the distance between the top of the protective casing and the top of the well casing is between 2.5 and 6 inches (6 and 15 centimeters).

A mortar collar will be poured within the annulus between the protective casing and the well casing from the ground surface to approximately 6 inches (15 centimeters) above the ground surface. After placement of the mortar collar, the remaining annulus formed between the outside of the protective casing and borehole or permanent casing, if present, will be filled with concrete to the ground surface and extend onto the apron around the well head to form a square-cornered concrete pad measuring approximately 30 by 30 inches (76 by 76 centimeters). The thickness of the pad will be no less than 4 inches (10 centimeters). Following the placement and curing of the pad, a drainage port approximately ¼ inch (0.64 centimeters) in diameter will be drilled into the protective casing immediately above the mortar collar.

Upon completion of the protective cover placement, a minimum of three and preferably four steel guard posts will be radially located 4 feet (1.2 meters) around each monitoring well. The guard post length will be 6 feet (1.8 meters), approximately 2 feet (0.61 meters) of which will be set in concrete below ground level. All of the guard posts, as well as the protective casings including the hinges and caps/lids, will be painted orange with a paint brush and will be completely dry before sampling the well.

Well Identification

For each well installed as part of the investigation, the well designation number will be stenciled with white paint on the outside of the protective casing (after application and drying of the orange paint). Each pair will have a root identifier followed by an intermediate (I, shallow bedrock) or deep (D, deeper bedrock) identifier. The well pairs will be identified numerically in sequential order. For example, the first pair will be identified as the following: JP-W-01I and JP-W-01D.

Well Development

The development of the wells will be initiated no sooner than 48 hours after nor longer than 7 days beyond the mortar collar placement or the final grouting of the wells.

Pump, Surge Block and Airlift Usage—Development of the wells will be accomplished using one of the following nondedicated combinations of devices: a surge block and pump or a surge block and air lift. During development, the surge block with be moved up and down the entire screened interval to force water in and out through the screen openings and through the filter pack to agitate and mobilize the particulates around the well screen during the removal of water from the well. Development will continue by alternating between the surge block and pumping with either a pump or air lift.

Development Criteria—Development of each well will proceed until each of the following criteria is achieved.

- A turbidity reading of 5 nephelometric turbidity units (NTUs) or less is achieved using a turbidity meter, or the water is clear to the unaided eye.
- The sediment thickness remaining in the well is less than 1.2 inches (3.0 meters).
- A minimum water removal of five times the standing water volume in the well (to include the well screen and casing plus saturated annulus, assuming 30 percent annular porosity) has been achieved.
- Indicator parameters (e.g., pH, specific conductivity, temperature) have stabilized to within 10 percent on three consecutive readings.

During the course of the development, the U.S. Army Project Manager will be contacted for guidance if well recharge is so slow that the required volume of water cannot be removed during 48 consecutive hours of development, if persistent water discoloration is observed after completion of the required volume removal, or if excessive sediment remains after completion of the required volume removal.

Well Survey

A topographic survey of the horizontal and vertical locations of all groundwater monitoring wells installed will be conducted after completion of the well installations. The topographic survey will be conducted by an individual licensed in an appropriate classification within the State of Indiana for the specific work anticipated to be conducted. This license will be current and active throughout the term of performance during the project. The wells will be surveyed horizontally referenced to the Indiana State Plane Coordinate System (ISPCS) and will have an accuracy of at least 1 foot. Locations of the monitoring wells will be measured from the rim of the well casing (not the protective casing). The wells will be surveyed for elevation and will be referenced to the National Geodetic Vertical Datum (NGVD) of 1929 and will have a vertical accuracy of at least 0.01 foot.

Alignment Testing

Alignment tests will be conducted on each monitoring well to ensure that deformation and/or bending of the PVC well casing and screen is minimal. Testing will be conducted using a pump or bailer no less than 1 inch (2.5 centimeters) smaller than the diameter of the well casing or screen diameter. A nylon rope will be attached to the device and it will be lowered to the bottom of the well and retrieved. The alignment test will be considered successful if the device can be lowered and retrieved without binding within the well. If the well fails the described test, the well will be considered for abandonment and replacement.

In Situ Permeability Testing

There is no in situ permeability testing anticipated to be completed as part of this investigation.

6.2.4.4 Documentation

The following sections describe field documentation related to the installation, development, maintenance, sampling, and abandonment of groundwater monitoring wells.

Boring Logs

Each borehole log generated will fully describe the subsurface environment and procedures used to gain that description. All borehole data will be recorded by the rig geologist on Engineer Forms 5056-R and 5056A-R (Figure 6-1). Original borehole logs and well construction diagrams will be of sufficient legibility and contract so as to provide comparable quality in reproduction and will be recorded directly in the field without transcribing from a field book or other document. All borehole logs generated will routinely contain the following information:

- Unique borehole/monitoring well number and location denoted on a sketch map as part of the log
- Depths or heights recorded in feet and decimal fractions thereof (tenths of feet)
- Field estimates of U.S. soil classification (USCS) prepared in the field at the time of drilling by the rig geologist
- Full description of soil and rock parameters such as:
  - Soil parameters: USCS classification, color (using Munsel or Geological Survey of America [GSA] rock color chart), plasticity, consistency, density, moisture, structure and orientation, and grain angularity
  - Rock parameters: rock type, formation, variety, bedding characteristics, color, hardness, degree of cementation, texture, structure, degree of weathering, solution or void conditions, and primary and secondary permeability
- Description of drilling equipment
- Sequence of drilling activities
- Any special problems encountered during drilling and their resolution
- Dates and times for start and completion of drilling activities
- Each sequential boundary between various soil types and individual lithologies
- The depth of first encountered free water
- Total depth of drilling
- Results of any field monitoring and instruments used
- Definition of any special abbreviations.

Well Construction Diagrams

Each groundwater monitoring well installed will be depicted in an as-built well construction diagram (**Figure 6-2**). Each diagram will be attached to the original borehole log for that installation and will graphically denote, by depth from the ground surface, the following information:

- Location of the borehole bottom and diameter(s)
- Location of the well screen
- Location of the granular filter pack
- Location of the bentonite seal
- Location of grout
- Location of centralizers
- Height of riser (stickup), without cap or plug, above ground surface
- Height of protective casing, without cap or cover, above ground surface
- Depth of protective casing base below ground surface
- Location and size of drainage port
- Location of internal mortar collar
- Sloped concrete pad height and diameter
- Protective post configuration
- Water level within 24 hours after completion of installation with date and time of measurement.

Additional information to be described on each as-built well construction diagram will include the following:

- Actual quantities of composition of grout, bentonite seal, and granular filter pack used
- Screen slot size in inches, slot configuration, total open area per foot of screen, outside diameter, nominal inside diameter, schedule/thickness, composition, and manufacturer
- Type of material located between bottom of borehole and bottom of screen
- Outside diameter, nominal inside diameter, schedule/thickness, composition, and manufacturer of the well casing
- Joint design and composition
- Design and composition of centralizers
- Composition and nominal inside diameter of protective casing
- Any special problems encountered during well construction and their resolution
- Dates and times for the start and completion of monitoring well installation
- Definition of any special abbreviations used at their first occurrence of their usage.

Development Records

For each monitoring well developed a record will be prepared to include the following information:

- Project name and location
- Well designation and location
- Date(s) and time(s) of monitoring well installation
- Date(s) and time(s) of monitoring well development
- Static water level from the top of the well casing before and 24 hours after completion of well development with dates and times of measurements

HTW DRILLING LOG

HOLE NO.	
1 COMPANY NAME	2. DRILLING SUBCONTRACTOR
SHEET 1 OF SHEETS	
3. PROJECT	4. LOCATION
5 NAME OF DRILLER	6. MANUFACTURER'S DESIGNATION OF DRILL
7 SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	8. HOLE LOCATION
	9. SURFACE ELEVATION
	10. DATE STARTED / 11. DATE COMPLETED
12 OVERBURDEN THICKNESS	15. DEPTH GROUNDWATER ENCOUNTERED
13 DEPTH DRILLED INTO ROCK	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED
14 TOTAL DEPTH OF HOLE	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)

18 GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES			
20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR		

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h

MRK FORM JUN 89 55 | PROJECT | HOLE NO.

Figure 6-2. Soil Boring and Well Construction Log

HTW DRILLING LOG (CONT.)

HOLE NO.							
PROJECT			INSPECTOR				SHEET OF SHEETS
ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h

MRK FORM JUN 89 55-2 | PROJECT | HOLE NO.

Figure 6-2. Soil Boring and Well Construction Log (Continued)

- Quantity of standing water contained within the well, and contained within the saturated annulus (assuming 30 percent porosity), before well development
- Field readings completed during development
- Depth from top of well casing to bottom of well
- Length of screen
- Depth from top of casing to top of sediment inside well, both before and after development, as measured directly at the time of development
- Physical character of removed water, including changes during development in clarity, color, particulates, and any noted odor
- Type and size/capacity of pump and/or equipment used during development
- Description of surge technique used during development
- Height of well casing above ground surface as measured directly at the time of development
- Estimated recharge rate into the well at the time of development
- Quantity of water removed from the well during development and the time for removal (present as both incremental and total values).

Geophysical Logs

At this time, it is not anticipated that geophysical borehole logging will be required or completed during the installation of the conduit wells.

Decommission/Abandonment Records

Abandonment of monitoring wells and/or boreholes will be conducted in a manner precluding any current or subsequent fluid media from entering or migrating within the subsurface environment along the axis or from the endpoint of the well/borehole. Abandonment will be accomplished by filling the entire volume of the well/borehole with grout and/or bentonite chips or a combination of both. The abandonment activities will be conducted in accordance with the applicable State of Indiana regulations concerning well/borehole abandonment.

For each abandoned well/borehole, a record will be prepared and will include the following information:

- Project and well/borehole designation
- Location with respect to the replacement well or borehole (if any)
- Open depth of well/borehole before grouting
- Casing or items left in the borehole by depth, description, composition, and size (if applicable)
- Copy of the borehole log
- Copy of the construction diagram for the abandoned well (if applicable)
- Reason for abandonment
- Description and total quantity of all sealing agents used initially
- Description and daily quantities of sealing agents used to compensate for settlement
- Dates of abandonment
- Water or mud level prior to grouting and date measured

- Remaining casing above ground surface: type (well, drill, protective), height above ground, size, and composition of each (if applicable).

All depths reported in the abandonment record will be designated in feet BGS. Any replacement wells/boreholes will be offset at a minimum of 20 feet (6.1 meters) from any abandoned site in a presumed upgradient or cross-gradient groundwater direction.

6.2.4.5 Water Level Measurement

Measurement of one complete set of initial static groundwater levels within all monitoring wells installed including existing DU ERM program (U.S. Army 2000a) and Range Study wells (CHPPM 2003) will be made over a single consecutive 10- to 12-hour period at least 24 hours after development and/or sampling of the wells. The depth to groundwater will be measured and recorded to the nearest 0.01 foot (0.003 meters). Measurements will be made from the designated measurement location on the well casing. The measurement location will be surveyed for vertical control. All measured groundwater level data will be presented in subsequent reports in tabular form, which will include, at a minimum, well location, total depth, top of casing elevation, measured depth to water, and groundwater elevation. Groundwater elevations will be contoured to denote flow directions and gradients provided that sufficient data points exist.

6.2.5 *Determine Free Product Presence and Sampling*

It is not anticipated that free product will be present in the newly installed wells. The presence of free product will be evaluated during development and water level measurement activities. No sampling of free product is anticipated or scheduled during this investigation.

6.2.6 *Aquifer Testing*

No aquifer testing is scheduled at this time to be conducted during this investigation.

6.2.7 *Field Measurement Procedures and Criteria*

Groundwater field measurements will include determination of static water level (± 0.01 feet [0.003 meters]), pH (± 0.1 units), conductivity (± µmhos/centimeters), dissolved oxygen (DO) concentration, and temperature (± 1°C). The specific instruments will be calibrated in accordance with the manufacturers' specifications and be able to provide results in the specified increments.

6.2.7.1 Static Water Level

Static water level measurements will be made using an electronic water level indicator. Initially, the indicator probe will be lowered into the monitoring well without touching the casing until an alarm sounds. The probe then will be withdrawn several inches to a foot and slowly lowered again until the groundwater surface is contacted as noted by the alarm. All probe cords will be incrementally marked at 0.01-foot (0.003 meters) intervals. Water level measurements will be estimated to the nearest 0.01 feet (0.003 meters).

The distance between the top of the well casing and the groundwater surface will be recorded to within 0.01 foot (0.003 meters). The static water level measurement procedures will be repeated two or three times to ensure that the water level measurements are consistent.

6.2.7.2 pH, Conductivity, Dissolved Oxygen, and Temperature

Conductivity, pH, DO, and temperature measurements will be made using individual or combination instruments. A groundwater sample will be retrieved and immediately poured into a clean container. Measurements will be recorded after the readings reach equilibration. Alternately, if micro-purging or purging at a rate at which a flow-though cell can be used the instrument can be inserted in-line with a flow through cell.

Sample pH will be recorded to the nearest 0.1 pH unit. The pH measurement will be considered stable when three consecutive readings produce less than 0.2 pH units variation. Sample conductivity will be recorded to the nearest 10 μmhos/centimeters, and the temperature to the nearest 0.1°C, with stable measurements consisting of less than 10 percent variation for conductance and less than 0.5°C variation for temperature. DO reading wills be considered stable when three consecutive readings produce less than 10 percent variation.

6.2.8 Sampling Methods for Groundwater – General

Specific well purging methods for the new conduit wells and existing wells will be determined following the installation and development of the wells and when further information is available, such as yield and water-bearing zones.

Collection of groundwater samples from monitoring wells will involve three general steps: measurement of field parameters, well purging, and groundwater sample collection. All of the activities normally would be accomplished within a 2 to 4 hour period per monitoring well. Measurements of field parameters are discussed in Section 6.2.7.2. Purging and sampling of the wells will be accomplished using either a Teflon® or stainless steel bailer or a bladder pump or a 2-inch (5 centimeters) diameter Grundfos® pump with a variable flow control. If it is necessary to sample an existing well, the integrity of the well will be checked prior to purging. The integrity of the well will be checked by visual inspection of the surface casing and riser pipe and by sounding the well to check for sedimentation or blockages. In the event that the condition of the monitoring well is questionable, the Project Manager will be contacted and a course of action will be determined.

Sampling of the wells will begin immediately after purging unless the well was purged to dryness. If a bailer is used, the device will be slowly lowered until it makes contact with the groundwater surface, allowed to sink and fill with a minimum of surface disturbance, and raised slowly to the surface. The sample then will be transferred to appropriate sample bottles by tipping the bailer so that a slow discharge of sample from the bailer top gently down the side of the sample bottle with a minimum of entry disturbance. Immediately after collection of each sample and completion of bottle label information, each sample container will be placed into a sealable plastic bag and then placed in an ice-filled cooler to ensure preservation.

When a bladder or submersible pump is used, the device will be lowered slowly until it contacts the groundwater surface, and then will continue to be lowered until the pump intake is located at the midpoint of the well screen. The pump then will be activated and allowed to operate until a steady flow of water is expelled from the return line at the surface. The discharge line is not allowed to touch any part of the inside of the sample container or the media inside the sample container. The sample will be collected and preserved in the same manner as described above.

6.2.8.1 Conventional Well Purging

Purging of each monitoring well will commence until pH, conductivity, DO, and temperature have reached equilibrium as described in Section 6.2.7.2. Equilibrium will be established by three consecutive readings, where one well casing volume is purged between each reading. However, purging will be terminated before establishment of equilibrium if one of the following conditions is met: five well volumes, including the saturated filter pack assuming a porosity of 30 percent, have been removed from the well, or the well is purged to dryness.

If a monitoring well is purged to dryness, sampling will be delayed for a time period of up to 24 hours to allow for recharge. During the delay period, the atmosphere of the well will be isolated to the greatest extent possible from the surface atmosphere. Upon sufficient recharge of groundwater into the well (i.e., if the well recharges to 90 percent of its initial water level within 4 hours), a sample will be collected without additional well purging. If sufficient well recharge does not occur within 24 hours after initial purging, the Project Manager will be contacted for guidance.

6.2.8.2 Micro-Purging

If it is determined to be beneficial to micro-purge the wells, the following procedure will be followed:

- A bladder or submersible pump will be used for purging
- The purge rate will not exceed 0.026 gallons/minute (100 mL/minute) unless it can be shown that higher rates will not disturb the stagnant water column above the well screen (i.e., will not result in drawdown)
- The volume purged will be either two pump and tubing volumes or a volume established through in-line monitoring and stabilization of water quality parameters
- Sample collection will occur immediately after micro-purging and will be collected directly from the pump discharge line.

6.2.9 Sample Handling Methods for Groundwater Filtration

If filtered samples are required, the following procedure will be followed. The method used for collection of filtered groundwater samples from monitoring wells will depend on whether a bailer or pump is used for sample collection.

When a bailer is used for groundwater sampling, the collected sample will be poured slowly into a decontaminated barrel filter. The barrel filter will be fitted with a disposable 0.45-µm pore size filter element. The barrel filter will be sealed and the sample will be filtered by pressurizing the barrel filter with a hand pump. The filter elements will be replaced as they become clogged with solids buildup and between sample collection sites.

When a pump is used for groundwater sampling, a disposable pre-sterilized 0.45-µm pore size filter will be attached to the end of the discharge tubing and the groundwater will be pumped through the disposable filter and into the sample containers. The disposable filters used for collection of filtered groundwater samples will be discarded after each use.

6.2.10 Sample Containers and Preservation Techniques

Information regarding sample containers and preservation techniques is presented in Section 8.2 and in the QAPP (Appendix A). All sample containers will be provided by the contracted laboratories. With regard to the required temperature preservation, all groundwater sample containers will be stored at 4°C (± 2°C) immediately after sample collection and will be maintained at this temperature until the samples are received at the contracted laboratory.

6.2.11 Field Quality Control Sampling Procedures

Section 8.4 and Appendix A describe the requirements for collecting QC samples.

6.2.12 Decontamination Procedures

Decontamination of nondedicated sampling equipment used for static water level measurement and for the development and purging of monitoring wells and collection of groundwater samples will be conducted within a temporary decontamination pad. The decontamination pad will be designed so that all decontamination liquids are contained from the surrounding environment and can be recovered for disposal as IDW. Nondedicated equipment will be decontaminated after the development of each well and again after purging and sampling of each well. The procedure for decontamination of equipment will be as follows:

1. Wash with approved water and phosphate-free detergent using various types of brushes required to remove particulate matter and surface films.
2. Rinse thoroughly with approved potable water.
3. Rinse thoroughly with American Society for Testing and Materials (ASTM) Type I or equivalent water.
4. Allow equipment to dry as long as possible.
5. Place equipment on clean plastic if immediate use is anticipated or wrap in aluminum foil or bags to prevent contamination if longer-term storage is required.

In addition to well development and sampling equipment, field measurement instruments also will be decontaminated between monitoring well locations. Only those portions of each instrument that come in contact with potentially contaminated media will be decontaminated. Due to the delicate nature of these instruments, the decontamination procedure only will involve initial rinsing of the instruments with approved water followed by a final rinse of ASTM Type I or equivalent water.

6.3 BIOTA SAMPLING

Historical sampling of biota has occurred at JPG and the data suggest that DU levels in biota are not a concern (U.S. Army 2002b). However, most samples were collected more than 10 years ago. Thus, there are no recent data to account for potential degradation of DU projectiles and subsequent migration of DU throughout a portion of the JPG environment over the past 10 years.

Deer hunts are held annually on the former JPG reservation at Big Oaks NWR, providing a mechanism of human exposure to contamination from earlier munitions tests. Approximately 400 to 800 deer are harvested per year. Local residents from surrounding communities who hunt deer at or near JPG are concerned about potential adverse health effects from exposure to DU. Although NRC has acknowledged that DU concentrations in the most recently collected deer samples were low from a human health perspective, there were modest DU increases in kidney and bone compared to background. As a result, NRC has expressed concern that concentrations may continue to increase to levels that could affect human health (NRC 2004a). Therefore, deer sampling will occur.

There also is potential for DU uptake by wildlife other than deer. Although most wildlife other than deer would not be consumed by humans, uptake and subsequent movement through the nondeer part of the food web could cause adverse effects in these organisms. As a result, sampling of biota other than deer also may occur. Please note that the level of detail concerning the sampling of other biota is limited in comparison to the deer sampling in this FSP, but will be presented in subsequent addenda if these samples need to be collected.

6.3.1 Rationale/Design

The initial phase of the biota sampling at JPG will be conducted in the fall of 2005. Deer tissue samples will be collected from three different areas at Big Oaks NWR. First, samples will be collected from hunting zones closest to the DU Impact Area. The size of the home range of a deer is approximately 1 square mile (Smith 1991), so there is potential for deer to forage in the DU Impact Area (1 mile [1.6 kilometers] in width by 3.25 miles [5,230 meters] long) and then be harvested by hunters in nearby hunting zones (portions of the nearby western hunting zones are less than 0.5 miles (0.8 kilometers) from the boundary of the DU Impact Area, while the boundary of the nearby eastern hunting zones is approximately 1 mile (1.6 kilometers) from the boundary of the DU Impact Area). However, due to the size of Big Oaks NWR and the relatively limited home range of deer, the potential for hunters in most of the hunting zones at Big Oaks NWR to harvest deer that have encountered DU in or near the DU Impact Area is remote.

Given the limited size of the home range of deer, background data will be collected from northern hunting zones at Big Oaks NWR, which are more than 5 miles (8.0 kilometers) from the DU Impact Area. If no DU is detected in deer tissue from the nearby hunting zones to the DU Impact Area above background levels, verification sampling of deer in 2007 will not occur. If DU is detected at levels above background, supporting analyses will be conducted to determine if additional deer samples will be collected in 2007 to verify the 2005 data.

In addition, deer samples also will be collected from the DU Impact Area, which is the zone of maximum exposure. Based on the size of the DU Impact Area, a number of deer could forage exclusively there. Although hunting is prohibited within the DU Impact Area, the data also will be used to determine if verification samples are needed. Absence of elevated DU in these samples provides indication that significant migration through the deer pathway is not occurring. For instance, if data from both the nearby hunting zones and the DU Impact Area indicate DU levels are within background, then verification sampling of deer would not be conducted. If DU concentrations are elevated only in the deer samples from the DU Impact Area, consumption of deer tissue from nearby hunting zones would not be a concern. However, this could be indicative that DU uptake could be occurring in other wildlife.

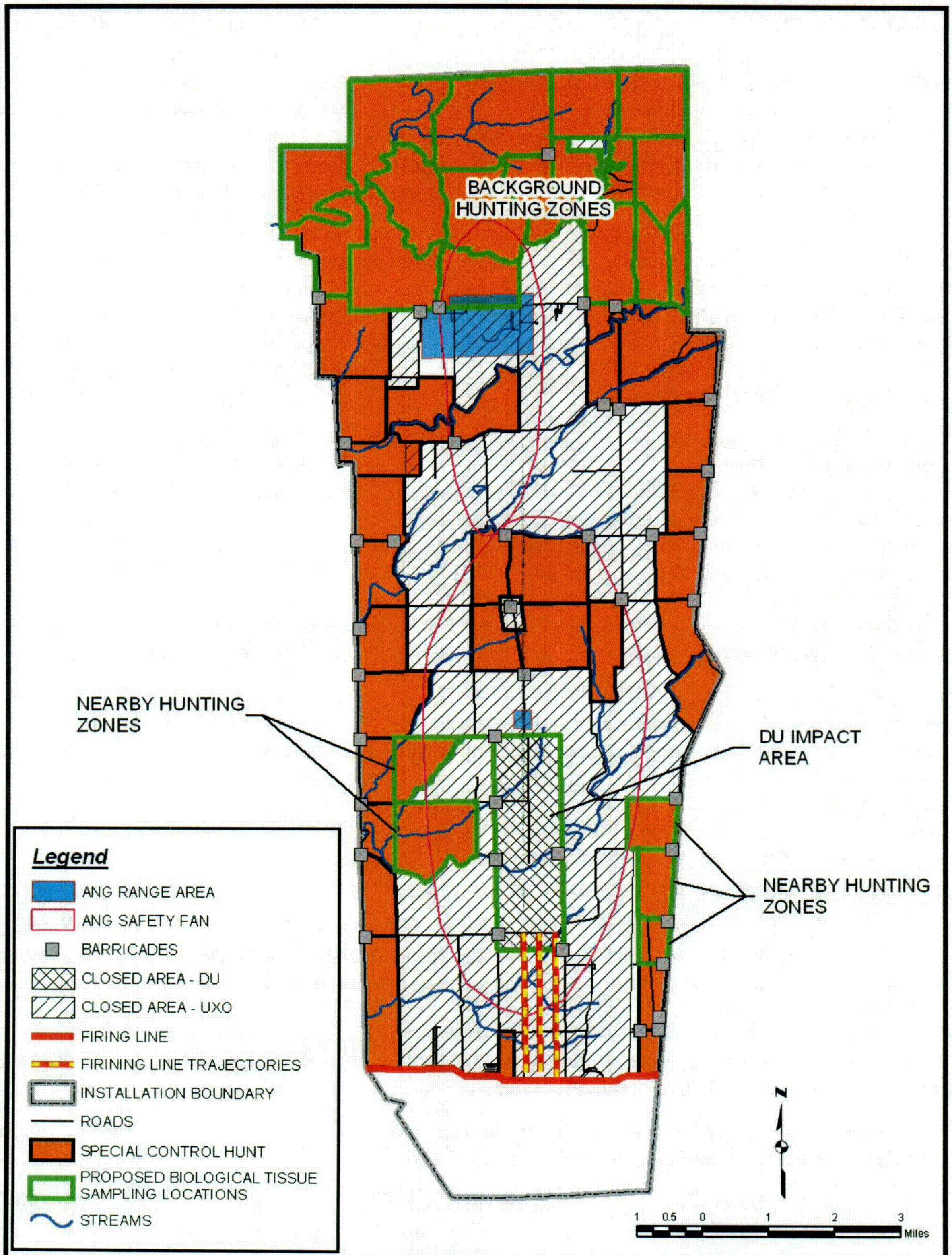
The trigger to collect tissue data from other biota will be based on a weight of evidence approach using the results of the abiotic sampling (e.g., surface soil, surface water) as well as the deer tissue sampling. If these data suggest that uptake of DU through other organisms might be occurring, an initial round of sampling of plants, earthworms, fish, small birds, and small mammals will occur in the DU Impact Area and in background locations in 2007. In a similar manner to deer, if DU is detected at levels above background, supporting analyses will be conducted to determine if one round of verification sampling will occur in 2008.

6.3.1.1 Sample Locations

Ten deer will be sampled from 3 areas for a total of 30 deer (see Section 6.3.1.4 for additional quality control [QC] samples). During the initial sampling round, deer samples will come from: the five nearby hunting zones closest to the DU Impact Area most likely to contain deer exposed to DU (two zones immediately to the west and three zones immediately to the east); within the DU Impact Area; and from background locations (any of the hunting zones north of the ANG Range Area). **Figure 6-3** shows the proposed areas from which deer samples will be collected.

Specific sample locations from the ***nearby hunting zones*** will be based on a number of factors and ultimately interpreted and applied by USFWS. These factors include:

- *Exposure Areas*—Six samples will be collected from the two western hunting zones that are the closest to the DU Impact Area. One of these hunting zones also contains the two major surface water creeks that traverse the DU Impact Area (Big Creek and Middle Fork Creek). Four samples will be collected from the three hunting zones closest to the eastern border of the DU Impact Area.
- *Accessibility*—Proximity to roads, paths, and UXO areas.



Source: USFWS 2001b

Figure 6-3. Proposed Biological Tissue Sampling Locations

C07

- *Safety*—Deer will be collected using a high-powered rifle.

Specific sample locations within the ***DU Impact Area*** will be based on a number of factors and ultimately interpreted and applied by USFWS. These factors include:

- *Exposure Areas*—Ten samples from the south-central portions of the DU Impact Area where DU exposure might be greatest.
- *Accessibility*—Proximity to roads, paths, and UXO areas.
- *Safety*—Deer will be collected using a high-powered rifle in an area with UXO.

Specific sample locations within the ***background areas*** will be based on a number of factors and ultimately interpreted and applied by USFWS. These factors include:

- *Exposure Areas*—Ten samples from locations north of the ANG Range Area.
- *Accessibility*—Proximity to roads, paths, and UXO areas.
- *Safety*—Deer will be collected using a high-powered rifle.

If needed, a verification round also would consist of 30 deer in addition to QC samples. If needed, other biota samples will be collected from within the DU Impact Area and background areas (northern hunting zones). Specific details concerning sample locations for other biota will be provided in subsequent addenda.

6.3.1.2 Discrete/Composite Sampling Requirements

All biota samples (including deer) will be discrete so that comparisons can be made between individual tissues and organisms where applicable. This eliminates the potential that averaging across composite samples will mask high levels of DU within an individual organism.

6.3.1.3 Sample Collection and Field and Laboratory Analysis

Specific deer tissues will be collected in each of the 30 deer (sample collection methods are discussed in Section 6.3.2.1). Kidney, bone (3 to 4 inches [7.5 to 10 centimeters] from foreleg), liver, and muscle tissue will be analyzed for total uranium, U-234, U-235, and U-238 following ASTM D3972-90M75-100. The first three tissues are being collected because information suggests that DU preferentially deposits in these tissues and they have been sampled previously at JPG. Although muscle tissue has not been sampled previously, partially because the data do not suggest preferential deposition to this tissue type, this tissue is consumed in greater amounts by the public than the other tissues.

Whole body samples, if needed, will be collected for plants, earthworms, fish, small birds, and small mammals and analyzed for total uranium, U-234, U-235, and U-238. No specific tissues will be analyzed for DU as the purpose is to document potential movement of DU through the food web rather than focus on specific tissues for human consumption.

A detection limit of 0.02 pCi U-238/g tissue will be used. This value was determined by considering the maximum allowable exposure rate of U-238 to people who eat deer. A Rocky Flats study (Todd and Sattelberg 2004) assumed a consumption rate of 62 pounds (28 kilograms) muscle and 5.1 pounds (2.3 kilograms) liver per year for 70 years. The authors concluded that a 10^{-6} excess cancer risk from consumption of deer tissue at those rates equates to a tissue concentration of 0.18 pCi/g. It is prudent to include an uncertainty factor for sampling and measurement errors. Applying an uncertainty factor ~ 10 yields a detection limit of 0.02 pCi/g.

U.S. Department of Homeland Security Method U-02-RC, "Isotopic Uranium in Biological and Environmental Materials" (DHS 1997) specifies that 0.35 ounces (10 grams) of ash should be used to determine uranium isotopes in tissue. Assuming that muscle tissue is ~ 1 percent ash, a 2.2-pound (1,000-gram) sample would be required. However, at the risk-based detection limit of 0.02 pCi/g tissue, a 2.2-pound (1,000-gram) sample would contain 20 pCi, three orders of magnitude more than the lower level of detection of the method. It is recommended that the quantity of muscle tissue be reduced to approximately 3.5 ounces (100 grams) to make processing easier but without reducing the amount of ash so much that recovery of material through the analytical process is compromised. Similarly, the quantity of bone per sample can be estimated by assuming that the ash content of bone is at least 20 percent; thus, 5 grams of bone would be required for 1 gram of ash. This amount of bone would be supplied easily by a 3- to 4-inch (7.5- to 10-cm) sample of foreleg (this is assumed to be approximately 30 grams of bone and 30 grams of marrow).

6.3.1.4 Background/Upgradient, QA/QC, and Blank Samples and Frequency

Background samples will be collected as discussed in Section 6.3.1.1. Field duplicate samples and matrix spike/matrix spike duplicate (MS/MSD) samples will be collected as part of the field QC sampling procedures. A duplicate sample is collected along with a field sample from the same deer and is placed into a separate container labeled with a unique sample number. The duplicate is submitted "blind" to check the accuracy of reported laboratory results. It is anticipated that the number of field duplicate samples will represent 10 percent of the total number of field samples collected and the number of MS/MSD samples will represent 20 percent of the total number of field samples. Thus, 10 percent of 30 deer is 3 field samples (assumes that a field duplicate is collected from 1 deer at each of the 3 sampling areas). In addition, 20 percent of 30 deer is 6 MS/MSD samples (assumes that 2 deer at each of the 3 sampling areas) for QC purposes. The sample quantity requirements will double for those samples including a field duplicate and triple for those samples including MS/MSDs.

6.3.2 Field Procedures

The following sections describe field procedures for sampling deer and other biological tissues from the JPG DU Impact Area and surrounding environs.

6.3.2.1 Sampling Methods – Deer

USFWS personnel will collect deer in late fall 2005 using a high-powered rifle, scope, bait, and floodlights. This method is being used to maximize sampling efficiency, minimize suffering to the deer, and minimize health and safety risks to the samplers as some of the deer will be collected in the DU Impact Area. At dusk each night, USFWS personnel will collect from 1 to 4 deer and rendezvous with SAIC personnel at a pre-designated safe sampling area (e.g., along roadways) in the adjacent hunting zones, DU Impact Area, or the northern background hunting zones. Muscle, liver, kidney, and bone (all tissues will be scraped from bone) tissues then will be removed, labeled, packed, and frozen on dry ice. No tissue preservatives will be used. The sampler will don clean nitrile or similar gloves. Samples will be collected using a properly cleaned knife or other suitable tool. The sample container will be wiped clean so that a label and security seal may be placed on it. Depending on the time of night after the first round of samples have been prepped, USFWS personnel may capture another 1 to 4 deer and return to the safe area for sampling. If it is too late at night, the sampling will begin again the next evening. Once samples have been collected from the deer, the carcasses will be scavenged at a location designated by USFWS. In some instances, meat collected from the adjacent hunting zones and northern hunting zones may be donated. All scavenging within the DU Impact Area will occur by USFWS while scavenging in the other hunting areas will be a collaboration between USFWS and SAIC.

6.3.2.2 Sampling Methods – Other Biota

Specific details concerning sample collection of other biota will be provided in subsequent FSP addenda.

6.3.2.3 Field Measurement Procedures and Criteria

The sex and weight of each deer as well as the presence of any external anomalies will be noted and recorded on the Biota Sample Worksheet (Section 7) or field logbook.

6.3.2.4 Sample Containers and Preservation Techniques

Once dissected, all deer samples will be double-bagged in Ziploc® bags and frozen on dry ice immediately after sample collection and will be maintained in this manner until the samples are received by the contracted laboratory. No tissue preservatives will be used.

6.3.2.5 Field Quality Control Sampling Procedures

Duplicate and MS/MSD samples will be collected as part of the field QC sampling procedures and as discussed in Section 6.3.1.4.

6.4 SURFACE WATER

In order to evaluate the surface water flows and discharges from groundwater to surface water, stream gauges and cave spring/stream gauges will be constructed and electronic data loggers will be installed. In addition to gauging surface water flows, precipitation will be recorded with an electronic precipitation recorder, which will be installed on a building south of the firing line. It is assumed that the Army will provide access to mount the precipitation recorder to a building designated by the Army and access or connection to 110-volt power supply will be provided or available for connecting the recorder. The precipitation recorder will be downloaded quarterly in conjunction with the downloading of the surface water gauge data recorders.

Surface water can be contaminated by DU transported by water erosion as well as contaminated groundwater surfacing into ponds or streams. Contaminated surface water can enter the human food chain indirectly as livestock drinking water or directly through the drinking water supply, as discussed previously for groundwater. In addition, fish or other organisms indigenous to streams or ponds that contain contaminated water represent a pathway to potential receptors.

6.4.1 Rationale, Design, and Surface Water Sample Locations

A total of 14 surface water sample locations will be included in this investigation and are co-located with sediment sample locations. The locations consist of five sample locations on Big Creek (one at the JPG western perimeter, and four within the DU Impact Area), four sample locations on Middle Fork Creek (one at the JPG western perimeter and three within the firing lines and impact area), four sample locations at spring/cave locations along Big Creek within the DU Impact Area, and one location at a cave/spring location along Middle Fork Creek.

The details for the surface water samples and determining the sampling locations will be continually developed based on ongoing investigation activities, such as soils verification, surface soils characterization, locations of physical features (e.g., caves, fracture traces), and hydrogeologic investigations. Through the course of surface sample collection and gamma walkover surveys, additional surface water drainageways and areas of erosion (sediment transport) may be identified and proposed for additional sediment and surface water sampling locations. The final surface water sampling locations will be documented in an addendum to this FSP.

6.4.2 Surface Water Gauging Locations

A total of five surface water gauging stations will be installed consisting of one at the bridge along Morgan Road where it crosses Big Creek, one at the bridge along Morgan Road where it crosses Middle Fork Creek, two at two separate caves entrances along Big Creek within the DU Impact Area, and one at a cave entrance along Middle Fork Creek. Contact has been made with the USGS and options are being evaluated for participation and assistance from the USGS for installing, maintaining, and providing data from proposed gauging stations.

6.4.3 Sample Collection and Field and Laboratory Analysis

Section 8.2 and Appendix A describe the requirements for sample collection and field and laboratory analysis.

6.4.4 Upgradient, QA/QC, and Blank Samples and Frequency

Section 8.4 and Appendix A describe the requirements for collecting QC samples.

6.4.5 Field Procedures – General Sampling Methods for Surface Water

SOPs for surface water sampling are as follows:

- The sampler will don clean nitrile or similar gloves.
- Samples will be collected in new sample containers using the grab method. Sample containers will be positioned pointing upstream and below the surface of the water.
- A sample quantity of 3.4 ounces (100 mL) of water will be collected.
- Radiation dose rate measurements will be taken at 3.3 feet (1 meter) above the sample location and recorded on a Surface Water Sample Worksheet (Section 7) or in the field logbook.
- Water samples will not be filtered and the only preservation is cooling to 4°C in the field.
- The sample containers will be wiped clean so that the label and security seal may be placed on it. The sample then will be placed into a sealed Ziploc® bag before being put into a cooler with ice.

6.4.5.1 Sample Handling Methods for Surface Water – Filtration

It is not anticipated that field sample filtration will be required as part of this investigation.

6.4.5.2 Field Measurement Procedures and Criteria

The following sections summarize the procedures and criteria for field measurements during the characterization of DU in the DU Impact Area.

Surface Water Sampling

After collecting surface water samples, the pH, temperature, and conductivity will be collected at each sample location with the Horiba U-10 Water Quality Meter or equivalent and recorded on a Surface Water Sample Collection Worksheet (Section 7) or the field logbook.

Measurements will be conducted with a portable radiation survey instrument that is sensitive to gamma radiation. The instrument should be held 3.3 feet (1 meter) above the sampling location. Any comments and notations that may be necessary for interpretation of the results should be recorded on the respective data collection worksheet or in the logbook.

Surface Water Gauging

The construction of each gauging station location will be unique and adjusted to the actual site conditions at the individual locations. A stilling well will be constructed at each location and the cave stream gauges also will include a weir. The stream gauge stilling wells will be secured to a bridge pillar along Morgan Road. Each gauging station will have an electronic data recorder installed that will continuously and automatically record water levels within the stilling wells. Each gauging station will be calibrated by measuring stream or spring/cave stream flows using a Gurley® flow meter or equivalent initially and during each quarterly download event. Each of the gauging station recorders will be operated for a minimum of one hydrologic year and will be downloaded quarterly.

6.4.5.3 Sample Containers and Preservation Techniques

Information regarding sample containers and preservation techniques is presented in Section 8.2 and in the QAPP (Appendix A). All sample containers will be provided by the contracted laboratories. With regard to the required temperature preservation, all groundwater sample containers will be stored at 4°C (± 2°C) immediately after sample collection and will be maintained at this temperature until the samples are received at the contracted laboratory.

Field Quality Control Sampling Procedures

Section 8.4 and Appendix A describe the requirements for collecting QC samples.

