FINAL

FUSRAP RECORD OF DECISION FOR THE IOWA ARMY AMMUNITION PLANT

MIDDLETOWN, IOWA

SEPTEMBER 2011

U.S. Army Corps of Engineers
St. Louis District Office
Formerly Utilized Sites Remedial Action Program

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prepared by
U.S. Army Corps of Engineers, St. Louis District Office,
Formerly Utilized Sites Remedial Action Program

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LIST OF ACRONYMS AND ABBREVIATIONS

AEC	U.S. Atomic Energy Commission
ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirement
ATSDR	Agency for Toxic Substances and Disease Registry
BEIR	National Research Council's Committee on the Biological Effects of Ionizing Radiation
BERA	baseline ecological risk assessment
bgs	below ground surface
BRA	baseline risk assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
COC	contaminant of concern
CR	carcinogenic risk
CSM	conceptual site model
CY	cubic yard
DERP	Defense Environmental Restoration Program
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOT	Department of Transportation
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
DU	depleted uranium
EPC	exposure point concentration
ERA	ecological risk assessment
FFA	Federal Facilities Agreement
FS	Feasibility Study
FSA	Firing Sites Area
Firing Site 12 Area	Firing Sites 9, 10, 11, and 12
Firing Site 6 Area	Firing Sites 6, 7, 8, and 15
ft	feet
FUSRAP	Formerly Utilized Sites Remedial Action Program
GPS	global positioning system
GWS	gamma walkover survey
HTRW	Hazardous, Toxic, and Radioactive Waste
IA	Iowa
IAAAP	Iowa Army Ammunition Plant
IDNR	Iowa Department of Natural Resources
INEEL	Idaho National Engineering and Environmental Laboratory
IRP	Installation Restoration Program
LAP	load, assemble, and pack
lb	pound
LLRW	low-level radioactive waste
m	meter
m^2	square meter
MARSSIM	*Multi-Agency Radiation Site Survey and Investigation Manual*
MMR	Military Munitions Rule

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

MMRP	Military Munitions Response Program
MO	Missouri
mrem/yr	millirem per year
mSv	millisievert
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
NRC	U.S. Nuclear Regulatory Commission
O&M	operation and maintenance
OU	operable unit
pCi/g	picocuries per gram
PP	Proposed Plan
RAGS	Risk Assessment Guidance for Superfund
RAO	remedial action objective
RD/RA	Remedial Design / Remedial Action
RDX	cyclotrimethylenetrinitramine
RESRAD	Residual Radioactive Material
RG	remediation goal
RI	Remedial Investigation
RME	reasonable maximum exposure
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SF	slope factor
TEDE	total effective dose equivalent
TNT	2,4,6-trinitrotoluene
U-234	uranium-234
U-235	uranium-235
U-238	uranium-238
UCL	Upper Confidence Limit
USACE	U.S. Army Corps of Engineers
USAEC	U.S. Army Environmental Center
USEPA	U.S. Environmental Protection Agency
UUUE	unlimited use and unrestricted exposure
UXO	unexploded ordnance
yr	year
µg/L	micrograms per liter

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1.0 DECLARATION FOR THE RECORD OF DECISION

1.1 SITE NAME AND LOCATION

Iowa Army Ammunition Plant (IAAAP) in Middletown, Iowa (IA)
Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) ID # IA7213820445
Operable Unit (OU) 8

1.2 STATEMENT OF BASIS AND PURPOSE

This Record of Decision (ROD) presents the Selected Remedy for the remediation of soil and structures at designated areas at the IAAAP in Middletown, IA. The IAAAP was listed on the Superfund National Priorities List (NPL) in 1990. The specific areas at the IAAAP for which this Selected Remedy applies include Line 1 Structures, the Firing Sites Area (consisting of five subareas), Yards C, G, and L and Warehouse 3-01. The Selected Remedy was chosen in accordance with Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) as amended by Superfund Amendments and Reauthorization Act (SARA) and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the Administrative Record file located at the Burlington Public Library, 210 Court Street, Burlington, IA and at the U.S. Army Corps of Engineers (USACE) St. Louis District Formerly Utilized Sites Remedial Action Program (FUSRAP) Project Office, 8945 Latty Avenue, Berkeley, Missouri (MO).

This ROD is published by the USACE. Under FUSRAP, USACE is authorized by Congress as the lead agency implementing the Selected Remedy. The remedy is jointly selected by the USACE and the U.S. Environmental Protection Agency (USEPA).

The State of Iowa concurs with the Selected Remedy.

Comments on the Proposed Plan (PP) (USACE 2011a) provided during the public comment period were evaluated and considered in selecting the final remedy.

1.3 ASSESSMENT OF THE SITE

The response action selected in this ROD is necessary to protect public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

1.4 DESCRIPTION OF THE SELECTED REMEDY

The Selected Remedy addresses soil and structures that are radiologically contaminated as a result of the U.S. Atomic Energy Commission (AEC) operations previously conducted at the IAAAP. The Selected Remedy is the final remedy for the FUSRAP areas of the IAAAP (OU-8). Six other OUs have been defined at IAAAP. They are being addressed by the U.S. Army under the U.S. Department of Defense (DoD) Installation Restoration Program (IRP) and are therefore outside the scope of this document. The IRP actions are ongoing and will continue to occur independently of the FUSRAP activity.

No principal threat wastes, as defined by the NCP [40 *Code of Federal Regulations* (*CFR*) §300.430(a)(1)(iii)(A)], are present at the FUSRAP areas of the IAAAP. The principal contaminant of concern (COC) for the FUSRAP areas is depleted uranium (DU). The Selected Remedy addresses the DU by excavating DU-contaminated soil and performing physical treatment prior to off-site disposal. Similarly, DU will be removed from the structures and disposed of off-site.

The main components of the Selected Remedy for soil (Alternative 4) include:

- Excavation of DU-contaminated soil to meet the industrial remediation goal (RG) at Firing Sites 1 and 2; Firing Sites 3, 4, and 5; the Firing Site 6 Area; and the Firing Site 12 Area;
- No excavation would be conducted at Yards C, G, and L and Firing Site 14;
- Physical treatment of DU-contaminated soil excavated from Firing Sites 1 and 2; Firing Sites 3, 4, and 5; the Firing Site 6 Area; and the Firing Site 12 Area via soil sorting;
- Materials exceeding the DU RG would be disposed at a properly permitted off-site facility. Materials meeting the DU RG may be used as backfill, as appropriate;
- Site restoration, including backfilling, grading and re-vegetation;
- Continued industrial land use supported by use restrictions and outgrants administered by the U.S. Army as part of its land management responsibilities; and
- Five-year reviews for FUSRAP areas where contaminants are left above levels acceptable for unlimited use and unrestricted exposure (UUUE) to ensure continued protectiveness of human health and the environment under industrial land use. Industrial land use would be verified during each five-year review.

The main components of the Selected Remedy for structures (Alternative S3) include:

- Decontamination of structural surfaces and/or replacement of structural components (e.g., Building 1-11 floor grate and Building 1-63-6 air filters) to achieve the industrial RG for structures;
- Disposal of DU-contaminated materials at a properly permitted off-site facility;
- Continued industrial land use supported by use restrictions and outgrants administered by the U.S. Army as part of its land management responsibilities; and
- Include structures in five-year reviews if they exceed levels appropriate for UUUE to ensure continued protectiveness of human health under industrial land use. Industrial land use would be verified during each five-year review.

1.5 STATUTORY DETERMINATIONS

The Selected Remedy is protective of human health and the environment, complies with Federal and State requirements that are applicable or relevant and appropriate to the remedial action, is cost-effective, and uses permanent solutions to the maximum extent practicable. The Selected Remedy also addresses the statutory preference for treatment as a principal element of the remedy through physical treatment to reduce the volume of radiologically contaminated soil.

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for UUUE, a statutory review will be conducted no less often than every five years after initiation of the remedial action to ensure that the remedy continues to be protective of human health and the environment until the concentrations of hazardous substances at the site are at such levels to allow for UUUE.

1.6 RECORD OF DECISION DATA CERTIFICATION CHECKLIST

Key information regarding the remedy selection contained in this ROD is presented in Table 1-1. The table also indicates where this key information can be found in the Decision Summary section of this ROD. Supporting information on the remedy selection can be found in the Administrative Record for the FUSRAP areas of the IAAAP at the Burlington Public Library, 210 Court Street, Burlington, IA and at the USACE St. Louis District, FUSRAP Project Office, 8945 Latty Avenue, Berkeley, MO.

Table 1-1. Record of Decision Data Certification Checklist

Data Checklist Item	Page Number
☑ COCs and their respective concentrations	2-20 (Table 2-1)
☑ Baseline risk represented by the COCs	2-24 (Table 2-3)
☑ RGs established for the COCs and the basis for these goals	2-30 (Table 2-4)
☑ How source materials constituting principal threats are addressed	No principal threat wastes present at the FUSRAP areas of the IAAAP
☑ Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of ground water used in the baseline risk assessment (BRA) and ROD	2-17
☑ Potential land and ground-water use that will be available at the Site as a result of the Selected Remedy	2-60
☑ Estimated capital, annual operation and maintenance (O&M), and the total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected	2-59
☑ Key factor(s) that led to selecting the remedy.	2-54

1.7 AUTHORIZING SIGNATURES

Michael J. Walsh
Major General, U.S. Army
Division Commander

2 May 2011
Date

Cecilia Tapia
Director
Superfund Division
U.S. Environmental Protection Agency, Region 7

9/2/11
Date

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2.0 THE DECISION SUMMARY

2.1 SITE NAME, LOCATION AND DESCRIPTION

The IAAAP (CERCLIS ID # IA7213820445) is an active, government-owned, contractor-operated facility located near Middletown, IA in Des Moines County (Figure 2-1). The IAAAP is located approximately 10 miles west of Burlington, Iowa and the Mississippi River. The primary activity at the IAAAP since 1941 has been to load, assemble, and pack (LAP) a variety of conventional ammunition and fusing systems for the DoD. The IAAAP consists of approximately 19,000 acres of which approximately one-third of the IAAAP property is occupied by active or formerly active munitions production or storage facilities. The remaining property is generally either forested (7,766 acres) or leased for agricultural use (7,107 acres).

From 1947 to 1975, portions of the IAAAP facility were under the control of the AEC for weapon-assembly operations. The areas identified as being under AEC control included Line 1; the Firing Sites Area [(FSA), consisting of five subareas]; Warehouse 3-01 (interior); Yard G; Yard C; and Yard L areas surrounding Warehouses L-37-1, L-37-2, and L-37-3 (Figure 2-2). The IAAAP was listed on the Superfund NPL in 1990.

The USACE, under the authority of FUSRAP, is the lead agency for executing the remedy selected in this ROD, in accordance with §611(a)(4) of Public Law 106-60 (September 29, 1999) and the 2006 Federal Facilities Agreement (FFA) (USEPA et al. 2006). USACE coordinated with USEPA Region 7 and the State of Iowa.