Decontamination Procedures

Decontamination of nondedicated sampling equipment used for static water level measurement and for the development and purging of monitoring wells and collection of groundwater samples will be conducted within a temporary decontamination pad. The decontamination pad will be designed so that all decontamination liquids are contained from the surrounding environment and can be recovered for disposal as IDW. Nondedicated equipment will be decontaminated after the development of each well and again after purging and sampling of each well. The procedure for decontamination of equipment will be as follows:

1. Wash with approved water and phosphate-free detergent using various types of brushes required to remove particulate matter and surface films.
2. Rinse thoroughly with approved potable water.
3. Rinse thoroughly with ASTM Type I or equivalent water.
4. Allow equipment to dry as long as possible.
5. Place equipment on clean plastic if immediate use is anticipated or wrap in aluminum foil or bags to prevent contamination if longer-term storage is required.

In addition to well development and sampling equipment, field measurement instruments also will be decontaminated between monitoring well locations. Only those portions of each instrument that come in contact with potentially contaminated media will be decontaminated. Due to the delicate nature of these instruments, the decontamination procedure will involve only initial rinsing of the instruments with approved water followed by a final rinse of ASTM Type I or equivalent water.

6.5 SOIL

Soil scans (gamma walkover scans) and sampling will be conducted to:

- Establish gamma scan background values for use in performance of scans in the DU Impact Area, assist in defining the aerial boundaries of the DU Impact Area (if necessary), identify locations of elevated uranium activity in surface soil and sediment for collection of biased samples and locate DU penetrators (and fragments) on and/or beneath the soil surface for excavation, collection, and analysis

- Establish background uranium concentrations in surface and subsurface soils for both Cincinnati and Cobbsfork soil types
- Verify the boundaries of the DU Impact Area
- Verify the areal and vertical extent of contamination in the DU Impact Area
- Quantify the concentrations of chemicals of concern in surface and subsurface soils
- Determine distribution coefficients (K_d) for both Cincinnati and Cobbsfork soil types.

6.5.1 Rationale, Design, and Methods

The following sections summarize the different methods for characterizing DU in the JPG DU Impact Area.

6.5.1.1 Soil Gamma Walkover Scans

A Ludlum Model 44-10 2-inch × 2-inch sodium iodide (NaI) gamma scintillation detector coupled with a Ludlum Model 2350 data logger (or similar portable survey instrument) and GPS (or equivalent) will be used to conduct the gamma walkover scans. The surveyor will advance at a speed of approximately 2 feet per second (approximately 0.5 meters per second) while passing the detector 4 to 6 inches (10 to 15 centimeters) above the ground surface. Scan results will be recorded in counts per minute (cpm).

Audible response of the instrument will be monitored, and locations of elevated audible response will be investigated when determining locations for biased surface soil sampling or locations of DU penetrators or penetrator fragments. Gamma scan data will be recorded in real time, using position and data recording methods. If satellite visibility is not available, the data will be geo-referenced at a later time.

NUREG-1507, *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions*, provides a scan minimum detectable concentration (MDC) of 56 pCi per gram for DU in soil when using a 2- by 2-inch NaI detector. Further evaluation indicates that a DU penetrator fragment as small as 0.37 cubic inches (6 cubic centimeters) can be located easily on the soil surface during a typical scan (assuming an investigation threshold of 2,000 cpm above background). Similar evaluation indicates that a DU penetrator fragment as small as 0.61 cubic inches (10 cubic centimeters) can be located easily below 2 inches (51 centimeters) of soil during a typical scan (again assuming an investigation threshold of 2,000 cpm above background). This evaluation is provided in Appendix C.

6.5.1.2 Screening Soil Samples Using Portable Survey Instruments

Soil samples collected for determining the vertical extent of contamination in the DU Impact Area may be screened using the Ludlum Model 44-10 2- by 2-inch NaI detector coupled with a portable survey instrument such as the Ludlum Model 2350 data logger.

To accomplish this, background count rates will first be determined for surface and subsurface soils (at each of the required sample depths) using the Ludlum Model 44-10/2350. Background soil samples will be monitored with the Ludlum Model 44-10 in a fixed position for a minimum count time of 1 minute. The background values, obtained in cpm, may then be applied to soil samples to determine the need for laboratory analysis.

Soil samples collected within the perimeter of the DU Impact Area at depths where contamination is not expected to exceed background may be screened using the same portable instrumentation used for background determination (Ludlum Model 44-10/2350). The soil samples requiring screening will be removed from the DU Impact Area to an area of low background for monitoring. Soil sample screening will be conducted in the same fixed position and a count rate obtained for the same time period (1 minute) as the background determination. If the screening value is indistinguishable from background (less than background count rate plus 2 standard deviations), the Field Manager may archive the sample without further laboratory analysis. All screening results and sample disposition will be recorded.

6.5.1.3 Soil Sampling

Soil sampling will be conducted at predetermined background and DU Impact Area locations. Surface and subsurface soil sampling will be conducted at each location when determining background and vertical extent of contamination. Additional soil sampling may be conducted directly beneath DU penetrators on the soil surface or beneath the soil to support analysis of DU metal (penetrator) corrosion rate and determination of K_d. The final soil sampling locations will be documented in an addendum to this FSP.

Surface soil is defined as the uppermost layer of soil to a depth of 6 inches (15 centimeters) BGS. Subsurface soil is defined as any soil below the upper 5.9 inches (15 centimeters) BGS.

Typically, surface and subsurface samples will be collected in an undisturbed state (cores) using a manually operated split spoon or split core sampler. If this is not possible, it is acceptable to collect a disturbed sample using a manually operated auger, trowel, or other equivalent sampling equipment. If it is necessary to advance the sample hole to a deeper collection location, this may be conducted with a manually operated auger. Soil samples may be collected in an undisturbed (core) or disturbed state (auger or trowel) below penetrators when the sample is for DU corrosion rate or K_d determination. Sample collection, control, and equipment decontamination will be in accordance with project procedures.

The preferred split spoon (split core) dimensions are 3 inches (7.6 centimeters) in diameter and 6 inches (15 centimeters) in length. Assuming a soil density of 0.86 ounces/cubic inch (1.5 grams per cubic centimeter), this will provide a sample of approximately 42 cubic inches (695 cubic centimeters) with a mass of approximately 37 ounces (1,040 grams). The minimum desired mass is 35 ounces (1,000 grams) per sample.

Surface sample locations will typically be physically identified with location flags and the GPS coordinates recorded. If satellite visibility is not available, the data will be geo-referenced at a later time. Subsurface samples will be referenced to the surface sample for identification of the sample location.

Samples will be collected and examined for physical attributes. Subsurface soil samples collected greater than 2 feet (0.61 meters) BGS may be monitored with the Ludlum Model 44-10/2350 to determine if radioactivity is present above background. If radioactivity is indistinguishable from background, the need for laboratory sample analysis will be determined by the Field Manager. QC samples (duplicate samples) will be collected and analyzed in accordance with the QAPP (Appendix A).

Each sample to be analyzed by the laboratory will be assigned a unique sample identification number and the sample will be prepared, packaged, and sample integrity maintained in accordance with applicable project procedures.

Soil samples requiring isotopic analysis will be prepared and shipped to an NRC licensed laboratory and analyzed for U-238, U-235, and U-234. Laboratory MDCs for uranium will be established in accordance with the QAPP (Appendix A).

6.5.2 Surveys and Sampling

The following sections summarize the survey and sampling techniques for characterizing DU in the JPG DU Impact Area.

6.5.2.1 Soil Background Determination

To determine background uranium concentrations in soil, locations will be selected outside the perimeter of the DU Impact Area known to have not been contaminated as a result of range activities. At least one location for each of the two soil types (Cincinnati and Cobbsfork) will be selected. At each of the locations the following will be conducted.

Gamma Scan

A gamma scan survey will be conducted using the Ludlum Model 44-10 coupled to an instrument, such as a Ludlum Model 2350, and GPS. The purpose of this survey will be to establish gamma scan background values in cpm for use/application to scans conducted in the DU Impact Area.

Background gamma scan values will be established for each soil type.

Surface Soil

A minimum of 10 surface soil samples will be collected. Upon removal of the sample from the sampler, the sample will be monitored with the Ludlum Model 44-10 in a fixed position for a minimum count time of 1 minute. The purpose of this measurement will be to establish background values in cpm for screening surface soil samples collected from the DU Impact Area.

Background values for the Ludlum Model 44-10 will be established for surface soil from each soil type.

Subsurface Soil

A minimum of 10 subsurface soil samples will be collected at the following depth intervals:

- 15 to 30 centimeters (approximately 1 foot BGS)
- 30 to 45 centimeters (approximately 1.5 feet BGS)
- 45 to 60 centimeters (approximately 2 feet BGS).

Note: For the following subsurface samples, a manually operated auger (or similar device) will be used to progress the sample hole to the desired sample depth:

- 75 to 90 centimeters (approximately 3 feet BGS)
- 105 to 120 centimeters (approximately 4 feet BGS)
- 135 to 150 centimeters (approximately 5 feet BGS).

Upon removal of the sample from the sampler, the sample will be monitored with the Ludlum Model 44-10 in a fixed position for a minimum count time of 1 minute. The purpose of this measurement will be to establish background values in cpm for screening subsurface soil samples collected from the DU Impact Area.

Background values for the Ludlum Model 44-10 will be established for subsurface soil for each soil type at each sampling depth interval.

6.5.2.2 DU Impact Area Gamma Scans and Soil Sampling (Outside Perimeter – Outer Edge)

A total of 12 sample locations will be identified outside the presently defined perimeter of the DU Impact Area (1 location at each corner of the defined area and 2 on each side approximately equal distance from each location). An area of approximately 108 square feet (10 square meters) will be scanned to verify the surface activity is not substantially higher than the established background scan value. If the scan activity is greater than two times the background scan value, the Field Manager will be notified and the perimeter will be extended outward an appropriate distance (108 feet [10 meters] is suggested) and the scan repeated. This process will be repeated as necessary until the perimeter is adequately defined.

Surface Soil

A surface soil sample will be collected at each of the 12 locations.

Subsurface Soil

A subsurface soil sample will be collected at the following depth intervals:

- 15 to 30 centimeters (approximately 1 foot BGS)
- 30 to 45 centimeters (approximately 1.5 feet BGS)
- 45 to 60 centimeters (approximately 2 feet BGS).

Note: For the following subsurface samples, a manually operated auger (or similar device) will be used to progress the sample hole to the desired sample depth.

- 75 to 90 centimeters (approximately 3 feet BGS)
- 105 to 120 centimeters (approximately 4 feet BGS)
- 135 to 150 centimeters (approximately 5 feet BGS).

Note: Sample screening using portable radiation survey instruments should be conducted outside the DU Impact Area in an area of low background.

For subsurface samples collected greater than 2 feet (0.61 meters) BGS, the sample may be screened by monitoring with the Ludlum Model 44-10 in a fixed position for a minimum count time of 1 minute. The result of this measurement then may be compared to the background value for samples at the same depth and from the same soil type (Cincinnati or Cobbsfork). If the measurement result is indistinguishable from background, the Field Manager may archive the sample without further laboratory analysis.

6.5.2.3 Soil Sampling Inside Perimeter of DU Impact Area

A total of 12 sample locations will be identified inside the perimeter of the DU Impact Area, approximately 33 feet (10 meters) from the perimeter boundary (1 location at each corner and 2 on each side approximately equal distance from each location). An area of approximately 108 square feet (10 square meters) will be scanned to identify the presence of DU penetrators on or just below the soil surface. If a penetrator is identified in the scan area, the location should be flagged and noted in the field log for future reference and possible retrieval. Each soil sample location should be selected such that the nearest penetrator is no closer than 3.3 feet (1 meter) in any direction. If this is not possible, the field log should indicate that a penetrator was located at the sample location (surface deposited or below soil, with approximate depth BGS).

Surface Soil

A surface soil sample will be collected at each of the 12 locations.

Subsurface Soil

A subsurface soil sample will be collected at the following depth intervals:

- 15 to 30 centimeters (approximately 1 foot BGS)
- 30 to 45 centimeters (approximately 1.5 feet BGS)
- 45 to 60 centimeters (approximately 2 feet BGS).

6.5.2.4 Soil Sampling Midway Between Perimeter of DU Impact Area and Trench(es)

A total of 12 sample locations will be identified approximately midway between the inside perimeter sample locations and the primary DU penetrator impact areas (trenches) (1 location at each corner of the defined area and 2 on each side approximately equal distance from each location). An area of approximately 108 square feet (10 square meters) will be scanned to identify the presence of DU penetrators on or just below the soil surface. If a penetrator is identified in the scan area, the location should be flagged and noted in the field log for future reference and possible retrieval. Each soil sample location should be selected such that the nearest penetrator is no closer than 3.3 feet (1 meter) in any direction. If this is not possible, the field log should indicate that a penetrator was located at the sample location (surface deposited or below soil, with approximate depth BGS).

Surface Soil

A surface soil sample will be collected at each of the 12 locations.

Subsurface Soil

A subsurface soil sample will be collected at the following depth intervals:

- 15 to 30 centimeters (approximately 1 foot BGS)
- 30 to 45 centimeters (approximately 1.5 feet BGS)
- 45 to 60 centimeters (approximately 2 feet BGS).

Note: For the following subsurface samples, a manually operated auger (or similar device) will be used to progress the sample hole to the desired sample depth:

- 75 to 90 centimeters (approximately 3 feet BGS)
- 105 to 120 centimeters (approximately 4 feet BGS)
- 135 to 150 centimeters (approximately 5 feet BGS)..

For subsurface samples collected greater than 2 feet (61 centimeters) BGS, the sample may be screened by monitoring with the Ludlum Model 44-10 in a fixed position for a minimum count time of 1 minute. The result of this measurement then may be compared to the background value for samples at the same depth and from the same soil type (Cincinnati or Cobbsfork). If the measurement result is indistinguishable from background, the Field Manager may archive the sample without further laboratory analysis.

6.5.2.5 Soil Sampling Outside Primary DU Impact Locations (Trenches)

A total of 12 sample locations will be identified outside the primary DU penetrator impact locations (trenches), approximately 32.8 feet (10 meters) from the outer edges of the trenches (1 location at each corner of the area encompassing all 3 trenches and 2 on each side approximately equal distance from each location). If there is a defined area between each of the three trenches, two additional samples locations should be identified approximately equal distance between the trenches and equally separated. An area of approximately 108 square feet (10 square meters) will be scanned to identify the presence of DU penetrators on or just below the soil surface. If a penetrator is identified in the scan area, the location should be flagged and noted in the field log for future reference and possible retrieval. Each soil sample location should be selected such that the nearest penetrator is no closer than 3.3 feet (1 meter) in any direction. If this is not possible, the field log should indicate that a penetrator was located at the sample location (surface deposited or below soil, with approximate depth BGS).

Surface Soil

A surface soil sample will be collected at each of the 12 sample locations.

Subsurface Soil

A subsurface soil sample will be collected at the following depth intervals:

- 15 to 30 centimeters (approximately 1 foot BGS)
- 30 to 45 centimeters (approximately 1.5 feet BGS)
- 45 to 60 centimeters (approximately 2 feet BGS).

Note: For the following subsurface samples, a manually operated auger (or similar device) will be used to progress the sample hole to the desired sample depth:

- 75 to 90 centimeters (approximately 3 feet BGS)
- 105 to 120 centimeters (approximately 4 feet BGS)
- 135 to 150 centimeters (approximately 5 feet BGS).

For subsurface samples collected greater than 2 feet (61 centimeters) BGS, the sample may be screened by monitoring with the Ludlum Model 44-10 in a fixed position for a minimum count time of 1 minute. The result of this measurement then may be compared to the background value for samples at the same depth and from the same soil type (Cincinnati or Cobbsfork). If the measurement result is indistinguishable from background, the Field Manager may archive the sample without further laboratory analysis.

6.5.2.6 Soil Sampling Within DU Impact Area Trenches

A total of four sample locations will be identified inside each of the three DU Impact Area trenches (one location at each end of the trench and two equal distances from the ends). An area of approximately 108 square feet (10 square meters) will be scanned to identify the presence of DU penetrators on or just below the soil surface. If a penetrator is identified in the scan area, the location should be flagged and noted in the field log for future reference and possible retrieval. If the sample location is within 3.3 feet (100 centimeter) in any direction from a DU penetrator, the field log should indicate that the penetrator is assumed located at the sample location (number of penetrators and surface deposited or below soil, with approximate depth BGS).

Surface Soil

A surface soil sample will be collected at each of the sample locations.

Subsurface Soil

A subsurface soil sample will be collected at the following depth intervals:

- 15 to 30 centimeters (approximately 1 foot BGS)
- 30 to 45 centimeters (approximately 1.5 feet BGS)
- 45 to 60 centimeters (approximately 2 feet BGS).

Note: For the following subsurface samples, a manually operated auger (or similar device) will be used to progress the sample hole to the desired sample depth:

- 75 to 90 centimeters (approximately 3 feet BGS)
- 105 to 120 centimeters (approximately 4 feet BGS)
- 135 to 150 centimeters (approximately 5 feet BGS).

For subsurface samples collected greater than 2 feet (61 centimeters) BGS, the sample may be screened by monitoring with the Ludlum Model 44-10 in a fixed position for a minimum count time of 1 minute. The result of this measurement may then be compared to the background value for samples at the same depth and from the same soil type (Cincinnati or Cobbsfork). If the measurement result is indistinguishable from background, the Field Manager may archive the sample without further laboratory analysis.

6.6 SEDIMENT

Sediment samples will be collected from the banks of the two major surface water creeks that traverse the DU Impact Area (Big Creek and Middle Fork Creek). At a minimum, sediment samples will be collected at the entrance, midpoint, and exit of each creek within the DU Impact Area. Locations should be selected where the surface water flow is low and/or deposition is most likely, such as bends in the creek as it changes direction. Samples generally should be collected within the top 5.9 inches (15 centimeters) of the sediment surface using trowels or other equivalent sampling equipment in accordance with project procedures. Samples should be a minimum of 35 ounces (1,000 grams) and no effort will be made to separate the sample into liquid and solid components.

In addition, accessible portions of both banks of the two creeks will be scanned using the equipment and methods described in Section 6.2. Any location where the scan activity is 2,000 cpm or greater above background will be identified and additional sediment samples will be collected. NOTE: The gamma scan investigation threshold of 2,000 cpm or greater above background is an arbitrary value chosen to indicate the need for additional sampling.

Sediment gamma scan background values in cpm will be determined by collecting 10 scan background samples from sediment found on the banks of both creeks upstream of the entrance point to the DU Impact Area. An appropriate background value then will be determined for application to gamma scans conducted on the banks of the creeks within the DU Impact Area.

Samples will be prepared, controlled, and analyzed as specified for soil samples in Section 6.2.1.3.

6.6.1 Rationale/Design

Sediment can be contaminated by DU transported by surface water, water erosion, and contaminated groundwater flowing into ponds or streams. Contaminated sediment can enter the human food chain indirectly from incidental ingestion by livestock, fish, or game. In addition, biotic material adsorbing contaminants from the sediment also represents an indirect exposure route.

6.6.1.1 Sediment Sample Locations from Onsite and/or Offsite Drainage Channels

A total of 14 sediment sample locations will be included in this investigation and are co-located with surface water sample locations. The locations consist of five sample locations on Big Creek (one at the JPG western perimeter and four within the DU Impact Area), four sample locations on Middle Fork

Creek (one at the JPG western perimeter and three within the firing lines and DU Impact Area), four sample locations at spring/cave locations along Big Creek within the DU Impact Area, and one sample location at a cave/spring along Middle Fork Creek.

Details regarding the sediment samples and determining the sampling locations will be developed continually based on ongoing investigation activities such as soils verification, surface soils characterization, locations of physical features (e.g., caves, fracture traces), and hydrogeologic investigations. Through the course of surface sample collection and gamma walkover surveys, additional surface water drainageways and areas of erosion (sediment transport) may be identified and proposed for additional sediment sampling locations. In addition, contact has been made with the USGS and options are being evaluated for participation and assistance from the USGS for providing sediment transport data within the surface water. The final sediment sampling locations will be documented in an addendum to this FSP.

6.6.1.2 Sediment Sample Locations from Ponds, Lakes, and Lagoons

It is not anticipated that any sediment samples will be collected from ponds, lakes, or lagoons as part of this investigation.

6.6.1.3 Sample Collection and Field and Laboratory Analysis

Section 8.2 and Appendix A describe the requirements for sample collection and field and laboratory analysis.

6.6.1.4 Upgradient, QA/QC, and Blank Samples and Frequency

The locations of upgradient sediment sampling locations to establish background levels of naturally occurring uranium in sediment will be included within the addendum FSP that specifies the locations of sediment sampling locations. The locations selected for upgradient samples will be documented in an addendum to this FSP.

Section 8.4 and Appendix A describe the requirements for collecting QC samples.

6.6.2 Field Procedures – Sampling Methods for Surface Soil/Dry Sediment

SOPs for sediment sampling are listed below:

- The sampler will don clean nitrile or similar gloves.
- Samples will be collected using a new or properly cleaned scoop, trowel, or other suitable tool. Samples will be placed in a glass sample jar.
- Sediment samples will be collected only after the water sample has been collected.
- Although a sediment sample is usually considered a soil sample matrix, a certain amount of water is expected in the sample. The sample should not be drained of water that is not collected as part of the sample.
- Radiation dose rate measurements will be taken at 3.3 feet (1 meter) above the sample location and recorded on the Sediment Sample Worksheet (Section 7) or field logbook.

The sample will be wiped clean so that a label and security seal may be placed on it. The sample then will be placed into a sealed Ziploc® bag before being put into a cooler with ice.

6.6.2.1 Sampling Methods for Underwater Sediments from Ponds, Lakes, and Lagoons

It is not anticipated that any sediment samples will be collected from ponds, lakes, or lagoons as part of this investigation.

6.6.2.2 Field Measurement Procedures and Criteria

Radiation exposure rate measurements will be taken at 3.3 feet (1 meter) above the sample location and recorded on the respective data collection worksheet or field logbook.

Measurements will be taken with a portable radiation survey instrument that is sensitive to gamma radiation. The instrument should be held 3.3 feet (1 meter) above the sampling location. Any comments and notations that may be necessary for interpretation of the results should be recorded on the form or in the logbook.

6.6.2.3 Sampling for Physical/Geotechnical Analyses

It is not anticipated that any sediment samples will be collected for physical or geotechnical analysis as part of this investigation.

6.6.2.4 Sampling for Chemical Analyses

It is not anticipated that any sediment samples will be analyzed for chemical constituents as part of this investigation.

6.6.2.5 Sample Containers and Preservation Techniques

Section 8.2 and Appendix A describe the requirements for sample containers and preservation techniques.

6.6.2.6 Field QC Sampling Procedures

Section 8.4 and Appendix A describe the requirements for field QC sampling.

6.6.2.7 Decontamination Procedures

Decontamination of nondedicated sediment sampling equipment will be conducted within a temporary decontamination pad. The decontamination pad will be designed so that all decontamination liquids are contained from the surrounding environment and can be recovered for disposal as IDW. Nondedicated equipment will be decontaminated after each piece of sampling equipment is used. The procedure for decontamination of equipment will be as follows:

1. Wash with approved water and phosphate-free detergent using various types of brushes required to remove particulate matter and surface films.
2. Rinse thoroughly with approved potable water.
3. Rinse thoroughly with ASTM Type I or equivalent water.
4. Allow equipment to dry as long as possible.
5. Place equipment on clean plastic if immediate use is anticipated or wrap in aluminum foil or bags to prevent contamination if longer-term storage is required.

6.7 DETERMINING DISTRIBUTION COEFFICIENTS (K_d STUDY)

As part of preparing the Decommissioning Plan for JPG, the predicted individual annual exposure to residual contamination will be determined. The annual exposure, in mrem/yr, will be calculated using the RESRAD model (Yu et al. 2001), in which the soil distribution coefficient or K_d is an important input parameter for simulating radionuclide leaching from contaminated soils. The K_d factor is defined as the concentration of a chemical species on the solid fraction divided by the concentration in the aqueous phase:

$$K_d = \frac{S}{C_w}$$

Where:

S = Mass of chemical species sorbed per unit mass of soil
C_w = Mass of chemical species per volume of solution.

When the K_d factor is used to model the leaching of chemicals from contaminated soils, the underlying assumption is that rapid equilibrium is reached between the dissolved and sorbed concentrations of a chemical species, and that these two concentrations are linearly related through the K_d factor. In theory, the K_d factor is used to characterize the *reversible* adsorption of a chemical species on solid surfaces, including soil minerals and organic matter. However, other chemical processes, including mineral precipitation, diffusion into dead-end pores, and attachment to microbes, can influence the experimental measurement of K_d. Although research efforts have attempted to differentiate adsorption from these other processes, there are no universally accepted standard methods for doing so.

There are two laboratory approaches for measuring K_d: the "batch" and the "column" methods. The "batch" method for measuring K_d consists of equilibrating a measured mass of soil with a selected contact solution (e.g., synthetic or site groundwater). In the more commonly used adsorption mode for K_d testing, the contact solution is spiked with a measured mass of the chemical species of interest, which then adsorbs onto the soil during equilibration. It is also possible to use contaminated soils, in which case the chemical species of interest desorbs from the soil into the contact solution. The concentration of the chemical species then is monitored in the contact liquid over time. When this concentration reaches a steady state, it is assumed that the liquid and solid concentrations are in equilibrium, and K_d is calculated from their ratio. The liquid concentration is directly measured, while the solid concentration usually is inferred from a mass balance knowing the initial mass of chemical species in the soil/water mixture.

In the "column" procedure for measuring K_d, a soil column (i.e., a cylinder packed with soil) is flushed with the contact solution under a controlled flow rate. The K_d factor then is determined by analyzing the breakthrough of the chemical species of interest at the effluent end of the soil column. The "column" procedure is a closer simulation of the physical processes occurring in the field; however, the experimental set-up and data interpretation are more difficult when compared to the "batch" procedure. Moreover, batch and column loading of uranyl complexes was compared in one study and no significant differences were observed (Bostick et al. 2002). Thus, the "batch" procedure is more commonly used when a large number of tests are needed to characterize spatial variability.

6.7.1 Rationale, Design, and Study Objectives

The primary objective of this study is to determine appropriate K_d factors for uranium to be used for modeling radionuclide leaching from soils at JPG. Because higher-than-background levels of uranium isotopes (U-234, U-235, and U-238) have been measured during previous characterization events, site-specific K_d factors for these radionuclides will be measured in the laboratory using soil samples collected from the DU Impact Area. The laboratory K_d measurements will be conducted following ASTM D 4319-

93, *Standard Test Method for Distribution Ratios by the Short-Term Batch Method,* which is the procedure recommended in the RESRAD data collection manual (Yu et al. 1993).

A secondary objective for this activity is to obtain additional radionuclide contamination data as well as basic geochemical and physical properties of soil samples collected from the JPG DU Impact Area. These data will be used in assessing the laboratory-measured uranium K_d factors, through comparisons with published studies on similar soils.

6.7.2 Soil Sampling

To conduct the analysis for determination of K_d for uranium in soils, it is important to collect soil samples containing radioactivity associated with the radionuclides of concern. Therefore, soil will be collected directly beneath DU penetrators on the surface and below the surface of soil within the DU Impact Area. In addition, since there are two soil types (Cincinnati and Cobbsfork) the analysis will be necessary for both. NOTE: Soil sampling for determination of K_d may be conducted in conjunction with the sampling effort for determining the areal and vertical extent of contamination, as well as collection of DU penetrators for determination of corrosion rate.

A minimum of 24 penetrators will be identified in the DU Impact Area associated with each of the 2 soil types (48 penetrators total). Of the 48 penetrators identified for the K_d study, 24 should be on the surface of the soil and 24 from below the soil surface (equal numbers from each soil type). The locations should be selected where intact or near intact penetrators are found.

DU penetrators on the soil surface will be carefully removed, leaving any corrosion material and/or soil adhering to the penetrator intact, and placed in a plastic bag.

For DU penetrators located below the soil surface, the soil above the penetrator will be removed and prepared for laboratory analysis of radionuclide concentrations, with a minimum of 35 ounces (1,000 grams) of soil collected. Soil collection may be conducted using a trowel or other suitable sampling equipment in accordance with project procedures. The subsurface penetrator will be carefully removed, leaving any corrosion material and/or soil adhering to the penetrator intact, and placed in a plastic bag.

The outside of each of the bagged DU penetrators will be marked with the date and time of removal, location, surface or subsurface (if subsurface, the approximate depth below the surface), and collector's name. The bagged penetrators will be staged in a pre-determined collection area for selection of penetrators for corrosion rate determination.

A minimum of 35 ounces (1,000 grams) of soil will be collected from the first 5.9 inches (15 centimeters) of soil directly beneath each of the removed penetrators. Soil collection may be conducted using a trowel or other suitable sampling equipment in accordance with project procedures. Upon removal of the soil, geologic descriptions will be recorded, with particular attention to mottling and appearance of iron oxide in order to estimate probable reduction/oxidation (redox) conditions of the soil. The soil samples will be placed in a sample container, and the container will be marked with a unique identification number, date and time of collection, location, surface or subsurface soil (if subsurface, the approximate depth), and collector's name and chain-of-custody (CoC) initiated. These soil samples will be designated for the K_d determination.

At each DU penetrator removal location, three additional soil samples will be collected at 5.9 inches (15-centimeters) intervals (depth below penetrators of 5.9 to 11.8 inches [15 to 30 centimeters], 11.8 to 17.7 inches [30 to 45 centimeters], and 17.7 to 23.6 inches [45 to 60 centimeters]). These samples are to provide additional data for determination of the areal and vertical extent of contamination. It is preferred that these samples be collected undisturbed, using split spoon samplers. Samples will be prepared and analyzed as specified in Section 6.6.2.

Each sample to be analyzed by an offsite laboratory will be prepared, packaged, and sample integrity maintained in accordance with applicable project procedures.

6.7.3 Groundwater Sample Collection and Field Analysis

Groundwater, uncontaminated by radionuclides associated with JPG (i.e., DU), will be collected for preparing contact solutions in the laboratory K_d tests. Groundwater will be collected and directly placed in a 5.3-gallon (20-liter) container. The headspace of the 20-liter container will be purged with nitrogen gas, immediately capped and a CoC seal affixed to the cap. Smaller volume groundwater samples also will be collected in 0.01-gallon (40-milliliter) vials for U-234, U-235, and U-238 activity analyses, major cation (Ca, K, Mg, Na) analyses, and anion (Cl, NO_3, SO_4) analyses. The groundwater samples will be shipped to the analysis laboratory where they will be stored at approximately 4°C prior to analyses or use in K_d tests. The samples for cation analyses will be preserved with nitric acid as soon as they are received in the laboratory. The purpose of nitrogen gas purging (for the 5.3-gallon [20-liter] sample) and cool storage is to maintain, to the extent possible, the DO content of the groundwater as well as minimize biological activity and chemical processes that can alter the water chemistry.

6.7.4 Laboratory Methods

The following sections describe laboratory methods for the K_d studies.

Radionuclide Analysis

Upon receipt, subsamples are typically collected from each soil sample and analyzed for isotopic uranium via alpha spectroscopy. A subsample of the groundwater sample also is analyzed for total uranium via kinetic phosphorescence analysis (KPA) following ASTM D5174.

Distribution Coefficient Measurement

K_d factors for uranium will be determined following ASTM 4319-93, as recommended in the RESRAD data collection handbook (Yu, et al., 1993). The ASTM method uses the term "distribution ratio" (or R_d) instead of "distribution coefficient" (or K_d) to avoid implying that equilibrium is attained in the measurements. Analyses test periods should be established based on the maximum time period at which point steady-state concentrations in the contact solutions are observed in most of the tests and assumed to represent equilibrium conditions.

Two types of K_d tests typically are conducted: (1) desorption tests, where a measured mass of soil is contacted with a measured volume of groundwater over the test period; and (2) adsorption tests, where a measured mass of soil is contacted with a measured volume of groundwater spiked to predetermined levels of uranium (as the uranyl ion or UO_2^{2+}).

Although the adsorption test protocol is more commonly applied in research and practice due to the ability to control and accurately quantify radionuclide levels in the soil/water mixtures, the desorption tests more closely simulate radionuclide leaching from contaminated soils in the field. Before the K_d tests are initiated, the field-sampled radionuclide levels are reviewed to select soil samples containing uranium at high enough levels such that detectable radionuclide levels likely would be present in the contact solution.

For each soil sample, soil/water mixtures are prepared to enable sacrificial sampling of each mixture for uranium analysis of the supernatant at predetermined time intervals (e.g., days 3, 7, 10, 14, 21, 28, 35, 45). Total uranium in the supernatant/contact liquids will be quantified through KPA.

Laboratory Measurement of Other Soil and Groundwater Parameters

Other soil and groundwater parameters measured in the laboratory may include:

- Moisture content
- Soil pH
- Particle size distribution
- Total organic carbon/soil
- Total carbon/soil
- Total iron (Fe)/soil
- Total manganese (Mn)/soil
- Major cations/groundwater
- Major anions/groundwater.

6.7.4.1 K_d Study Results

The results of the K_d study, as well as the concentrations of radionuclides in the soil samples provided to the laboratory, will be provided in a summary report. The K_d values provided in this report will serve the basis for applicable RESRAD input parameter values.

6.8 CORROSION AND DISSOLUTION DATA COLLECTION

The purpose of this activity is to determine the site-specific corrosion rate of the DU penetrators in the DU Impact Area at JPG.

Several DU penetrators have been recovered from the DU Impact Area and physical examination that was conducted. Inspection of penetrator photographs indicates a variable degree of yellow surface corrosion product. Based upon physical appearance, this corrosion rind likely could be a relatively soluble (leachable) hexavalent uranium oxide U (VI), such as Schoepite (nominally $UO_3 \cdot 2H_2O$). Such a corrosion product would represent a significant, potentially long-term source for groundwater contamination. Other uranium alteration products also could be formed in the vicinity of the emplaced penetrator, depending upon the site-specific geochemical environment. Thus, uranium speciation (*q.v.*), local groundwater properties (especially solution pH, redox condition, and alkalinity), and local soil mineralogy (especially iron-containing minerals) will determine the potential solubility and subsequent migration or retardation of toxic uranium into the subsurface and groundwater. A technical approach to gather the minimum information needed to assess this potential risk is discussed below.

6.8.1 Rationale, Design, and Corrosion Product Identification

As indicated in previous sections, there are two soil types within the DU Impact Area at JPG. Therefore, the corrosion rate may vary significantly if the soil chemistry associated with these two soil types is also different. As a result, the following will be conducted for both Cincinnati and Cobbsfork soils:

- At least 24 penetrators will be required from locations within the DU Impact Area (specific to the soil type). Some or all of these penetrators may have been identified, removed, bagged, and stored during soil sampling for determination of areal and vertical extent of DU contamination, as well as K_d determination. Should it be necessary to collect additional penetrators from the site, this will be conducted in a manner similar to that described in Section 6.7.1.2. A soil sample immediately beneath the additional penetrators also will be collected in a manner similar to Section 6.7.1.2.
- Penetrators will be physically examined at JPG and scrapings obtained from the surface corrosion layer.

- Penetrators then will be archived onsite while the corrosion layer scrape samples are transferred to an offsite laboratory for characterization.
- Scrape samples will be analyzed via x-ray diffraction (XRD) to identify the specific mineral phases that have been formed under actual field conditions. For example, UO_3 exists in an amorphous form and in at least four crystalline modifications, with some variability in solubility and dissolution rate. Ancillary techniques that may be utilized for further uranium speciation on selected samples include optical microscopy and scanning electron microscopy with energy-dispersive x-ray analysis. In addition, x-ray photoelectron spectroscopy (XPS), a surface-selective analytical technique, may be used to identify average uranium valence state. Since reduced uranium, U (IV), is generally less mobile in the environment than is uranyl, U (VI), Davies-Gray titration can be used to determine the proportions of U (IV) and U (VI) in the surface deposits.

6.8.2 Characterization of Local Soil and Groundwater Composition

Historical JPG analytical information will be reviewed for information related to potential migration of uranium. Review of groundwater chemistry will permit formulation of a credible simulant to use in leachability testing (*q.v.*). Soil mineralogy, including uranium and iron content, will be determined in the laboratory using representative composites of the soil samples collected from the location of penetrator removal. The uranium mobility in soil is known to be significantly affected by the presence of iron oxide minerals in the soil. Other selected variables, such as pH, soil texture, and redox status, have similar effects. Uranium mobility will be evaluated using a selective sequential extraction procedure to augment characterization data. While this sequential extraction procedure cannot be used to identify the actual chemical or physical form of a given metal in soil (true speciation), it is useful in categorizing the metal partitioning into several operationally defined geochemical fractions and, thus, in predicting the mobility of uranium in representative site soil.

6.8.3 Leachability Testing

Selection of representative specimens (penetrators archived onsite as discussed in Section 6.7.1) for leachability testing will be based on results obtained from corrosion product identification. Initial surface contaminant wash-off and subsequent longer-term effective dissolution kinetics will be estimated with use of a testing regime based upon the American National Standard/American National Standard Institute (ANS/ANSI)-16.1 protocol. This standard is intended to serve as a basis for indexing radionuclide release from solid forms in a short-term ($\leq$ 3-month) test under controlled conditions in a well-defined leachant. For purposes of this evaluation, it is proposed that the selected leachant be a synthetic groundwater simulant, based upon average JPG groundwater composition. The ANS/ANSI-16.1 protocol recommends a leachant replacement interval frequency (up to 10 replacements for a 3-month test) and a nominal leachant volume (cubic centimeters) to specimen external surface area (square centimeters) ratio ($V/S \sim 10 \pm 0.2$ centimeters). The data (radionuclide concentration and median leaching time) will be analyzed to determine an effective leachability index, or effective diffusivity of soluble uranium from the waste form surface.

Leachability testing will be conducted on: (1) a segment of penetrator with site-formed corrosion rind, and (2) a segment from which the initial surface rind has been mechanically removed. At the end of the testing, the surfaces of both specimen types (1 and 2), in replicate, will be examined to determine the effect of leaching on the surface. Results obtained in leachability tests will be used to establish a "theoretical" estimate of DU penetrator corrosion/dissolution rate that represents the combined effects of a number of site-specific parameters.

6.8.4 *Environmental Chamber Tests*

During operations at JPG, DU penetrators were fired and deposited in the impact area over an 11-year timeframe. Since it is impossible to determine the age of a DU penetrator collected from the area (time since placement on or in the soil in the DU Impact Area), it will be necessary to estimate the time using laboratory simulation.

The exposure of cleaned and polished or unexposed penetrator sections in controlled environmental chamber tests and subsequent examination by techniques described in Section 6.7.1 will yield time-related data that can be compared with observed effects and allow prediction or estimation of dissolution rates for penetrators in various corrosion rates. This information then will be used to validate the "theoretical" estimate of DU penetrator corrosion/dissolution determined in Section 6.7.3.

7. FIELD OPERATIONS DOCUMENTATION

This section summarizes the field operations documentation, including daily QCRs in Section 7.1, field logbooks and/or sample field sheets in Section 7.2, photographic records in Section 7.3, sample documentation (e.g., labels) in Section 7.4, field analytical records in Section 7.5, documentation procedures/data management and retention in Section 7.6, and field variance system in Section 7.7.

7.1 DAILY QUALITY CONTROL REPORTS

QA reporting from the laboratory (Section 7.1.1) and QC reporting at SAIC (Section 7.1.2) is described in this section.