2.1.1 Line 1

The Line 1 production facility is located within the IAAAP boundaries in the northeast portion of the property (Figure 2-2). The Line 1 area is approximately 173 acres [700,106 square meters (m^2)] in size and encompasses over 250 buildings and related facilities. The facility was constructed in 1941 and, from 1941 until August 1945, production at Line 1 included many types of ammunition, including fixed artillery rounds and bombs which contained a mixture of 2,4,6-trinitrotoluene (TNT) and ammonium nitrate explosives. AEC took over operations at Line 1 for weapons assembly from 1947 to 1975. During this period, a number of buildings were used in the production of baratols consisting of baratol (a mixture of barium nitrate and TNT), boracitol (boric acid and TNT), TNT, Composition B [TNT and cyclotrimethylenetrinitramine (RDX)], and cyclotol (RDX and TNT). AEC operations at Line 1 included machining of DU (USEPA et al. 2006). The buildings at Line 1 are currently used on an as needed basis in support of the U.S. Army mission. Specifically Buildings 1-11 and 1-63-6 are both inactive as of the writing of this document.

2.1.2 Firing Sites Area (FSA)

The area referred to as the FSA is a fenced operational range located in the western portion of the IAAAP that encompasses 450 acres (1,821,085 m^2) and is approximately 1 mile from the nearest IAAAP boundary (Figure 2-2). The FSA was developed by the AEC to support test firing of munitions for the IAAAP and was used by AEC between 1948 and 1974. Individual firing sites are located within the FSA and are grouped by proximity into five firing site areas (Figure 2-3):

- **Firing Sites 1 and 2:** Each firing site is comprised of one building, the surrounding land, and the entrance road to both areas located at the access point to the FSA (Figure 2-4). Firing Site 1 was constructed in 1952, used as an administrative facility, and contained an x-ray film-processing machine to develop film of test shots. Firing Site 2 was constructed in 1948 and was used as an inert storage facility. Firing Sites 1 and 2 are used on an as needed basis in support of the U.S. Army mission.

- **Firing Sites 3, 4, and 5:** Between 1948 and 1952, Firing Sites 3, 4, and 5 were constructed and used as general purpose storage magazines (Figure 2-5) (TN and Associates, Inc. 2002). Firing Sites 3 and 4 were used for storage of munitions and radiological materials. Firing Site 5 was a general-purpose storage magazine, but components for hydro-shots also were assembled at Firing Site 5 during AEC operations between 1965 and 1973. Hydro-shots consisted of conventional munitions surrounded by a large ring of DU that was broken, partially dissipated, and scattered upon detonation. No actual ordnance testing was done at any of these facilities. Firing Sites 3, 4, and 5 are currently used as storage magazines (USACE 2001; TN and Associates, Inc. 2002).
- **Firing Site 6 Area (Firing Sites 6, 7, 8, and 15):** The Firing Site 6 Area includes Firing Sites 6, 7, 8, and 15 (Figure 2-6). Firing Site 6 is believed to have been the primary testing area for the IAAAP until Firing Site 14 was built in 1972. Historic drawings indicate the presence of a concrete observation bunker and test fire pad at Firing Site 6. Firing Sites 7 and 8 were used as observation bunkers based on engineering drawings. Prior to the construction of Firing Site 14, Firing Site 6 was used for detonation tests of "plane wave" shots. The explosives used in these shots were a mix of Composition B and barium nitrate. Some other tests conducted at Firing Site 6 involved explosive components that contained a thin sheet of DU. The quantity of these tests conducted at Firing Site 6 is unknown. There is little known information available on Firing Site 15 (USACE 2001). The Firing Site 6 Area is currently used for test firing of munitions for the IAAAP.
- **Firing Site 12 Area (Firing Sites 9, 10, 11, and 12):** The Firing Site 12 Area includes Firing Sites 9, 10, 11, and 12 (Figure 2-7). At Firing Site 9, an abandoned concrete underground observation bunker is present, and historical drawings indicate the bunker was used in support of testing at a Firing Site 10 test fire pad. Firing Site 11 contained an underground high explosive supply magazine, and remnants of an underground bunker were also found. Firing Site 12 was used as an ordnance testing area for munitions and contains a concrete observation bunker and concrete firing pad. Between 1965 and 1973, a series of specialized tests called hydro-shots were conducted exclusively at Firing Site 12. A hydro-shot was a diagnostic operation that used DU as a surrogate for weapons-grade material and was a quality control technique for measuring the performance of plastic-bonded explosives produced at the IAAAP. Approximately 4,000 kilograms [8,820 pounds (lb)] of DU were associated with 701 hydro-shots used at the Firing Site 12 Area [Agency for Toxic Substances and Disease Registry (ATSDR) 2003]. Currently, the Firing Site 12 Area is fenced off and is not used by the U.S. Army because of the presence of DU fragments found at the area (USACE 2006).
- **Firing Site 14:** Firing Site 14 is located in the southern portion of the FSA, was built in 1972, and was used as a test firing range (Figure 2-5). Little information is available as to what was tested at Firing Site 14 or when testing occurred, although some information obtained indicates that tile shot testing was performed (USACE 2001). Tile shots conducted during AEC operations consisted of a relatively small amount of conventional explosives and boosters.