7.1.1 Quality Assurance Reports

Each laboratory will provide letters of receipt (LORs) and analytical QC summary statements (case narratives) with each data package. All CoC forms will be compared with samples received by the laboratory, and an LOR will be prepared and sent to the QA Officer describing any differences in the CoC forms and the sample labels or tags. All deviations will be identified on the receiving report, such as broken or otherwise damaged containers. This report will be forwarded to SAIC within 24 hours of sample receipt and will include the following: a signed copy of the CoC form, itemized sample numbers, laboratory sample numbers, and itemization of analyses to be conducted.

Any departures from approved plans will receive prior approval from ISMA and will be documented with field change requests (FCRs). These FCRs will be incorporated into the project evidence file.

SAIC will maintain custody of the project evidence file and will maintain the contents of files for this project, including all relevant records, reports, logs, field logbooks, pictures, subcontract reports, correspondence, and CoC forms. Analytical laboratories will retain all original analytical raw data information (both hard copy and electronic) in a secure, limited-access area.

7.1.2 Quality Control Summary Reports

At the conclusion of field environmental sampling activities and laboratory analysis, the QA Officer will validate submitted data. This activity will include assignment of flags to data, documentation of the reason(s) for the assignments, and description of any other data discrepancies. The QA Officer then will prepare a Quality Control Summary Report (QCSR), which will be included as an appendix to the final report. This report will be submitted to ISMA in accordance with the project schedule. The contents of the QCSR will include data validation documentation and discussion of all data that may have been compromised or influenced by aberrations in the sampling and analytical processes. Both field and laboratory QC activities will be summarized. Problems encountered, corrective actions taken, and their impact on project data quality objectives (DQOs) will be determined.

The following are examples of elements to be included in the QCSR, as appropriate:

- Laboratory QC evaluation and summary of the data quality for each analytical type and matrix; summary of the accuracy, precision, and sensitivity from the data quality assessment
- Field QC evaluation and summary of data quality relative to data usability; summary of the accuracy, precision, and sensitivity from the data quality assessment
- Overall data assessment and usability evaluation
- QCSR consolidation and summary
- Summary of lessons learned during project implementation.

Specific elements to be evaluated within the QCSR include the following:

- Sample results
- Field and laboratory blank results
- Laboratory control sample percent recovery (method dependent)
- Sample MS percent recovery (method dependent)
- MS/MSD or sample duplicate relative percent difference (RPD) (method dependent)
- Analytical holding times.

7.2 FIELD LOGBOOK AND/OR SAMPLE FIELD SHEETS

Sufficient information will be recorded in the field logbooks to permit reconstruction of all drilling and sampling activities conducted. Information recorded on other project documents will not be repeated in the logbooks except in summary form where determined necessary. All field logbooks will be numbered sequentially and kept in the possession of field personnel responsible for completing the logbooks or in a secure place when not being used during field work. Upon completion of the field activities, all logbooks will become part of the final project file.

7.3 PHOTOGRAPHIC RECORDS

A photographic record will be made during the field program, documenting field activities. A photographic logbook will document the date and time the picture was taken, the subject matter, and the photograph number. This photographic record may be used to highlight and enhance appropriate sections in the report resulting from these activities.

7.4 SAMPLE DOCUMENTATION

The following sections describe requirements for sample labels, field sample identification procedures, and CoC records.

7.4.1 Sample Labels

A preprinted label will be attached to all sample containers with waterproof tape at the time of sample collection. An example of the sample label that will be used is presented in Figure 7-1. The label will be completed in indelible ink and will contain:

- Initials of collector
- Date and time sample collected (including name of collector)
- Media type
- Method matrix
- Purpose of the sample (parameter and sample group)
- Sample identification (I.D.) number
- Project number and location of sampling (i.e., compost piles)
- Installation
- Preservative used (if any).

7.4.2 Field Sample Identification Procedures

A sample identification system will be used to identify each sample collected and field QC sample prepared during the DU characterization at the JPG DU Impact Area. This identification system will provide a tracking procedure to allow information about a particular location to be retrieved easily and accurately. This system also will ensure that each sample is unique and will not be confused with any other sample. Sample I.D. codes and field sample numbers will be assigned to every compost and field QC sample collected. A complete list of field sample numbers and sample I.D.s will be maintained by the Site Manager.

Science Applications International Corporation 11251 Roger Bacon Drive Reston, VA 20190 Telephone (703) 318-4714 Fax (703) 709-1042		
Installation: ______	Project No: ______	
Location (Compost Pile No.): ______		
Sample Date/Time: ______	Media Type: ______	Method Matrix: ______
Sample I.D.: ______		
Sample No: ______		
Analysis: ______		
Preservative: ______		
Comments: ______		
		Collector's Initials: ______

Figure 7-1. Sample Label

7.4.2.1 Sample Identification

A sample identification will serve as a unique identification code for each sample collected. These sample I.D.s will be assigned before the study begins. The sample identification JP-T-CCx represents samples that will be collected. "JP" represents the JPG DU Impact Area site characterization. "T" represents the type of sample ("W" = water, "S" = soil/sediment). "(CC)" represents the sample number. "x" represents information about the groundwater well ("T" = shallow bedrock groundwater sample; "D" = deep bedrock groundwater sample), but is left blank for other media.

7.4.2.2 Duplicate and Field QC Blanks

The following QC test and flagging codes will be used to identify duplicate environmental and field QC blank samples:

- "D" entered in the flagging code field will be used to identify all field duplicates collected in the field.
- "R" entered in the QC test code field will be used to identify all rinsate blanks collected in the field.
- "F" entered in the QC test code field will be used to identify all source water blanks collected in the field.

7.4.3 Chain-of-Custody Records

Because samples collected are in support of NRC license commitments, CoC procedures will be followed. Samples will be secured from unauthorized access during the period of sampling. Prior to shipment of samples to the analytical laboratory, a properly completed CoC Record will be placed in each shipping container. Survey personnel will maintain a copy of the CoC Record (**Figure 7-2**) for verification of sample transport. Water samples must reach the analytical laboratory no later than 1 day from the time of sampling. To ensure that this schedule is met and that the laboratory has time to filter and preserve the samples if necessary, water samples should be collected on the first day of the sampling trip and shipped the following day. It is not necessary to ship the water, sediments, soils, biota, and penetrators together.

SAIC.

Chain of Custody Record

PO #: ____________ COC #: ____________

SAMPLING EVENT / PROJECT NAME: ____________

PHONE NUMBER:
CONTACT NAME:
DATA REVIEWER:

LABORATORY:
ADDRESS:

REQUIRED TAT *(circle one)*: 30hr 5days 15days 30days

Page ____ of ____

# of containers this page:

Sample ID #	Station	Date	Time	Depth/Flow/Vol.	Matrix	Requested Analyses											Comments

Special Instructions/
Comments:

Relinquished By:	Date:	Time:	Received By:	Date:	Time:

Figure 7-2. Chain-of-Custody (CoC) Record

7.5 FIELD ANALYTICAL RECORDS

Field records will be maintained to a sufficient level of detail to re-create all sampling and measurement activities. The requirements listed in this section apply to all measuring and sampling activities. Requirements specific to individual activities are listed in the section that addresses each activity. The information will be recorded with indelible ink in a permanently bound notebook with sequentially numbered pages. These records will be archived in an easily accessible form and made available to the Army upon request.

The following information will be recorded for all field activities: (1) location, (2) date and time, (3) identity of people conducting the activity, and (4) weather conditions. The following information will be recorded for field measurements: (1) the numerical value and units of each measurement, and (2) the identity of and calibration results for each field instrument.

The following additional information will be recorded for all sampling activities: (1) sample type and sampling method; (2) the identity of each sample and depth(s), where applicable, from which it was collected; (3) the amount of each sample; (4) sample description (e.g., color, odor, clarity); (5) identification of sampling devices; and (6) identification of conditions that might affect the representativeness of a sample (e.g., refueling operations, damaged casing).

Sampling and field measurements will be recorded on the forms listed in this section (**Tables 7-1 through 7-3**). Additional forms or the field logbook will be used to record such information as water level and purge data.

The results of a sampling event completed in support of the JPG DU Impact Area site characterization will be documented and provided to ISMA. The report will include, but not necessarily be limited to, planned and actual sampling events, analytical and field results, data quality assessment results, and completed forms. A draft and a final report on the sampling event will be prepared.

Procedures associated with field measurements are described in this section. Related equipment operation and maintenance procedures are identified.

Request for instrumentation to support the sampling program, including field measurements, will be made no later than 30 days prior to the scheduled departure date. Radiation detection instrumentation, and sampling tools, as well as pH, temperature, DO, and conductivity instruments, either will be rented or obtained from SAIC's equipment and supply center. Specific field measurements for groundwater, surface water, and radiation doses are described in the following paragraphs.

7.5.1 Groundwater

When collecting groundwater samples, the field parameters of pH, temperature, conductivity, DO, and turbidity will be monitored and recorded during purging of groundwater wells using a Horiba U-10 Water Quality Meter and recorded in the Groundwater Sample Collection Worksheet (Table 7-1). Well purging will be complete after the indicator parameters have stabilized within the following ranges over three consecutive readings:

- pH = 0.2 pH units
- Temperature = 1°C
- Conductivity = 10 percent
- Turbidity = 5 NTUs.

Table 7-1. Groundwater Sample Collection Worksheet for Characterization of JPG DU Impact Area Jefferson Proving Ground, Madison, Indiana

GROUNDWATER SAMPLES						
Sample I.D.	Sample Date	Exposure Reading (μR/hr)	Sample Locations	Comments		
				pH	Temp (°C)	Conductivity (MHOS)

°C = degrees Celsius
DU = depleted uranium
I.D. = identification
JPG = Jefferson Proving Ground
MHOS = ohm^{-1}
μR/hr = microroentgens per hour
MW = monitoring well
pH = hydrogen ion concentration

Table 7-2. Surface Water Sample Collection Worksheet for Characterization of JPG DU Impact Area Jefferson Proving Ground, Madison, Indiana

SURFACE WATER SAMPLES				
Sample I.D.	Sample Date	Exposure Reading (μR/hr)	Sample Locations	JPG I.D. Code

I.D. = identification
DU = depleted uranium
JPG = Jefferson Proving Ground
μR/hr = microroentgens per hour

Table 7-3. Soil and Sediment Sample Collection Worksheet for Characterization of JPG DU Impact Area Jefferson Proving Ground, Madison, Indiana

SEDIMENT SAMPLES				
Sample I.D.	Sample Date	Exposure Reading (μR/hr)	Sample Locations	JPG I.D. Code

I.D. = identification
DU = depleted uranium
JPG = Jefferson Proving Ground
μR/hr = microroentgens per hour

Measurements of static water levels will be taken prior to purging and sampling and upon completion of sampling using an electronic water level indicator. The groundwater level will be measured to the nearest 0.01 foot (0.003 meters) and from a marked survey datum on the rim of the riser. The water level measurements will be recorded on the monitor well static water level form. Wells that are dry will be noted as such. Groundwater levels will be measured in all wells to be sampled in as short a period as practical. The electronic water level indicator will be decontaminated between each monitoring well measurement.

7.5.2 Surface Water

After collecting the surface water sample, the pH, temperature, DO, and conductivity will be collected at the sample location with a Horiba U-10 Water Quality Meter and recorded in the Surface Water Sample Collection Worksheet (Table 7-2).

7.5.3 Sediment and Soil

After collecting the sediment and soil samples, the sample I.D., date, location, and I.D. code will be recorded in the Soil and Sediment Sample Collection Worksheet (Table 7-2).

7.5.4 Biota

After collecting the biota sample, the sex, weight, and any external anomalies of each deer will be recorded in the Biota Sample Collection Worksheet (**Table 7-4**).

Table 7-4. Biota Sample Collection Worksheet for Characterization of JPG DU Impact Area Jefferson Proving Ground, Madison, Indiana

BIOTA SAMPLES						
Sample I.D.	Sample Date	Sex	Weight (kg)	External Anomalies	Sample Locations	JPG I.D. Code

I.D. = identification
DU = depleted uranium
JPG = Jefferson Proving Ground
kg = kilogram
μR/hr = microroentgens per hour

7.5.5 Gamma Radiation Measurements

Radiation exposure rate measurements will be taken at 3.3 feet (1 meter) above the sample location and recorded on the respective data collection worksheet (Tables 7-1 through 7-3).

Measurements will be conducted with a portable radiation survey instrument that is sensitive to gamma radiation. The instrument should be held 3.3 feet (1 meter) above the sampling location. The radiation levels will be documented on the appropriate form (Tables 7-1 through 7-3). Any comments and notations that may be necessary for interpretation of the results should be recorded on the form.

7.6 DOCUMENTATION PROCEDURES/DATA MANAGEMENT AND RETENTION

The JPG DU Impact Area site characterization will require the administration of a central project file. The data and records management protocols will provide adequate controls and retention of all materials related to the project. Record control will include receipt from external sources, transmittals, transfer to storage, and indication of record status. Record retention will include receipt at storage areas, indexing, filing, storage, maintenance, and retrieval.

7.6.1 Record Control

All incoming materials related to the JPG DU Impact Area site characterization, including sketches, correspondence, authorizations, and logs, will be forwarded to the Project Manager or her designated assistant. These documents will be placed in the project file as soon as placement becomes practical. If correspondence is needed for reference by project personnel, a copy will be made, rather than retaining the original. All records will be legible and easily identifiable. Examples of the types of records that will be maintained in the project file include:

- Field documents
- Correspondence
- Photographs
- Laboratory data
- Reports
- Procurement agreements.

Outgoing project correspondence and reports must be reviewed by the Project Manager before mailing. The office copy of all outgoing documents will list individuals to be included in the document distribution.

7.6.2 Record Status

To prevent the inadvertent use of obsolete or superseded project-related procedures, all project and laboratory personnel will be responsible for reporting changes in protocol to the SAIC Project Manager or Laboratory Manager, who then will inform the project and laboratory staffs, respectively, upon concurrence with the SAIC QA Officer and Field Manager. No laboratory methods or procedures will be changed without approval from the Army.

Revisions to procedures will be subject to the same level of review and approval as the original document. The revised document will be distributed to all holders of the original document and discussed with project personnel. Outdated procedures will be marked "void." The voided document may be destroyed at the request of the Project Manager. However, one copy of the voided document will be maintained in the project file. The reasons for and the date the document was voided will be recorded.

7.6.3 Record Storage

All project-related information will be maintained by SAIC. Designated personnel will ensure that incoming records are legible and in suitable condition for storage. A records index will be initiated at the beginning of the overall project. Each document that is placed into the project file will be logged. The logging of the records will be the responsibility of the document custodian appointed by the Project Manager. Record storage will be conducted during and immediately following the project. SAIC will arrange for permanent storage of records directly related to the project upon conclusion of all activities at JPG.

All documents will be stored in areas or storage facilities that provide a suitable environment to minimize deterioration or damage, and that prevent loss. The facilities will, where possible, have controlled access and will provide protection from excess moisture and temperature extremes. Records will be secured in steel file cabinets that are labeled with the appropriate project identification.

At the completion of the project, the Project Manager or his appointed document custodian will be responsible for inventorying the project file. The records contained in the project file will be compared against the records listed on the file index sheets; discrepancies must be resolved prior to transferring the file to a storage facility. The final evidence file will be offered to ISMA prior to disposal. All project records will be provided to the U. S. Army in hard copy upon request following the completion of the JPG DU Impact Area site characterization. SAIC will keep copies of these records for 3 years following the close of this project.

7.6.4 Onsite Control

A file, similar to the project central file, will be established and maintained by the field personnel under the direction of the Field Manager. Upon completion of the field program, the onsite file will be transferred to and integrated with the office project files.

7.7 FIELD VARIANCE SYSTEM

Variances from the sampling procedures, QAPP, and/or HASP will be documented on a FCR form or an NCR, as appropriate. If a variance is anticipated (e.g., because of a change in the field instrumentation), the applicable procedure will be modified and approved by the QA Officer and the change noted in the field logbooks. FCRs and NCRs are processed in accordance with SAIC Field Technical Procedures.

8. SAMPLE PACKAGING AND SHIPPING REQUIREMENTS

Because samples collected are in support of NRC license commitments, CoC procedures will be followed. Samples will be secured from unauthorized access during the period of sampling. Prior to shipment of samples to the analytical laboratory, a properly completed CoC Record will be placed in each shipping container. Survey personnel will maintain a copy of the CoC Record for verification of sample transport. Water samples must reach the analytical laboratory no later than 4 days from the time of sampling. To ensure that this schedule is met and that the laboratory has time to filter and preserve the samples if necessary, water samples should be collected on the first day of the sampling trip and shipped the following day. It is not necessary to ship the water, sediments, and soils together.

Sample analysis of all environmental samples will be conducted through the analytical laboratory. Samples will be managed and analyzed in accordance with the established protocols and procedures of the analytical laboratory.

8.1 SAMPLE CONTAINERS

The analytical laboratory will provide sample containers and labels prior to the sampling event. Sample bags, labels, and coolers will be shipped to the following address:

U.S. Army
Jefferson Proving Ground
Attention: Ken Knouf
1661 West J.P.G. Niblo Road, Bldg. 125
Madison, IN 47250
(812) 273-2551

8.2 SAMPLE VOLUMES, TYPES, AND PRESERVATIVE REQUIREMENTS

The sample volumes, types, and preservative requirements are identified in **Table 8-1.**

Table 8-1. Sample Volumes, Types, and Preservative Requirements for Groundwater, Surface Water, Sediment, Soil, and Biota Samples Jefferson Proving Ground, Madison, Indiana

Sample Type	Analysis	Volume	Container	Preservative
Surface Water	Total and isotopic dissolved uranium	100 mL	Polypropylene bottle	4°C
Sediment/Soil	Total and isotopic uranium	8 ounces	Glass jar	NA
Groundwater	Total and isotopic dissolved uranium	100 mL	Polypropylene bottle	4°C
Biota	Total and isotopic uranium	75-100 grams	Ziploc® Bags (Double Bagged)	Frozen upon collection or field dressing/dissection

ml = milliliter
L = liter
°C = degrees Celsius
NA = not applicable

8.3 PACKAGING POTENTIALLY RADIOACTIVE MATERIALS

Because of the potential for environmental samples collected from the JPG DU Impact Area to contain radioactive material (DU), samples to be shipped offsite will be prepared, packaged, and shipped in accordance with SAIC St. Louis Health Physics procedures.

All personnel involved in the collection, packaging, and shipment of hazardous materials (as defined by the Department of Transportation) will be trained in accordance with 49 CFR 172, Subpart H and this training will be current (within 3 years). Training records sufficient to demonstrate compliance will be maintained in accordance with applicable regulatory and SAIC requirements.

8.4 QUALITY CONTROL SAMPLES

In accordance with the QAPP (Appendix A), QC samples will be collected to achieve data quality objectives. These samples include MS/MSD, field duplicate, and field replicate samples.

MS/MSD samples will be collected to evaluate the accuracy and precision of the analysis and the matrix effect of the sample on the analytical methodology. A pair of MS/MSD samples will be collected for every 20 samples of similar matrix received at the laboratory (10 percent). MS/MSD samples do not release the laboratory from its own QC requirements for laboratory control samples (LCSs).

A field duplicate sample is a second sample collected at the same location as the original sample. Duplicate samples are collected simultaneously or in immediate succession, using identical recovery techniques, and are treated in an identical manner during storage, transportation, and analysis. The sample containers are assigned an I.D. number in the field so that they cannot be identified (blind duplicate) as duplicate samples by laboratory personnel conducting the analysis. Specific locations are designated for collection of field duplicate samples prior to the beginning of sample collection. Field duplicates will be collected at a ratio of 1 per 10 investigative samples collected.

8.5 SAMPLE IDENTIFICATION

All sample containers will have the following information listed on the label:

- Unique sample I.D.
- Date and time of sample collection
- Source of sample (including name, location, and sample type)
- Designation of MS/MSD
- Preservative used
- Analyses required
- Name of collector(s).

8.6 SAMPLE CUSTODY

Procedures to ensure the custody and integrity of the samples begin at the time of sampling and continue through transport, sample receipt, preparation, analysis and storage, data generation and reporting, and sample disposal. Records concerning the custody and condition of the samples are maintained in field and laboratory records.

SAIC will maintain CoC records for all field and field QC samples (Figure 7-1). A sample is defined as being under a person's custody if any of the following conditions exist: (1) it is in his/her possession; (2) it is in his/her view, after being in his/her possession; (3) it was in his/her possession and he/she locked it up; or (4) it is in a designated secure area.

All sample containers will be sealed in a manner that will prevent or allow for detection of tampering if it occurs. Furthermore, each sample will be uniquely identified, labeled, and documented in the field at the time of collection.

Samples collected in the field will be transported to the laboratory as expeditiously as possible. When a 4°C requirement for preserving the sample is indicated, the samples will be packed in ice or chemical refrigerant to maintain the temperature of the samples at 4°C ± 2°C during collection and transportation. Biota samples will be immediately frozen upon field dressing, dissection, or collection, depending on the biota type (e.g., deer, earthworms, plants). A temperature blank will be included in every cooler and used to determine the internal temperature of the cooler upon receipt of the cooler at the laboratory. If the temperature of the samples upon receipt exceeds the temperature requirements, the exceedance will be documented in laboratory records and discussed with SAIC's QA Officer and Project Manager. Decisions regarding the potentially affected samples also will be documented.

After samples reach the laboratory, they will be checked against information reported on the CoC forms for anomalies. The condition, temperature, and appropriate preservation of the samples will be checked and documented on the CoC form. The occurrence of any anomalies in the received samples and decisions regarding the potentially affected samples will be documented in laboratory records.

The laboratory will confirm sample receipt and login information through the transmission of an LOR to the SAIC QA Officer. Within 24 hours of sample receipt, the laboratory will send a facsimile or e-mail a copy of the completed CoC form, related log-in information, and a report specifying the condition of the samples upon receipt.

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9. INVESTIGATION-DERIVED WASTES

Waste management (e.g., purged groundwater, equipment decontamination liquids, and disposable personal protective clothing) will be addressed on a site-by-site basis. Waste may be classified as noninvestigative waste or IDW.

Noninvestigative waste, such as litter and household garbage, will be collected on an as-needed basis at each sample location in a clean and orderly manner. This waste will be containerized and transported to a JPG-designated collection bin. Acceptable containers will be sealed boxes or plastic garbage bags.

IDW, such as soil and rock cuttings and discharged groundwater from borehole advancement and well construction activities, will be containerized and temporarily stored at each site prior to transport to a JPG-designated storage location. Acceptable containers will be sealed, U.S. Department of Transportation (DOT)-approved steel 55-gallon drums or small dumping bins with lids. The containers will be transported to prevent spillage or particulate loss to the atmosphere.

Each container will be labeled properly with site identification, sampling point, depth, matrix, constituents of concern, and other pertinent information for waste management.

IDW generated during groundwater sampling includes purged groundwater, equipment decontamination liquids, and disposable personal protective clothing. Purged groundwater and equipment decontamination liquids will be containerized in 55-gallon drums. Mixing of the fluids is permissible. The drums will be labeled and transported to a secure staging area designated by JPG. In no instance will a drum containing IDW be left unattended at an unsecured location. The drums will be staged on pallets (with built-in secondary containment) and covered with plastic sheeting. Disposable personal protective equipment (PPE) will be placed in plastic bags and disposed of in a site dumpster. PPE will be scanned for radiological contamination prior to disposal.

Once samples have been collected from deer, the carcasses will be scavenged at a location designated by USFWS. Meat collected from the adjacent hunting zones and northern hunting zones may be donated. All scavenging within the DU Impact Area will be conducted by USFWS, while scavenging in the other hunting areas may be a collaboration between USFWS and SAIC.

After field activities are completed, a representative sample of the wastewater will be collected for analysis. The sample will be a composite composed of liquid from each drum of liquid IDW. Based on the results of the analysis, an appropriate disposal option will be selected. If the water meets the discharge limits, it will be released to the ground surface. If water analyses indicate that levels exceed discharge limits, the water will be transported and disposed of offsite.

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10. FIELD ASSESSMENT/THREE-PHASE INSPECTION PROCEDURES

Field assessments/three-phase inspection procedures are components of contractor quality control (CQC), which is a management system for ensuring construction activities comply with contract requirements. At this time, the JPG DU Impact Area characterization study does not include the construction of any structures.

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11. NONCONFORMANCE/CORRECTIVE ACTIONS

When a significant condition adverse to quality is noted at the project site, laboratory, or subcontractor locations, the cause of the condition will be determined and corrective action taken to preclude repetition. Condition identification, cause, reference documents, and corrective action planned to be taken will be documented and reported to the SAIC Project Manager, QA Officer, Field Manager, and involved subcontractor management, as a minimum. Implementation of corrective action will be verified by documented follow-up action. All project personnel have the responsibility, as part of their normal work duties, to promptly identify, solicit approved correction for, and report conditions adverse to quality.

11.1 INITIATION OF CORRECTIVE ACTION

Corrective actions may be initiated as a result of the following circumstances, as a minimum:

- When predetermined acceptance standards are not met (objectives for precision, accuracy, and completeness)
- When procedures or data compiled are determined to be incorrect
- When equipment or instrumentation is found incorrectly operated or maintained
- When the custody of the samples and analytical results cannot be traced with certainty
- When QA requirements have not been achieved
- When designated approvals have not been obtained
- As a result of nonconformances observed during system and performance audits
- As a result of a management assessment
- As a result of unsatisfactory laboratory or interlaboratory comparison studies or performance evaluation results.

11.2 PROCEDURE DESCRIPTION

Project management and staff, including field investigation teams, QA auditors, document and sample control personnel, and laboratory groups, monitor ongoing work performance in the normal course of their daily responsibilities.

Work will be audited at the site, laboratory, and subcontractor locations by the SAIC QA Manager or designee. Noncompliant items, activities, or documents will be documented and corrective actions mandated by submittal of a Nonconformance Report (NCR) (as presented in **Figure 11-1**) specific to each item, activity, or document, and attached to the audit report. NCR forms are logged, maintained, and controlled by the QA Officer. NCRs will be directed to the SAIC Project Manager for response and concurrence on corrective action procedures. The SAIC QA Officer will verify that all appropriate corrective action procedures have been conducted, the nonconformance has been resolved, and the corrective measures taken will prevent a recurrence.

Following identification of an adverse condition or QA problem, notification of the deficiency will be made to the SAIC Project Manager and the senior individual in charge of the activity found to be deficient, along with recommendations for correction. A record of this notification will be attached to the audit report. Following implementation of corrective action, the senior individual in charge will report actions taken and results to the SAIC Project Manager and QA Officer. The QA Officer will notify the Army when conditions adverse to quality have been corrected. A record of action taken and results will be attached to the audit report.

NONCONFORMANCE REPORT	DATE OF NCR	NCR NUMBER	
	LOCATION OF NONCONFORMANCE		PAGE— OF—
INITIATOR (NAME/ORGANIZATION/ PHONE)	FOUND BY		DATE FOUND
RESPONSIBLE ORGANIZATION/INDIVIDUAL			PROGRAM
			PROJECT
DESCRIPTION OF NONCONFORMANCE		CATEGORY:	

A — INITIATOR — DATE — QA/QC OFFICER — DATE — CAR REQ'D — YES ☐ — NO ☐

DISPOSITION:

PROBABLE CAUSE:

ACTIONS TAKEN TO PREVENT RECURRENCE:

B — PROPOSED BY: — NAME — DATE

JUSTIFICATION FOR ACCEPTANCE:

C — INITIATOR: — NAME — DATE

VERIFICATION OF DISPOSITION AND CLOSURE APPROVAL

REINSPECTION/RETEST REQUIRED YES ☐ NO ☐ IF YES; — DATE — RESULT

D — QUALITY ASSURANCE: — NAME — DATE

Figure 11-1. Nonconformance Report

Corrective actions may be required for two major types of problems: analytical/equipment problems and noncompliance with criteria. Analytical and equipment problems may occur during sampling, sample handling, sample preparation, laboratory instrumental analysis, and data review.

Noncompliance with specified criteria and analytical/equipment problems will be documented through a formal corrective action program at the time the problem is identified. The person identifying the problem is responsible for notifying the SAIC Project Manager, who will notify ISMA. When the problem is analytical in nature, information on the problem will be communicated promptly to the SAIC QA Officer. Implementation of corrective action will be confirmed in writing.

Any nonconformance with the established QC procedures in the QAPP or ERM Program Plan will be identified and corrected in accordance with the QAPP. The Project Manager or his/her designee will issue an NCR for each nonconforming condition.

Corrective actions will be implemented and documented in the field record book. No staff member will initiate corrective action without prior communication of findings through the proper channels. If corrective actions are deemed insufficient, work may be stopped through a stop-work order issued by the Project Manager and/or ISMA.

11.3 SAMPLE COLLECTION/FIELD MEASUREMENTS

Technical staff and project personnel will be responsible for reporting all suspected technical and QA nonconformance or suspected deficiencies of any activity or issued document by reporting the situation to the Project Manager or his/her designee. The Project Manager will be responsible for assessing the suspected problems in consultation with the QA Officer and Field Manager to make a decision based on the potential for the situation to impact data quality. If the situation warrants a reportable nonconformance and corrective action, the Project Manager will complete an NCR.

The Project Manager will be responsible for ensuring that corrective actions for nonconformance are initiated by the following:

- Evaluating all reported nonconformance items
- Controlling additional work on nonconforming items
- Determining disposition or action to be taken
- Maintaining a log of nonconformance
- Reviewing NCRs and corrective actions taken
- Ensuring that NCRs are included in the final site documentation project files.

If appropriate, the Project Manager will ensure that no additional work dependent on the nonconforming activity is conducted until the corrective actions are completed.

Corrective action for field measurements may include the following:

- Repeating the measurement to check the error
- Checking for all proper adjustments for ambient conditions, such as temperature
- Checking the batteries
- Recalibrating equipment
- Checking the calibration
- Modifying the analytical method, including documentation and notification (i.e., standard additions)
- Replacing the instrument or measurement devices
- Stopping work (if necessary).

The Project Manager or his/her designee is responsible for all site activities. In this role, he/she at times may be required to adjust the site activities to accommodate activity-specific needs. When it becomes necessary to modify an activity, the responsible person notifies the Project Manager of the anticipated change and implements the necessary change after obtaining the approval of the SAIC Project Manager and ISMA. All such changes will be documented on an FCR that will be signed by the initiators and the Project Manager. The FCR for each document will be numbered serially as required. The FCR will be attached to the file copy of the affected document. The Project Manager must approve the change in writing or verbally before field implementation. If unacceptable, the action taken during the period of deviation will be evaluated in order to determine the significance of any departure from established program practices and actions taken.

The Project Manager for the site is responsible for controlling, tracking, and implementing the identified changes. Reports on all changes will be distributed to all affected parties, including ISMA. ISMA will be notified whenever program changes in the field are made.

11.4 LABORATORY ANALYSES

Laboratory QA plans will provide systematic procedures to identify out-of-control situations and document corrective actions. Corrective actions will be implemented to resolve problems and restore malfunctioning analytical systems. Laboratory personnel will receive QA training and be made aware that corrective actions are necessary for the following situations:

- QC data are outside warning or control windows for precision and accuracy.
- Blanks contain target analytes above acceptable levels and must be investigated.
- Undesirable trends are detected in spike recoveries or RPD between duplicates.
- There are unusual changes in detection limits.
- Deficiencies are detected by internal audits, external audits, or performance evaluation sample results.
- Inquiries concerning data quality are received.

Corrective action procedures often are handled at the bench level by the analyst who reviews the preparation or extraction procedure for possible errors and checks such factors as instrument calibration, spike and calibration mixes, and instrument sensitivity. If the problem persists or cannot be identified, the matter is referred to the Laboratory Supervisor, Manager, and/or QA Department for further investigation. When resolved, full documentation of the corrective action procedure is filed with project records and the laboratory QA Department, and the information is summarized within case narratives.

Corrective actions may include, but are not limited to, the following:

- Reanalyzing the samples if holding time criteria permit
- Evaluating blank contaminant sources, eliminating these sources, and reanalyzing
- Modifying the analytical method (i.e., standard additions) with appropriate notification and documentation
- Resampling and analysis
- Evaluating and amending sampling procedures
- Accepting data and acknowledging the level of uncertainty.

If resampling is deemed necessary due to laboratory problems, the Project Manager will identify the necessary recovery approach to implement the additional sampling effort.

The following corrective action procedures will be required:

- Problems noted during sample receipt will be documented in the appropriate laboratory LOR. The QA Officer, Project Manager, and ISMA will be contacted immediately to determine problem resolution. All corrective actions will be documented thoroughly.
- When sample extraction/digestion or analytical holding times are not within method-required specifications, the QA Officer, Project Manager, and ISMA will be notified immediately to determine problem resolution. All corrective actions will be documented thoroughly.
- All initial and continuing calibration sequences that do not meet method requirements will result in a review of the calibration. When appropriate, reanalysis of the standards or reanalysis of the affected samples back to the previous acceptable calibration check is warranted.
- All appropriate measures will be taken to prepare and clean up samples in an attempt to achieve the practical quantitation limits as stated. When difficulties arise in achieving these limits, the laboratory will notify the QA Officer, Project Manager, and ISMA to determine problem resolution. All corrective actions will be documented thoroughly.
- Any dilutions impacting the practical quantitation limits will be documented in case narratives along with revised quantitation limits for those analytes affected. Analytes detected above the method detection limits, but below the practical quantitation limits, will be reported as estimated values.
- Failure of method-required QC to meet the requirements specified in this FSP will result in review of all affected data. Resulting corrective actions may encompass those identified earlier. The QA Officer, Project Manager, and ISMA will be notified as soon as possible to discuss possible corrective actions, particularly when unusual or difficult sample matrices are encountered.

When calculation and reporting errors are noted within any given data package, reports will be reissued with applicable corrections. Case narratives will clearly state the reasons for reissuance of reports.

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APPENDIX A

QUALITY ASSURANCE PROJECT PLAN

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TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF ACRONYMS AND ABBREVIATIONS

ASTM	American Society for Testing and Materials
%R	Percent Recovery
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
CoC	Chain-of-Custody
DOT	U.S. Department of Transportation
DQO	Data Quality Objective
DU	Depleted Uranium
EPA	U.S. Environmental Protection Agency
FCO	Field Change Order
FCR	Field Change Request
HASP	Health and Safety Plan
HSWP	Health and Safety Work Permit
I.D.	Identification
ISMA	Installation Support Management Activity
JPG	Jefferson Proving Ground
LCS	Laboratory Control Sample
LIMS	Laboratory Information Management System
LOR	Letter of Receipt
MCL	Materials and Chemistry Laboratory, Inc.
MDC	Minimum Detectable Concentration
MDL	Method Detection Limit
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NCR	Nonconformance Report
NEIC	National Enforcement Investigations Center
NIST	National Institute of Standards and Technology
NRC	Nuclear Regulatory Commission
NTU	Nephelometric Turbidity Units
PARCC	Precision, Accuracy, Representativeness, Comparability, and Completeness,
PID	Photoionization Detector
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
QCSR	Quality Control Summary Report
RL	Reporting Limit
RPM	Radiation Protection Manager
RPD	Relative Percent Difference
SAIC	Science Applications International Corporation
SHSO	Site Health and Safety Officer
SOP	Standard Operating Procedure
TO	Task Order
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service

A.1 PROJECT DESCRIPTION

This document presents the overall Quality Assurance Project Plan (QAPP) for activities to be conducted by Science Applications International Corporation (SAIC) during the Jefferson Proving Ground (JPG) Depleted Uranium (DU) Impact Area site characterization. This effort is a part of the Nuclear Regulatory Commission (NRC) License SUB-1435 amendment. The U.S. Army and the U.S. Environmental Protection Agency (EPA) require that all environmental monitoring and measurement efforts mandated or supported by these organizations participate in a centrally managed quality assurance (QA) program. Any party generating data for this project has the responsibility to implement minimum procedures to ensure that the precision, accuracy, representativeness, comparability and completeness (PARCC) of its data are known and documented. To ensure that these responsibilities are met uniformly, each party must adhere to the QAPP.

This QAPP presents the overall organization, objectives, functional activities, and QA and quality control (QC) activities associated with the JPG DU Impact Area site characterization. It describes the specific protocols that will be followed for sampling, sample handling and storage, chain-of-custody (CoC), and laboratory analysis. This plan also presents information regarding data quality objectives (DQOs) for the program, sampling and preservation procedures for samples collected in the field, field and sample documentation, sample packaging and shipping, and laboratory analytical procedures for all media sampled.

All QA/QC procedures are based on applicable professional technical standards, EPA requirements, Government regulations and guidelines, and specific project goals and requirements. This QAPP was prepared in accordance with EPA QAPP and U.S. Army Corps of Engineers (USACE) guidance documents, such as *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans* (EPA 1991), *Data Quality Objectives Process* (EPA 1993), *EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations* (EPA 1994a), and *Requirements for the Preparation of Sampling and Analysis Plans* (USACE 2001). This document will be utilized in conjunction with the FSP and site Health and Safety Plan (HASP).

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A.2 PROJECT ORGANIZATION AND RESPONSIBILITIES

The overall organizational chart presented in the FSP outlines the management structure that will be used to implement the site environmental monitoring efforts at the DU Impact Area. Functional responsibilities of key personnel implementing this QAPP are described in this section. The assignment of Science Applications International Corporation (SAIC) personnel to each position will be based on a combination of (1) experience in the type of work to be conducted, (2) experience working with U.S. Army personnel and procedures, (3) a demonstrated commitment to high quality and timely job performance, and (4) staff availability.

A.2.1 PROJECT MANAGER

The SAIC Project Manager manages the overall performance and quality of the JPG DU Impact Area site characterization program for the U.S. Army Installation Support Management Activity (ISMA) under USACE Contract No. F44650-99-D0007, Task Order (TO) CY02. This individual oversees the SAIC Field Manager in meeting project goals and objectives in a high-quality and timely manner. In coordination with the Field Manager and the QA Officer, this individual will address issues including identification of non-conformances and verification of corrective action.

A.2.2 FIELD MANAGER

The Field Manager is responsible for assisting the Project Manager in meeting project goals and objectives in a high-quality and timely manner and coordinating project activities, including field activities, data management, and data reporting. The Field Manager will support the Project Manager in addressing nonconformance issues and verifying corrective actions. The Field Manager is responsible for implementing all field activities in accordance with the FSP and this QAPP. This individual is responsible for ensuring proper technical performance of field sampling activities, adherence to required sample custody and other related QA/QC field procedures, coordination of field personnel activities, checks of all field documentation, and preparation of Field Change Orders (FCOs) if required.

A.2.3 QUALITY ASSURANCE OFFICER

The QA Officer is responsible for project QA/QC in accordance with the requirements of the QAPP, other work plan documentation, and appropriate management guidance. This individual will be responsible for participating in the project field activity readiness review; approving variances during field activities before work continues; approving, evaluating, and documenting the disposition of Nonconformance Reports (NCRs); and designing audit/surveillance plans followed by supervision of these activities.

The QA Officer reviews analysis reporting conducted by the subcontract laboratory/laboratories in accordance with the requirements defined in this QAPP. This individual coordinates the shipment of samples to the analytical laboratory. This individual will be responsible for resolving questions the laboratory may have regarding QAPP requirements and deliverables and coordinating data reduction, validation, and documentation activities related to sample data package deliverables received from the laboratories. The QA Officer reports directly to the Project Manager.

A.2.4 SITE SAFETY AND HEALTH OFFICER

The Site Health and Safety Officer (SHSO) is responsible for ensuring that health and safety procedures designed to protect personnel are maintained throughout the field activities. This will be accomplished by strict adherence to the applicable HASP. This individual, in conjunction with ISMA, will have the authority to halt field work if health or safety issues arise that are not immediately resolvable in accordance with the applicable HASP. The SHSO reports directly to the Field Manager.