2.1.3 Storage Yards C, G, and L

Yard C is located in the eastern portion of the IAAAP and is approximately 301 acres (1,218,291 m^2) in size (Figure 2-2). Yard C was constructed in 1941 and 1942 to serve as a storage yard and consists primarily of an open field with 43 storage igloos and several other support buildings. From 1947 until 1975, Yard C was under the control of AEC and was used for the storage of raw explosive materials and sealed radiological components that were placed into the warheads. These raw materials were transported to Building 1-50 at Line 1. Yard C is currently in use by the U.S. Army.

Yard G is located in the southern portion of the IAAAP and is approximately 259 acres (1,048,103 m^2) in size (Figure 2-2). Yard G is located in a heavily forested valley of Long Creek. AEC used this secured, fenced facility from 1948 until 1954 as a storage area for the finished castings of classified shapes with seven igloos having been used for this purpose (Mason and Hanger – Silas Mason Co., Inc. 1959). Yard G was returned to U.S. Army control in 1975. Yard G is currently in use by the U.S. Army.

Yard L is located approximately 1,000 feet (ft) south of the northern boundary of the IAAAP (Figure 2-2). Yard L consists of long buildings that run in an east-to-west orientation with railroad tracks that service the buildings. Three warehouses in the southeastern portion of Yard L (L-37-1, L-37-2, and L-37-3) were used by AEC to provide storage space for classified component parts for inert storage starting in 1960. The area of Yard L that is identified as being used by AEC is approximately 12 acres (48,268 m^2) in size. Yard L is currently in use by the U.S. Army.

2.1.4 Warehouse 3-01

Warehouse 3-01 is located in the central portion of the IAAAP in the north-central area of Line 3 (Figure 2-2). Warehouse 3-01 consists of a large brick building and surrounding land of approximately 0.64 acres (2,608 m^2). Information obtained from the project history of Line 1 indicates that Warehouse 3-01 was used as part of AEC operations (Ahlstrand 1956). Warehouse 3-01 is currently in use by the U.S. Army.

2.2 SITE HISTORY AND ENFORCEMENT ACTIVITIES

The IAAAP is under the command of the U.S. Army Joint Munitions Command, Rock Island, Illinois. Since 1941, the IAAAP's mission to LAP ammunition items required the use of explosive materials and lead-based initiating compounds at the facility. From 1947 to 1975, portions of the IAAAP facility were under the control of the AEC for weapon-assembly operations. Throughout the remaining years, the IAAAP tested, assembled, and disassembled a wide variety of weapons.

On July 14, 1989, the IAAAP was proposed for inclusion on the USEPA's NPL pursuant to Section 105 of CERCLA, as amended by SARA, due to surface water contaminated with explosives leaving the IAAAP boundary. The IAAAP was added to the NPL in August 1990 and, in September 1990, the U.S. Army and USEPA Region 7 entered into an FFA to define the roles and responsibilities for the U.S. Army's cleanup work at the IAAAP and the process for inter-agency coordination. The IAAAP was placed under the DoD IRP, which manages CERCLA activities to identify, investigate, and mitigate past hazardous waste disposal practices that may have contributed to the release of pollutants into the environment at U.S. Army installations/facilities. Past munitions production at the IAAAP has resulted in contamination of soil and ground water as well as discharges of waste water containing explosives to surface water.

In March 2000, after performing historical research regarding AEC activities at the IAAAP, the U.S. Department of Energy (DOE) provided USACE with a determination that portions of the IAAAP may contain contamination resulting from activities that supported the nation's early atomic energy program. In July 2002, several areas of the IAAAP previously used by AEC were designated by Congress as being eligible to be addressed by the FUSRAP and therefore, were subsequently removed from the DoD IRP.

The FUSRAP was created in 1974 to identify and remediate sites where residual radioactivity remains from activities conducted during the nation's early atomic energy program under AEC, a predecessor to the DOE. Congress transferred the responsibility for administration and execution of cleanup at eligible FUSRAP areas from DOE to the USACE in 1997.

In 2004, USACE conducted a radiological site screening survey to determine the presence of any radiological material at some of the FUSRAP areas at the IAAAP including the Explosive Disposal Area, Inert Disposal Area, Demolition Area/Deactivation Furnace, and the Line 1 Former Waste Water Impoundment Area. The site screening survey, as reported in the *Final Summary of the Radiological Survey Findings for the Iowa Army Ammunition Plant Explosive Disposal Area, Inert Disposal Area, Demolition Area/Deactivation Furnace, and Line 1 Former Waste Water Impoundment Area* (USACE 2005), concluded that these sites are radiologically non-impacted and, therefore, require no further FUSRAP action (USEPA et al. 2006).

As investigations continued at the FUSRAP areas, an additional FFA for the IAAAP was finalized on August 16, 2006, among the USACE, St. Louis District; the USEPA Region 7; the DOE; and the Iowa Department of Natural Resources (IDNR) to address FUSRAP investigatory and cleanup work at the IAAAP. The scope of this project, as defined in the 2006 FFA (USEPA et al. 2006), "covers response actions at 7 areas associated with AEC activity." These seven areas were defined as Line 1; the FSA (consisting of five subareas); the West Burn Pads Area (South of the Road); Yard G; Yard C; Yard L (surrounding Warehouses L-37-1, L-37-2, and L-37-3); and Warehouse 3-01 (interior) (Figure 2-2). Non-FUSRAP actions are being conducted by the U.S. Army at other IAAAP areas and operable units. Discussions of these activities are outside the FUSRAP scope and are not presented in this document.