A.2.5 RADIATION PROTECTION MANAGER

The SAIC Radiation Protection Manager (RPM) is responsible for addressing radiological hazards associated with the project. Specific responsibilities include the following: providing, or reviewing, radiation portions of the HASP; conducting site training and audits as needed; ensuring that the SAIC St. Louis Health Physics procedures (SAIC 2004b) are being implemented, as necessary; assessing radiological exposure measurements; and reviewing and approving Health and Safety Work Permits (HSWPs).

A.2.6 TECHNICAL AND SUPPORT STAFF

The technical and support staff will assist the Field Manager with planning, technical oversight, data interpretation, and sampling activities. The technical and support staff also will assist the Project Manager with the evaluation and resolution of construction, operation, and maintenance issues. The technical and support staff will report to the Project Manager.

A.2.7 SUBCONTRACTORS AND VENDORS

The subcontractors will be responsible for conducting work in accordance with the work plans and will follow the required health and safety practices and QA procedures. The onsite subcontractors will report to and receive direction from the Field Manager and SHSO. The laboratory subcontractor will report to and receive direction from the SAIC QA Officer. The subcontractors will interact with the Field Manager, SHSO, or QA Officer, as appropriate, to resolve discrepancies or issues that may arise during the JPG DU Impact Area site characterization. The subcontractors will provide proof of license or certification required for conducting the field and laboratory analytical work, where applicable. The planned subcontractors are a drilling company, who will conduct soil boring and monitoring well drilling and installation; the U.S. Fish and Wildlife Service (USFWS), who will collect and assist with preparation of deer specimens; Paragon Analytics, who will provide laboratory services; and Materials and Chemistry Laboratory, Inc. (MCL), who will conduct penetrator studies.

The vendors will provide the materials and supplies in accordance with the specifications and requirements in the contract agreement. The vendors will be responsible for providing the materials and supplies in a timely manner. The vendors will report either to the subcontractor or to the Field Manager, as appropriate.

A.2.7.1 Laboratory Responsibilities

The analytical responsibilities for the JPG DU Impact Area site characterization are shared between SAIC and the analytical laboratories. The key analytical personnel and responsibilities are discussed below.

A.2.7.1.1 Subcontractor Laboratories

Paragon Analytics of Fort Collins, Colorado and MCL of Oak Ridge, Tennessee, will provide the primary analytical services for SAIC. The addresses for Paragon Analytics and MCL are:

Paragon Analytics
225 Commerce Drive
Fort Collins, Colorado 80524

MCL
East Tennessee Technology Park, Building K-1006
2010 Highway 58, Suite 1000
Oak Ridge, Tennessee 37830-1702

Laboratory Project Manager—During the field activities, the laboratory Project Manager will coordinate directly with the SAIC QA Officer and Field Manager on issues pertaining to sample shipments, schedules, container requirements, and other field and laboratory logistics. The laboratory Project Manager will monitor the daily activities of the laboratory; coordinate all production activities; ensure that work is being conducted as specified in this document; and contact the SAIC Field Manager, SAIC QA Officer, and ISMA if any problems arise that would affect the quality and integrity of the data.

Laboratory Quality Assurance Manager—The laboratory QA Manager has the overall responsibility for electronic data and the laboratory data packages that have been transmitted to SAIC. The laboratory QA Manager will be independent of the laboratory, but will communicate issues through the Laboratory Director and laboratory Project Manager.

Laboratory Sample Custodian—The laboratory Sample Custodian will report to the laboratory Project Manager. The laboratory Sample Custodian will receive, inspect, and document the condition of the incoming sample containers, verify and sign CoC sheets, assign a unique identification number to each sample, initiate transfer of samples to appropriate laboratory sections, and control and monitor storage of samples and extracts.

Laboratory Technical Staff—The laboratory Technical Staff will be responsible for sample analysis and identification of corrective actions. The staff will report directly to the laboratory Division Manager.

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A.3 DATA QUALITY OBJECTIVES

The overall objective is to develop and implement procedures for field sampling, CoC, laboratory analysis, and reporting that will provide information for site evaluation and assessment. Data must be technically sound and legally defensible. Procedures for sampling, CoC, laboratory instrument calibration, laboratory analysis, reporting of data, internal QC, audits, preventive maintenance of field equipment, and corrective action are described in other sections of this QAPP. The purpose of this section is to address the objectives for data precision, accuracy, representativeness, completeness, and comparability. The JPG FSP identifies specific task objectives as they relate to site action levels. This QAPP provides the details of the analytical parameters, methods, and quantitation levels.

DQOs are qualitative and quantitative statements that specify the quality of data required to support decisions made during JPG DU Impact Area site characterization activities and are based on the end uses for the data collected.

A.3.1 PROJECT OBJECTIVES

General objectives are as follows:

- To provide data of sufficient quality and quantity to assess the nature and extent of potential contamination in the media within the JPG DU Impact Area
- To ensure that samples are collected and analyzed using approved techniques and methods and are representative of existing site conditions
- To specify QA/QC procedures for both field and laboratory methodology to meet the Army and other applicable guidance document requirements.

A.3.2 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

Laboratories are required to comply with all methods as documented. The laboratory selected for the project will be required to submit all project-relevant method standard operating procedures (SOPs) and references and the current associated method detection limit studies to Army ISMA. Attachment I of this QAPP presents the analytical method reporting limits. These analytical method SOPs are presented in Attachment II.

Definitive data represent data generated under laboratory conditions using EPA-approved procedures. Data of this type, both qualitative and quantitative, are used for determination of source, nature and extent, or characterization.

A.3.2.1 Level of Quality Control Effort

To assess whether QA objectives have been achieved, analyses of specific field and laboratory QC samples will be required. These QC samples include field duplicates, laboratory method blanks, laboratory control samples (LCSs), laboratory duplicates, rinsate blanks, source water blanks, and matrix spike/matrix spike duplicate (MS/MSD) samples. Analytical criteria that are expected to apply to the JPG DU Impact Area site characterization program are discussed in Section A.8.

Field duplicates will be submitted for analysis to provide a means to assess the quality of the data resulting from the field sampling program. Field duplicates, which will be collected and analyzed at a frequency of 10 percent per sample matrix, are analyzed to determine sample homogeneity and sampling methodology reproducibility.

Rinsate and water source blanks will be submitted for analysis along with field duplicate samples to provide a means to assess the quality of the data resulting from the field sampling program. Rinsate blanks are used to assess the effectiveness of field decontamination processes in conjunction with water source blanks of the site potable water source used for decontamination. Rinsate and water source blanks will be collected and analyzed at a frequency of 10 percent, or a minimum of one sample per matrix sampled.

Laboratory method blanks and LCSs are employed to determine the accuracy and precision of the analytical method implemented by the laboratory. Matrix spikes provide information about the effect of the sample matrix on the measurement methodology. Laboratory sample duplicates and MSDs assist in determining the analytical precision of the analysis for each batch of project samples. One MS/MSD sample will be designated in the field and collected for at least every 20 environmental samples.

Field instruments and their method of calibration are discussed in Section A.7. Internal QC checks are discussed in Section A.8.

A.3.2.2 Accuracy, Precision, and Sensitivity of Analysis

The fundamental QA objectives for accuracy, precision, and sensitivity of laboratory analytical data are the QC acceptance criteria of the analytical protocols. An accuracy and precision summary for the analytical parameters of this project is incorporated in **Table A.3-1** and will be consistent with the analytical protocols. Typical sensitivities (reporting limits [RLs] and minimum detectable concentration [MDCs]) required for project analyses are provided in Attachment I.

Accuracy is the nearness of a result, or the mean of a set of results, to the true or accepted value. Analytical accuracy is expressed as the percent recovery of an analyte that has been added to a blank sample or environmental sample, at a known concentration, during sample preparation. Accuracy will be determined in the laboratory through the use of MS analyses, LCS analyses, and blank spike analyses. The percent recoveries for specific target analytes will be calculated and used as a QC indication of the field procedures, matrix effects, and accuracy of the analyses conducted.

Precision is the measure of the degree of reproducibility exhibited by a set of replicate results or the agreement among repeat observations made under the same conditions. Analytical precision will be determined through the use of spike analyses conducted on duplicate pairs of environmental samples (MS/MSD) or comparison of laboratory duplicate responses. The relative percent difference (RPD) between two positive results will be calculated and used as a QC indication of the field procedures, matrix effects, and precision of the analyses conducted.

Sample collection precision will be measured in the laboratory by the analyses of field duplicates. Precision will be assessed during data validation and recorded as the RPD for two positive measurements of a given analyte.

A.3.2.3 Completeness, Representativeness, and Comparability

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount of data expected under normal conditions. The laboratory is required to provide data meeting system QC acceptance criteria for all samples tested. Overall project completeness goals take into account the potential for sample losses (e.g., breakage) and data losses (e.g., severe matrix interferences). Completeness goals are identified in Table A.3-1.

Representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition.

Table A.3-1. Sample Data Quality Objective Summary
Jefferson Proving Ground, Madison, Indiana

Sample Type	Precision Field Duplicates	RPD Laboratory Duplicates	Accuracy Laboratory (Matrix Spike)	Completeness Goals	Reporting Limits
Isotopic Uranium (U-234, U-235, U-238):					
Biota	< 50 RPD	< 35 RPD	75–125% recovery	90%	0.02 pCi/g
Sediment	< 35 RPD	< 35 RPD	75–125% recovery	90%	2 pCi/g
Surface Water/ Groundwater	< 25 RPD	< 25 RPD	75–125% recovery	90%	1 pCi/L
Inorganic Parameters in Water:					
Metals	< 30 RPD	< 25 RPD	75–125% recovery	90%	TBD
Anions	< 30 RPD	< 25 RPD	75–125% recovery	90%	TBD
Alkalinity	< 30 RPD	< 25 RPD	75–125% recovery	90%	TBD

pCi/g = Picocuries per gram
pCi/L = Picocuries/liter
RPD = Relative percent difference

Representativeness is a qualitative parameter that depends upon the proper design of the sampling program and proper laboratory protocol. The sampling approach was designed to provide data representative of site conditions. During development of this plan, consideration was given to site history, past waste disposal practices, existing analytical data, physical setting and processes, and constraints inherent to this investigation. The rationale of the sampling design is discussed in detail in the FSP.

Representativeness will be achieved by ensuring that the FSP is followed. The DQO for representativeness is met when proper sampling techniques are used, appropriate analytical procedures are selected and followed, and holding times are not exceeded. Representativeness will be determined by assessing the combined aspects of the QA program, QC measures, and data evaluations.

Comparability expresses the confidence with which one data set can be compared with another. The extent to which existing and planned analytical data will be comparable depends upon the similarity of sampling and analytical methods. The procedures used to obtain the planned analytical data are expected to provide comparable data.

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A.4 SAMPLING LOCATIONS AND PROCEDURES

Planned environmental sampling for the JPG DU Impact Area site characterization includes biota, soil, sediment, surface water, and groundwater. Estimated numbers of samples by media and parameter are defined in the FSP. Environmental samples will require radionuclide, metals, and inorganic analyses depending on the matrice. Field parameters, hydrogen ion concentration (pH), temperature, conductivity, dissolved oxygen, and turbidity will be measured for water samples.

The FSP presents the rationale for the planned sampling program; the number, type, and locations of samples; and sampling procedures. In addition, the FSP identifies the field equipment and supporting materials to be used for investigations outlined in the FSP. Several different types of field measurements will be conducted during the environmental sampling. A description of the field instruments and associated calibration requirements and performance checks to be used for field measurements is presented in Section 6 of the FSP and Section A.7 of this QAPP.

A.4.1 SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIMES

Sample containers, chemical preservation techniques, and holding times are presented in **Table A.4-1 through Table A.4-3,** as well as Section 8 of the FSP.

The specific number of containers required for each study will be estimated and supplied by SAIC or the laboratory. Additional sample volumes will be collected and provided, when necessary, for the express purpose of conducting associated laboratory QC (laboratory duplicates, MS/MSDs). Additional sample volumes generally apply to collecting water samples.

In the event that sample integrity, such as holding times, is compromised, resampling will occur as directed by the QA Officer. Any affected data will be qualified per data validation instructions and guidance.

A.4.2 FIELD DOCUMENTATION

Field documentation procedures, including protocol for sample numbering, are defined in Section 7 of the FSP and this section.

A.4.2.1 Field Logbooks

Sufficient information will be recorded in the field logbooks to permit reconstruction of all drilling and sampling activities conducted. Information recorded on other project documents will not be repeated in the logbooks except in summary form where determined necessary. All field logbooks will be numbered sequentially and kept in the possession of field personnel responsible for completing the logbooks or in a secure place when not being used during field work. Upon completion of the field activities, all logbooks will become part of the final project file.

A.4.2.2 Sample Numbering System

A unique sample numbering scheme will be used to identify each sample collected, following the general outline established in the FSP. The sample numbering system will use letter codes to distinguish matrices and various QC samples. Unique serial number ranges will distinguish sample type categories (e.g., regular field samples versus field duplicates). In addition, location numbers in the form of sample location identification (I.D.) will be documented on the CoC for each sample collected. The purpose of this numbering scheme is to provide a tracking system for the retrieval of analytical and field data on each sample. Sample I.D. numbers will be used on all sample labels, field data sheets or logbooks, CoC records, and all other applicable documentation used during each project.

Table A.4-1. Summary of Sample Containment and Sample Preservation Methods for Biota Samples DU Impact Area, Jefferson Proving Ground, Madison, Indiana

Biota Type	Parameter	Analytical Method	Sample Container		Preservation Methods	Holding Times
			Quantity	Type		
Deer (kidney, liver, muscle, and bone)	Isotopic Uranium: U-234, U-235, U-238	ASTM D3972-90M	75-100 grams	Ziploc® bags (double bagged)	Frozen upon field dressing/dissection	6 months
Other Biota (may include plants, earthworms, birds, mammals, and fish)	Isotopic Uranium: U-234, U-235, U-238	ASTM D3972-90M	75-100 grams	Ziploc® bags (double bagged)	Frozen upon collection or field dressing/dissection	6 months

ASTM = American Society for Testing and Materials

Table A.4-2. Summary of Sample Containment and Sample Preservation Methods for Soil and Sediment Samples DU Impact Area, Jefferson Proving Ground, Madison, Indiana

Parameter	Analytical Method	Sample Container		Preservation Methods	Holding Times
		Quantity	Type		
Isotopic Uranium: U-234, U-235, U-238	ASTM D3972-90M	8 ounces	Glass jar, can, or plastic bag	None	6 months

Table A.4-3. Summary of Sample Containment and Sample Preservation Methods for Surface Water and Groundwater Samples DU Impact Area, Jefferson Proving Ground, Madison, Indiana

Parameter	Analytical Method	Sample Container		Preservation Methods	Holding Times
		Quantity	Type		
Isotopic Uranium: U-234, U-235, U-238	ASTM D3972-90M	100 mL	Polypropylene bottle	HNO_3 to pH<2	6 months
Anions (nitrate, chloride, and sulfate	E300	2	1-liter, narrow-mouth amber glass, Teflon®-lined cap	Cool, 4°C	Extraction: 7 days Analysis: 40 days
Metals (calcium, potassium, magnesium, and sodium)	SW6020	1	500-mL, polyethylene bottle	HNO_3 to pH<2 Cool, 4°C	6 months
Dissolved Iron	SW6020	1	500-mL, polyethylene bottle	HNO_3 to pH<2 Cool, 4°C	6 months
Alkalinity	E310.1	1	500-mL, polyethylene bottle	Cool, 4°C	28 Days

A.4.2.3 Documentation Procedures

Labels will be affixed to all sample containers during sampling activities. Some information may be pre-printed on each sample container label. Information that is not pre-printed will be recorded on each sample container label at the time of sample collection. The information to be recorded on the labels includes the following:

- Contractor name
- Sample I.D. number
- Sample type (discrete or composite)
- Site name and sample station number
- Analysis to be conducted
- Type of chemical preservative in container
- Date and time of sample collection
- Sampler's name and initials.

Sample logbooks and CoC records will contain the same information as the labels affixed to the containers, along with sample location measurements. These records will be maintained and will document all information related to the sampling effort and the process employed. The tracking procedure to be used for documentation of all samples collected during the project field effort is outlined in the FSP.

A.4.3 FIELD VARIANCE SYSTEM

Variances from the sampling procedures, FSP, and/or HASP will be documented on a Field Change Request (FCR) form or an NCR, as appropriate. If a variance is anticipated (e.g., because of a change in the field instrumentation), the applicable procedure will be modified and approved by the QA Officer and the change noted in the field logbooks.

FCRs and NCRs are processed in accordance with SAIC Field Technical Procedures.

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A.5 SAMPLE CUSTODY AND HOLDING TIMES

EPA policy regarding sample custody and CoC protocols as described in *NEIC Policies and Procedures* (EPA 1985) will be implemented during the JPG DU Impact Area site characterization program. This custody is in three parts: sample collection, laboratory analysis, and final evidence files. Final evidence files, including originals of laboratory reports and electronic files, are maintained under document control in a secure area. A sample or evidence file is under someone's custody when it is:

- In his/her possession
- In his/her view after being in his/her possession
- In his/her possession before he/she places the file in a secured location
- In a designated secure area.

A.5.1 SAMPLE DOCUMENTATION

The sample packaging and shipment procedures summarized in the following paragraphs will ensure that samples will arrive at the laboratory with the CoC intact. The protocol for specific sample numbering using case numbers and traffic report numbers (if applicable) and other sample designations will be followed.

A.5.1.1 Field Procedures

The field sampler is responsible for the care and custody of the samples until they are transferred or properly dispatched. As few people as possible should handle the samples. Each sample container will be labeled with a sample number, date and time of collection, sampler, and sampling location. Sample labels are to be completed for each sample. The Field Manager, in conjunction with the QA Officer, will review all field activities to determine whether proper custody procedures were followed during the field work and to decide if additional samples are required.

A.5.1.2 Field Logbooks/Documentation

Samples will be collected following the sampling procedures documented in Sections 6 and 8 of the FSP. When a sample is collected or a measurement is made, a detailed description of the location will be recorded. The equipment used to collect samples will be noted, along with the time of sampling, sample description, depth at which the sample was collected, volume, and number of containers. A sample I.D. number will be assigned before sample collection. Field duplicate samples, which will receive an entirely separate sample I.D. number, will be noted under sample description. Equipment employed to make field measurements will be identified along with their calibration dates.

A.5.1.3 Transfer of Custody and Shipment Procedures

Samples will be accompanied by a properly completed CoC form. The sample numbers and locations will be listed on the CoC form. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record will document transfer of custody of samples from the sampler to another person, to a mobile laboratory, to the permanent laboratory, or to/from a secure storage area.

All shipments will be accompanied by the CoC record identifying the contents. The original record will accompany the shipment, and copies will be retained by the sampler for return to project management and the project file.

All shipments will be in compliance with applicable U.S. Department of Transportation (DOT) regulations.

A.5.2 LABORATORY CHAIN-OF-CUSTODY PROCEDURES

Custody procedures, along with the holding time and preservative requirements for samples, will be described in laboratory QA Plans. These documents will identify the laboratory custody procedures for sample receipt and log-in, sample storage, tracking during sample preparation and analysis, and laboratory storage of data.

A.5.2.1 Sample Receipt

Sample chests (packages/coolers) are transported to the laboratory. The deliverer signs, dates, and indicates the time of delivery, the number of packages, the Sample Custodian or designee, and any comments, including visible or suspected physical condition of the packages. The chests then are recorded as having been received by the laboratory Sample Custodian. The samples are checked in by the Sample Custodian for proper preservation (e.g., pH, temperature of coolant blank above 2°C or below 6°C), integrity (e.g., leaking, broken bottles), and proper and complete sample documentation and ID. The temperature of the coolant blank is noted on the CoC form. Sample chests or coolers that are not within the 4°C ± 2°C requirement are reported immediately to the laboratory Project Manager, who will call SAIC to determine if resampling will be required. All samples contained in the shipment are compared to the logsheet to ensure that all samples designated on the logsheet have been received. The Sample Custodian notes any special remarks concerning the shipment. The Sample Custodian reviews the integrity of all sample fraction containers, as well as the accuracy and clarity of all documentation received. The Sample Custodian audits a portion of all fractions requiring field preservation to ensure that they have been properly preserved, and preserves unpreserved fractions or adds additional preservative, if needed, upon receipt. Deficiencies in sample preservation, additional preservative added, and all other inadequacies are recorded on the logsheet and reported to the laboratory Project Manager.

All insufficiencies and/or discrepancies are recorded using the cooler receipt checklist and immediately reported to the appropriate laboratory Project Manager. The laboratory Project Manager informs the SAIC QA Manager and field team of any insufficiency or discrepancy noted during sample receipt. The SAIC QA Manager, upon consultation with the Project Manager and Army, may decide if resampling is required.

The laboratory confirms sample receipt and log-in information through transmission of a letter of receipt (LOR) to the SAIC QA Officer. This transmission includes returning a copy of the completed CoC, a copy of the cooler receipt checklist, and confirmation of the analytical log-in indicating laboratory sample and sample delivery group numbers. The original completed cooler receipt checklist is transmitted to SAIC with the final analytical results from the laboratory. The original CoC form is placed in the project file and a copy is placed in the lot-specific data package. If samples are divided over more than one lot, copies of the CoC forms are placed in the data packages with the reference to where the original CoC form is located.

A.5.2.2 Sample Logging, Lotting, and Labeling

Documentation in the laboratory is initiated by the Data Manager or his designee, who uses the field CoC form to initiate sample logging procedures. Each shipment of samples received is logged into the laboratory computer database. Initial entries include field sample number, date of receipt, and analyses required. These are documented in a computer-based log.

As samples for a particular aliquot are received, they are assigned a sample I.D. number. These numbers are grouped by batch. The Sample Custodian labels each container with its unique number and sample I.D. number, and the samples then are transferred to their designated storage areas.

A.5.2.3 Sample Storage

Samples are placed in appropriate storage areas in the laboratory depending on storage requirements. The Department Managers or their designees are notified that the samples have arrived through the distribution of arrival notices. The majority of the samples are stored in the main coldroom with the temperature maintained at 4°C ± 2°C. The temperature of the coldroom is monitored daily and the temperature is recorded in a logbook. The Sample Custodian scans the samples delivered into the coldroom. Access to samples is limited to authorized personnel. A sample request form is used to inform the Sample Custodian of the need for samples requiring preparation and/or analysis. Removal of samples is documented on the internal CoC form.

A.5.2.4 Sample Tracking

Samples remain in secure storage areas, except when they are actively involved in the analytical process. The Sample Custodian distributes the requested samples to the appropriate analysts. The internal CoC form remains with the samples. All laboratory personnel taking samples out of the storage areas for analytical purposes are responsible for the care and custody of the samples from the time each sample, or fraction thereof, is received, until the sample is returned to long-term storage pending disposal. All subsets (e.g., extracts and digestates) of the sample are kept in secure storage, controlled by the appropriate Analytical Section Manager.

A.5.2.5 Laboratory and Sample Security

Samples received by the analytical laboratory are considered to be physical evidence, and are handled according to procedural safeguards established by EPA. In addition, all data generated from the sample analyses, including all associated calibrations, method blanks, and other supporting QC analyses, are identified with the project name, project number, and lot designation. All data are maintained under the proper custody. Because of the legal nature of the work, the laboratory provides complete security for samples, analyses, and data.

To ensure complete security for samples during analysis procedures, analytical samples are always in the custody of the individual technician assigned to the task. The following security measures are employed:

- Doors to the laboratory are kept closed at all times.
- Only authorized personnel and visitors under escort have access to the laboratory.
- Outside exit doors (with the emergency bar) are kept closed and locked at all times.
- All laboratory personnel are aware of the need to question and determine the legitimacy of a stranger's presence in the laboratory.
- Persons with deliveries are escorted to the laboratory from the main reception area or from the loading dock.

All personnel display identification badges at all times.

A.5.3 FINAL EVIDENCE FILES CUSTODY PROCEDURES

SAIC is the custodian of the evidence file for this project. The evidence file will include all relevant records, reports, logs, field notebooks, pictures, subcontract reports, correspondence, laboratory logbooks, and CoC forms. The evidence file will be stored in a secure, limited-access area and under custody of the Project Manager or designee.

The analytical laboratory will retain all results, supporting QC, CoCs, and original raw data for 7 years (both hard copy and electronic) in a secure, limited-access area and under custody of the laboratory Project Manager.

A.6 ANALYTICAL PROCEDURES

All analytical samples collected during this investigation will be analyzed by laboratories that were reviewed and validated by the Army. Each laboratory supporting this work will provide statements of qualifications, including organizational structure, QA Manual, and SOPs. Attachment I of this QAPP contains the analytical method reporting limits and Attachment II contains the analytical SOPs and the calibration procedures specific to each analytical method.

A.6.1 LABORATORY ANALYSIS

Principal laboratory facilities will not subcontract or transfer any portion of this work to another facility, unless expressly permitted to do so in writing by the Army.

Any proposed changes to analytical methods specified require written approval from ISMA. All analytical method variations will be identified in field change records. These may be submitted for regulatory review and approval when directed by ISMA.

Laboratory SOPs will be prepared for each analytical method. Each SOP will address the following issues:

- Procedures for sample preparation
- Instrument startup and performance check
- Procedures to establish the actual and required detection limits for each parameter
- Initial and continuing calibration check requirements
- Specific methods for each sample matrix type
- Required analyses and QC requirements.

Methods to be used for analysis of biota, soil, sediment, surface water, groundwater, and penetrator samples and associated field QC blanks collected during the JPG DU Impact Area site characterization are presented in Tables A.4-1 through A.4-3. The analytical method SOPs are presented in Attachment II and kept on file at the analytical laboratory and SAIC. Internal laboratory QC requirements for each analytical batch of samples are described in Sections A.3 and A.8.

A.6.2 FIELD SCREENING ANALYTICAL PROTOCOLS

During the JPG DU Impact Area site characterization collection activities, selected physical and chemical parameters in the biota, air, water, and soil at the site will be measured. Because field instrumentation and analytical methodology is continually being updated, field personnel are required to consult the manufacturer's instruction manual for each piece of equipment for operating procedures. Calibration of all field screening equipment will be conducted according to the manufacturer's instructions and the procedures provided in Section 6 of the FSP and Section A.7 of this QAPP.

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A.7 CALIBRATION PROCEDURES AND FREQUENCY

This section describes procedures for maintaining the accuracy of the instruments and measuring equipment that are used for conducting field tests and laboratory analyses. These instruments and equipment will be calibrated before each use or on a scheduled, periodic basis according to SAIC procedures based on manufacturer recommendations.

A.7.1 FIELD INSTRUMENTS/EQUIPMENT

Instruments and equipment used to gather, generate, or measure environmental data will be calibrated with sufficient frequency and in such a manner that accuracy and reproducibility of results are consistent with the manufacturer's specifications. All field instruments for this purpose will have unique identifiers. The SAIC Health Physicist, Field Manager, or their designee will be responsible for conducting and documenting daily calibration/checkout records for instruments used in the field.

Equipment to be used during field sampling will be examined to certify that it is in operating condition. This will include checking the manufacturer's operating manual and instructions for each instrument to ensure that all maintenance requirements are being observed. Field notes from previous sampling trips will be reviewed so that the notation on any prior equipment problems will not be overlooked, and all necessary repairs to equipment will be carried out. Spare parts for maintenance or minor repairs and redundant equipment will be available for the sampling effort.

Calibration of field instruments is governed by the SOP for the applicable field analysis method and will be conducted at the intervals specified in the SOP. If no SOP is available, calibration of field instruments will be conducted at intervals specified by the manufacturer or more frequently as conditions dictate. Calibration procedures, frequency, and results will be recorded in a field logbook.

Field instruments will include hand-held exposure rate detectors for radioactivity screening levels and photoionization detectors (PIDs) for organic vapor detection. Water quality measurement instrumentation will include a hand-held pH meter, conductivity meter, nephelometer, dissolved oxygen meter, and mercury or digital thermometer. If an internally calibrated field instrument fails to meet calibration/checkout procedures, it will be returned for service and a backup instrument will be calibrated and used in its place.

Detailed instructions on the proper calibration and use of each field instrument follow the guidelines established by the manufacturer. The technical procedures for each instrument used on this project include the manufacturer's instructions detailing the proper use and calibration of each instrument.

Exposure rate meters will be checked daily by using sealed calibration source checks. Meters will be calibrated routinely, with calibration dates clearly identified on each instrument. Calibration of health and safety instruments will be conducted daily, before use, at the intervals specified by the manufacturer, or more frequently if field personnel suspect that calibration may have been altered. Health and safety instruments will include a PID. All instruments used to measure water quality will be calibrated daily before use and more frequently if field personnel suspect that calibration has been affected by an external factor (e.g., temperature or humidity). All daily calibration check information will be recorded on the appropriate form.

A.7.2 LABORATORY INSTRUMENTS

Calibration is the process of determining and adjusting instrumental response, relative to physical or chemical standards traceable to EPA or the National Institute of Standards and Technology (NIST). Each calibration point is a reproducible reference to which all sample measurements can be correlated. To ensure that daily variances have not adversely affected the operation of the instrument, a series of calibration standards will be analyzed before any samples are analyzed. The calibration will be verified with another calibration standard each day. Calibration check standards will be analyzed according to the method specifications. Calibration of laboratory equipment will be based on approved written procedures. Records of calibration, repairs, or replacement will be filed and maintained by laboratory personnel conducting QC activities. These records will be filed at the location where the work is conducted and will be subject to a QA audit. Procedures and records of calibration will follow laboratory-specific QA plans reviewed by ISMA and the contractor. The laboratory will maintain service contracts with the applicable instrument vendor, as appropriate. Attachment II of this QAPP contains the analytical SOPs and the calibration procedures specific to each analytical method.

Records of calibration will be kept as follows:

- Each instrument will have a record of calibration with an assigned record number.
- A label will be affixed to each instrument showing I.D. numbers, manufacturer, model numbers, date of last calibration, signature of calibrating analyst, and due date of next calibration. Reports and compensation or correction figures will be maintained with each instrument.
- A written step-wise calibration procedure will be available for each piece of test and measurement equipment.
- Any instrument that is not calibrated to the manufacturer's original specifications will display a warning tag to alert the analyst that the device is out of service until corrections can be made.

A.8 INTERNAL QUALITY CONTROL CHECKS

This section describes QC checks to be conducted during field work and laboratory analyses of environmental samples.

A.8.1 FIELD SAMPLE COLLECTION

The assessment of field sampling precision and accuracy will be made by collecting field duplicates and MS/MSDs in accordance with the procedures described in Section 8 of the FSP.

A.8.2 FIELD MEASUREMENT

QC procedures for most field measurements (e.g., activity levels, pH, specific conductance) are limited to calibrating the instruments and checking the reproducibility of measurements by obtaining multiple readings on a single sample or standard. Section A.7 of this QAPP and the FSP contain more details regarding these measurements.

A.8.3 LABORATORY ANALYSIS

To ensure the production of analytical data of known and documented quality, laboratories associated with the environmental sampling will implement all applicable QC methods. Analytical QC procedures for this environmental sampling are specified in the individual method descriptions. These specifications include the types of QC checks normally required: method blanks, LCSs, MSs, MSDs, calibration standards, internal standards, tracer standards, calibration check standards, and laboratory duplicate analysis.

A.8.3.1 Quality Assurance Program

The subcontracted analytical laboratory will have a written QA program that provides rules and guidelines to ensure the reliability and validity of work conducted at the laboratory. Compliance with the QA program is coordinated and monitored by the laboratory's QA Department, which is independent of the operating departments.

Minimum project objectives for the laboratory QA program follow:

- Properly sub-sample, preserve, prepare, and store all samples and extracts
- Maintain adequate custody records from sample receipt through reporting and archiving of results
- Use properly trained personnel to analyze all samples by approved methods within holding times
- Produce scientifically sound and legally defensible data with associated documentation to show that each system was calibrated and operating within precision and accuracy control limits
- Accurately calculate, check, report, and archive all data using the Laboratory Information Management System (LIMS)
- Document all of the above activities so that all data can be independently validated.

All laboratory procedures are documented in writing as SOPs, which are approved, revised, and controlled by the QA Department. Internal QC measures for analysis will be conducted in accordance with their SOPs and as specified in the individual method requirements. Analytical SOPs are provided in Attachment II.

A.8.3.2 Quality Control Checks

Implementation of QC procedures during sample collection, analysis, and reporting ensures that the data obtained are adequate for their intended use. Analytical QC measures are used to determine if the analytical process is in control, as well as to determine the sample matrix effects on the data being generated. Both field QC and laboratory QC checks are conducted throughout the project to document potential bias in the data and to establish a basis for using the results with confidence.

Specifications include the types of QC required (e.g., duplicates, sample spikes, reference samples, controls, blanks), the frequency for implementing each QC measure, compounds to be used for sample spikes and isotopic tracers, and the acceptance criteria for the QC results.

Laboratories will provide documentation in each data package that both initial and ongoing instrument and analytical QC functions have been met. Any nonconforming analysis will be reanalyzed by the laboratory if sufficient sample volume is available. It is expected that sufficient sample volumes will be collected to provide for reanalysis if required.

A.8.3.2.1 Analytical Process Quality Control

QC procedures are described in the following paragraphs for method and extraction blanks and LCSs.

Method and Extraction Blanks

A method blank is a sample of an analyte-free substance similar to the matrix of interest (usually distilled/deionized water or silica sand) that is subjected to all of the sample preparation (digestion, distillation, extraction) and analytical methodology applied to the samples. The purpose of the method blank is to check for contamination from within the laboratory that might be introduced during sample preparation and analysis that would adversely affect analytical results. A method blank must be analyzed with each analytical sample batch. An extraction blank specifically monitors contamination that may be introduced during the extraction step for certain methods. An extraction blank must be analyzed for each extraction batch.

Laboratory Control Samples

The LCS contains known concentrations of specified target analytes and is carried through the entire preparation and analysis process. Commercially available LCSs or those from EPA may be used. LCS standards prepared in-house must be made from a source independent of that of the calibration standards. Each LCS analyte must be plotted on a control chart. The primary purpose of the LCS is to establish and monitor the laboratory's analytical process control. An LCS must be analyzed with each analytical sample batch.

Matrix and Sample-specific Quality Control

Matrix and sample-specific QC procedures are outlined in this section.

Laboratory Duplicates—Laboratory duplicates are separate aliquots of a single sample that are prepared and analyzed concurrently at the laboratory. The duplicate sample must be selected from one of the project's environmental media samples (not a blank). The primary purpose of the laboratory duplicate is to check the precision of the laboratory analyst, the sample preparation methodology, and the analytical methodology. If there are significant differences among the duplicates, the affected analytical results will be reexamined. One in 20 samples will be a laboratory duplicate, with fractions rounded to the next whole number.

Isotopic Tracers—An isotopic tracer is prepared by adding a unique isotope of the same or similar element to a sample before preparation and analysis. The purpose of this isotopic tracer is to determine the efficiency of recovery of the targeted isotope or isotopes in the sample preparation and analysis. The percent of recovery of the tracer then is used to gauge the total accuracy of the analytical method for that sample and to compensate for the effect of efficiency variations on the quantification of radiochemical activity.

Matrix Spikes and Matrix Spike Duplicates—An MS is an aliquot of a sample spiked with known quantities of specified target analytes and subjected to the entire analytical procedure. It is used to measure method accuracy and to indicate matrix effects. An MSD is a second aliquot of the same sample spiked with known quantities of the same compounds. The purpose of the MSD, when compared to the MS, is to determine precision for the method, field procedures, and matrix. MSs and MSDs are analyzed at a minimum frequency of 1 per 20 samples of a similar matrix.

Method-specific Quality Control—The laboratory must follow specific quality processes as defined by the method. These include measures such as calibration verification samples, instrument blank analysis, internal standards implementation, tracer analysis, method of standard additions utilization, serial dilution analysis, post-digestion spike analysis, and chemical carrier evaluation.

A.8.3.2.2 Temperature Blank Samples

A temperature blank is a container of water packaged along with field samples in the shipment cooler that will represent the temperature of the incoming cooler upon receipt at the laboratory. Use of these samples within a shipping container enables the receiving laboratory to assess the temperature of the shipment without disturbing any project field samples. The contract laboratory will provide a temperature blank with each cooler.

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A.9 CALCULATION OF DATA QUALITY INDICATORS

The approach to assessing the quality of field (Section A.9.1) and analytical data (Section A.9.2) is defined in this section. Sections A.9.3 and A.9.4, respectively, address project completeness and the representativeness and comparability of the data.

A.9.1 FIELD MEASUREMENTS DATA

Field results will be assessed for compliance with the required precision, accuracy, and completeness, as described in the following sections.

A.9.1.1 Precision

Duplicate biota, soil, sediment, surface water, groundwater, and penetrator samples collected at JPG and analyzed by the laboratory will assess the precision of the sampling effort. Control limits for duplicate RPDs are listed in Table A.3-1.

A.9.1.2 Accuracy

Field instruments will be calibrated daily or more frequently, if needed, to ensure accuracy of field parameter measurements. All blanks associated with each sample set will be analyzed and evaluated for cross-contamination. Blank contamination and the resulting corrective action will be assessed on an individual basis.

A.9.1.3 Completeness

The SAIC Field Manager will be responsible for ensuring that all field instrumentation and equipment are functioning properly and calibrated according to set procedures, and that all data are recorded accurately and legibly. In addition, the SAIC Field Manager will ensure that all sites are sampled for all of the specified analyses, sufficient sample volume has been provided to complete those analyses, and all of the QC samples have been included with each sample set. For the purposes of this project, the goal for completeness for each sample set shipped to the laboratory will be 100 percent. The minimum acceptable field completeness limit is 90 percent.

Field data completeness will be calculated using Equations (1a) and (1b).

Sample Collection (1a):

$$\text{Completeness} = \frac{\text{Number of Sample Points Sampled}}{\text{Number of Sample Points Planned}} \times 100\% \qquad \textbf{(1a)}$$

Field Measurements (1b):

$$\text{Completeness} = \frac{\text{Number of Valid Field Measurements Made}}{\text{Number of Field Measurements Planned}} \times 100\% \qquad \textbf{(1b)}$$

A.9.2 LABORATORY DATA

Laboratory results will be assessed for compliance with required precision, accuracy, completeness, and sensitivity, as described in the following paragraphs.

A.9.2.1 Precision

The precision of the laboratory analytical process will be determined through evaluation of LCS analyses. The standard deviation of these measurements over time will provide confidence that implementation of the analytical protocols was consistent and acceptable. These measurements will establish the precision of the laboratory analytical process.

Environmental sample matrix precision will be assessed by comparing the analytical results between laboratory duplicates and field duplicates for each analytical parameter. The RPD will be calculated for each pair of duplicate analysis using Equation (2) below and will produce an absolute value for RPD. This precision measurement is impacted by variables associated with the analytical process, influences related to sample matrix interferences, consistent implementation of sampling procedures, and degree of sample homogeneity.

$$RPD = \frac{S-D}{\frac{(S+D)}{2}} \times 100, \tag{2}$$

where

S = First sample value (original value)
D = Second sample value (duplicate value).

A.9.2.2 Accuracy

The accuracy of the laboratory analytical measurement process will be determined by comparing the percent recovery for the LCS versus its documented true value.

Environmental sample accuracy will be assessed for compliance with the established QC criteria that are described in Section A.3 using the analytical results of method blanks, reagent/preparation blanks, MS/MSDs, isotopic tracers, and field blanks. The percent recovery (%R) of MS samples will be calculated using Equation (3) below. This accuracy measurement is impacted by variables associated with the analytical process, influences related to sample matrix interferences, consistent implementation of sampling procedures, and degree of sample homogeneity.

$$\%R = \frac{A-B}{C} \times 100, \tag{3}$$

where

A = The analyte concentration determined experimentally from the spiked sample
B = The background level determined by a separate analysis of the unspiked sample
C = The amount of the spike added.

A.9.2.3 Completeness

Data completeness of laboratory analyses will be assessed for compliance with the amount of data required for decisionmaking. The completeness is calculated using Equation (4) below.

$$\text{Completeness} = \frac{\text{Number of Valid Laboratory Measurements Made}}{\text{Number of Laboratory Measurements Planned}} \times 100\% \tag{4}$$

A.9.2.4 Sensitivity

Achieving method detection limits (MDLs) for inorganics samples depends on sample preparation techniques, instrument sensitivity, and matrix effects. Therefore, it is important to determine actual MDLs through the procedures outlined in 40 Code of Federal Regulations (CFR) 136, Appendix C. MDLs will be established for each major matrix under investigation (i.e., water, sediment [soil]) through multiple determinations, leading to a statistical evaluation of the MDL.

It is important to monitor instrument sensitivity through calibration blanks and low concentration standards to ensure consistent instrument performance. It also is critical to monitor the analytical method sensitivity through analysis of method blanks, calibration check samples, and LCSs.

A.9.3 PROJECT COMPLETENESS

Project completeness will be determined by evaluating the planned versus actual data. Adjustments will be made if project field changes alter planned sample numbers during the implementation of the JPG DU Impact Area site characterization. All data not flagged as rejected by the review, verification, validation, or assessment processes will be considered valid. Overall, the project completeness will be assessed relative to media, analyte, and area of investigation. Completeness objectives are listed in Table A.3-1.

A.9.4 REPRESENTATIVENESS/COMPARABILITY

Representativeness is the term most concerned with the proper design of the sampling program. Representativeness qualitatively expresses the degree to which data accurately reflect site conditions. Factors that affect the representativeness of analytical data include appropriate sample population definitions, proper sample collection and preservation techniques, analytical holding times, use of standard analytical methods, and determination of matrix or analyte interferences. Sample collection, preservation, analytical holding time, analytical method application, and matrix interferences will be evaluated by reviewing project documentation and QC analyses.

Comparability is a qualitative term that relates a project data set to other data sets. This investigation will employ narrowly defined sampling methodologies, site audits/surveillances, use of standard sampling procedures and equipment, uniform training, documentation of sampling, standard analytical protocols/procedures, QC checks with standard control limits, and universally accepted data reporting units to ensure comparability to other data sets. Through proper implementation and documentation of these standard practices, the project will establish confidence that data will be comparable to other project and programmatic information.

Additional input to determine representativeness and comparability may be gained through statistical evaluation of data populations, compound evaluations, or dual measurement comparisons.

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A.10 CORRECTIVE ACTIONS

Corrective actions may be required for two major types of problems: analytical/equipment problems and noncompliance with criteria. Analytical and equipment problems may occur during sampling, sample handling, sample preparation, laboratory instrumental analysis, and data review.

Noncompliance with specified criteria and analytical/equipment problems will be documented through a formal corrective action program at the time the problem is identified. The person identifying the problem is responsible for notifying the SAIC Project Manager, who will notify ISMA. When the problem is analytical in nature, information on the problem will be communicated promptly to the SAIC QA Officer. Implementation of corrective action will be confirmed in writing.

Any nonconformance with the established QC procedures in this QAPP or the FSP will be identified and corrected in accordance with the QAPP. The Project Manager or his/her designee will issue an NCR for each nonconforming condition.

Corrective actions will be implemented and documented in the field record book. No staff member will initiate corrective action without prior communication of findings through the proper channels. If corrective actions are deemed insufficient, work may be stopped through a stop-work order issued by the Project Manager and/or ISMA.

A.10.1 SAMPLE COLLECTION/FIELD MEASUREMENTS

Technical staff and project personnel will be responsible for reporting all suspected technical and QA nonconformance or suspected deficiencies of any activity or issued document by reporting the situation to the Project Manager or his/her designee. The Project Manager will be responsible for assessing the suspected problems in consultation with the QA Officer and Field Manager to make a decision based on the potential for the situation to impact data quality. If the situation warrants a reportable nonconformance and corrective action, the Project Manager will complete an NCR. An example of an NCR is presented in Section 11 of the FSP.

The Project Manager will be responsible for ensuring that corrective actions for nonconformance are initiated by the following:

- Evaluating all reported nonconformance
- Controlling additional work on nonconforming items
- Determining disposition or action to be taken
- Maintaining a log of nonconformance
- Reviewing NCRs and corrective actions taken
- Ensuring that NCRs are included in the final site documentation project files.

If appropriate, the Project Manager will ensure that no additional work dependent on the nonconforming activity is conducted until the corrective actions are completed.

Corrective action for field measurements may include the following:

- Repeating the measurement to check the error
- Checking for all proper adjustments for ambient conditions, such as temperature
- Checking the batteries
- Recalibrating equipment
- Checking the calibration

- Modifying the analytical method, including documentation and notification (i.e., standard additions)
- Replacing the instrument or measurement devices
- Stopping work (if necessary).

The Project Manager or his/her designee is responsible for all site activities. In this role, he/she at times may be required to adjust the site activities to accommodate activity-specific needs. When it becomes necessary to modify an activity, the responsible person notifies the Project Manager of the anticipated change and implements the necessary change after obtaining the approval of the SAIC Project Manager and ISMA. All such changes will be documented on an FCR that will be signed by the initiators and the Project Manager. The FCR for each document will be numbered serially as required. The FCR will be attached to the file copy of the affected document. The Project Manager must approve the change in writing or verbally before field implementation. If unacceptable, the action taken during the period of deviation will be evaluated in order to determine the significance of any departure from established program practices and actions taken.

The Project Manager for the site is responsible for controlling, tracking, and implementing the identified changes. Reports on all changes will be distributed to all affected parties, including ISMA. ISMA will be notified whenever program changes in the field are made.

A.10.2 LABORATORY ANALYSES

Laboratory QA plans will provide systematic procedures to identify out-of-control situations and document corrective actions. Corrective actions will be implemented to resolve problems and restore malfunctioning analytical systems. Laboratory personnel will receive QA training and be made aware that corrective actions are necessary for the following situations:

- QC data are outside warning or control windows for precision and accuracy.
- Blanks contain target analytes above acceptable levels and must be investigated.
- Undesirable trends are detected in spike recoveries or RPD between duplicates.
- There are unusual changes in detection limits.
- Deficiencies are detected by internal audits, external audits, or performance evaluation sample results.
- Inquiries concerning data quality are received.

Corrective action procedures often are handled at the bench level by the analyst who reviews the preparation or extraction procedure for possible errors and checks such factors as instrument calibration, spike and calibration mixes, and instrument sensitivity. If the problem persists or cannot be identified, the matter is referred to the Laboratory Supervisor, Manager, and/or QA Department for further investigation. When resolved, full documentation of the corrective action procedure is filed with project records and the laboratory QA Department, and the information is summarized within case narratives.

Corrective actions may include, but are not limited to, the following:

- Reanalyzing the samples if holding time criteria permit
- Evaluating blank contaminant sources, eliminating these sources, and reanalyzing
- Modifying the analytical method (i.e., standard additions) with appropriate notification and documentation
- Resampling and analysis

- Evaluating and amending sampling procedures
- Accepting data and acknowledging the level of uncertainty.

If resampling is deemed necessary due to laboratory problems, the Project Manager will identify the necessary recovery approach to implement the additional sampling effort.

The following corrective action procedures will be required:

- Problems noted during sample receipt will be documented in the appropriate laboratory LOR. The QA Officer, Project Manager, and ISMA will be contacted immediately to determine problem resolution. All corrective actions will be documented thoroughly.
- When sample extraction/digestion or analytical holding times are not within method-required specifications, the QA Officer, Project Manager, and ISMA will be notified immediately to determine problem resolution. All corrective actions will be documented thoroughly.
- All initial and continuing calibration sequences that do not meet method requirements will result in a review of the calibration. When appropriate, reanalysis of the standards or reanalysis of the affected samples back to the previous acceptable calibration check is warranted.
- All appropriate measures will be taken to prepare and clean up samples in an attempt to achieve the practical quantitation limits as stated. When difficulties arise in achieving these limits, the laboratory will notify the QA Officer, Project Manager, and ISMA to determine problem resolution. All corrective actions will be documented thoroughly.
- Any dilutions impacting the practical quantitation limits will be documented in case narratives along with revised quantitation limits for those analytes affected. Analytes detected above the method detection limits, but below the practical quantitation limits, will be reported as estimated values.
- Failure of method-required QC to meet the requirements specified in this QAPP will result in review of all affected data. Resulting corrective actions may encompass those identified earlier. The QA Officer, Project Manager, and ISMA will be notified as soon as possible to discuss possible corrective actions, particularly when unusual or difficult sample matrices are encountered.
- When calculation and reporting errors are noted within any given data package, reports will be reissued with applicable corrections. Case narratives will clearly state the reasons for reissuance of reports.

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A.11 DATA REDUCTION, VALIDATION, AND REPORTING

The procedures for data reduction, validation, and reporting are discussed in Sections A11.1 through A.11.3, respectively.

A.11.1 DATA REDUCTION

Data reduction protocols for field measurements and analytical data are addressed in this section.

A.11.1.1 Field Measurements

All field measurements and observations will be recorded in project logbooks, field data records, or similar types of recordkeeping books. Field measurements include radioactivity levels, pH, specific conductance, turbidity, dissolved oxygen, temperature, water levels, and certain air quality parameters used for personnel health and safety protection. All data will be recorded directly and legibly in field logbooks, with all entries signed and dated. If entries must be changed, a single line will be drawn through the incorrect entry. The reason for the change will be stated, and the correction and explanation signed and dated at the time the correction is made. Field data records will be organized into standard formats, whenever possible, and retained in permanent files. Field measurements will be made by competent field geologists, engineers, environmental scientists, and technicians. The following standard reporting units will be used during all phases of the project:

- pH will be reported to 0.1 standard units
- Specific conductivity will be reported to two significant figures below 100 μmhos/cm and three significant figures above 100 μmhos/cm
- Temperature will be reported to the nearest 0.5°C
- Turbidimeter readings will be reported to 0.1 nephelometric turbidity units (NTUs)
- Dissolved oxygen meter readings will be reported to 0.1 mg/L
- Water levels measured in wells will be reported to the nearest 0.01 foot
- Soil sampling depths will be reported to the nearest 0.5 foot.

The Field Manager or his/her designee is responsible for data review of all field-generated data. This includes verifying that all field descriptive data are recorded properly, that field instrument calibration requirements have been met, all field QC data have met frequency and criteria goals, and field data are entered accurately in all applicable logbooks and worksheets.

A.11.1.2 Analytical Laboratory Data

All analytical samples collected for this investigation will be sent to Army-qualified laboratories. Data reduction, evaluation, and reporting for samples analyzed by a laboratory will be conducted according to specifications outlined in the laboratory's QA plan. Laboratory reports specifically will include documentation verifying analytical holding time compliance.

The laboratory QA Manager is responsible for assessing data quality and informing the QA Officer, Project Manager, and ISMA of any data that are considered unacceptable or require caution on the part of the data user in terms of their reliability. Data will be reduced, evaluated, and reported as described in the laboratory QA plan.

The data review process will include identification of any out-of-control data points and data omissions, as well as interactions with the laboratory to correct data deficiencies. The Project Manager may elect to repeat sample collection and analyses based on the extent of the deficiencies and their importance in the overall context of the project. The laboratory will provide flagged data to include such items as (1) concentration below required detection limit, (2) estimated concentration due to poor spike recovery, and (3) concentration of chemical also found in the laboratory blank.

Laboratories will prepare and retain full analytical and QC documentation for the project. Such retained documentation will be both hard (paper) copy and electronic storage media (e.g., magnetic tape) as dictated by the analytical methodologies employed. As needed, laboratories will supply hard copies of the retained information.

Laboratories will provide the following information in each analytical data package submitted:

- Cover sheets listing the samples included in the report and narrative comments describing problems encountered in analysis
- Tabulated results of radionuclide and miscellaneous parameters identified and quantified
- Analytical results for QC sample spikes, sample duplicates, initial and continuing calibrations, verifications of standards and blanks, standard procedural blanks, LCSs, and other deliverables as identified in Section A.11.3
- Tabulation of water analysis instrumentation detection limits determined in pure water.

A.11.2 DATA VALIDATION

Data validation procedures are specified in this section.

A.11.2.1 Data Validation Approach

A systematic process for data verification and validation will be conducted by SAIC to ensure that the precision and accuracy of the analytical data are adequate for their intended use. The greatest uncertainty in a measurement is often a result of the sampling process and inherent variability in the environmental media rather than the analytical measurement. Therefore, analytical data validation will be conducted only to the level necessary to minimize the potential of using false positive or false negative results in the decisionmaking process (i.e., to ensure accurate identification of detected versus nondetected compounds). This approach is consistent with the DQOs for the project, with the analytical methods, and for determining chemicals of concern and calculating risk.

Samples will be analyzed through implementation of definitive analytical methods. Definitive data will be reported consistent with the deliverables identified in Section A.11.3. This report content is consistent with what is understood as an EPA Level III deliverable (data forms including laboratory QC and calibration information). This definitive data then will be validated through the review process presented in Section A.11.2. DQOs identified in Section A.3 and method-specified criteria will be validated. Comprehensive analytical information will be retained by the subcontract laboratory.

The SAIC QA Officer or designee will initiate a validation of the analytical data packages. Ten percent of the data (i.e., biota, sediment, soil, surface water, and groundwater) will be validated the 1994 USEPA Contract Laboratory Program (CLP) *National Functional Guidelines for Inorganic Data Review* (USEPA 1994b), including recalculations. Ninety percent of the remaining biota data and 40 percent of the data for the remaining matrices will be validated using a modification of the 1994 USEPA CLP *National Functional Guidelines for Inorganic Data Review* (USEPA 1994b), which does not include recalculations. These 1994 USEPA CLP *National Functional Guidelines for Inorganic Data Review* (USEPA 1994b) will be modified for radiochemistry data.

As such, CLP-like Forms 1 through 14 will be reviewed to ensure that the QC results fall within appropriate QC limits for holding times, blank contamination, calibrations, MS/MSDs, LCSs, internal standards, retention times, second column confirmation, laboratory duplicates, serial dilutions, detection limits, isotopic tracers (radionuclide methods), and any other required QC data. Laboratory QC forms will be reviewed to ensure that the QC results fall within the appropriate QC limits. Recalculations will be done on the required 10 percent of the data. Any resulting data validation qualifiers will be applied and a data validation report, as previously described, will be prepared.

A secondary stage of validation will occur once the initial validation for a discrete sampling event has been completed. Individual trip blanks, equipment rinsate blanks, and field blanks will be associated with the corresponding environmental samples. These field QC blanks then will be evaluated following the same criteria as method blanks, and the associated environmental samples will be appropriately qualified.

After all of the data validation for the project has been completed, a final project data validation report will be written. This will include an overall review of all validated results including a discussion of PARCC parameters and limitations of the data.

All laboratory data are approved for presentation in the final report by the SAIC QA Officer and Project Manager. The basic activities that will be conducted as part of the laboratory data evaluation include the following:

- Validation of the laboratory data received using the relevant and applicable criteria described in the USEPA CLP *National Functional Guidelines for Inorganic Data Review* (USEPA 1994b); SW846, Third Edition with most current updates; and this document.
- Reconciliation of all data received with that proposed in this document and the analyses requested on the CoC documentation. Compilation of all missing data points and notification of the SAIC Project Manager and laboratory QA Manager.

Review of laboratory QC check data applicable to all samples in one analytical batch for all sample shipments received. Compilation of all check points outside method control ranges. Assessment of the impact of laboratory QC data on data quality.

A.11.2.2 Analytical Data Validation

Analytical data for each sampling event will be verified and validated by qualified chemists. Qualifiers signifying the usability of data will be noted and entered into an analytical database. Deficiencies in data deliverables will be corrected through direct communication with the field or laboratory, generating immediate response and efficient resolution. All significant data discrepancies noted during the validation process will be documented through NCRs, which are sent to the laboratory for clarification and correction.

Decisions to repeat sample collection and analyses may be made by the QA Officer, Project Manager, and ISMA based on the extent of the deficiencies and their importance in the overall context of the project.

All data generated for environmental sampling will be computerized in a format organized to facilitate data review, evaluation, and reporting. The computerized data set will include data qualifiers in accordance with the above-referenced protocols.

The JPG data assessment will be accomplished by the joint efforts of the QA Officer, Project Manager, and Field Manager. Data assessment will be based on the criterion that the sample was properly collected and handled according to the FSP and Sections A.4 and A.5 of this QAPP. An evaluation of data accuracy, precision, sensitivity, and completeness, based on criteria in Section A.9, will be conducted by a data assessor. This data quality assessment will indicate that data are (1) usable as a quantitative concentration, (2) usable with caution as an estimated concentration, or (3) unusable due to out-of-control QC results.

The environmental data sets will be available for controlled access by the Project Manager and authorized personnel. Data will be incorporated into summary reports as required.

A.11.3 DATA REPORTING

Laboratories will prepare and submit analytical and QC data reports to SAIC and ISMA in compliance with the requirements of this QAPP. The laboratory will be required to confirm sample receipt and log-in information. The laboratory will return a copy of the completed CoC and confirmation of the laboratory's analytical log-in to SAIC within 24 hours of sample receipt.

The subcontractor analytical laboratory will prepare and retain full analytical and QC documentation for 7 years. Such retained documentation will include all hard copies and other storage media (e.g., magnetic tape). As needed, the subcontract or analytical laboratory will make available all retained analytical data information.

A.12 PREVENTIVE MAINTENANCE PROCEDURES

A.12.1 FIELD EQUIPMENT

Field instruments will be checked and/or calibrated before they are shipped or carried to the field. Each field instrument will be checked daily against a traceable standard or reference with a known value to ensure that the instrument is in proper calibration. Instruments found to be out of calibration will be recalibrated before use in the field. If an instrument cannot be calibrated, it will be tagged for return to the supplier or manufacturer for recalibration and the SAIC Project Manager will be notified. A replacement will be shipped immediately by overnight courier. Whenever possible, duplicates of all equipment will initially be shipped to the field. For specific preventive maintenance procedures, the appropriate instrument manual should be consulted. Field personnel are strongly cautioned that these instructions are for general purposes only.

Manufacturer's procedures identify the schedule for servicing critical items to minimize the downtime of the measurement system. It will be the responsibility of the operator to adhere to this maintenance schedule and to arrange necessary and prompt service, as required. Service of the equipment, instruments, tools, and gauges will be conducted by qualified personnel. In the absence of any manufacturer-recommended maintenance criteria, a maintenance procedure will be developed by the operator, based upon experience and previous use of the equipment.

Field Meter/Calibration Log Sheets will be established in a logbook to record maintenance and service procedures and schedules. All maintenance records will be documented and traceable to the specific equipment, instruments, tools, and gauges. Records produced will be reviewed, maintained, and filed with all other project-specific documentation when and if equipment, instruments, tools, and gauges are used at the sites.

A list of critical user-replaceable spare parts such as batteries will be requested from the manufacturer and identified by the operator. These spare parts will be stored for availability and use to reduce downtime.

A.12.2 LABORATORY INSTRUMENTATION

As part of the QA/QC program, a routine preventive maintenance program is conducted by the laboratories to minimize the occurrence of instrument failure and other system malfunctions. The laboratory instrumentation preventive maintenance program is summarized in the laboratory-specific Quality Assurance Project Plan (QAPP) and is in accordance with the requirements of the Army. Most instruments are maintained by the manufacturers under contract. Each instrument is labeled with a unique number and instrument information. Instrument service records and maintenance calibrations are maintained by the appropriate section and in a logbook unique for each instrument.

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A.13 PERFORMANCE AND SYSTEM AUDITS

Performance and system audits of both field and laboratory activities will be conducted to verify that sampling and analysis are conducted in accordance with the procedures established in the FSP and this QAPP. Audits of laboratory activities may include both internal and external audits.

A.13.1 FIELD AUDITS

Internal audits of field activities (sampling and measurements) will be conducted by the QA Officer and/or Field Manager. The audits will include examination of field sampling records, field instrument operating records, sample collection, handling and packaging in compliance with the established procedures, maintenance of QA procedures, and CoC. These audits will occur at the onset of the project to verify that all established procedures are followed (systems audit).

Performance audits will follow to ensure that deficiencies have been corrected and to verify that QA practices/procedures are being maintained throughout the duration of the project. These audits will involve reviewing field measurement records, instrumentation calibration records, and sample documentation.

External audits may be conducted at the discretion of ISMA or the NRC.

A.13.2 LABORATORY AUDITS

ISMA may conduct an independent onsite systems audit of an analytical laboratory. This system's audit includes examining laboratory documentation of sample receiving, sample log-in, sample storage, CoC procedures, sample preparation and analysis, and instrument operating records. Performance audits consist of sending performance evaluation samples to designated laboratories for ongoing assessment of laboratory precision and accuracy. The analytical results of the analysis of performance evaluation samples are evaluated to ensure that laboratories maintain acceptable performance.

System audits include examination of laboratory documentation of sample receiving, sample log-in, sample storage, CoC procedures, sample preparation and analysis, and instrument and operating records. Internal performance audits also may be conducted on a regular basis. Single-blind performance samples are prepared and submitted along with project samples to a designated laboratory for analysis. The analytical results of these single-blind performance samples are evaluated to ensure that the laboratory maintains acceptable performance.

SAIC is not contracted to conduct laboratory audits; however, an audit may be accommodated if requested by ISMA. External audits may be conducted in conjunction with or at the direction of the NRC.

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A.14 QUALITY ASSURANCE REPORTS TO MANAGEMENT

QA reporting from the laboratory (Section A.14.1) and SAIC (Section A.14.2) is described in this section.

A.14.1 QUALITY ASSURANCE REPORTS

Each laboratory will provide LORs and analytical QC summary statements (case narratives) with each data package. All CoC forms will be compared with samples received by the laboratory, and an LOR will be prepared and sent to the QA Officer describing any differences in the CoC forms and the sample labels or tags. All deviations will be identified on the receiving report, such as broken or otherwise damaged containers. This report will be forwarded to SAIC within 24 hours of sample receipt and will include the following: a signed copy of the CoC form, itemized sample numbers, laboratory sample numbers, and itemization of analyses to be conducted.

Any departures from approved plans will receive prior approval from ISMA and will be documented with FCRs. These FCRs will be incorporated into the project evidence file.

SAIC will maintain custody of the project evidence file and will maintain the contents of files for this project, including all relevant records, reports, logs, field logbooks, pictures, subcontract reports, correspondence, and CoC forms. Analytical laboratories will retain all original analytical raw data information (both hard copy and electronic) in a secure, limited-access area.

A.14.2 QUALITY CONTROL SUMMARY REPORTS

At the conclusion of field environmental sampling activities and laboratory analysis, the QA Officer will validate submitted data. This activity will include assignment of flags to data, documentation of the reason(s) for the assignments, and description of any other data discrepancies. The QA Officer will then prepare a Quality Control Summary Report (QCSR), which will be included as an appendix to the final report. This report will be submitted to ISMA in accordance with the project schedule. The contents of the QCSR will include data validation documentation and discussion of all data that may have been compromised or influenced by aberrations in the sampling and analytical processes. Both field and laboratory QC activities will be summarized. Problems encountered, corrective actions taken, and their impact on project DQOs will be determined.

The following are examples of elements to be included in the QCSR as appropriate:

- Laboratory QC evaluation and summary of the data quality for each analytical type and matrix; summary of the accuracy, precision, and sensitivity from the data quality assessment
- Field QC evaluation and summary of data quality relative to data usability; summary of the accuracy, precision, and sensitivity from the data quality assessment
- Overall data assessment and usability evaluation
- QCSR consolidation and summary
- Summary of lessons learned during project implementation.

Specific elements to be evaluated within the QCSR include the following:

- Sample results
- Field and laboratory blank results
- LCS percent recovery (method dependent)
- Sample MS percent recovery (method dependent)
- MS/MSD or sample duplicate RPD (method dependent)
- Analytical holding times.

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A.15 REFERENCES

EPA (U.S. Environmental Protection Agency). 1985. National Enforcement Investigations Center (NEIC) Policies and Procedures.

EPA. 1991. Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans. QAMS-005/80.

EPA. 1993. Data Quality Objectives Process. EPA-540-R-93-071. September.

EPA. 1994a. EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations. EPA QA/R-5. January.

EPA. 1994b. EPA National Functional Guidelines for Inorganic Data Review. EPA-540/R-94/013. February.

USACE (U.S. Army Corps of Engineers). 2001. Requirements for the Preparation of Sampling and Analysis Plans. EM 200-1-3. February.

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APPENDIX B

GEOPHYSICAL PROCEDURE GP011
SURFACE ELECTRICAL IMAGING SURVEY

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An Employee-Owned Company

Geophysical Procedure
GP011

SURFACE ELECTRICAL IMAGING SURVEY

June 1998
(Revised April 2002)

Reviewed by:

George R.A. Fields

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Project Geophysicist

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TABLE OF CONTENTS

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B.1 SCOPE AND OBJECTIVES

B.1.1 SCOPE

This Geophysical Procedure (GP) provides instructions and establishes requirements for conducting surface Electrical Imaging (EI) surveys. This procedure is applicable to all Science Applications International Corporation (SAIC) personnel involved in surface EI surveys.

B.1.2 OBJECTIVES

The objective of this GP is to provide uniform methods and instructions for conducting surface EI surveys including:

1. Site preparation.
2. Survey field procedures.
3. EI data processing.

B.2 DEFINITIONS

Anomaly – An anomaly is a feature distinguished by geophysical means that is different from the general surroundings (i.e., departure from the expected or normal).

Electrical Interference – electrical input measured during the resistivity data collection from sources other than those transmitted by the resistivity system.

EI Operator – An individual or geophysicist who operates the EI surveying instruments and records the results in the field.

B.3 RESPONSIBILITIES

B.3.1 SAIC PROJECT MANAGER

The SAIC Project Manager is responsible for ensuring the EI survey crew is trained and indoctrinated in the content of this procedure and related procedures prior to performing the activity and that surface EI survey activities are documented in accordance with this geophysical procedure.

B.3.2 SAIC GEOPHYSICS MANAGER

The SAIC Geophysical Manager shall be responsible for ensuring that the EI survey is properly designed and implemented according to the objective of the investigation. The manager is also responsible for reviewing all of the survey data, data processing, reporting activities, and verifying that the data effectively achieves the objective of the investigation. The Geophysical Manager shall be responsible for the interpretation and geophysical reporting.

B.3.3 SAIC FIELD SUPERVISOR

One of the SAIC surface EI survey field crew members shall be designated as the field supervisor and shall be responsible for ensuring the completion of all applicable forms and for notifying the SAIC Project Manager or designee of site-specific activities, survey progress, problems, and results. The SAIC field supervisor shall be a geophysicist responsible for ensuring that surface EI survey activities are performed in accordance with this geophysical procedure.

B.3.4 SAIC EI SURVEY FIELD PERSONNEL

Each surface EI survey field team shall consist of appropriately trained and qualified personnel, as determined by the SAIC Project Manager. The SAIC field team shall be responsible for ensuring that surface EI survey activities are performed and documented in accordance with this geophysical procedure.

B.4 MATERIAL/EQUIPMENT AND CALIBRATION

B.4.1 MATERIAL AND EQUIPMENT

Specific equipment used to conduct surface EI surveys may consist of one or more of the items shown in Table B-1 below.

Table B-1. Surface EI Survey Specific Equipment

AGI SuperSting® resistivity system main unit
AGI SuperSting® multi-electrode cables
AGI SuperSting® test box kit and supplies
Stainless steel electrodes (84)
Two 12-volt marine batteries

Note: The AGI SuperSting® may in some instance be substituted with an AGI R1 unit. The equipment is similar except that the switch box is external and separate from the main unit. Geophysical procedures will be modified based on the usage of the R1 unit if applicable.

The following is a list of additional equipment necessary to complete a surface EI survey:

1. Two heavy hammers
2. Salt (sodium chloride)
3. Water
4. Water jugs
5. Extra rubber bands
6. Laptop computer and diskettes
7. Metric measuring tape(s)
8. Pin flags or wooden stakes/lath
9. Marking paint
10. Flagging
11. Caution tape
12. Electrical and rubber splicing tape
13. Field Logbook
14. Battery charger
15. Global Positioning System (GPS) (optional)

B.4.2 CALIBRATION REQUIREMENTS

Calibration and use of the instruments shall be in accordance with the manufacturer's instructions. Calibration checks shall be performed daily to verify the equipment is functioning properly.

B.5 METHODS

Surface EI surveys are conducted to aid in the characterization of the subsurface by locating buried features (e.g., buried structures, fractures, voids, waste pit/ trenches, bedrock/soil stratigraphy, plume delineation, top of bedrock). Instrument output of apparent ground resistivity is recorded electronically using a data logger built into the SuperSting® resistivity system main unit.

The SuperSting®, a multi-electrode switching system, passes an electrical current automatically along multiple paths at various depths and measures the resulting associated voltages. This system utilizes two arrays of multicore cables, which extend outward in opposite directions from the centrally located main unit, which contains a switching system and resistivity meter with data storage capability. Apparent resistivity measurements are automatically recorded from all possible combinations between electrode pairs. As the spacing increase, the resistivity meter measures at greater depths and increasing volumes of ground. At the completion of data collection the EI system automatically shuts the power supply off.

When performing an EI survey, SAIC typically collects the data with a dipole-dipole electrode arrangement. Other electrode configurations (such as the Schlumberger, Wenner, pole-dipole, or pole-pole) may also be appropriate to match site conditions and survey objectives. Generally, with the dipole-dipole survey method, two electrodes are used to provide current to the subsurface in one location, while two other electrodes some distance away are used to measure the voltage. The SuperSting® system is capable of being programmed to collect over six different types of arrays. For the dipole-dipole array, the SuperSting® system utilizes two electrodes to provide current to the subsurface and uses up to six additional electrodes to simultaneously measure voltage. This allows the SuperSting® to record data faster than conventional resistivity systems.

B.5.1 SURFACE EI SURVEY PREPARATION

Prior to performing surface EI surveys, the following activities should be performed:

1. Existing site information shall be reviewed such as ground surface cover (grass or asphalt) and topography changes.
2. The potential influence of cultural features (e.g., manhole covers, utilities, fences, buildings, well casings, grounding wires, and power lines) shall be evaluated.
3. Health and safety hazards shall be defined and documented within the Field Logbook.

B.5.2 SITE PREPARATION

Prior to conducting a surface EI survey, the survey traverse will be established. The traverse must be as straight as possible for the entire length of the EI traverse. The traverse should not be set up running parallel to subsurface utilities or other subsurface conductors. If a subsurface conductor is present parallel to the survey traverse, the EI traverse should be moved as far away from the conductor as possible. If a subsurface utility or conductor transects the EI traverse the location of that conductor will be noted in the field notes or on the SuperSting® Field Data Sheets.

The survey traverse end location, and individual electrode locations shall be marked with pin flags or wooden stakes/lath to provide spatial control for the EI survey team. Ideally, the traverse shall be accessible by vehicle, however field personnel should be able to transport equipment for short distances across open terrain. If necessary, the proposed traverse should have passages cut through bramble patches, thickets, or other obstructions so the placement of the electrodes can proceed.

B.5.3 SURFACE EI SURVEY FIELD PROCEDURES

A standard procedure for conducting EI surveys is provided below. The EI Field Supervisor shall conduct a visual survey along the proposed lines. The visual survey shall accomplish the following tasks:

1. Review site utility plans and complete site walkover to check for underground utilities.

2. Check for overhead features, grounded power lines, and other sources of potential electrical interference.
3. Check for manhole covers and steel-cased wells.

The location of any structure that may affect the EI survey data (i.e., subsurface utilities, ephemeral streams, changes in soil and vegetation, etc.) shall be located on a site map and the location described on the Field Logbook or on the SuperSting® Field Data Sheet.

Prior to data collection the EI operator, with advisement from the EI Field Supervisor and Geophysics Manager, chooses the array type, the appropriate number of current pairs (in electrode spacing measurements) to be used for energizing, and the maximum separation (in electrode spacing measurements) to be used for measuring the potentials. These parameters determine the total number of measurements to be collected along the electrode spread, the spatial distribution of the measurements, and the total depth of investigation. Once these parameters are determined, the EI operator can create the appropriate command file that operates the SuperSting® resistivity system. This command file is created within the AGI SuperSting® Administrator Software (SSADMIN®) and uploaded to the SuperSting® main unit. (Note: The command files can be stored within the SuperSting® main unit memory and may not need to be uploaded for every field effort.)

To set up the resistivity system, a series of stainless steel stakes (typically 56) are driven six to twelve inches into the ground at a fixed interval to establish earth contact. The SuperSting® cables and electrodes were attached to the stakes using a rubber band to complete the electrical circuits between the SuperSting® and the ground surface. These electrodes must be flush on the stake platform, clean, and dry.

Once the cable setup is complete, the EI Operator shall check the SuperSting® for adequate function (calibration). This is completed by attaching the test box to the SuperSting® (while the cables are not connected), using a small current input, and completing a test box survey. This survey is a ten-minute test that checks the measurement components of the SuperSting® main unit. This test is recorded digitally within the main unit and is identified with a file name denoted as "test__" with "___" being the site survey identifier. The test file will be downloaded to a field PC at the end of the field day.

The EI Operator shall then check the SuperSting® for sufficient charge and complete a contact resistance check using adequate current input. A contact resistance check is completed along the electrodes to ensure adequate contact with the ground surface (typically a contact resistance of less than 2,000 ohms with the earth is recommended). In the event an abnormally high contact resistance is measured, the earth is soaked with a salt/water solution to reduce the resistance. When elevated contact resistances are encountered at a site (i.e., dry sand within the near surface), pre-watering the electrode locations and allowing time for the solution to soak into the ground is recommended. Whenever possible electrode locations should be pre-watered. The contact resistance data are recorded on the SuperSting® Field Data Sheet and also within the main unit memory. These data are downloaded from the main unit memory during each download event.

The SuperSting® cables are tested prior to mobilization to the survey site and should not need to be re-tested during the field effort unless a problem is detected.

The EI Operator shall record the survey parameters on the SuperSting® Field Data Sheet (Attachment A). The SuperSting® Field Data Sheets will document the survey start and end times, the initial battery charge, contact resistance information, starting and ending electrodes, data file name, array type, and command file name. The SuperSting® Field Data Sheet is also used to document surface conditions and changes, utilities, or cultural features along the EI traverse. The starting and ending survey times are also recorded within the Field Logbook. Surface EI measured data, station numbers, and time of acquisition and various quality control values are stored within the SuperSting® main unit. Weather conditions should be noted on either the field data sheet or the Field Logbook.

Subsequent to recording the survey data, an adequate number of markers shall be left in the ground, at an appropriate spacing, for land surveying of horizontal and vertical positions.

Surface EI survey data shall be downloaded to a laptop computer after each traverse of data is collected prior to the breakdown of the EI equipment. Checks to ensure correct data transfer shall be performed. Field team comments and file names assigned to the data files during downloading shall be recorded on the SuperSting® Field Data Sheet. At the end of the field day (or more often) survey data shall be backed up onto diskettes and also sent to the SAIC Geophysics computer network for further processing and archival purposes. Following download, the SAIC Field Supervisor should perform a preliminary inversion of the data to ensure the collected data is reasonable. At a minimum, this preliminary inversion should be performed daily. (Note, if download following the completion of the EI traverse is impossible due to field logistics, at a minimum the EI data file must be checked within the SuperSting® main unit memory).

B.5.4 DATA PROCESSING AND INTERPRETATION

Surface EI survey field data shall be tracked by recording the dates of acquisition, site-specific field data file names, and corresponding file names on the SuperSting® Field Data Sheet (Attachment A) and the Geophysical Daily Log (Attachment B). Corresponding GPS data file names are also recorded on the Geophysical Daily Log or in the field log book.

Before processing, all EI field survey files shall be reviewed by the SAIC Field Supervisor to ensure data quality. Data quality parameters include reasonable root-mean-squared (RMS) errors from redundant field measurements, spatial distribution of field measurements, and minimal variation between adjacent measurement locations. EI data file names, line and station numbers, field errors, corrections made to files, and corrected file names shall be documented on EI Data Processing Form (Attachment C).

Interpretation of the raw imaging (apparent resistivity) data without reduction would provide a product very similar to electromagnetic (EM) methods (i.e., the interpretation would only be qualitative). Inversion of the data to true resistivities provides a more unique or quantitative interpretation of the data. SAIC will use the resistivity inversion program RES2DINV© to produce a two-dimensional resistivity model based on the apparent resistivity data. Using a three-step process, this program begins with the observed apparent resistivity. The apparent resistivities are calculated using finite-difference forward modeling. A resistivity pseudosection is developed with a non-linear least-squares optimization technique (deGroot-Hedlin and Constable, 1990, Loke and Barker, 1996) that is the best fit to the resistivity pseudosection. The data are then contoured using the mapping software SURFER© and record on the SURFER Data Processing Form (Attachment D).

B.6 REQUIRED INSPECTION/ACCEPTANCE CRITERIA

The EI data shall be checked for quality assurance purposes and will be preliminarily processed during the field effort. The locations of all significant preliminary anomalies identified on the color cross-sections shall be checked against the SuperSting® Field Data Sheet information (for example, the identified field locations of cultural fill, underground utilities, or other surface features). By comparing the SuperSting® Field Data Sheet information and the preliminary inversion, any indications of surface features that could contribute to the anomaly may be identified.

B.7 RECORDS

The following records generated as a result of implementation of this procedure shall be maintained in a safe manner and submitted to the project central files for storage:

1. SuperSting® Field Data Sheet
2. Daily Geophysical Operations Log
3. Site Maps
4. EI Data Processing Form
5. SURFER Data Processing Form

B.8 REFERENCES

B.8.1 REQUIREMENTS AND SPECIFICATIONS

U.S. Environmental Protection Agency, 1987. *A Compendium of Superfund Field Operations Methods.* EPA/540/P-87/001.

U.S. Environmental Protection Agency, 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*. EPA, Interim Final.

U.S. Environmental Protection Agency, 1989. *RCRA Facility Investigation Guidance*, EPA, Interim Final.