According to the 2006 FFA (USEPA et al. 2006), the USACE shall respond to all releases and threats of releases of hazardous substances, pollutants, or contaminants, except for ground-water and surface-water contamination, at the areas associated with previous AEC activity. Ground-water and surface-water contamination existing on or migrating from the IAAAP, including such contamination associated with the seven areas identified in the 2006 FFA, are considered outside the scope of FUSRAP and shall be addressed pursuant to the 1990 FFA (U.S. Army and USEPA, 1990).

According to the 2006 FFA (USEPA et al. 2006), other areas beyond those identified may be added to the list of FUSRAP areas if it is determined that they contain contamination resulting from AEC activities. Three additional areas, consisting of portions of Yard E, Yard F, and the Area West of Line 5B (Figure 2-2), were investigated during the FUSRAP Remedial Investigation (RI) and found to be radiologically non-impacted. As a result, these areas require no further FUSRAP action and the responsibility remains with the DoD IRP.

The FUSRAP RI was conducted by USACE, St. Louis beginning in 2006 to refine the nature and extent of contaminants in soil and structures at the FUSRAP areas identified in previous RI documents prepared by JAYCOR and TN and Associates. The results of the FUSRAP RI were used to prepare a baseline risk assessment (BRA) for AEC-related contaminants and media, which has been detailed in the *Iowa Army Ammunition Plant FUSRAP Remedial Investigation Report for Firing Sites Area, Yards C, E, F, G, and L, Warehouse 3-01 and Area West of Line 5B* (USACE 2008).

The results of the FUSRAP RI conducted by the USACE concluded that the soil at Line 1 and the West Burn Pads Area (South of the Road) was not DU-contaminated and, therefore, is addressed under two existing IAAAP RODs: the *Interim Action Record of Decision, Soils Operable Unit, Iowa Army Ammunition Plant, Middletown, Iowa* [U.S. Army Environmental Center (USAEC) 1998] and the *Record of Decision, Soils Operable Unit #1, Iowa Army Ammunition Plant, Middletown, Iowa* (USACE 1998). Therefore, the soil at Line 1 and the West Burn Pads Area (South of the Road) is not included in the scope of this ROD. Structures remaining at Line 1 and used by AEC were evaluated for radioactive surface contamination and are addressed in the FUSRAP (OU-8) ROD.

Based on the results of the RI and BRA, the USACE has concluded that surface and subsurface soil and structures at some of the FUSRAP areas at the IAAAP are at levels that pose an unacceptable risk and dose to human health and the environment under industrial land use scenarios. Unacceptable risks and doses were estimated for soil contaminants at the FSA and for structures in Line 1. However, the contaminants found at the FUSRAP areas are defined as low-level radiological and chemical threats. Other hazardous substances, pollutants, or contaminants that may be present on any other part of the IAAAP are not eligible for remediation under FUSRAP and are not addressed by this ROD.

2.3 COMMUNITY PARTICIPATION

The community has been provided opportunities to be involved with the decision process at the FUSRAP areas of the IAAAP. The USACE maintains a web site with current information about the status of the IAAAP FUSRAP areas and historical documentation [http://www.mvs.usace.army.mil/eng-con/expertise/fusrap-IAAAP.html]. The Administrative Record, which contains the documentation used to select the response action, is available at the following locations:

Burlington Public Library
210 Court Street
Burlington, IA 52601

U.S. Army Corps of Engineers St. Louis District
FUSRAP Project Office
8945 Latty Avenue
Berkeley, MO 63134

The documents describing the results of the RI/Feasibility Study (FS) process for the FUSRAP areas at the IAAAP were made available to the public for review and comment at the information repositories noted above. The following documents were issued by the USACE:

- *Iowa Army Ammunition Plant FUSRAP Remedial Investigation Report for Firing Sites Area, Yards C, E, F, G, and L, Warehouse 3-01, and Area West of Line 5B* (USACE 2008). The document describes the nature and extent of contamination at the FUSRAP areas. This document includes the BRA that evaluated the potential risk to human health and the environment from contaminants associated with prior AEC activities at the site.

- *FUSRAP Feasibility Study Report for the Iowa Army Ammunition Plant, Middletown, Iowa* (USACE 2011b). This FS identifies, develops, and evaluates the remedial action alternatives for the FUSRAP areas based on the nature and extent of contamination.
- *FUSRAP Proposed Plan for the Iowa Army Ammunition Plant, Middletown, Iowa* (USACE 2011a) summarizes the information on the FUSRAP areas at IAAAP, describes the alternatives considered for remedial action, presents the rationale for selection of the preferred remedy, and solicits public comment.

The notice of availability for these documents was published in *The Hawk Eye* on April 22, 2011. A 30-day public comment period began on April 22, 2011. A public meeting was held on May 17, 2011 at the Comfort Suites Hotel and Conference Center in Burlington, Iowa to present the FS/PP to interested members of the community. A transcript of the public meeting was prepared and is included as part of the Administrative Record. Responses to the comments received from the public are provided in the Responsiveness Summary included as Section 3.0 of this ROD.

2.4 SCOPE AND ROLE OF OPERABLE UNIT

In accordance with the 2006 FFA (USEPA et al. 2006), this ROD completes the RI/FS process, sets forth the final Selected Remedy for the FUSRAP Operable Unit (OU-8) of the IAAAP, and serves as the basis for remedial design and remedial action, culminating in final closeout. It has been prepared in accordance with USEPA's guidance document *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents* (USEPA 1999a).

This ROD addresses contaminated soil and structures at specific FUSRAP areas. The following areas are included within the scope of OU-8:

- Line 1 (structures only),
- FSA (consisting of five subareas) soil and structures,
- Yard C soil and structures,
- Yard G soil and structures,
- Yard L soil (areas surrounding Warehouses L-37-1, L-37-2, and L-37-3), and
- Warehouse 3-01 structure (building interiors).

Concurrent with the execution of this remedy, the USACE will evaluate the residual condition of the FUSRAP areas and verify that the performance objectives of this remedy are met. This assessment will be performed and documented as part of the remedial design (RD)/remedial action (RA) process.

The focus of this FUSRAP response at the FSA is limited to the removal of DU in accordance with the December 2006 Dispute Resolution Agreement executed by the Department of the Army and the USEPA Regional Administrator for Region 7 (U.S. Army 2006). That agreement reflects the application of the Military Munitions Rule [(MMR) See 40 *CFR* 266.200 et. seq.] to the determination of the scope of FUSRAP authority on the Firing Sites. However, because the DU that is present in the FSA is a product of historic AEC operations which are no longer conducted at this site, and DU is not currently used at the FSA on the IAAAP, it is included in the USACE response in a manner that is consistent with USACE FUSRAP authority. As part of the 2006 Dispute Resolution Agreement, the U.S. Army and USEPA's approach to handling the FSA was outlined. The settlement agreement stated:

> "*FUSRAP will primarily be addressing the presence of depleted uranium (DU) at the Firing Site resulting from past testing operations conducted by the Atomic Energy Commission. The Firing Site is an operational testing range currently being used by the Army to test military munitions. DU rounds are no longer tested at the Firing Site by the Army. Any additional response actions at the Firing Site beyond those which will be addressed by FUSRAP will be addressed when the range ceases to be operational unless releases from the Firing Site require an immediate response to protect human health or the environment. If such a condition is determined to exist, response actions will be implemented consistent with provisions of the FFA.*"

Furthermore, conducting response actions to fully address chemical contamination at an operational range (e.g., the FSA) (where re-contamination is anticipated) is inconsistent with the need of the United States to maintain its military capabilities through training and testing until the site has been put to a new use that is incompatible with range activities.

The soils in the FSA may contain materials defined as hazardous substances by CERCLA §101(14). If such materials are excavated with soil as part of a remedial action, the soil and the substances contained therein will be handled as a hazardous waste relative to treatment and/or disposal. Any reference to handling/disposal of material other than DU should be understood as part of this authorized activity. Thus, it is noted that the authorized remediation of DU may result in remediation of other materials. The incidental benefits of an authorized activity are necessarily within this authorization.

The Selected Remedy will be implemented by the USACE, St. Louis District under its authority to implement the FUSRAP at the IAAAP. The USACE is conducting response actions (i.e., investigations and cleanups) at the IAAAP under the legislative authority contained in Public Law 106-60, the Energy and Water Development Appropriations Act for Fiscal Year 2000. This law establishes the USACE's authority to conduct response actions for releases related to the nation's early atomic energy program as the lead federal agency, subject to the CERCLA and the NCP. FUSRAP also addresses commercial operations that Congress has authorized or directed FUSRAP to remediate. The DOE managed FUSRAP until 1997. On October 13, 1997, the U. S. Congress transferred responsibility for FUSRAP from DOE to the USACE through the 1998 Energy and Water Development Appropriations Act.

The response actions conducted by USACE under FUSRAP are separate from the cleanup work being conducted by the U.S. Army under the Defense Environmental Restoration Program (DERP). The DERP activities at the IAAAP include ongoing actions under the IRP and the Military Munitions Response Program (MMRP). The IRP is responsible for five OUs at the IAAAP: Soils (OU-1), Off-Site Ground Water (OU-3), the Inert Disposal Area closure (OU-4), On-Site Ground Water (OU-6), and the Installation-Wide OU (OU-7). The MMRP is responsible for the munitions response sites in OU-5.

The 2006 FFA explicitly excludes ground water from the scope of FUSRAP, noting it will be addressed by the U.S. Army pursuant to the U.S. Army's FFA. Ground-water contamination at the FUSRAP areas is within the scope of the On-Site Ground Water OU (OU-6) that is being addressed under the IRP. The final remedy for OU-6 has not yet been selected.

2.5 SITE CHARACTERISTICS

2.5.1 Environmental Setting

The IAAAP is located in Des Moines County near Middletown, Iowa. It consists of approximately 19,000 acres and has security fencing around the entire facility. Approximately 7,800 acres consist of forested land, approximately 7,100 acres are leased for agricultural use, and the remaining acres are occupied by active and formerly active munitions production or storage facilities. All of the FUSRAP areas are located in the developed areas of the IAAAP.

Site topography ranges from flat tier at the northern portion of the facility to steep-sloped drainageways down to creek beds at the southern portion of the facility. The topographic elevation of IAAAP ranges from a highpoint of 730 ft above mean sea level at the northern portion of the facility to a low of 530 ft above mean sea level at the creek beds to the south (USAEC 1996).

The IAAAP is drained by three major streams (Brush Creek, Long Creek, and Spring Creek) that divide the facility into four drainage basins trending northwest to southeast. There is also an unnamed tributary that drains the southwestern portion of the IAAAP and discharges into Skunk River and Little Flint Creek which drains a small portion of the northern area of the site. There are 30 ponds and small surface-water impoundments across the IAAAP site including the 85-acre George H. Mathes Lake (Figure 2-2). There are several sloped areas and storm-water drainage ditches that convey storm-water runoff and eventually discharge into Brush Creek. Long Creek drains the western portion of the facility, flowing into Mathes Lake and exiting the site along the southern boundary where it discharges into Skunk River, a major tributary to the Mississippi River. Brush Creek drains the central portion of the site, and Spring Creek drains the eastern portion of the site. Both creeks exit the site toward the southeastern boundary and continue to flow southeasterly for approximately 4 miles where they discharge into the Mississippi River.