B.8.2 RELATED PROCEDURES

GP001 Geophysical Project Management
GP004 Field Activities Documentation Procedures

B.8.3 OTHERS

Manufacturer's Manual for AGI SuperSting® EI System
Users Manual for RES2DINV© inversion software

B.9 ATTACHMENTS

Attachment A	SuperSting® Field Data Sheet
Attachment B	Daily Geophysical Operations Log
Attachment C	EI Data Processing Form
Attachment D	SURFER Data Processing Form

ATTACHMENT A

SUPERSTING® FIELD DATA SHEET

Survey Date: ___________ By: ______________________________ Line # ______

Electrodes ____ to ____ Bearing: __________ Data File Name: ______________

Command File Name: ____________ Survey Site Name: ____________ Project Number: ____________

Cont.Res	Electrode
1 ——	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10
11	11
12	12
13	13
14	14
15	15
16	16
17	17
18	18
19	19
20	20
21	21
22	22
23	23
24	24
25	25
26	26
27	27
28	28
29	29
30	30
31	31
32	32
33	33
34	34
35	35

Electrode	Elevation

Battery = ______v

Start Adr = ______

End Adr = _______

Command Line Start: ____

Elect. Sep = _____m

Max Dipole (a)= ____

Nxt Dipole = ___1___

Max Sep (n)= _____

Next Sep = ___1___

Direction = Forward

Next B-Loc = 0.000

Start Survey Time: ______

End Survey Time: ______

Quality Checked? ______

Cont.Res.	Electrode
36	36
37	37
38	38
39	39
40	40
41	41
42	42
43	43
44	44
45	45
46	46
47	47
48	48
49	49
50	50
51	51
52	52
53	53
54	54
55	55
56	56

ATTACHMENT B

DAILY GEOPHYSICAL OPERATIONS LOG

<table>
<tr><th colspan="6">DAILY GEOPHYSICAL OPERATIONS LOG</th></tr>
<tr><td>Date:</td><td colspan="2"></td><td>Weather:</td><td colspan="2"></td></tr>
<tr><td>Team Leader:</td><td colspan="2"></td><td>Field Crew:</td><td colspan="2"></td></tr>
<tr><td>Project Number:</td><td colspan="2"></td><td>Project Name:</td><td colspan="2"></td></tr>
<tr><td>Site Location:</td><td colspan="5"></td></tr>
<tr><td rowspan="2">Survey Application:</td><td>o Engineering</td><td>o Utility Locating</td><td>o UXO</td><td>o Environmental</td><td>o Groundwater</td></tr>
<tr><td colspan="2">o Resource Evaluation</td><td>o Other</td><td></td><td></td></tr>
<tr><td rowspan="4">Survey Type:</td><td>o EM31</td><td>o EM61</td><td>o EM34</td><td>o EM47</td><td>o SP</td></tr>
<tr><td>o Utility</td><td>o Gravity</td><td>o Magnetometer</td><td colspan="2">o Electrical Imaging</td></tr>
<tr><td>o Resistivity</td><td>o GPR Antenna Frequency:
o Mono o Bi</td><td>o Borehole Camera
o Color o B&W</td><td colspan="2">o Borehole Geophysics Borehole Tools:</td></tr>
<tr><td>o Seismic Refraction</td><td>o Seismic Reflection</td><td colspan="3">o Other</td></tr>
<tr><td>Positioning Used:</td><td>o Tape</td><td>o Hip Chain</td><td>o GPS</td><td>o Ultra</td><td>o Professional Surveyor</td></tr>
<tr><td colspan="6">Daily Activity Summary:</td></tr>
<tr><td colspan="6">Data Recorded:</td></tr>
<tr><td colspan="6">Problems/Observations:</td></tr>
</table>

ATTACHMENT C
EI DATA PROCESSING FORM

Traverse: ________________
Project Name: ____________ Project Number: ________________ Sheet ___ of ___
Site Name: ____________________ Processed by: __________________ Date: _______

File Conversion (SSADMIN)

Input File Name (.stg): ____________________ *Output File Name (.dat):* _______________

Output File Type: 2D Dipole-Dipole Other: ______ *Format:* 2DINV Other:

Keep Negative Values? Y N *Remove Errors >* ____ X 1/10% *Output Records:* ____

ELEVATIONS

Added? Y N *File Name with Elevations (.dat)* _______________

RES2DINV

Editing Data

Pseudo Section Reversed? Y N
Points Exterminated: ____

____

____ *Output file name(.dat):* ______

Topography None — Least Squares Straight Line
Average Elevation — End to End Straight Line

Settings

Initial Damping Factor: 0.15 — Minimum Damping Factor: 0.03
Line Search: Always — Percentage Change For Line Search: 0.04%
Convergence Limit: 5.00% — Number of Iterations: 5
Finite Mesh Grid Size: 4 — Model Resistivity Values Check: Yes
Contour Intervals: Logarithmic — Increase Damping with Depth: 1.20
Vertical/Horizontal Flatness Filter Ratio: 1.00
Thickness of Model Layers Increase: 10%
Include Smoothing of Model Resistivity: No

Inversion

Method: Least Squares Inversion
Finite -Difference -Element

Jacobian Matrix Chosen:
a) Quasi-Newton Approx. for all iterations
b) Recalculate Jacobian for ALL iterations
c) Recalculate Jacobian for 2 iterations

Iteration	RMS Error
1	
2	
3	
4	
5	

Output Data: Inversion File (.inv): ____________
XYZ File (.xyz): ____________________
Edited XYZ file for Surfer (.dat): ______________

ATTACHMENT D
SURFER DATA PROCESSING FORM

(Page 1 of 1)

Traverse: ____________________
Project Name: ___________ Project Number: _________ Sheet ___ of ___
Site Name: ____________________ Processed by: ____________________
Data Type: ____________________ Date: ___________

				Comments:
INPUT FILE:	.dat	File name:		
Z data Column	-----	Column:		
DATA SUMMARY	Min.	Max.		
X:				
Y:				
Z:				
GRIDDING	-----	Grid Method:		
	-----	X Spacing:		
	-----	Y Spacing:		
	.grd	Output File name:		
BLANKING	.bln	File name:		
Blanked Grid File	.grd	File name:		
BASEMAP FILE		File name:		
POSTED DATA FILE:	.dat	File name:		
COLOR LEVEL FILE:	.lvl	File name:		
MAP SCALE	1.0"=	Length=		
X:		inches	-----	
Y:		inches	-----	
MAP LIMITS	Min:	Max		
X:			-----	
Y:			-----	
CONTOURED FILE:	.srf	File name:		

APPENDIX C

METHODOLOGY FOR SCAN DETECTION OF DEPLETED URANIUM FRAGMENTS USING 2-INCH BY 2-INCH SODIUM IODIDE (NA) DETECTOR

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APPENDIX C

METHODOLOGY FOR SCAN DETECTION OF DEPLETED URANIUM FRAGMENTS USING 2-INCH BY 2-INCH SODIUM IODIDE (NA) DETECTOR

NUREG 1507, *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions (NRC, 1998), and NUREG 1575, Multi-Agency Radiation Survey and Site Investigation Manual, Revision 1* (MARSSIM) (EPA 2000) provide examples of typical MDCs for various radionuclides using gamma scan detectors. These documents state that the MDCs provided are examples only and other scan MDC values may be equally justifiable depending on the values chosen for the various input parameters and site-specific conditions. The MDC value listed in NUREG 1507 for soil contaminated with depleted uranium is considered justifiable and sufficient. However, the use of this value is not appropriate for the detection of visible, solid DU fragments. Due to the specific activity of a depleted uranium fragment there is little doubt that the typical hotspot modeled in NUREG 1507 (0.25-centimeters radius) could be detected. The question is how small of a fragmented piece of depleted uranium can be detected with confidence.

The steps for calculating the size of a depleted uranium fragment that can be detected generally follow the approach detailed in NUREG 1507. The steps include:

1. Calculating the minimum detectable count rate (MDCR) by selecting a given level of performance, scan speed, and background level of a 2-inch by 2-inch (or 2" × 2") NaI detector,
2. Selecting a surveyor efficiency, and
3. Relating the surveyor's MDCR ($MDCR_{surveyor}$) to a given exposure rate.
4. Modeling the exposure rate of various size fragments.
5. Comparing the MDCR exposure rate to the modeled exposure rates.

The development of this relationship in item three requires two significant steps. In step one, the relationship between the detector's net counting rate to net exposure rate in counts per minute per micro-Roentgen per hour (cpm/μR/hr) is established. In step two, the relationship between the specific activity of depleted uranium and exposure rate is determined. For particular gamma energies, the relationship of the 2-inch × 2-inch NaI detector's counting rate (in cpm) and exposure rate may be determined analytically. Once this relationship is known, the $MDCR_{surveyor}$ (in cpm) of the NaI detector can be related to the minimum detectable net exposure rate. This minimum rate is used to determine the minimum detectable depleted uranium fragment by modeling a specified postulated fragment.

For determining the MDCR, an average background for the 2-inch × 2-inch NaI detector of 10,000 cpm was selected. The observable background counts is the number of background counts observed within the observation interval. This is commonly referred to as *b'*. The equation used for calculating *b'* is as follows:

$$b' = (\text{background count rate}) \times (\text{observation interval}) \times (1\ \text{min}/60\ \text{sec}) = \text{counts/interval}$$

$$b' = (10{,}000\ \text{cpm}) \times (1\ \text{sec}) \times (1\ \text{min}/60\ \text{sec}) = 166.67\ \text{counts}.$$

The observational interval of 1 second is based on the selected instrument to be used during the GPS assisted gamma walkover. The detector/meter combination will produce a data point or estimated cpm reading every second during operation. This reading will be married to a specific X Y coordinate and recorded in the associated data logger.

The MDCR is defined as the increase above background recognizable during a survey in a given period of time. The variable, *d'*, is the alpha/beta error acceptable for a given survey. Alpha and beta errors of 95 percent (true positive rate) and 60 percent (false positive rate), respectively, were selected to be consistent with NUREG 1507. Selection of a high beta error signifies that the surveyor will stop the scan at very small increases in detection signal "clicks" in order to conduct an intensified scan. This slows down the survey but provides a higher level of confidence in the results of the survey. The value of 1.38 was obtained from Table 6.1 in NUREG 1507 (Table 6.5 in MARSSIM).

MDCR = (d') × (sq. root of b') × (# of observation/minute) = cpm

MDCR = (1.38) × (sq. root 166.67) × (60 observations/min) = 1069 cpm

The $MDCR_{surveyor}$ or minimum detectable count rate of the surveyor is defined as the increase above background during a survey that will be identified as an increase by the surveyor. Surveyor efficiency was selected to be 50 percent, consistent with NUREG 1507:

$MDCR_{surveyor}$ = (MDCR) / (sq. root of surveyor efficiency)

$MDCR_{surveyor}$ = (1069) / (sq. root of 0.5) = 1512 cpm.

An estimated exposure rate for various sizes of square depleted uranium fragments was obtained by modeling with Microshield Version 5.01. A rectangular volume of depleted uranium with various lengths and a constant width and thickness of 1.0 centimeter was selected. The modeled exposure rate was used to calculate the expected increase in count rate above background for the 2" × 2" NaI detector. Using the same parameters as above, the same sizes of depleted uranium fragments were modeled with 5 centimeters (approximately 2 inches) of soil cover material. The density of the soil was estimated at 1.5 g/centimeters^3. Table 1 shows the size of the depleted uranium fragment, associated cpm increase for a sodium iodide 2" × 2" modeled for a fragment located on the ground surface, and the associated cpm increase for a 2" × 2" NaI detector modeled for a fragment covered with 5 centimeters of soil.

Table 1. Modeled Count Rate versus DU Fragment Size
Jefferson Proving Ground, Madison, Indiana

DU Fragment Size (centimeters^3)	Net count rate with DU fragment on ground surface (cpm)[1]	Net count rate with DU fragment beneath 5 centimeters of soil (cpm)[1]
1.0	2058	1081
2.0	4065	2147
3.0	5976	3186
4.0	7756	4186
5.0	9385	5137
6.0	10853	6032
7.0	12162	6865
8.0	13321	7637
9.0	14337	8347
10.0	15227	8994

[1] Net count rate using a 2"x2" NaI detector.

Since the $MDCR_{surveyor}$ = 1512 cpm a one cubic centimeter depleted uranium fragment located on the surface of the survey area is capable of being detected. However, survey experience has shown that random background fluctuation interferes with recognizing a 1500 cpm increase in count rates. An investigation level of 2,000 cpm above relevant background is typically established and used as a field screening value. Setting 2,000 cpm above background as the investigation level maintains the size of detectable DU fragments on the ground surface to 1.0 cubic centimeters when the detector is located directly above the fragment for one second. Maintaining the investigation level constant at 2,000 cpm above relevant background establishes that a 2 cubic centimeters depleted uranium fragment buried beneath 5 centimeters of soil can be detected when the detector is located directly above the fragment for one second. As shown in the table, in both cases, as the size of the fragment increases the modeled count rate increases. The larger the fragment size the easier it becomes to detect.

However, the detection of the above fragments is dependent on the detector being positioned directly above the fragment for the entire 1 second count interval. The typical scan rate employed during gamma walkovers is 0.5 meters per second. This means that the detector will cover approximately 0.5 m^2 or 50 square centimeters in one second. Therefore, during a typical scan survey the detector would only be positioned above the fragment for a fraction of the 1 second count time.

To maintain the required confidence that the fragment would be detected during a normal scan survey the lowest count rate for a specific size depleted uranium fragment obtainable in the 1 second count rate window when normalized to cpm must be greater than 2,000 cpm. The lowest obtainable count rate within the 1 second count rate window when moving at 50 centimeters per second would occur 25 centimeters from the fragment.

An estimated exposure rate 25 centimeters from various sizes of square depleted uranium fragments was obtained by modeling with Microshield Version 5.01. A rectangular volume of depleted uranium with a various lengths and a constant width and thickness of 1.0 centimeters was selected. The modeled exposure rate was used to calculate the expected increase in count rate above background for the 2" × 2" NaI detector. Using the same parameters as above, the same sizes of depleted uranium fragments were modeled with 5 centimeters (2 inches) of soil cover material. The density of the soil was estimated at 1.6 g/centimeters^3. Table 2 shows the size of the depleted uranium fragment, associated cpm increase for a 2" × 2" NaI detector modeled for a fragment located on the ground surface, and the associated cpm increase for a 2" × 2" NaI detector modeled for a fragment covered with 5 centimeters of soil.

Table 2. Modeled Count Rate versus DU Fragment Size at 25 centimeters

DU Fragment Size (centimeters^3)	Net count rate at 25 centimeters with DU fragment on ground surface (cpm)[1]	Net count rate at 25 centimeters with DU fragment beneath 5 centimeters of soil (cpm)[1]
5.0	1717	1113
6.0	2047	1326
7.0	2370	1534
8.0	2684	1736
9.0	2990	1932
10.0	3286	2121

Maintaining the investigation level constant at 2,000 cpm above relevant background establishes that a 6.0-cubic centimeter depleted uranium fragment on the surface of the survey area and that a 10.0-cubic centimeters depleted uranium fragment buried beneath 5 centimeters of soil can be detected with confidence during a normal scan survey. Once again, the larger the fragment the higher the probability of detection.

In summary, the smallest piece of DU located on the surface of the survey area that can be detected is approximately a 1.0 cubic centimeter fragment. The smallest piece of DU that can be detected with confidence during a normal scan survey using conservative assumptions is a 6.0 cubic centimeter fragment. The smallest piece of DU that is covered with 5 centimeters of soil that can be detected is approximately a 2.0 cubic centimeter fragment. The smallest piece of DU that is covered with 5 centimeters of soil that can be detected with confidence during a normal scan survey using conservative assumptions is a 10 cubic centimeter fragment.

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HEALTH AND SAFETY PLAN

Depleted Uranium Impact Area
Site Characterization
Jefferson Proving Ground, Madison, Indiana

Final

Prepared for:

U.S. Department of Army
Installation Support Management Activity
5183 Blackhawk Road
Aberdeen Proving Ground, Maryland 21010-5424

and

U.S. Army Corps of Engineers
Louisville District
600 Dr. Martin Luther King, Jr. Place
Louisville, Kentucky 40202-2230

Submitted by:

From Science to Solutions

Science Applications International Corporation
11251 Roger Bacon Drive
Reston, Virginia 20190

Contract No: F44650-99-D0007
Task Order: CY02

May 2005

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HEALTH AND SAFETY PLAN
Depleted Uranium Impact Area Site Characterization
Jefferson Proving Ground, Madison, Indiana

Contract No: F44650-99-D0007
Task Order: CY02

Nuclear Regulatory Commission License SUB-1435

May 2005

Final

COMMITMENT TO IMPLEMENT THE ABOVE HEALTH AND SAFETY PLAN

Corinne Shia	(703) 318-6993	5/24/05
Corinne M. Shia Project Manager	Phone	Date
Joseph Peters	(703) 318-4763	5/24/05
Joseph E. Peters Quality Assurance Officer	Phone	Date
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Randy C. Hansen Health and Safety Officer	Phone	Date
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Michael W. Lambert Radiation Protection Manager	Phone	Date
	(765) 278-3520	5/24/05
Seth T. Stephenson Field Manager	Phone	Date

The approved Health and Safety Plan (HASP) will be provided to subcontractors (i.e., drillers, surveyors, and laboratories) at the time of subcontract execution.

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CERTIFICATION 4

CONTRACTOR STATEMENT OF INDEPENDENT TECHNICAL REVIEW

Science Applications International Corporation (SAIC) has prepared this Health and Safety Plan (HASP) for performing site characterization at Jefferson Proving Ground's Depleted Uranium Impact Area, located in Madison, Indiana. Notice is hereby given that an independent technical review has been conducted that is appropriate to the level of risk and complexity inherent in the project, as defined in the Quality Control Plan (QCP). During the independent technical review, compliance with established policy principles and procedures, utilizing justified and valid assumptions, was verified. This included review of assumptions; methods, procedures, and material used in analyses; alternatives evaluated; the appropriateness of data used and level of data obtained; and reasonableness of the results, including whether the product meets the customer's needs consistent with law and existing Corps policy.

Corinne Shia

Corinne Shia
Project Manager
Science Applications International Corporation

5/24/05
Date

Joseph Peters

Joseph Peters
Quality Assurance Officer
Science Applications International Corporation

5/24/05
Date

Corinne Shia

Corinne Shia
Independent Technical Review Team Leader
Science Applications International Corporation

5/24/05
Date

Significant concerns and explanation of the resolutions are documented within the project file.

As noted above, all concerns resulting from independent technical review of the project have been considered.

Lisa D. Jones-Bateman
Vice President
Science Applications International Corporation

5/24/05
Date

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TABLE OF CONTENTS

Page

TABLE OF CONTENTS (Continued)

APPENDICES

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

Ac	Actinium
ACGIH	American Council of Governmental Industrial Hygienists
AHA	Activity Hazard Analysis
ALARA	As Low as Reasonably Achievable
ANG	Air National Guard
ANSI	American National Standards Institute
BRAC	Base Realignment and Closure
CGI	Combustible Gas Indicator
CFR	Code of Federal Regulations
CPR	Cardiopulmonary Resuscitation
CSM	Conceptual Site Model
CWM	Chemical Warfare Material
DAC	Derived Air Concentration
dBA	Decibels
DOT	U.S. Department of Transportation
dpm	Disintegrations per Minute
DU	Depleted Uranium
EC&HS	Environmental Compliance and Health and Safety
EM	Engineering Manual
EPA	U.S. Environmental Protection Agency
ERM	Environmental Radiation Monitoring
FP	Flash Point
FSHO	Field Safety and Health Officer
FSP	Field Sampling Plan
FTP	Field Technical Procedure
GFCI	Ground Fault Circuit Interrupter
GM	Geiger-Mueller
H&S	Health and Safety
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
HP	Health Physics
HPT	Health Physics Technician
HSO	Project Health and Safety Officer
HSWP	Health and Safety Work Permit
IDLH	Immediately Dangerous to Life and Health
IP	Ionization Potential
JPG	Jefferson Proving Ground
LEL	Lower Explosive Limit
MOU	Memorandum of Understanding
MSDS	Material Safety Data Sheet
mrem	Millirem
NA	Not Available
NIOSH	National Institute of Occupational Safety and Health
NRC	Nuclear Regulatory Commission
NVLAP	National Voluntary Laboratory Accreditation Program
OJT	On-the-Job Training
OSHA	Occupational Safety and Health Administration
OVA	Organic Vapor Analyzer
PEL	Permissible Exposure Limit

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

PID	Photoionization Detector
PPE	Personal Protective Equipment
ppm	Parts per Million
PVC	Polyvinyl Chloride
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QCP	Quality Control Plan
RDECOM	Research, Development, and Engineering Command
ROPS	Rollover Protective Structure
RPM	Radiation Protection Manager
RSM	Radiation Safety Manager
RSO	Radiation Safety Officer
SAIC	Science Applications International Corporation
STEL	Short-term Exposure Limit
TEDE	Total Effective Dose Equivalent
TES	Task Evaluation Standard
TLD	Thermoluminescent Dosimeter
TLV	Threshold Limit Value
TSD	Treatment, Storage, and Disposal
TWA	Time-weighted Average
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USFWS	U.S. Fish and Wildlife Service
UXO	Unexploded Ordnance
VP	Vapor Pressure

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1. INTRODUCTION

1.1 OBJECTIVE

The purpose of this Health and Safety Plan (HASP) is to: (1) provide a written assessment of potential health and safety (H&S) hazards associated with performance of work at the Jefferson Proving Ground (JPG) Depleted Uranium (DU) Impact Area site characterization project, (2) specify minimum acceptable protective equipment that will be used, and (3) specify procedures that shall be followed during the performance of work. The requirements of this plan are applicable to all Science Applications International Corporation (SAIC) personnel and SAIC subcontractors. Site-specific tasks covered by this HASP for the JPG DU Impact Area site characterization project will be governed by the Quality Control Plan (QCP) (SAIC 2005) and are documented in Section 2.

SAIC personnel and subcontractors are required to be trained on the contents of this plan prior to onsite project participation. SAIC subcontractors are further required to verify that the hazard controls contained in this plan are sufficient to protect their employees and, if not, to supplement this plan with additional and sufficient controls. Whenever possible, standard procedures shall be used to minimize the potential for personnel injury or illness. These will include site-specific training requirements, routine inspections, visual and instrument surveillance for hazards, selection and use of personal protective equipment (PPE), and enforcement of the H&S requirements by project management. SAIC's Environmental Compliance and Health and Safety (EC&HS) Program procedures (SAIC 2004a) and the SAIC St. Louis Health Physics (HP) procedures (SAIC 2004b), together with this HASP, provide the requirements for safely conducting field work for the JPG DU Impact Area site characterization. These documents also establish practices to protect the public and the immediate environment from hazards caused by onsite work.

This HASP and any referenced SAIC procedures must be onsite during field work and accessible to employees and subcontractors.

1.2 POLICY STATEMENT

It is the policy of SAIC to require its employees and SAIC subcontractors to take every reasonable precaution to protect the H&S of employees, the public, and the environment. All SAIC and subcontractor organizational components must not only comply with applicable local, state, and Federal environmental, health, and safety regulations, but shall do so in a proactive fashion. Ultimate responsibility for compliance with EC&HS requirements lies with each organization's line managers.

The operating philosophy of SAIC is that no job is too important or too small that the company cannot devote the time and resources to protect its most important asset, the employees, and to meet, or exceed, local, state, and Federal standards. SAIC (and subcontractor) line managers are responsible for the H&S of their employees and must comply with local, state, and Federal regulations. Any SAIC employee, or SAIC subcontractor employee, found not in compliance with this document, the SAIC EC&HS program, or other safety documents, shall be subject to disciplinary action up to and including termination.

All SAIC employees, and subcontractor employees, shall promptly report any environmental, health, and safety concerns to their line management. SAIC and its subcontractors shall not reprimand or otherwise take disciplinary action against their employees for reporting such concerns.

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2. PROJECT DESCRIPTION AND OBJECTIVES

Background information on JPG, including the former uses of the DU Impact Area and the Nuclear Regulatory Commission (NRC) licensing history of the DU testing program, are provided in Section 2.1. Information on the site background is based on the QCP and should be referred to for additional detail. Within this framework, the DU Impact Area site characterization project objectives and scope are defined in Section 2.2. Site-specific tasks, as defined in the QCP (SAIC 2005), are presented in Section 2.3.

2.1 SITE BACKGROUND

JPG was established in 1941 as a proving ground for the test firing of a wide variety of ordnance. The facility is approximately 55,264 acres (224 square kilometers) and is located in Jefferson, Jennings, and Ripley Counties in southeastern Indiana. A firing line with 268 gun positions used for testing ordnance separates JPG into two areas: a 4,000-acre southern portion and a 51,000-acre (206-square kilometer) northern portion.

The Army used JPG as a proving ground from 1941 to 1994. During this time, more than 24 million rounds of conventional explosive ammunition were fired. Approximately 1.5 million rounds did not detonate upon impact, remaining as unexploded ordnance (UXO) either on, or beneath, the ground surface. This remaining UXO and its hazard has been a major factor in decisions about managing the area north of the firing line.

As part of its munitions testing program, JPG test-fired DU projectiles. The possession and test firing of DU penetrators were conducted under a license issued by the NRC (License SUB-1435, Docket 040-08838). The test firing of DU projectiles occurred between 1983 and 1994 in an area known as the DU Impact Area, in the northern portion of the Installation.

The DU projectiles were fired from three fixed-gun positions on the firing line at soft (cloth) targets placed at intervals of 3,280 feet (1,000 meters), starting at 3,280 feet (1,000 meters) from the gun position and continuing to 13,123 feet (4,000 meters). Because of the type of testing conducted, the DU projectiles would impact in approximately the same location each time on their respective lines of fire. This firing protocol, with repeated impacts in the same area, resulted in the formation of a trench approximately 3.4 feet (1 meter) deep by 16.4 to 26.3 feet (5 to 8 meters) wide, extending for approximately 3,937 feet (1,200 meters) at the most frequently used gun position. These tests were nondestructive (i.e., no aerosolization occurred), although the rounds may have fragmented upon impact.

The primary impact location was the trench. Secondary impact locations developed when the projectile skipped, either whole or in fragments. A similar pattern was repeated at each of the other two firing positions but to a lesser extent because a smaller quantity of DU was fired from each location.

Approximately 220,462 pounds (100,000 kilograms) of DU projectiles were fired at soft targets in a 2,080-acre (8.4-square kilometer) DU Impact Area. Approximately 66,139 pounds (30,000 kilograms) of DU projectiles and projectile fragments were recovered on or near the surface periodically to ensure that the total 100,000-kilogram license limit was not exceeded. Approximately 154,323 (70,000 kilograms) pounds of DU remain in the DU Impact Area.

JPG was closed in September 1995 under the Defense Authorization Amendments and Base Realignment and Closure (BRAC) Act of 1988. At that time, the area south of the firing line where DU was stored was surveyed to determine the extent of DU contamination. Any contaminated areas were decontaminated, and the total area south of the firing line was released for unrestricted use in 1996. The NRC license for the area north of the firing line was amended for possession of DU only in May 1996. Site access to the area north of the firing line and to the DU Impact Area at JPG is controlled by the U.S. Army via the Army/Air Force/U.S. Fish and Wildlife Service (USFWS) Memorandum of Understanding (MOU) of 2000.

2.2 PROJECT OBJECTIVES AND ONSITE WORK TASKS

The objectives of the site characterization project are documented in the QCP (SAIC 2005). By implementing this project, the Army will establish a solid foundation to support decommissioning in 5 years. The onsite project tasks, as outlined in **Table 2-1**, are structured and phased to address the data gaps outlined in Army and NRC documentation. Tasks not specifically addressed in this document will be planned and detailed as addenda to this HASP.

Table 2-1. DU Impact Area Site Characterization Project Onsite Tasks*
Jefferson Proving Ground, Madison, Indiana

Onsite Task	Description	Fiscal Year (FY)
	Biota Investigations	
Deer Sampling	Collection and analysis of 30 to 40 deer (kidney, liver, bone, and muscle) from within and outside the DU Impact Area. The USFWS will obtain the permit and acquire deer for the contractor.	2006
Other Biota Sampling	An optional task involves other biota (plants, earthworms, birds, mammals, and fish); sampling includes 10 samples from the DU Impact Area and background locations.	2008 - 2009
	Hydrogeology Investigations	
Electrical Imaging Survey	Survey, combined with the fracture trace analysis, will be used to identify preferential flow paths and karst features for groundwater. Survey will be conducted to identify entry and exit pathways.	2006
Other Monitoring Equipment Installation (precipitation, cave streams, streams, and groundwater levels)	Installation and maintenance of automatic, continuous recorders for stream (Big Creek and Middle Fork), precipitation gauge, and three cave stream/spring gauges, and groundwater level (monitoring wells).	2007
Well Installation	Installation of 10 multi-level well clusters located on preferential groundwater flow paths.	2007
	Media Sampling and Analysis	
Groundwater Sampling	Four quarters of sampling for all wells for DU.	2008
Sediment/Surface Water Sampling	Four quarters of sampling of sediment and surface water for DU.	2008
Other Monitoring (precipitation, cave streams, and streams)	Four quarters of sampling for DU and other field parameters.	2008
Soil Sampling		
Verification	Field verification of soil mapping conditions.	2006
Extent and Depth	Approximately 380 soil samples (including QC samples) at 60 locations will be sampled at various depths.	2008
	DU Penetrator Corrosion Analysis	
Corrosion Field Measurements of DU Penetrators	Collect 24 samples (penetrators) from the DU Impact Area and select the minimum number, based on field examination, for further laboratory analysis to determine a "theoretical" estimate of DU penetrator corrosion/dissolution rate. In addition, subject several new penetrators to laboratory test methods designed to validate the "theoretical" estimate. The objective will be to establish a corrosion/dissolution rate for the penetrators subject to the environmental conditions specific to JPG.	2008
	ERM Sampling	
	Includes soil, sediment, surface water, and groundwater sampling.	2005 - 2010

* The Quality Control Plan (SAIC 2005) identifies additional tasks. This table addresses only those tasks where activities will occur onsite (i.e., at the JPG DU Impact Area).

DU = depleted uranium
ERM = Environmental Radiation Monitoring
JPG = Jefferson Proving Ground
QC = quality control
USFWS = U.S. Fish and Wildlife Service

3. STAFF ORGANIZATION, QUALIFICATIONS, AND RESPONSIBILITIES

The organization for this project, shown in **Figure 3-1**, indicates the reporting lines of key project personnel to the Project Manager. The Field Manager and support staff for site characterization report to the Project Manager. The project Quality Assurance (QA) Officer, H&S Officer, and Radiation Safety Manager (RSM) each report independently to his/her corporate counterparts and assist the Project Manager. The following sections outline the responsibilities of those personnel assigned to the JPG site characterization project. This section presents the lines of authority, responsibilities, and communication procedures concerning site safety and health and emergency response. All field work will be under the supervision of the SAIC Field Manager. The SAIC Field Manager will oversee normal and emergency work and will conduct any required emergency notification. Figure 3-1 identifies the JPG DU Impact Area characterization project organization.

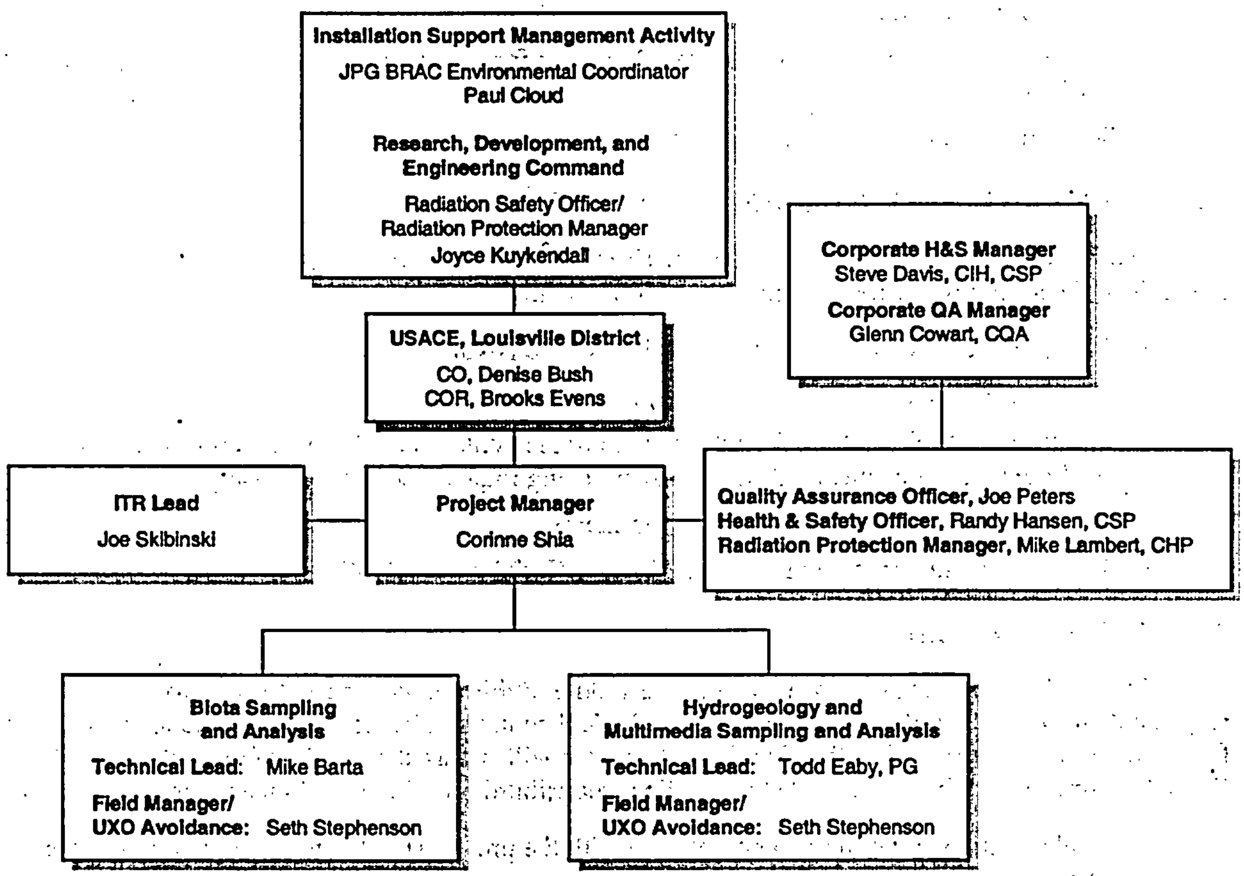

Figure 3-1. Project Organization for the DU Impact Area Site Characterization Project Jefferson Proving Ground, Madison, Indiana

3.1 SAIC PROGRAM MANAGER

The SAIC Program Manager is responsible for ensuring conformance with SAIC and the U.S. Army Corps of Engineers (USACE) policies and procedures and the JPG NRC license. Specific responsibilities of the Program Manager ensure that:

- The Field Manager satisfies SAIC and USACE H&S requirements
- Project staff implement the project HASP
- Projects have the necessary resources to operate safely
- An approved HASP is issued prior to commencement of field activities

- A qualified H&S Officer is designated.

3.2 SAIC CORPORATE HEALTH AND SAFETY MANAGER

The SAIC corporate H&S Manager manages the corporate-level H&S program. This includes establishing H&S policies and procedures, supporting project and office activities, and verifying safe work practices and conditions. The specific responsibilities of the corporate H&S Manager include the following:

- Overseeing the corporate-level H&S program
- Conducting periodic assessments of projects for compliance with corporate and project-specific H&S requirements
- Monitoring corrective actions based on corporate-level reviews
- Coordinating with the SAIC Program Manager for the appointment of the SAIC project H&S Officer
- Reporting to the SAIC Program Manager on program status.

3.3 SAIC RADIATION PROTECTION MANAGER

The SAIC Radiation Protection Manager (RPM) will address radiological hazards associated with the project. Specific responsibilities include the following:

- Providing, or reviewing, radiation portions of the HASP
- Conducting site training and audits as needed
- Ensuring that relevant H&S guidelines are implemented (e.g., USACE 2003a and b) and SAIC St. Louis HP procedures (SAIC 2004b) are being implemented, as necessary
- Assessing radiological exposure measurements
- Reviewing and approving Health and Safety Work Permits (HSWPs).

3.4 FIELD MANAGER

The SAIC Field Manager will oversee the field activities associated with the project and will be responsible for site accessibility, safety, and radiological controls. He/she is responsible for enforcing the field requirements of this HASP. The Field Manager will act as the Field Safety and Health Officer (FSHO), if one has not been designated. Specific responsibilities of the Field Manager are listed below:

- Implementing and enforcing compliance with the project HASP under the direction of the H&S Officer
- Coordinating and managing onsite operations, including coordinating with the USFWS and Air National Guard (ANG) on field activities and overseeing subcontractor activities
- Coordinating and controlling any emergency response actions
- Conducting and documenting daily safety inspections (an example safety inspection is provided in Appendix A)
- Maintaining current copies of the project HASP, SAIC EC&HS and HP procedures (SAIC 2004a and b), training, environmental and personal exposure monitoring results, and other project documentation onsite
- Stopping work or upgrading protective measures (including protective clothing) if uncontrolled H&S hazards are encountered (e.g., UXO presence)

- Ensuring that a site-specific, pre-entry H&S briefing covering potential chemical and physical hazards, safe work practices, and emergency procedures is conducted and documented for site workers
- Confirming that all onsite personnel have received the training listed in the "Training Requirements" section of this HASP
- Verifying that the project HASP emergency points of contact are correct.

3.5 PROJECT HEALTH AND SAFETY OFFICER

The SAIC Health and Safety Officer (HSO) is responsible for making H&S decisions for specific H&S activities, and for verifying the effectiveness of the H&S program. The HSO has primary responsibility for the following:

- Reviewing, approving, maintaining, and ensuring compliance with the Corporate H&S program and HASP
- Delegating responsibilities to and overseeing FSHO activities
- Participating in project reviews
- Stopping work or upgrading protective measures (including protective clothing) if uncontrolled H&S hazards are encountered
- Documenting deficiencies identified in inspections and designating responsible parties, procedures, and timetables for correction
- Ensuring that monitoring for potential onsite exposures is conducted in accordance with this HASP
- Conducting work site safety inspections
- Ensuring that daily work site safety inspections are conducted by the Field Manager, FSHO, or qualified technicians
- Updating the project HASP (field changes) to ensure that it adequately identifies all tasks and significant hazards at the site and notifying project personnel of changes
- Investigating accidents and near misses and reporting them to the Program Manager and Corporate H&S Manager
- Coordinating with the Program Manager to notify USACE of accidents and incidents immediately
- Reviewing industrial hygiene and radiological monitoring data
- Recommending changes to engineering controls, work practices, and PPE.

3.6 FIELD SAFETY AND HEALTH OFFICER

The SAIC FSHO is responsible for making H&S decisions for specific H&S activities, and for verifying the effectiveness of the H&S program. The FSHO has primary responsibility for the following:

- Conducting any HSO duties delegated by the HSO
- Enforcing compliance with the project HASP
- Stopping work or upgrading protective measures (including protective clothing) if uncontrolled H&S hazards are encountered
- Coordinating and controlling any emergency response actions

- Ensuring that all monitoring equipment is operating according to the manufacturer's specifications and conducting field checks of instrument calibration
- Ensuring that at least two persons currently certified in first aid/cardiopulmonary resuscitation (CPR) are on staff
- Conducting and recording daily "tailgate" safety briefings
- Controlling visitor access to the exclusion zone
- Stopping work if uncontrolled H&S hazards are encountered
- Approving upgrades and downgrades in PPE.

3.7 HEALTH PHYSICS TECHNICIAN

Health physics technicians (HPTs) are responsible for assessing radiological exposures, verifying that radiological control practices are being implemented, and stopping work if controls are insufficient. HPTs will be trained to at least the requirements listed in Engineering Manual (EM) 385-1-1, Section 6 (USACE 2003a), with responsibilities identified in the following sections.

3.7.1 Senior Health Physics Technician

The responsibilities of the senior HPT include the following:

- Conducting routine radiation, contamination, and airborne radioactivity surveys
- Establishing protective barriers and posting appropriate radiological signs
- Implementing the contractor's PPE and respiratory protection program for the purposes of keeping radiation exposure as low as reasonably achievable (ALARA)
- Conducting operability checks of radiation monitors and survey meters
- Conducting unconditional release surveys of materials from the restricted area
- Evaluating the results of routine radiation, contamination, and airborne radioactivity surveys
- Conducting shipping and receiving surveys of radioactive material
- Conducting job coverage surveys and directing activities to ensure compliance with applicable procedures and regulations
- Conducting and documenting personnel decontamination
- Implementing the SAIC St. Louis HP procedures (SAIC 2004b)
- Implementing HSWP requirements related to radiological controls.

3.7.2 Junior Health Physics Technician

The responsibilities of the junior HPT include the following:

- Conducting routine radiation, contamination, and airborne radioactivity surveys
- Establishing protective barriers and posting appropriate radiological signs
- Implementing the SAIC St. Louis HP procedures (SAIC 2004b)
- Conducting operability checks of radiation monitors and survey meters.

3.8 SUBCONTRACTOR FIELD MANAGER

The Subcontractor Field Manager will oversee the field activities of his/her employees. He/she is responsible for enforcing the field requirements of this HASP. Specific responsibilities are listed below:

- Ensuring that his/her personnel onsite follow the requirements of the project HASP and any other applicable H&S requirements (Occupational Safety and Health Administration [OSHA], equipment-specific controls, state requirements, and USACE Safety and Health Requirements Manual)
- Verifying that this HASP adequately addresses the hazards and controls of the subcontracted work, and supplementing the information in the HASP, if necessary
- Ensuring the safe operation of any subcontractor equipment
- Coordinating onsite operations of his/her personnel
- Maintaining any required documentation (e.g., drill rig manual) specific to his/her operations.

3.9 EMPLOYEES

Each employee is responsible for the following:

- Complying with the requirements of this HASP
- Completing his/her work assignment(s) in a safe and effective manner
- Accepting an assignment or beginning a task only after understanding the risks and hazards associated with that activity
- Completing the training, medical evaluations, and respirator fit testing, and wearing protective clothing, as specified in the HASP, before beginning any job
- Viewing the USFWS safety video prior to working north of the firing line (documentation of this training shall be maintained by the Field Manager)
- Maintaining, and providing to the HSO, a copy of medical correspondence, training certificate(s), and documentation of supervised field experience needed to gain access to field sites
- Not working alone at a field location (i.e., using the buddy system)
- Having thorough knowledge of specific emergency response procedures for his/her specific work site(s)
- Immediately reporting any occupational illness or injury to the appropriate supervisor/field manager, including any potential exposure to hazardous substances for which protection was not provided
- Wearing and maintaining PPE, as specified in the HASP and HSWPs
- Reporting to the HSO or FSHO any hazards not documented in the HASP or inadequately controlled by procedures contained in the HASP
- Implementing assigned responsibilities in accordance with the HASP
- Observing work in controlled areas to verify compliance with radiological controls
- Reporting all findings and activities to the Field Manager.

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4. CONTAMINANT AND HAZARD DESCRIPTION

Site tasks will include, but are not limited to, conducting radiological surveys; collecting and analyzing soil, surface water, groundwater, sediment, biota, and DU projectile samples to gather data that will be used to enhance the understanding of the nature and extent of contamination in the DU Impact Area (CSM) and the fate and transport of DU in the environment; defining and verifying the conceptual site model; and providing the basis for modifying the current monitoring program. Because DU projectiles remain in the area, there is some potential for exposure to ionizing radiation in contaminated soil and the spread of contamination to previously uncontaminated areas. Exposure to chemical contaminants also is possible but less likely. Site tasks present a variety of possible physical hazards, with the potential presence of UXO, drilling operations, and uneven terrain offering the greatest potential for significant injury. Physical hazards include, but are not limited to, contact with UXO, entanglement with rotating equipment, being struck by moving equipment or other objects, inclement weather, and radiation exposure. Changes (i.e., upgrades and downgrades) in protective measures require prior approval of the HSO or FSHO and concurrence from the RPM.

Table 4-1 is a checklist of common hazards that may be posed by this type of project. It includes negative declarations for hazards that will not be encountered.

**Table 4-1. Hazards Inventory
Jefferson Proving Ground, Madison, Indiana**

Yes	No	Hazard
X		Biological hazards (bees, ticks, wasps, and poison ivy)
	X	Confined space entry (potential for entry)
X		Drowning
X		Electrical shock
	X	Excavation entry (excavations will not be entered)
X		Exposure to chemicals
X		Fire
X		Unexploded ordnance
X		Heavy equipment
X		Noise
X		Radiation or radioactive contamination
X		Temperature extremes
X		Lifting
X		Slips, trips, and falls
X		Inclement weather

Before beginning each activity involving any type of work presenting hazards not experienced in previous project operations, an activity hazard analysis (AHA) shall be prepared as described below. Every potential hazard associated with work at the JPG DU Impact Area should be considered when generating AHAs and when writing HSWPs. If additional tasks or significant hazards are encountered during the work, this document will be modified by addendum or field change order to include the additional information.

4.1 ACTIVITY HAZARD ANALYSES

An AHA shall be prepared and documented for each SAIC activity as warranted by the hazards associated with the activity. Generally, an AHA shall be prepared for all field operations other than routine surveillance and inspection of field activities. In developing the analysis for a particular activity, the HSO and/or FSHO should draw upon the knowledge and experience of employees in that activity. An

HSWP, if applicable, will be written to prescribe the necessary controls for the activity, based on the results of the AHA.

Analyses shall define the activities being conducted, identify the sequences of work, the specific hazards anticipated, and the control measures to be implemented to eliminate or reduce each hazard to an acceptable level. Work shall not begin until the hazard analysis has been approved by the HSO, or designee.

A number of activities are planned. The major activities from Table 2-1 include the following:

- Deer and biota sampling
- Geophysical survey
- Installation of groundwater monitoring wells
- Collection of groundwater samples from wells
- Collection of DU projectiles
- Surface water and sediment sampling
- Soil sampling with hand augers or scoops
- Equipment decontamination.

The nonintrusive tasks, such as geophysical surveying, and minimally intrusive tasks, such as surface water sampling and groundwater sampling, pose a very limited potential for external radiation exposure and radiological and chemical contamination. Some water samples will be preserved with corrosive materials, posing a skin and eye contact hazard. Physical hazards for such tasks will be minor, since the tasks will not involve heavy equipment, power tools, or other physical hazards beyond slip/trip and potential contact with UXO hazards.

Intrusive tasks utilizing heavy equipment (groundwater well installation) and deer sampling pose more significant physical hazards. Contact with moving equipment, being struck by falling equipment, and noise are all hazards associated with heavy equipment use. Contact with sharp objects and cold stress are hazards associated with deer sampling. Surface soil sampling and equipment decontamination pose significantly lesser physical hazards. The intrusive tasks (soil sampling and DU collection) also pose a greater probability of radiological contamination because potentially contaminated soils/materials will be uncovered and handled.

A general AHA has been provided in Appendix B. The tasks listed above and other tasks not described in this document will have task-specific AHAs prepared to evaluate the requirements necessary to conduct the tasks safely. The AHAs will be documented on a form similar to the example provided in Appendix B.

4.2 POTENTIAL EXPOSURES

The following sections present information on site contaminants, radiological hazards, and nonradiological hazards.

4.2.1 Site Contaminants

Information on the significant suspected contaminants and chemicals that will be used for the project is presented in **Table 4-2.** This list does not include all of the contaminants that have been detected. Only those contaminants with relatively low exposure limits and that are present in relatively large concentrations are listed in Table 4-2. If additional contaminants or chemical tools that pose new or significantly greater hazards are identified prior to or during site activities, they will be provided as an addendum to this document.

Table 4-2. Potential Chemical Exposures
Jefferson Proving Ground, Madison, Indiana

Chemical	TLV, PEL, STEL, IDLH, or DAC[a]	Health Effects/ Potential Hazards[b]	Chemical and Physical Properties[b]	Exposure Route(s)[b]
Isopropyl alcohol	TLV/TWA: 400 ppm STEL: 500 ppm	Irritation of eyes, skin, respiratory system; headache, drowsiness; flammable liquid	Colorless liquid; VP: 33 mm; IP: 10.10 eV; FP: 53°F	Inhalation, Ingestion
Liquinox (used for decontamination)	TLV/TWA: NA	May cause local irritation to mucous membranes	Aqueous liquid, odorless, nonflammable	Ingestion, Contact
Gasoline (fuel)	TLV/TWA: 300 ppm IDLH: NA	Dizziness, eye irritation, dermatitis; flammable liquid	Liquid with aromatic odor; FP: -45°F	Inhalation, Ingestion, Contact
Nitric acid (used to preserve water samples)	PEL/TWA: 2 ppm IDLH: 25 ppm	Eye, skin, respiratory system irritation/burns; delayed pulmonary edema	Liquid with acrid odor; VP: 48 mm; IP: 11.95 eV; FP: none	Inhalation, Ingestion, Contact
Hydrochloric acid (used to preserve water samples)	TLV: 0.5 mg/m^3 IDLH: 50 ppm	Eye, skin, respiratory system irritation/burns	Liquid with irritating odor; FP: none	Inhalation, Ingestion, Contact
Uranium 238	TLV: 0.2 mg/m^3; A1 DAC: 2E-11 µCi/ml	Cancer Kidney damage	Solid; VP: NA; FP: NA	Inhalation, Ingestion, Contact
Uranium 234	TLV: 0.2 mg/m^3; A1 DAC: 2E-11 µCi/ml	Cancer Kidney damage	Solid; VP: NA; FP: NA	Inhalation, Ingestion, Contact
Uranium 235	TLV: 0.2 mg/m^3; A1 DAC: 2E-11 µCi/ml	Cancer Kidney damage	Solid; VP: NA; FP: NA	Inhalation, Ingestion, Contact

[a] From 1999 *Threshold Limit Values*, *NIOSH Pocket Guide to Chemical Hazards* (NIOSH 2004), or 10 *CFR* 20.
[b] From *NIOSH Pocket Guide to Chemical Hazards* (NIOSH 2004).

A1 = confined human carcinogen
CFR = Code of Federal Regulations
DAC = derived air concentration
FP = flash point
IDLH = immediately dangerous to life or health
IP = ionization potential
µCi/ml = microcuries per milliliter
mg/m^3 = milligrams per cubic meter
NA = not available
NIOSH = National Institute of Occupational Safety and Health
PEL = permissible exposure limit
ppm = parts per million
STEL = short-term exposure limit
TLV = threshold limit value
TWA = time-weighted average
VP = vapor pressure

4.2.2 Radiological Hazards

The JPG DU Impact Area contains surface and subsurface DU projectiles. The primary radiological contaminants associated with DU are uranium isotopes and their associated decay products. The DU projectiles pose primarily an external radiation hazard, whereas the soil contaminated with corroded DU poses primarily an internal radiation exposure hazard, through inhalation, ingestion, or injection through open wounds. Control of radiological hazards is addressed in specific SAIC St. Louis HP procedures (SAIC 2004b) and HSWPs.

4.2.2.1 Airborne Radioactive Contamination

Although unlikely, airborne radioactive contamination may be produced as a result of disturbance of contaminated soils or eroded DU projectiles that have fixed or removable contamination. The RPM will establish personnel air sampling requirements, as necessary, and determine the need for respiratory protection based upon actual site conditions and the activity being conducted.

4.2.2.2 Health Effects Associated with Radiation Exposure

The health effects of potential radiological hazards associated with radiological contaminants at the JPG DU Impact Area are included in Table 4-2.

At the JPG DU Impact Area, external exposure to radioactive material presents the greatest concern because of the potential dose rates from the DU projectiles. Internal exposure presents a lesser concern since inhalation of airborne radioactive contamination is less likely due to the low concentrations of uranium in soil and water samples. Chronic exposure to radiation is associated with an increased risk of cancer. Uranium in high concentrations also is associated with toxic kidney effects.

Provided that effective administrative controls, respiratory protection (as applicable), and protective clothing measures are implemented and strictly adhered to, radiation exposures will be maintained well within USACE and SAIC administrative limits.

4.2.3 Nonradiological Hazards

The health effects of potential chemical hazards associated with nonradiological contaminants are included in Table 4-2.

The contaminants are listed by common name. The lower of the published exposure limits (i.e., threshold limit value [TLV] or permissible exposure limit [PEL]) is listed along with applicable short-term exposure limits (STELs) and immediately dangerous to life or health (IDLH) values. Field crews shall utilize engineering controls as the primary means of maintaining employee exposures below these levels and ALARA.

Although the current environmental sampling areas and associated routes have been cleared of UXO, the target area, impact area, ricochet area, and surrounding areas may contain UXO. UXO may be found on the surface and/or subsurface. The varying types of ammunition, angle of fire, and soil types preclude the accurate estimation of the depth of any subsurface UXO. General UXO safety guidelines are presented in Section 8.13. The cardinal principle to be observed involving UXO is to limit the exposure of a minimum number of personnel, for the minimum amount of time, to a minimum amount of hazardous material consistent with a safe and efficient operation.

5. TRAINING AND MEDICAL SURVEILLANCE

Personnel who participate in field activities associated with this project are subject to the training requirements presented in **Table 5-1**. Field activities include all of the tasks specified in Section 2.2, as well as any other unspecified tasks that take place within the JPG DU Impact Area or other onsite areas where personnel are exposed to site hazards. Activities such as driving or walking on paved roads that have been cleared of UXO, doing paperwork or attending meetings inside routinely occupied buildings, and doing paperwork and similar activities inside field trailers are not considered field activities and are not subject to these training requirements. Visitors, such as individuals that will be onsite but who will not enter hazardous areas, are not required to have the site visitor training listed in Table 5-1. Any entry to a hazardous area shall require all worker training, except as outlined in Section 5.3. Delivery, service/repair, and administrative personnel, who only access the office or staging areas of the support zone, are not subject to these training requirements.

Table 5-1. Training Requirements
Jefferson Proving Ground, Madison, Indiana

Training	Worker	Supervisor	Site Visitor
Hazardous Waste Operations (40-hour, 3-day OJT)	✓	✓	×
Hazardous Waste Operations Annual Refresher (8 hours)	✓	✓	×
SAIC Rad Worker Annual Training (or RPM-approved equivalent)	✓	✓	×
Hazardous Waste Operations Supervisors Training (8 hours)	×	✓	×
General Hazard Communication Training (Contained in 40-hour and 8-hour courses)	✓	✓	×
Hearing Conservation Training (for workers in hearing conservation program; contained in 40-hour and 8-hour courses)	✓	✓	×
Site Worker Training	✓	✓	×
Site-specific Hazard Communication (contained in HSWP pre-job briefings, as applicable)	✓	✓	×
Safety Briefing (daily when field work is being conducted and whenever conditions or tasks change)	✓	✓	×
Site Visitor Training	×	×	✓
First Aid/CPR (Red Cross or Equivalent) [if medical services >5 min. away]	≥2 workers	×	×

✓ = Required
× = Not required
OJT = on-the-job training
CPR = cardiopulmonary resuscitation

5.1 HAZARDOUS WASTE OPERATIONS AND EMERGENCY RESPONSE TRAINING REQUIREMENTS

The 40-hour Hazardous Waste Site Worker course is required for field activities that pose the potential to encounter hazards associated with hazardous waste. Three days of relevant field experience are required in conjunction with this training.

The 8-hour Hazardous Waste Safety Refresher course is required annually to maintain currency in the 40-hour course.

The Hazardous Waste Safety Supervisors Training is required for personnel who directly supervise hazardous waste site workers. This is an 8-hour course that must be taken once. Note that the 40-hour course is a prerequisite.

General Hazard Communication Training is required for all site workers. This training must communicate the risks and protective measures for chemicals and radionuclides that personnel may encounter. This requirement is met by taking the 40-hour Hazardous Waste Site Worker course, annual refreshers, and site-specific training.

Hearing Conservation Training is required on an annual basis by Title 29, Code of Federal Regulations (CFR), Part 1910.95 (29 CFR 1910.95) for all employees enrolled in a hearing conservation program. This category will include all employees exposed to occupational noise in excess of 85 decibels (dBA) on a time-weighted average. This refresher training is provided as part of the Hazardous Waste Safety Refresher course.

The SAIC Radiation Worker ("Rad Worker") training is required annually for personnel who are expected to receive more than 100 millirem per year (mrem/yr) or greater. The content of the Rad Worker training includes, at a minimum, the health effects of ionizing radiation, exposure limits (including those for declared pregnant workers), use of dosimetry and instruments, effects of radiation on the embryo/fetus, employee rights and responsibilities, site contaminants and probability of exposure, required monitoring, and exposure control methods. Current Rad Worker training, other than that provided by SAIC, may be approved by the RPM if course content can be verified as having met the minimum requirements.

5.2 SITE WORKER TRAINING

Personnel onsite must have received the site-specific safety training. Two versions of this training will be used. The site worker version will contain full information on site hazards, hazard controls, and emergency procedures. A shortened version will be used for visitors who will be onsite for short times and who will not do hands-on work. This shortened version will contain the hazard information that is directly relevant to the purpose of the visit. Signatures of those attending and the type of briefing must be entered into project documentation before site access will be granted. The site-specific training will include the following site-specific information, as appropriate:

- JPG site-specific training
- Overview of site hazards and conditions
- Names of site H&S personnel and alternates
- Contents of the project HASP
- Hazards and symptoms of contaminant exposure (chemical and radiological)
- Hazards and symptoms of chemicals used onsite
- Physical hazards in the workplace
- Actions to take when UXO is encountered
- Location and availability of the written hazard communication program
- Site and task PPE (including purpose, donning, doffing, and proper use)
- Safe work practices to minimize risks
- Safe use of engineering controls and equipment
- Medical surveillance requirements
- Site control measures
- Reporting requirements for spills and emergencies
- Decontamination procedures for cleanup of chemical and radiological contamination

- Contingency plans (e.g., communications, telephone numbers, emergency exits, assembly point)
- Hearing conservation (for noisy work if worker does not have documented hearing conservation training)
- Spill containment procedures (e.g., reporting, cleanup methods)
- Emergency equipment locations and use (e.g., fire extinguishers, spill kits).

Safety briefings will be held daily and when conditions or tasks change. These briefings will be conducted by the FSHO and/or Field Manager and will be attended by all site workers and supervisors. These briefings will address site-specific safety issues and will be used as an opportunity to refresh workers on specific procedures and to address new hazards and controls.

Site workers scheduled to conduct field activities as defined in Section 2.2 will undergo Rad Worker training. Successful completion of the Rad Worker training provides the necessary knowledge to work safely in all areas where field activities will be conducted and the qualifications needed to become a Rad Worker. Rad Worker training will be conducted by qualified personnel designated by the RPM.

5.3 SITE VISITOR TRAINING

Site visitors will receive a briefing specific to hazards and controls associated with their intended site duties from the FSHO and/or Field Manager. A site visitor will be escorted by qualified personnel when in a controlled area to ensure that the individual will not be exposed to hazards for which he/she has not received appropriate training.

5.4 HEALTH PHYSICS TECHNICIAN TRAINING

HPTs are required to complete appropriate HP training prior to assuming responsibility for radiation safety activities. HPTs shall be qualified to conduct certain tasks by the training and evaluation of the task performance being documented on the Task Evaluation Standard (TES) by a qualified trainer/evaluator for the task. TESs shall be conducted in accordance with the SAIC St. Louis HP procedures (SAIC 2004b).

Training on the SAIC HP and EC&HS programs and their associated procedures (SAIC 2004a and b) is accomplished through required reading of applicable documents and procedures. Program and procedural training is assigned by the HSO and RPM in coordination with the FSHO and Field Manager.

5.5 TRAINING DOCUMENTATION

Documentation of the required training will be maintained in the onsite project files. This documentation will include copies of 40-hour and 3-day on-the-job training (OJT), 8-hour refresher, and supervisor training certificates; SAIC Rad Worker training records; copies of first aid/CPR certificates; and records showing the topics covered, trainer, and signatures of those attending onsite training.

5.6 MEDICAL SURVEILLANCE

All employees conducting onsite work will be enrolled in a medical surveillance program to meet the requirements of 29 *CFR* 1910.120(f), 1910.134, 1910.1020, and SAIC EC&HS Procedures 12 ("Medical Surveillance") and 20 ("Hazardous Waste Operations") (SAIC 2004a) to assess and monitor workers' health and fitness for employment in the field. Employees are provided with summaries of medical examination results following each examination and are provided more detailed information upon written request. Documentation of medical clearance will be maintained onsite during the project.

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6. RADIOLOGICAL AND CHEMICAL PROTECTION

Based on the site history, nature, and extent of radiological contamination, and results of the ongoing Environmental Radiation Monitoring (ERM) program, radiological hazards to workers from ingestion, inhalation, and direct exposure to DU are expected to be low. The RPM will assess radiological conditions for each activity and ensure that appropriate controls are commensurate with the hazard.

6.1 RAD WORKER TRAINING

As required by EM 385-1-1 (USACE 2003a), Section 06.E.03, and 10 CFR 19, personnel who have the potential to receive 100 millirem (mrem) or greater total effective dose in a year must complete Rad Worker training. Although onsite workers involved in sampling activities at JPG are not expected to receive a dose of 100 mrem/yr, each person will receive Rad Worker training so that doses might be kept ALARA. Collecting DU projectile samples poses the greatest potential for personnel exposure. The RPM will determine appropriate radiological controls based upon actual radiological conditions.

Rad Worker training will include, at a minimum, instruction in the following aspects of radiological safety: health effects of ionizing radiation, exposure limits (including those for pregnant workers), use of dosimetry and instruments, effects of radiation on the embryo/fetus, employee rights and responsibilities, site contaminants and probability of exposure, required monitoring, and exposure control methods.

6.2 RADIOLOGICAL EXPOSURE MONITORING

Past environmental sampling has indicated that uranium concentrations in the water, sediment, and soil are not sufficient to require personnel exposure monitoring. If conditions warrant, monitoring for external exposure and/or breathing zone air sampling will be conducted. Collection of DU projectiles may require radiological monitoring. The RPM will determine appropriate radiological controls based upon actual radiological conditions.

6.3 OTHER EXPOSURE MONITORING

Exposure monitoring for nonradiological contaminants/chemicals is not required. It is unlikely that personnel could be overexposed to nonradiological contaminants while conducting the tasks listed in Section 2.2. If changing conditions warrant, the FSHO and/or Field Manager will ensure appropriate exposure monitoring is conducted.

SAIC has conducted noise monitoring of standard types of site equipment at previous projects and has established basic hearing protection requirements. Drill rigs, portable drilling devices, and generators will be assumed to generate sound levels in excess of 85 dBA (requiring hearing protection) unless site-specific sound level measurements are conducted and indicate otherwise. If used, sound level meters will be calibrated daily (each day of use).

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7. PERSONAL PROTECTIVE EQUIPMENT

PPE for site tasks is based on potential site-specific physical, radiological, and chemical hazards. In cases where multiple hazards are present, a combination of protective equipment items will be selected so that adequate protection is provided for each hazard. This section emphasizes the programmatic requirements for PPE. Task-specific equipment is listed on the task-specific HSWP. More information on HSWPs is provided in the SAIC St. Louis HP procedures (SAIC 2004b).

7.1 PPE PROGRAM

SAIC's PPE program is controlled by EC&HS Procedures 13 and 20 (SAIC 2004a); 29 CFR 1910, Subpart I, "Personal Protective Equipment"; and EM 385-1-1, Section 5 (USACE 2003a). The level of protection and types of materials selected for a particular task are based on the following:

- Potential for exposure because of work being conducted
- Activity duration
- Route of exposure
- Measured or anticipated concentration in the medium of concern
- Toxicity, reactivity, or other measure of adverse effect
- Physical hazards (e.g., falling objects, flying projectiles).

In situations where the type of contaminant and probability of contact are unknown, the appropriate protection is selected based on the professional judgment of the HSO or FSHO until the hazards are further evaluated.

The HSO or FSHO may raise or lower the level of PPE worn by the teams, depending upon the site-specific hazards encountered in the field. If site conditions are such that the level of PPE is insufficient or work must be stopped, the FSHO or Field Manager will take appropriate action immediately. Criteria indicating a possible need for reassessment of the PPE selection include the following:

- Commencement of an unplanned (hazard not previously assessed) work phase
- Working in unplanned temperature extremes
- Evidence of contamination, such as discolored soil or elevated instrument readings near the soil
- Exceeding the action limits of chemical or radiological hazards
- Changing the work scope so that the degree of contact with contaminants changes.

Should respiratory protection (Level C) become necessary, SAIC EC&HS Procedure 9, "Respiratory Protection," (SAIC 2004a) will be implemented. As a minimum, this will require that respirator users have current training, fit tests, and medical clearance for respirator use. Workers will wear only the type and size respirator for which they have been fitted. The HSO will provide site-specific respirator training to ensure that workers understand proper respirator use.

7.2 TYPES OF EQUIPMENT

This section presents the types of protective clothing that may be used for the project. Requirements for task-specific levels of protective clothing are presented in the AHA provided in Appendix D of this HASP and the task-specific HSWP. Employees shall wear clothing suitable for the weather and work conditions: the minimum for field work shall be a short-sleeved shirt, long pants (excessively long or baggy pants are prohibited), and leather or other protective work shoes or boots. Other levels of protection that could be required to protect against chemical, radiological, and physical hazards at this site include the following:

- Level C Protective Equipment –
  - Full-face respirator and air-purifying cartridges capable of filtering out organic vapors, acid gases, and radionuclides
  - Hooded chemical-resistant clothing (polyethylene-coated Tyvek® or equivalent) with all openings taped
  - Two pair of chemical-resistant gloves (nitrile and nonlatex exam gloves)
  - Safety boots
  - Shoe covers
  - Hard hat – if overhead hazards exist.
- Level D+ Protective Equipment (may vary depending on activity-specific hazards) –
  - Tyvek® or equivalent coveralls with openings taped closed, as applicable
  - Nitrile or polyvinyl chloride (PVC) gloves
  - Safety boots
  - Disposable boot covers
  - Hard hat – if overhead hazards exist
  - Safety glasses with side shields
  - Splash goggles or face shield (if splash hazard for eye or face/skin is present)
  - Welding goggles and leather coat/gloves (welding/cutting operations).
- Level D Protective Equipment –
  - Coveralls/field clothes
  - Safety boots
  - Safety glasses with side shields
  - Hard hat – if overhead hazards exist
  - Leather, or similar, work gloves if sharp or abrasive materials are handled.

8. STANDARD OPERATING SAFETY PROCEDURES

Site safety and health requirements for tasks being conducted onsite are based on potential physical, radiological, and chemical hazards. The sampling team will follow the general site safety and health requirements documented in this plan. These documents and procedures comply with NRC, OSHA, and USACE regulations.

This section presents those general safety rules that apply to all operations conducted by SAIC and its subcontractors. These requirements are generic in the sense that they apply to all tasks. Therefore, there may be portions of this section that do not apply to a specific task. The provisions of the plan are mandatory for all onsite employees, subcontractors, and visitors.

8.1 SITE RULES

The following rules apply to all site activities:

- Daily safety briefings ("tailgates") will be conducted by the Field Manager and/or FSHO to inform personnel of new hazards or procedures.
- The FSHO, project personnel, and management personnel are responsible for suspending or stopping work and requiring all personnel to evacuate the affected area if any of the following situations occur:
  - Inadequate H&S precautions on the part of any onsite personnel
  - Potential significant environmental insult as a result of planned activities.
- Personnel will conduct only those tasks that they believe they can do safely.
- Personnel will notify the FSHO of any medical conditions (e.g., allergy to bee stings, diabetes, pregnancy) that require special consideration.
- Personnel will maintain proper workplace housekeeping to minimize the potential for tripping and other accidents.
- Contact with potentially contaminated substances will be avoided.
- Spills will be prevented to the greatest extent possible. In the event that a spill occurs, the material will be contained, cleaned up, and reported as necessary.
- Eating, drinking, smoking, chewing gum or tobacco, and other practices that increase the probability of hand-to-mouth transfer are prohibited in contaminated and potentially contaminated areas.
- Workers will wash their hands and faces upon leaving the work area and prior to eating or drinking.
- All injuries and accidents requiring more than first aid will be reported to the FSHO, Project Manager, HSO, and the U.S. Department of Army.
- All onsite workers will abide by a buddy system. Members of a buddy team will maintain verbal or visual contact.

8.2 PERMIT REQUIREMENTS

SAIC will obtain, or coordinate with the U.S. Department of Army to obtain all permits necessary for the safe execution of this project. At a minimum, all activities such as digging or drilling will be preceded by an investigation to preclude encountering subsurface utilities and UXO. This process will be documented in accordance with SAIC EC&HS Procedure 130, "Subsurface Asset Hazard Avoidance," (SAIC 2004a) and Section 8.13 of this HASP.

8.3 HEALTH AND SAFETY WORK PERMITS

The HSWP system of documents is used for control of specific work that provides the minimum protective requirements for the performance of the work. HSWPs will be developed in accordance with SAIC St. Louis HP procedures (SAIC 2004b). The HSWP shall follow the applicable provisions of this HASP; applicable OSHA and USACE requirements; and any special safety, health, and environmental protective measures SAIC intends to implement, based on chosen work methods. All HSWPs and their revisions shall be reviewed by the HSO and approved by the RPM, or designees. A copy of the HSWP and all pre-job briefing forms shall be maintained by the Field Manager onsite. In order to provide for safety awareness at the worker level, the SAIC FSHO, or designee, shall review the HSWP with the work crew prior to the start of work on the first day of the activity. The review meeting shall include the following topics, as applicable: (1) scope of work being conducted; (2) hazardous conditions of the workplace and controls; (3) procedural and HSWP requirements; (4) limiting conditions that may void the HSWP or attached permits; (5) hold points; (6) communication and coordination with other work groups; (7) provisions for housekeeping and final cleanup; and (8) emergency response and evacuation planning, as applicable. All workers and supervisors directly participating in the job shall attend the briefing. Following the review, all participants shall sign and date the pre-job briefing form.

Should conditions/concerns change while working under an HSWP, work shall stop until the conditions can be evaluated by the Field Manager, HSO, FSHO, and/or RPM, and a revision to the HSWP shall be issued to address the change. All personnel listed on the original HSWP shall be informed of the change prior to resuming work activities and shall attend an HSWP review conducted by the SAIC FSHO, or designee, prior to the start of work on the first day that work is conducted under the revised HSWP.

An HSWP must be prepared for all entries into a Radiological Restricted Area, all tasks that may pose a threat of chemical exposure, and all tasks that pose physical threats in excess of those posed by routine in-office activities. Work activities that do not require an HSWP include the following:

- Office work, site tours outside restricted areas, administrative support, and work area inspections/surveillances
- Routine maintenance of barricades, barriers, or tarpaulins
- Placement of labels and signs when movement of containers is not involved
- General housekeeping when no PPE other than standard safety apparel (hard hat and safety glasses) is required
- Packaging of routine environmental samples for offsite shipment
- Relocation of clean, empty containers when no equipment is needed for lifting.

All emergency response activities conducted by SAIC employees, subcontractors, and offsite personnel will bypass HSWP requirements. These activities may include fire response, medical emergency response, or natural disaster response. After the immediate emergency response activities have been completed, HSWP paperwork will be filled in for completion of the response.

8.4 HOT WORK, SOURCES OF IGNITION, AND FIRE PROTECTION

This work will be conducted in conformance with EM 385-1-1, Sections 9 and 10 (USACE 2003a). The following procedures will be implemented:

- Hot work (oxyfuel cutting, welding) will be conducted using a welder's helmet or shaded goggles, leather gloves, and a long-sleeved shirt at a minimum.
- An appropriate fire extinguisher will be immediately available in the vicinity of hot work.

- A fire watch will be stationed in the vicinity of the hot work. The fire watch will have no other duties while conducting this function and shall maintain watch for 30 minutes after completion of the hot work.
- Sources of ignition will be kept at least 15 meters from flammables storage areas.
- Flammables storage areas will be posted with signs indicating, "No smoking or open flame."
- At least one fire extinguisher with a rating of not less than 20-B:C will be kept 8 to 23 meters from all flammables storage areas.
- An approved flammables cabinet (if necessary) will be used to store 25 or more gallons of flammable liquid.
- Flammable liquids (other than decontamination solvents) will be kept in safety containers with flame arresters.

8.5 ELECTRICAL SAFETY

This work will be conducted in conformance with 29 CFR 1910, Subpart S, and EM 385-1-1, Section 11 (USACE 2003a).

- All portable electrical equipment will be double insulated or grounded and connected through a ground fault circuit interrupter (GFCI). All extension cords must be at least of the heavy-duty exterior grade. They must be checked prior to each shift and maintained in accordance with EM 385-1-1, Section 11 (USACE 2003a).
- Conductive materials (drill rigs) will be kept clear of energized power lines. The following minimum distances will be observed: 0 to 50 kilovolts (kV) – 10 feet; 51 to 200 kV – 15 feet; 201 to 300 kV – 20 feet; 301 to 500 kV – 25 feet; 501 to 750 kV – 35 feet; and 750 to 1000 kV – 45 feet.

8.6 HAZARD COMMUNICATION

Hazard communication will be governed by SAIC EC&HS Procedure 8 "Hazard Communication" (SAIC 2004a); 29 CFR 1910.1200; and EM 385-1-1, Section 8 (USACE 2003a). At a minimum, the following steps will be taken:

- All hazardous materials used as part of this effort onsite will be labeled to comply with the hazard communication standard as follows:
  - Must have clear labeling as to the contents
  - Must have the appropriate hazard warning
  - Must show the name and address of the manufacturer.
- Material Safety Data Sheets (MSDSs) will be available onsite for all hazardous materials used as part of this effort.
- Site-specific training will include the hazards posed by site chemicals, protective measures, and emergency procedures, including reporting requirements in the event of releases or spills.
- Copies of MSDSs for all hazardous chemicals (chemicals brought onsite) will be maintained in the work area. MSDSs will be available to all employees for review during each work shift.

8.7 SANITATION

Means for washing hands and faces prior to eating will be provided at the work site. Potable drinking water will be provided in labeled, sanitary dispensers.

8.8 HEAT/COLD STRESS

Important factors in preventing heat stress-induced illnesses are acclimatization, consumption of copious quantities of fluids, and appropriate work and rest cycles. General controls will consist of making fluids readily available, using the buddy system, and taking scheduled and unscheduled breaks in temperature-controlled areas as necessary. The specific steps identified below will be followed to reduce the potential for heat stress-induced illness:

- If ambient temperatures exceed 70°F, site training will include heat stress control, recognition of heat stress-induced illness, and first aid for heat stress.
- If ambient temperatures exceed 70°F, workers will be instructed to monitor their own and their buddy's condition relative to heat stress.
- Workers will be allowed to take unscheduled breaks if needed.
- Workers wearing Tyvek® or other impermeable clothing when ambient temperatures exceed 70°F will be monitored for heat stress by taking their pulses at the beginning of each rest period. If any worker's heart rate exceeds 110 beats per minute, the next work period will be shortened by one-third (NIOSH/OSHA/USCG/EPA 1985).
- An initial work and rest cycle will be established for employees wearing impermeable clothing based on the air temperature. The length of each work period will be as follows (NIOSH/OSHA/USCG/EPA 1985):

° Fahrenheit	Work Period
72.5 – 77.5°F	120 minutes
77.5 – 82.5°F	90 minutes
82.5 – 87.5°F	60 minutes
87.5 – 90°F	30 minutes
≥90°F	15 minutes

Critical factors in preventing cold stress disorders are adequate clothing and staying dry. The HSO and FSHO will ensure the capability to quickly move individuals who become wet to a sheltered, warm area. The following specific steps will be taken (adapted from American Conference of Governmental Industrial Hygienists [ACGIH] *Threshold Limit Values* booklet).

- If ambient temperatures are less than 40°F, site training will include prevention of cold injury, cold injury symptoms, and cold injury first aid.
- A heated break area will be provided if ambient temperatures are less than 32°F.
- As a minimum, breaks will be taken in a warm area every 120 minutes if ambient temperatures are less than 32°F.
- Workers will be allowed to take unscheduled breaks, if needed, in a warm area.
- No outdoor work will be conducted if the equivalent chill temperature (temperature combined with the effect of wind) is less than -29°F.

8.9 MACHINE GUARDING

All equipment will be operated with all guards provided by the manufacturer and in compliance with 29 CFR 1910, Subpart O, and EM 385 1-1, Section 16.B (USACE 2003a). If any guarding must be removed for servicing onsite, the equipment will be disabled and locked out, as appropriate, to preclude movement or release of energy.

8.10 FALL PROTECTION

Work areas with the potential for a fall of 6 feet or more will be provided with fall protection in compliance with EM 385-1-1, Section 21.A.15 (USACE 2003a). This fall protection will consist of guardrails or personal fall protection. Personal fall protection will be used if it is necessary for drilling personnel to climb the upright mast or derrick.

8.11 ILLUMINATION

Most site field work will be conducted during daylight hours and natural illumination will be used. Fieldwork to be conducted during nondaylight hours will be specifically identified in the hazard assessment table. Work conducted in buildings will be illuminated to meet the minimums stated in 29 CFR 1910.

8.12 DRILL RIG OPERATIONS

The following practices shall be followed when conducting drill rig operations onsite:

- Incoming drill rigs will receive an initial radiological survey.
- Operating manuals will be present onsite for each type of drill rig in use.
- Drill rigs will have at least two functional kill switches, one for the driller and one for the driller's helper. These switches will be confirmed to be functional each day that the rig is used.
- Drill rigs will have functional backup alarms.
- Drill rigs will be inspected daily and this inspection will be observed by H&S personnel. Inspections should be documented in the driller's logbook or equivalent. An example drill rig inspection checklist is provided in Appendix C.
- Only the driller, driller's helper, and personnel who have a critical need shall be allowed near moving parts of the drill rig.
- Drill sites will be verified free of underground utilities by clearing each site with local utilities or appropriate Base personnel prior to beginning drilling.
- Drill-mounted fire fighting equipment will not be tampered with and will not be removed for other than the intended fire-fighting purposes or for servicing.
- Drilling crews and personnel who work near the drilling rig will be trained in the location and use of the kill switches.
- Personnel within 25 feet (7.6 meters) of an operating drill rig shall wear hearing protection.
- No loose clothing, loose jewelry, or loose long hair is permitted near the drill rig while in operation.
- If lubrication fittings are not accessible with guards in place, machinery will be stopped and disabled (locked out or ignition key removed) for oiling and greasing.
- Work areas and walkways will not be obstructed.
- The derrick (mast) will not be raised unless the area is free of overhead obstructions and far enough from power lines (see Section 8.5).
- The derrick will not be raised until the rig has been blocked, leveled, and chocked.
- Prior to drilling, the area at the rear of the rig will be cleared of any items such as chains or shovels that might become entangled with the drilling equipment.

8.13 UNEXPLODED ORDNANCE

The target area, impact area, ricochet area, and surrounding areas may contain UXO. UXO may be found on the surface and/or subsurface. The varying types of ammunition, angle of fire, and soil types preclude the accurate estimation of the depth of any subsurface UXO.

8.13.1 General Information

The following UXO principles apply while onsite:

- The cardinal principle to be observed involving explosives, ammunition, severe fire hazards, and/or toxic materials is to limit the exposure of a minimum number of personnel, for the minimum amount of time, to a minimum amount of hazardous material consistent with a safe and efficient operation.
- The age or condition of ordnance does not decrease its effectiveness. Ordnance that has been exposed to the elements for extended periods becomes more sensitive to shock, movement, and friction due to the fact that the stabilizing agent in the explosives may be degraded.
- Consider ordnance that has been exposed to fire as extremely hazardous. Chemical and physical changes may have occurred to the contents, which render them more sensitive than they were in their original state.
- DO NOT be misled by markings on the ordnance stating "practice bomb," "dummy," or "inert." Even practice bombs contain explosive charges that are used to mark/spot the point of impact. The item(s) also could be mis-marked.
- DO NOT rely on color codes for positive identification of ordnance item(s) or their contents.
- Always assume that ordnance contains a live charge until it can be ascertained otherwise.

8.13.2 Onsite Instructions

The following instructions apply while onsite:

- All onsite workers will be trained to recognize the types of ordnance that may be present (e.g., JPG UXO safety video).
- SAIC and its subcontractors will not handle, move, or otherwise disturb ordnance or any items that cannot be identified as not being ordnance.
- For intrusive work in areas where subsurface UXO may reasonably be expected (e.g., former ordnance disposal sites and range fans), qualified UXO personnel will conduct a survey (visual and magnetometer) prior to intrusive work to preclude disturbing subsurface UXO. Intrusive work will be conducted only at locations that can be verified free of potential UXO.
- For work in areas where UXO reasonably may be exposed at the surface, the work areas will be cleared by visual and instrument surveys conducted by qualified UXO specialists. The surveyed areas will be marked and non-UXO personnel will operate only within the designated cleared areas. All field work in areas where UXO reasonably may be exposed at the surface will be subject to continuous surveillance by qualified UXO personnel.
- If UXO is encountered during sampling, project personnel will immediately cease all activity.
- Personnel will proceed to a safe evacuation distance from the UXO.
- Notify the appropriate U.S. Army personnel of the location of the UXO.
- DO NOT touch or move any ordnance regardless of the markings or apparent condition.