There are two main aquifers underlying the IAAAP: the drift aquifer and the underlying upper bedrock aquifer. The drift aquifer is comprised of glacially derived windblown silt (loess material) and the Kellerville Till. The depth of the loess ranges from approximately 6 to 15 ft across the IAAAP. The Kellerville Till has a minimum thickness of 35 ft. The ground-water surface in the drift aquifer roughly occurs within 10 ft below ground surface (bgs). The shallow ground-water surface nearly parallels the ground surface. Thus, shallow ground water throughout the IAAAP flows from the higher elevation points, including most of the Line 1 and yard areas, toward several unnamed tributaries feeding Spring, Brush, and Long Creeks and the Skunk River.

The uppermost bedrock unit underlying the facility is associated with the Southern Iowa Mississippian Osage Series, composed mostly of cherty limestones interstratified with small amounts of shale. The water in the upper bedrock aquifer generally flows to the south and east, toward the Skunk River and the Mississippi River. In some on-site areas, including the southwestern portion of the IAAAP, the upper bedrock aquifer is exposed at ground surface and discharges into surface water. In other areas of the site, the upper bedrock aquifer lies at depths of more than 50 to 100 ft bgs (USACE 2001).

Forest, agricultural land, roadside, riparian, and other habitats suitable for terrestrial and aquatic species exist throughout the IAAAP (TN and Associates, Inc. 2002). The terrestrial habitats are composed of temperate deciduous forests, prairies, industrial and ruderal areas, and agricultural croplands. Forest types can be separated into floodplain and upland forests, with the former predominating. Agricultural uses include row crops (corn and soybeans) and pasture for beef production (TN and Associates, Inc. 2002).

The aquatic habitats include sections of Long Creek, Brush Creek, and Spring Creek that flow within the IAAAP along with any related tributaries and the surface water bodies on-site. These areas primarily flow through deciduous forests and deciduous wetland swamps and are removed some distance from the potential source areas. These streams provide habitat for a variety of aquatic receptors including fish, benthic invertebrates, and amphibians and are a source of food and water for wildlife and avian species (TN and Associates, Inc. 2002).

One federal-listed threatened or endangered species has been recorded on the IAAAP property, the Indiana bat *(Myotis sodalis)*. The Indiana bat has been recorded to feed on the property and may have maternal roosts in the floodplain forests. Other state-listed endangered, threatened, and special concern species observed at the IAAAP are presented in the FUSRAP RI Report (USACE 2008).

The FUSRAP areas of the IAAAP do not contain any historic buildings or archaeological sites and no known archeological or historical sites are affected by the contamination at the FUSRAP areas.

2.5.2 Conceptual Site Models

The conceptual site model (CSM) is a graphical representation of the exposure pathways and potential receptor populations considered for the FUSRAP areas under current and expected future land use at the IAAAP. The IAAAP is currently an industrialized military installation with land use controls in place to limit access to the property as a whole and to individual plant production areas. The expected future use of the property is to continue under the authority of DoD as a military installation with industrial use. Therefore, CSMs for industrial land use were developed for the FUSRAP areas that facilitated development of the BRA, RGs, and the FS evaluations of actions needed to protect human and/or ecological receptors from direct and indirect contact exposures to soil COCs, and humans from direct contact exposures to contaminated structures. The industrial land use basis for the FUSRAP RI/BRA and FS is consistent with past and on-going investigations and remedial actions conducted at other IAAAP sites under the IRP. The soil CSM is presented in Figure 2-8 and discussed in Section 2.5.2.1. The structural CSM is discussed in Section 2.5.2.2. A complete exposure pathway includes all of the following elements:

- a source and mechanism of contaminant release,
- a transport or contact medium (e.g., soil),
- an exposure point where humans could contact the contaminated medium, and
- an exposure (intake) route (such as ingestion or inhalation).

The absence of any one of the above elements results in an incomplete exposure pathway. Where there is no potential exposure, there is no potential risk. In the IAAAP FUSRAP areas, the completeness of an exposure pathway, particularly as a function of release and transport mechanisms, as well as availability for intake by a receptor, is often dependent on the physical/chemical form of the DU.

During the RI, DU was found to be present in soil and on structural surfaces at the FSA and Line 1. On structural surfaces, DU particles were found by survey instrumentation to be embedded in the surface and/or adhered to the surface. In soil, DU was found as oxidized and non-oxidized fragments and particles (generically referred to hereafter as “DU” or “DU-contaminated soil”). Generally, fragments are visibly observable pieces of metallic DU found on the surface of the soil, or just below the surface of the soil. However, DU particles are not readily observable in soil, unless made visible by a yellowish discoloration as an effect of chemical oxidation. The yellowish discoloration was only observed in soil directly beneath fragments. The surfaces of DU fragments in soil exposed to the atmosphere will slowly oxidize. Small particles will oxidize faster than large pieces. Upon weathering, non-oxidized small particles may be adsorbed to clay minerals and humus. These oxides are only sparingly soluble but will gradually form hydrated uranium oxides in moist conditions, which will then slowly dissolve and be transported into the surrounding soil, and eventually ground water.