- DO NOT visit an ordnance site if an electrical storm is occurring or approaching. If a storm approaches during a site visit, leave the site immediately and seek shelter.
- DO NOT use radios or cellular phones in the vicinity of suspect ordnance.
- DO NOT walk across an area where the ground cannot be seen. If dead vegetation or animals are observed, leave the area immediately because of potential contamination by chemical agents.
- DO NOT drive vehicles into a suspected UXO area; use clearly marked lanes.
- DO NOT carry matches, cigarettes, lighters, or other flame-producing devices onto a UXO site.

There is no evidence of the potential existence of chemical warfare material (CWM) or CWM byproducts on JPG. In the event suspect CWM is encountered, all work will cease immediately and project personnel will be evacuated along cleared paths upwind from the discovery. A team consisting of a minimum of two personnel will immediately secure the area to prevent unauthorized access. Reporting procedures will be in accordance with this HASP.

8.14 IONIZING RADIATION

All work involving ionizing radiation will be conducted in compliance with SAIC EC&HS Procedure 19 (SAIC 2004a), SAIC St. Louis HP procedures (SAIC 2004b), and USACE EM 385-1-1, Section 6 (USACE 2003a). The guiding philosophy will be to keep exposures ALARA.

8.14.1 Exposure Limits

All personnel working on this project will be administratively limited to 100-mrem total effective dose equivalent (TEDE) annually. Personnel trained as Rad Workers are limited to 500 mrem TEDE, unless a higher limit is approved by an authorized agent of the licensee (U.S. Department of the Army, Radiation Safety Officer/Radiation Protection Manager [RSO/RPM]). Personnel exposure shall not exceed the SAIC annual administrative limit of 2000 mrem TEDE. The SAIC RPM shall coordinate authorization of increased personnel exposure limits. The SAIC RPM will document any exceptions in accordance with SAIC St. Louis HP procedures (SAIC 2004b).

8.14.2 Surface Radioactivity Limits

Table 8-1 presents contamination limits as they apply to this project.

8.14.3 General Requirements

The SAIC RPM will determine the need for and document personnel radiological monitoring requirements on the HSWP for a specific task. A whole-body frisk will be conducted upon leaving a potentially contaminated area. In areas where personnel contamination is unlikely, the employee (self-monitoring) may conduct this monitoring. Any detected personnel contamination will be reported immediately to an HPT. In areas where contamination is probable, this monitoring must be conducted by an HPT. Any detectable contamination will require decontamination to nondetectable levels following established procedures. Removal of contamination on personnel will be attempted with moist paper towels (if in the field) followed by washing with soap and water, if necessary.

Table 8-1. Acceptable Surface Contamination Levels
Jefferson Proving Ground, Madison, Indiana

Nuclide[a]	Average[b,c]	Maximum[b,d]	Removable[b,e]
U-nat, U-235, U-238, and associated decay products	5,000 dpm α/100 cm^2	15,000 dpm α/100 cm^2	1,000 dpm α/100 cm^2
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, and I-129	100 dpm/100 cm^2	300 dpm/100 cm^2	20 dpm/100 cm^2
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-234, I-126, I-131, and I-133	1,000 dpm/100 cm^2	3,000 dpm/100 cm^2	200 dpm/100 cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above	5,000 dpm $\beta\gamma$/100 cm^2	15,000 dpm $\beta\gamma$/100 cm^2	1,000 dpm $\beta\gamma$/100 cm^2

Source: NRC 1974

[a] Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides should apply independently.

[b] As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[c] Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each such object.

[d] The maximum contamination level applies to an area of not more than 100 cm^2.

[e] The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

The RPM may determine that less restrictive monitoring (i.e., hands, feet, and face) is appropriate. However, the whole-body frisk will be conducted using the following process:

- Verify the instrument has passed a source test.
- Verify the instrument is on and set to its most sensitive scale.
- Hold hands approximately ¼ to ½ inches from the face of the probe and verify hands are free of contamination prior to picking up probe.
- Hold the probe approximately ½ inch from the surface being frisked and move the probe at approximately 1 to 2 inches per second, when using a Geiger-Müeller (GM) detector (¼ inch from surface at ½ inch per second for alpha scintillation detectors).
- Survey hands.
- Survey head (pausing around mouth and nose), neck and shoulders (pause at elbows), chest and abdomen, back, seat of pants, legs (pause at each knee), and shoes in that order.

Employees likely to exceed a radiation dose from external sources of 500 mrem/yr or enter a posted Radiation Area or High Radiation Area will be monitored with thermoluminescent dosimeters (TLDs) analyzed under a program meeting the National Voluntary Laboratory Accreditation Program (NVLAP) program. TLDs will be issued and controlled using established procedures.

Instruments and equipment used inside radiologically contaminated areas or airborne radioactivity areas will be surveyed prior to release from the area. This survey will be conducted by a qualified HPT.

Samples taken in restricted areas, contaminated areas, radiation areas, or airborne activity areas will be surveyed to determine removal and shipping restrictions.

Surface contamination will be evaluated to determine the potential to generate airborne particulates. Areas where the potential exists for airborne radioactivity concentrations greater than 10 percent of a derived air concentration (DAC) will be sampled for airborne radioactivity. In sampled areas, DAC-hours will be tracked and the need for respiratory protection will be evaluated.

All radiation meters will be calibrated at least annually and will be checked against a known source prior to each day of use. The results of source checks will be maintained onsite.

Radiological restricted areas will be identified and posted. Areas will be posted as Radiation Areas, Airborne Radioactivity areas, or other designations, as required and defined in EM 385 1-1, Section 6 (USACE 2003a) and 10 CFR 20.

8.15 WORKING ON OR NEAR WATER

The proposed tasks for the JPG DU Impact Area characterization project are not expected to expose personnel to drowning hazards. However, due to the presence of creeks and streams onsite, the following guidance is provided, as necessary, for changes in current conditions (e.g., swollen creeks during rain events).

This guidance specifies safety procedures to be taken during operations on, or within, 5 feet of water deeper than 3 feet (0.9 meters). This guidance does not apply to areas where handrails, standard rigid barricades, gratings, or other protective systems are in place.

If necessary, the Field Manager and HSO shall determine the appropriate water rescue equipment for use in applicable activities. The following equipment shall be considered:

- A rescue boat
- Safety belts
- Vinyl life jackets (Coast USCB approved)
- 30-inch life rings with 90-foot lines (USCG approved)
- Two-way radios
- A lifeline.

Employees using equipment shall inspect it prior to use. Any equipment found to be unsafe should be identified as "Defective" and replaced. Upon completion of activities, all safety equipment shall be inspected for damage; damaged items shall be tagged "defective" and replaced as necessary.

When personnel are working on a downward slope, where a slip and fall could result in the worker falling into water deeper than 3 feet (0.9 meters), the worker shall wear a safety belt or harness with a lifeline attached. The lifeline shall be secured to a sturdy object and shall be manned by an attendant. Where it is not feasible to attach a lifeline to a sturdy object, the attendant may man the lifeline. However, the attendant must be physically capable of holding the worker to prevent him/her from falling into the water.

8.16 BIOLOGICAL HAZARDS

The JPG DU Impact Area characterization project will include outdoor work that could expose personnel to biological hazards, including poisonous plants, insects, and animals. All personnel working in outdoor environments shall notify their supervisor of any allergies or sensitivities they have to these hazards. Examples of poisonous plants, insects, and animals that may be encountered include the following:

- Bees, wasps, and hornets
- Snakes, ticks and spiders
- Poison ivy, poison oak, and poison sumac.

Personnel shall tape interfaces of clothing, use insect repellant, and conduct self-inspection for ticks as necessary. They also should wash their hands and faces when leaving areas where poisonous plants are present.

Copperhead snakes have been identified at JPG. Although copperheads are venomous, bites from copperheads are very seldom fatal; however, a bite may still produce serious consequences. Copperheads can be found in most all habitats, although they often prefer to be near streams and other waterways. They may be found on hilltops or lowlands. When danger is perceived, copperheads will usually freeze in place and remain motionless for the threat to pass. This strategy works well in their natural habitat. Unless a person steps on them, grasps them, or otherwise comes very close to them, copperheads usually will not bite. However, the bite will be readily used as a last defense. An agitated copperhead will vibrate its tail rapidly.

8.17 HEAVY EQUIPMENT

Operation of heavy equipment, such as excavators, loaders, graders, rollers, and bulldozers, shall only be conducted by trained and skilled operators who have demonstrated the ability and necessary skills to operate such machinery safely. Ground-based workers should be trained in how to work safely around the equipment and how to stay clear. Unsafe practices by either the operator or those around the equipment can create very dangerous situations. Serious injuries can occur if the equipment strikes a worker, or if the equipment is rolled over.

Safety rules for operators and ground-based workers include the following:

- *Good communication is essential.* A standardized set of hand signals should be used by the operator and signal person. Operators should always know exactly where all ground-based workers are located. High-visibility vests worn by the workers will help the operators to locate them quickly. The operators shall use spotters, as necessary, to ensure safe operation. The equipment should have a back-up warning alarm that can be heard by all nearby workers. Two-way radios are also valuable communication tools.
- *Heavy equipment must have a rollover protective structure (ROPS) meeting OSHA requirements.* The ROPS is designed to protect the operator if the machine tips over. A seat belt must be worn so that the operator will not be thrown out of the seat during a rollover or upset situation. If working on slopes, avoid moving equipment across the face of the slope and instead operate up and down the slope face if possible. Use extreme caution when operating near open excavations.
- *Wear hearing protection when required.* If it has been determined that noise levels around the equipment could potentially cause hearing loss, always use protective plugs or muffs when working on or around the equipment.
- *Never jump onto or off the equipment.* Operators should always use the three-point contact rule when climbing onto or off heavy equipment. The three-point rule means having both feet and one hand, or one foot and both hands, in contact with the ladder access at all times.
- *Inspect and service the equipment regularly.* Complete equipment service in accordance with the manufacturer's recommendation. Periodic safety inspections on all components of the equipment should be conducted regularly by qualified personnel. Inspect the steering system and brake systems carefully. A pre-shift, walk-around inspection by the operator is required.

8.18 OTHER SITE ACTIVITIES

Due to the immense size and various uses of the JPG facility, there is always a potential that other activities, including controlled burns, seasonal hunting, and ANG training may be occurring onsite. The

Field Manager shall ensure that all necessary activity coordination is made prior to commencing any field work. This coordination includes, but is not limited to:

- Coordinating with the USFWS to avoid any conflicts with USFWS-prescribed burns. USFWS burns normally occur in February and March.
- Coordinating with the USFWS to avoid any conflicts with any scheduled public hunting programs.
- Coordinating with the Indiana ANG on a daily or as-needed basis to avoid any conflicts with scheduled ANG flights and/or training.

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9. SITE CONTROL MEASURES

Site access to the area north of the firing line and to the DU Impact Area at JPG is controlled by the U.S. Army via the Army/Air Force/USFWS MOU of 2000. The Field Manager will ensure that all notifications and requirements of this MOU are completed prior to accessing these areas.

The HSO and FSHO will be responsible for establishing the site control zones, as necessary, around SAIC-controlled areas that present physical, radiological, and/or chemical hazards. Implementation of the site control zones will help to minimize the number of employees potentially exposed and the potential for the spread of contamination.

Site control zones will be established in a number of locations over the site. The exact locations will vary depending on site conditions; therefore, it is not possible to predetermine the size or exact locations of site control zones. SAIC will attempt to exclude all unauthorized personnel (e.g., members of the public) from site control zones. If unauthorized personnel enter an SAIC-controlled area and refuse to leave, work will be stopped and the U.S. Department of Army technical manager will be notified. Authorized visitors will be required to show proof of current training and medical surveillance, as appropriate.

Site control zones will be established around drilling sites, areas of heavy equipment use, and all activities where loose contamination and/or airborne contamination are a potential hazard. At a minimum, the site control zone for drilling operations will be at least equal to the mast height in radius so that no part of an overturned drill rig will fall outside the zone.

9.1 SITE COMMUNICATION

The field crew will be equipped with a cellular phone. Section 11.1 identifies communication requirements during emergencies.

9.2 HAZARDOUS WASTE MANAGEMENT

SAIC personnel, or SAIC subcontract personnel, are not authorized to sign uniform hazardous waste manifests or waste profiles on behalf of the USACE, or in any way direct final transportation to a Treatment, Storage, and Disposal (TSD) facility or disposal of field-generated waste. Hazardous waste management will be addressed in the Field Sampling Plan (FSP) for the JPG DU Impact Area site characterization.

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10. PERSONAL HYGIENE AND DECONTAMINATION

HSWPs, in conjunction with HP procedures and practices, will be used to control the spread of contamination from site control zones and to ensure that workers are sufficiently free of contamination to preclude adverse health effects. PPE doffing, radiological contamination scan (frisk), and personnel decontamination will be conducted in accordance with the SAIC St. Louis HP procedures (SAIC 2004b), as necessary. This section presents basic requirements for personnel decontamination keyed to the level of protection. These requirements may be modified by the FSHO, with RPM concurrence, if improvements are needed.

10.1 LEVEL D PROTECTION DOFFING SEQUENCE

Step 1: Equipment drop—Place potentially contaminated equipment in a designated area.

Step 2: Removal of disposable gloves and boot covers (if worn)—Deposit disposable gloves and boot covers in a designated container. Note that this step is necessary only if gloves and boot covers are in use.

Step 3: Frisk—Examine hands, shoes, and any other areas that may have become contaminated. Because of the unlikelihood of contamination, the individual may conduct the frisk. Any personal contamination will be removed with tape, a moistened towel, or soap and water.

The doffing procedure for Level C PPE will be documented on appropriate task-specific HSWPs.

10.2 EQUIPMENT DECONTAMINATION

Sampling and related equipment will be decontaminated to a level sufficient to prevent cross-contamination of subsequent samples. This stringent requirement ensures that decontaminated sampling equipment is sufficiently clean from a personnel contact perspective. Decontamination of sampling equipment will be conducted in accordance with Field Technical Procedure (FTP)-400 (SAIC 2004a).

Decontamination of radiologically contaminated equipment will be conducted in accordance with appropriate SAIC St. Louis HP procedures (SAIC 2004b). Radiologically decontaminated equipment must be surveyed by an HPT and meet the site release limits listed in Table 8-1 prior to removal from a radiologically controlled area.

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11. EMERGENCY PROCEDURES AND COMMUNICATION

In the event of an accident or incident, the SAIC Field Manager will notify the Army RSO/RPM immediately according to the requirements of EM 385-1-1 (USACE 2003a). Additional reporting requirements and associated procedures are documented in this section.

11.1 EMERGENCY PROCEDURES

EM 385-1-1 (USACE 2003a) requires specific items of information to be included in a Project Accident Prevention Plan. Appendix D provides the locations of these specific items within SAIC's program documents and this HASP. All accidents will be investigated and reported within 24 hours as specified in EM 385-1-1 (USACE 2003a). The Accident Report (ENG Form 3394) will be completed and submitted to the Army at this address:

Joyce Kuykendall, RSO/RPM
U.S. Department of Army
RDECOM
ATTN: AMSRD-MSF
5183 Blackhawk Road
APG, MD 21010-5424

All personnel working onsite will be trained in the requirements of this section. This training will include recognizing emergencies, reporting emergencies to the Field Manager or FSHO, and responding to emergencies. Employees also will be informed of any changes in potential emergency or response plans.

Field crews will use a variety of equipment that could cause injuries. In support of emergency operations, the FSHO or Field Manager will designate the assembly area and evacuation routes. In the event of a medical emergency, the Field Manager will notify the local emergency medical service immediately. Personnel with serious injuries will be stabilized onsite pending arrival of emergency medical service personnel. At least one first aid or CPR-trained individual will be onsite at all times, and this person will provide first aid pending release of the injured person to emergency medical staff. Contaminated, injured personnel will be decontaminated to the extent feasible. Personnel with minor injuries will follow normal decontamination procedures. Personnel with serious injuries will be decontaminated, if necessary, by disrobing and wrapping in a blanket. Decontamination may be bypassed in the event of life-threatening injuries or illnesses.

The emergency groups and their telephone numbers listed in **Table 11-1** will be posted onsite. A cellular phone will be present in the field and available for use.

**Table 11-1. Emergency Points of Contact
Jefferson Proving Ground, Madison, Indiana**

Organization	Telephone
Ambulance	911
Fire Department	911
King's Daughters' Hospital	911 or (812) 265-5211
JPG Site Manager (Ken Knouf)	(812) 273-2551
SAIC Field Manager/FSHO (Seth Stephenson)	(765) 278-3520
SAIC HSO (Randy Hansen)	(314) 486-6916
SAIC RPM (Mike Lambert)	(314) 770-3098
SAIC Project Manager (Corinne Shia)	(703) 318-6993
U.S. Army RDECOM (Joyce Kuykendall)	(410) 436-7118
SAIC Corporate Health and Safety Manager (Steve Davis)	(865) 481-4755

King's Daughters' Hospital, located in Madison, will be used for any required medical services. Medical emergencies will be handled by dialing 9-1-1 for medical assistance and contacting the JPG Site Manager to serve as an escort to the sampling location.

Directions to King's Daughters' Hospital are as follows: exit the Main Gate, drive south on Highway 421, and turn right on 4th Street to the emergency entrance (**Figure 11-1**).

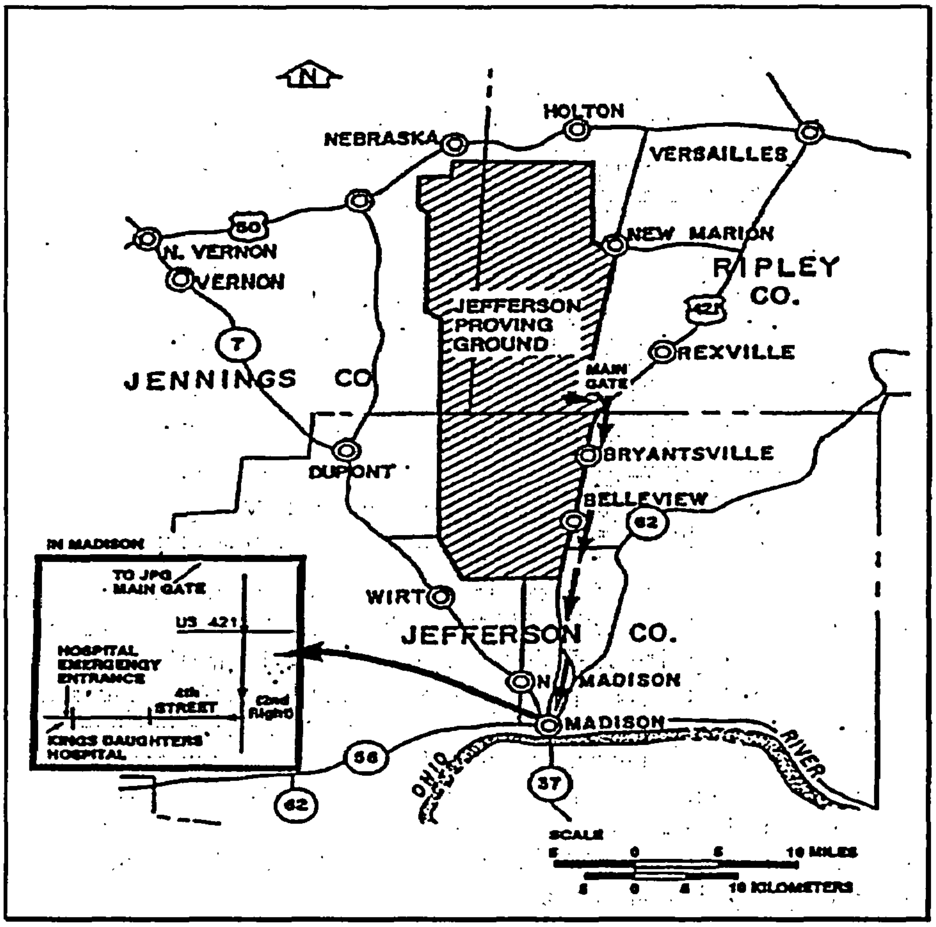

Figure 11-1. Directions from Jefferson Proving Ground to King's Daughters' Hospital

11.2 EMERGENCY EQUIPMENT

Several items of emergency equipment will be maintained at the work site. Any incident that clearly is not controllable by personnel wearing standard site clothing plus protective gloves and using the listed equipment will require reevaluation by the FSHO. If the FSHO does not feel that onsite personnel can safely control the emergency with the available equipment, the crew will use alternate approaches, such as allowing a small fire to burn out or evacuating the site. The required emergency equipment includes the following:

- A 16-unit first aid kit indoors or in weatherproof container, inspected weekly
- An ABC fire extinguisher in each work vehicle
- A basic spill kit suitable to handle small spills of decontamination fluids, hydraulic fluid, or fuels and containing sorbent pads, tubes, and nitrile or similar gloves
- A telephone and/or portable radios.

12. LOGS, REPORTS, AND RECORDKEEPING

A system of reports and logs will be used to document activities related to site H&S. These reports will include injuries, accidents, and near accidents; interpretations of the HASP or regulations; interactions with auditors, regulators, and U.S. Army personnel; and any abnormal events:

- Accident and injury reports for all accidents other than first aid cases;
- Training certificates
- Medical clearance forms
- Related procedures, such as for equipment and personnel decontamination
- The H&S debrief form contained in EC&HS Procedure 20 (SAIC 2004a), which should be completed by the FSHO at the end of the project and submitted to the SAIC H&S Manager.

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13. REFERENCES

ACGIH (American Conference of Governmental Industrial Hygienists). 2001. *Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices.*

NIOSH (National Institute for Occupational Safety and Health). 2004. *Pocket Guide to Chemical Hazards*, February.

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APPENDIX A

EXAMPLE SAFETY INSPECTION FORM

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EXAMPLE DAILY SAFETY INSPECTION PROJECT:____			Page 1 of 2
N	Y	NA	Item
			Daily safety briefing conducted
			Emergency numbers and route to hospital posted
			HASP onsite, available to employees, and complete?
			Required exposure monitoring conducted and documented
			Monitoring instruments (PID, OVA, CGI) calibrated daily against known standard and documented
			16-unit first aid kit available and inspected weekly
			Personnel wearing PPE required by HASP for field work (at least safety shoes or boots, safety glasses with side shields, and nitrile or similar gloves to handle potentially contaminated material)
			Personnel using buddy system (maintain visual or verbal contact and able to render aid)
			If temperature >85°F: heat stress training conducted, cool fluids available, pulse rates of personnel wearing Tyvek are being monitored, work/rest cycle in HASP being followed
			If temperature <40°F: cold stress training conducted, controls in HASP implemented
			Personnel using appropriate biological hazard controls (see HASP)
			Drill rig operating manual onsite
			Drill rigs inspected weekly and documented
			Personnel near drill rig or other overhead hazards wearing hardhats
			Each of two drill rig kill switches tested daily
			Employees excluded from under lifted loads
			Unnecessary personnel excluded from hazardous areas, specifically near drill rigs
			Radius of exclusion zone around drill rig at least equal to mast height
			Personnel wearing hearing protection when within 25 feet of drill rigs, generators, or other noisy equipment
			Containers of flammable liquids closed and labeled properly
			Fully charged fire extinguisher available 25 to 50 feet from flammables storage area and inspected monthly
			Personnel exiting potentially contaminated areas washing hands and face before eating
			Personnel using steam washer wearing face shield, hearing protection, heavy-duty waterproof gloves, Saranax or rainsuit
			Portable electrical equipment double insulated or plugged to a GFCI
			Electrical wiring covered by insulation or enclosure
			Three-wire, UL-approved, extension cords used
			Housekeeping adequate (walkways clear of loose, sharp, or dangerous objects and trip hazards, work areas clear of objects that might fall on employees)
			Walking/working surfaces safe (not slippery, no unguarded holes, and no trip hazards)
			Confined space entry (entry into trenches deeper than 4 feet) conducted according to HASP and EC&HS Procedure 10 Moving (rotating) machinery guarded to prevent employee contact
			Excavations deeper than 5 feet shored or sloped (if personnel will enter) and in compliance with HASP

EXAMPLE DAILY SAFETY INSPECTION PROJECT:________________				Page 2 of 2
			Fall protection provided for work at elevations greater than 4 feet	
			All containers of hazardous material labeled to indicate contents and hazards	
			MSDSs for hazardous materials onsite	
			If work is conducted in areas open to hunting (and during season), high-visibility vests and other alerting systems such as lights, noise devices (radios) in use	
			15-minute eyewash (accessible and full) within 100 feet of areas where corrosive sample preservatives are poured	
			Potable and nonpotable water labeled	
			Chainsaws have anti kick-back protection, personnel wearing cut-resistant gloves, protective chaps	
			Visitor access controlled	
			Site hazards and controls consistent with HASP	
			Site hazard controls appropriate and sufficient	
Areas checked, equipment in use, and employees present				
Actions taken to current or control and "N" responses				
Name			Signature	Date

CGI = combustible gas indicator
EC&HS = Environmental Compliance and Health and Safety
GFCI = ground fault circuit interrupter
HASP = Health and Safety Plan
MSDS = Material Safety Data Sheet
OVA = organic vapor analyzer
PID = photoionization detector

APPENDIX B

EXAMPLE ACTIVITY HAZARD ANALYSIS

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Activity Hazard Analysis

Activity:________________ Analyzed by:___________ Reviewed by:_________________

Principal Steps	Potential Safety/Health Hazards	Recommended Controls
Travel to/at Project Site	Operation of motor vehicles and trucks	All site personnel operating motor vehicles shall comply with all Federal, state, and local traffic regulations. Personnel shall use only vehicles that are in good condition and are safe to operate. Personnel shall routinely inspect vehicles and document as outlined in the HASP. All personnel will drive defensively, wear seatbelts while vehicles are in motion, and comply with site speed limits. Backing of vehicles shall be avoided when possible. Extra care shall be taken to back vehicles when unavoidable.
Unloading Equipment	Heavy lifting, strains, or sprains	No individual employee is permitted to lift any object that weighs over 50 pounds. Proper lifting techniques shall be used. Multiple employees or the use of mechanical lifting devices are required for lifting objects over the 50-pound limit.
	Use of forklifts or other mechanical equipment	Only qualified personnel shall be permitted to operate equipment. Forklifts and mechanical equipment shall be inspected daily. Forklift inspections shall be documented on SAIC EC&HS Procedure 26, "Powered Industrial Trucks," Exhibit 26-1. Deficiencies in equipment shall be noted on the inspection form. Equipment found to be unsafe shall not be used. All equipment shall be operated at safe speeds and in a safe manner. Equipment operators shall wear safety belts and hearing protection, as necessary. Ground personnel shall not position themselves between equipment and stationary objects and shall only approach the equipment after the bucket/fork/load (if applicable) is on the ground and after receiving a signal from the operator. Personnel shall maintain eye contact with the operator when approaching equipment. Equipment load capacities shall not be exceeded. Personnel shall never stand under suspended loads No person is to operate a powered industrial truck (e.g., a forklift) until the training requirements of SAIC EC&HS Procedure 26 "Powered Industrial Trucks," Section 26.7, "Operators Training," and 29 CFR 1910.178 are satisfied. Personnel shall ensure all mechanical guards are in place and functioning properly. All equipment shall be shut down with energies dissipated prior to conducting maintenance activities. Lockout/tagout procedures may apply. Only qualified mechanics shall work on or repair mechanical equipment.

Activity Hazard Analysis (Continued)

Principal Steps	Potential Safety/Health Hazards	Recommended Controls
	Overhead power lines	Equipment operators must remain aware of overhead powerlines and maintain safe distances. Spotters shall be used as necessary.
	Slips, trips, and falls	Keep work areas clear and maintain proper housekeeping – mark, barricade, or eliminate trip/fall hazards. Personnel shall not jump from equipment or elevated surfaces. Unloaded equipment and materials shall be stored appropriately. Provide and use fall protection at working heights > 6 feet. Install and use fall restraints or other appropriate controls when working on roof areas. Appropriate fall protection equipment shall be used while working in man-lifts. Only Type I ladders are permitted. Ladders shall be inspected before each use, be in good condition, and only used as intended by their design. Ladders shall be erected on level surfaces and tied off while being used. When tying off is impractical, other personnel shall be used to steady the ladder. Personnel shall not overextend their reach while working on ladders.
	Hand injuries	Items to be handled shall be inspected for sharp edges prior to being handled. Personnel shall wear leather gloves when handling sharp materials. Personnel shall be aware of and avoid pinch point hazards.
	Fire	Engines shall be shut off before refueling. An ABC fire extinguisher shall be available at refueling areas. Smoking shall not be permitted near fueling areas. Fuel will be stored in safety cans with flame arrestors.
	Electrocution	Only qualified electricians shall make electrical connections. All electrical work shall comply with National Electric Code standards. All circuit breakers shall be labeled. There shall be no work on energized electrical lines or equipment. Lockout/tagout procedures will apply during service or repair of machines or equipment in which the unexpected energization or release of stored energy could cause injury to employees. GFCIs shall be used on all power tools and extension cords. Extension cords, power tools, and lighting equipment shall be inspected before each use, protected from damage, and kept out of wet areas.

Activity Hazard Analysis (Continued)

Principal Steps	Potential Safety/Health Hazards	Recommended Controls
	Excavation hazards (contact with underground utilities, excavation cave-in, work around heavy equipment, and hazardous atmospheres)	Underground utilities shall be located and marked prior to commencing excavation activities. Excluding personnel from trenches deeper than 4 feet will control cave-in hazards. Personnel will be kept at least 3 feet away from trenches deeper than 4 feet. Visual examination of excavation will be conducted from the trench ends, rather than the sides. If it becomes necessary for personnel to enter trenches deeper than 4 feet, the requirements of 29 CFR 1926.651 will be applied. This will include daily inspections of the excavation, shoring, benching, or sloping of the trench sides. Entry also will be treated as confined space entry and will be conducted in accordance with 1926.651, OSHA's confined space standard, and SAIC EC&HS Procedure 10, "Confined Space Entry."
	Noise	Noise surveys shall be conducted to determine the extent and limits of hazardous noise areas. Engineering controls shall be implemented where feasible. Areas with noise that cannot be controlled shall be posted as such, and personnel shall wear hearing protection to reduce exposures below the OSHA limits. Hearing protection is required for SAIC activities where noise levels exceed 85 dBA in an 8-hour TWA.
	Radiological/ chemical contamination	Personnel shall wear Modified Level D (D+) PPE as required by the HASP and outlined in the HSWP. Medical clearance in accordance with 29 CFR 1910.120. TLDs shall be worn by personnel working in radiological areas or determined by the RPM and SAIC St. Louis HP procedures. Entry, routine, special, and exit bioassay samples shall be submitted to HP if working in radiological areas or determined by the RPM. All employees and equipment shall be monitored for contamination prior to exit from radiological areas. The extent of personnel surveys (e.g., whole body, hand and foot) shall be conducted as listed on the HSWP. Minimize contact with radiological materials, survey and wash hands and face prior to taking anything by mouth (e.g., eating, drinking, smoking, chewing) No eating, drinking, smoking, chewing, etc., permitted in any radiological area. All incoming heavy equipment shall be surveyed for contamination prior to being allowed into radiological areas. Monitoring for chemicals is not anticipated to be necessary but shall be conducted, if applicable.

Activity Hazard Analysis (Continued)

Principal Steps	Potential Safety/Health Hazards	Recommended Controls
	Injury from steam/pressure washers	Personnel shall be trained in the use of steam/pressure-washing equipment. The spray from such equipment shall only be directed at surfaces to be cleaned and never at body parts or other personnel. Face protection shall be worn by all personnel associated with the use of steam/pressure washers. Rain gear shall be worn by personnel in addition to other PPE.
	Drum/container handling	An HSWP must be developed prior to any sampling of drums or handling of drums showing evidence of damage, corrosion, or any condition that may result in a leak, spill, or release. Any drums used for the transportation of project materials will meet DOT and 10 CFR 20 requirements and will be labeled to comply with applicable EPA requirements. Drums weighing more than 40 pounds must be handled with a drum dolly or other suitable device.
	Chemical hazards	Copies of MSDSs for all hazardous chemicals onsite will be maintained in the work area. MSDSs will be available to all employees for review. PPE requirements for work with, or around, hazardous chemicals (i.e., sample preservation or in the laboratory) shall be commensurate with hazards, chemical use, and MSDS recommendations. No eating, drinking, smoking, chewing, etc., permitted in any chemical use area. Emergency eye wash (ANSI Z 358.1) will be available in the vicinity of chemical use areas. Medical clearance in accordance with 29 CFR 1910.120. Prevent contact with chemical, wash hands and face prior to taking anything by mouth (e.g., eating, drinking, smoking, chewing.)
	Illumination	Site field work will be conducted during daylight hours (no earlier than 15 minutes after sunrise and no later than 15 minutes before sunset), and natural illumination will be used. Work conducted in buildings will be illuminated to meet the minimums stated in 29 CFR 1910.120.

Activity Hazard Analysis (Continued)

Principal Steps	Potential Safety/Health Hazards	Recommended Controls
	Drowning	When working within 5 feet of water deeper than 3 feet, employees shall utilize applicable water rescue equipment. Equipment shall be inspected for damage prior to use. When personnel are working on a downward slope where a slip and fall could result in the worker falling into water deeper than 3 feet, the worker shall wear a safety belt or harness with a lifeline attached. The lifeline shall be secured to a sturdy object and shall be manned by an attendant. If work involves sampling or other activities that require the use of a boat, one life ring shall be placed in the boat and one shall be placed with an attendant. When a boat is not within sight of the onshore attendant, radio contact must be maintained.
	Heat stress	General controls will consist of making fluids readily available, use of the buddy system, and taking scheduled and unscheduled breaks in temperature controlled areas, as necessary.
	Cold stress	General controls consist of adequate clothing, staying dry, use of the buddy system, and taking scheduled and unscheduled breaks in temperature-controlled areas, as necessary. Move individuals who become wet to a sheltered, warm area.
	Biological hazards (bees, wasps, ticks), poison plants (poison ivy/oak/s	Tape interfaces of clothing, use insect repellant, and conduct self-inspection for ticks as necessary. Personnel should inform supervisors of allergies to biological hazards. Wash hands and face when leaving areas where poison plants are present.
Equipment To Be Used	**Inspection Requirements**	**Training Requirements**
Support vehicles Manual and electric hand tools Heavy-duty extension cord and GFCI Sampling instruments Monitoring instruments	Inspect hand tools and extension cords each day of use Inspect monitoring instruments for calibration each day of use	Site Orientation Radiological Worker (if work is in radiological area) 40-hour HAZWOPER and current refresher (if work is in chemically/radiologically contaminated area) Hazard Communication (if hazardous chemicals are used) Hearing Conservation (if noise exposures are > 85 dBA in 8-hour TWA)

Activity Hazard Analysis (Continued)

ANSI	=	American National Standards Institute.
CFR	=	Code of Federal Regulations.
DOT	=	U.S. Department of Transportation
dBA	=	decibels
EC&HS	=	Environmental Compliance and Health and Safety
EPA	=	U.S. Environmental Protection Agency
GFCI	=	ground fault circuit interrupter
HASP	=	Health and Safety Plan
HP	=	health physics
HAZWOPER	=	hazardous waste operations and emergency response
HSWP	=	Health and Safety Work Permit
MSDS	=	Material Safety Data Sheet
OSHA	=	Occupational Safety and Health Administration
PPE	=	personal protective equipment
RPM	=	Radiation Protection Manager
TLD	=	thermoluminescent dosimeter
TWA	=	time-weighted average

Reviewed by:______________________ Date:__________________
Health and Safety Officer

APPENDIX C

DRILL RIG INSPECTION CHECKLIST

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APPENDIX C
DRILL RIG INSPECTION CHECKLIST

Site Name: ______________________

Rig
Model: ______________________ Manufacturer: ______________________

Serial Number: ______________________ Rig Owner: ______________________

Inspection Performed
by: ______________________

(Driller's signature) (Date)

Checklist Reviewed and
Emergency shutdown Observed
by: ______________________

(Signature)

Place an X in each appropriate ( )

1.0 GENERAL

1.1 Check all safety devices which are part of drill rig and which can be verified (see note).
Is (are all) devices(s) intact and operating as designed:

Emergency Interrupt System

A.	Kill Switch 1	Yes ( ) No ( ) NA ( )
B.	Kill Switch 2	Yes ( ) No ( ) NA ( )
C.	Kill Switch 3	Yes ( ) No ( ) NA ( )
D.	Kill Switch 4	Yes ( ) No ( ) NA ( )
E.	Kill Switch 5	Yes ( ) No ( ) NA ( )
F.	Other ______________________	Yes ( ) No ( ) NA ( )
G.	Other ______________________	Yes ( ) No ( ) NA ( )
H.	Other ______________________	Yes ( ) No ( ) NA ( )

Note: All safety devices (not otherwise listed in this checklist) should be identified for each drill rig at the beginning of each project and subsequently checked at each inspection. Testing of all safety devices must be observed by health and safety personnel. List only safety devices that can be checked without disassembly or without rendering the device ineffective. this checklist does not cover United States Department of Transportation requirements.

1.2 Is the proper type and capacity of fire extinguisher(s) present, properly charged, and inspected? Yes ( ) No ( ) NA ( )

1.3 Is rig properly grounded? Yes ( ) No ( ) NA ( )

DRILL RIG INSPECTION CHECKLIST (Continued)

1.4	Are rig and mast a safe distance from electrical lines?	Yes ( ) No ( ) NA ( )
1.5	Can mast be raised without encountering overhead obstructions?	Yes ( ) No ( ) NA ( )
1.6	Have spill prevention materials been placed under rig (i.e., plastic sheeting)?	Yes ( ) No ( ) NA ( )
1.7	Is a spill kit present?.	Yes ( ) No ( ) NA ( )
1.8	Is the safe operating zone/exclusion zone posted (minimum radius at least equal to height of raised drill mast)?	Yes ( ) No ( ) NA ( )
1.9	Do all modifications made to the drill rig permit it to operate in a safe manner and allow the drill to operate within the manufacturer's specifications?	Yes ( ) No ( ) NA ( )
1.10	Are moving parts (excluding cathead and other moving parts normally used during operations) properly guarded?	Yes ( ) No ( ) NA ( )

APPENDIX D

ACCIDENT PREVENTION PLAN INFORMATION

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APPENDIX D
ACCIDENT PREVENTION PLAN INFORMATION

USACE Guidance (USACE 2003a and b) requires specific items of information to be included in a Project Accident Prevention Plan. The following table gives the locations of these specific items within Science Applications International Corporation's program documents and this Health and Safety Plan (HASP).

Requirement	Location of Information
Signature sheet	HASP, inside front cover
Background information	HASP Section 2.1
Statement of safety and health policy	HASP Section 1.2
Responsibilities and lines of authority	HASP Section 3
Training	Environmental Compliance and Health and Safety (EC&HS) Procedure 20, HASP Section 5
Safety and health inspections	HASP Section 3.4
Safety and health expectations, incentive programs, and compliance	Policy Statement, EC&HS Program Implementation Guide C.2 – Discipline
Accident reporting	EC&HS Proc. 4 & 6, HASP Sections 3.9 and 11
Medical support	HASP Section 11
Personal protective equipment	HASP Section 7
Emergency response	HASP Section 11
Contingency plans	HASP Section 11
Job cleanup and safe access	HASP Section 8.1
Public safety requirements	HASP Section 9
Local requirements	None
Prevention of alcohol/drug abuse on the job	Policy A18, "Drug and Substance Abuse"
Hazard communication	EC&HS Procedure 8 and HASP Section 8.6

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