Soil exposure pathways that were determined to be complete and significant were quantitatively evaluated in the BRA as part of the FUSRAP RI Report (USACE 2008). The designation of any pathway as being potentially complete in Figure 2-8 does not mean that a dose or risk exceeding target criteria was determined for that pathway in the BRA. Potentially complete exposure pathways are identified in the CSM with a solid circle. Only those circles with the “1” designation warranted quantitative evaluation in the BRA.

2.5.2.1 Soil Conceptual Site Model

Figure 2-8 schematically presents site-specific elements of both complete and incomplete soil exposure pathways considered and/or evaluated for the FUSRAP areas under industrial land use. The source of contamination identified in the soil CSM is DU-contaminated soil from former AEC munitions activities. All pathways and release mechanisms presented in the soil CSM are applicable only to DU, which is the COC driving the FUSRAP response actions under this ROD.

2.5.2.1.1 Potential Human Receptors and Soil Exposure Pathways

Those human population groups identified as receptors to contaminants via the complete exposure pathways are considered by the CSM as being the most likely to be exposed under current and future land use scenarios. The IAAAP serves as a military installation; therefore, the current land use is industrial in nature due to ongoing ordnance-production activities. It is expected that these activities will continue into the future; therefore, the future land use is expected to remain industrial. It is reasonable to assume that the IAAAP property will not be re-developed for residential use in the foreseeable future. This assumption was used in identifying the most likely potential receptors and complete soil exposure pathways as part of the CSM for quantitative risk evaluations in the BRA.

The potentially exposed populations include the current and future site worker and the future construction worker. The current and future site worker is an IAAAP employee or contractor conducting ordnance production/testing activities. While performing these duties, the site worker could be exposed to residual contamination present in surface soil (0 to 1 ft bgs) but would not be expected to have regular contact with subsurface soil (i.e., depths greater than 1 ft bgs). It is reasonable to assume that construction activities could occur within FUSRAP areas; therefore, the adult construction worker was also identified as a potential receptor. The construction worker could be exposed to residual contamination present in soil within the depth interval of 0 to 10 ft bgs.

Below-grade structural surfaces exist at the FSA that could potentially be in direct contact with DU-contaminated soil (e.g., Firing Site 12 bunker). Because these surfaces are below grade and have not been surveyed, there are no data to determine if they are indeed contaminated; however, there are currently no complete pathways for human exposures. Potential contamination of these surfaces will be addressed during remediation as discussed in Sections 2.9.3 and 2.9.4 in this ROD.

Exposures to potential trespassers and recreational users (e.g., hunters) are considered infrequent and insignificant because of access restrictions to the IAAAP property, as well as the physical characteristics of each area therein. The potential for rancher/farmer exposures to FUSRAP area soil contaminants was considered. It is known that commercial agricultural activities occur within the IAAAP, but are only allowed at Yard C of the FUSRAP areas, where soil was not found to have been impacted with DU. The current commercial agricultural use of Yard C is the seasonal cutting of hay. Therefore, exposures to commercial ranchers/farmers in Yard C were determined to be insignificant. It is also known that ground water directly beneath the IAAAP is not used for agricultural purposes. Therefore, due to the absence of DU contamination and agricultural exposure pathways associated with all FUSRAP areas, including Yard C, neither humans nor animals were evaluated in the BRA as potential receptors under an agricultural exposure scenario. Consequently, these population groups are not presented in the CSM (Figure 2-8).

Exposures to off-site individuals (e.g., via air transport, runoff, etc.) are considered insignificant due to the large distances of the FUSRAP areas from potential off-site receptor locations. Also, because of the presence of heavy vegetation, airborne migration of contaminants to off-site areas is minimized and insignificant.

A complete soil exposure pathway is one that results in direct contact exposures to COCs in source surface and/or subsurface soil or indirect contact exposures to soil COCs from source soil that has impacted other media such as air, ground water, surface water, sediment, and structures. As shown in Figure 2-8, the release mechanisms that could impact the media at the FUSRAP areas and potentially lead to indirect human exposures are air volatilization (fugitive dusts), wind erosion, surface soil drainage/runoff to surface water and sediment, or infiltration/percolation from surface soil to subsurface soil to ground water.

Both direct and indirect contact exposures can occur to on-site receptors via the routes of ingestion, dermal contact, inhalation, and/or external gamma radiation. However, it should be noted that in accordance with the scope of the FFA (USEPA et al. 2006), ground-water, surface-water, and sediment exposures were not quantitatively evaluated in the BRA because they will be addressed as part of the IRP. Ground water is presented in the CSM as a potential receptor medium to vertically migrating contaminants from FUSRAP area soil via water infiltration/percolation during precipitation events. Ground water is not used at the FUSRAP areas for industrial or potable purposes; therefore, all potential exposure pathways are considered to be incomplete for site and construction workers.

2.5.2.1.2 Potential Ecological Receptors and Soil Exposure Pathways

The results of the baseline ecological risk assessment (BERA) and information contained within Appendix M of the BERA (USACE 2004), as well as the *Explanation of Significant Differences for the Interim Action Record of Decision (IROD) Soils Operable Unit (OU-1), Addition of Environmental Protectiveness to the Remedy and Transfer of Sites from OU-4 to OU-1 for Iowa Army Ammunition Plant Middletown, Iowa* (Tetra Tech 2008), were the basis for identifying the Indiana bat as the ecological receptor of concern that could be roosting and/or foraging at the FUSRAP areas. Appendix M of the BERA (USACE 2004) and the FUSRAP RI Report focused evaluations only on this receptor because it is the only federal threatened and endangered species observed to inhabit the IAAAP. Indiana bats do not forage or roost at ground level; therefore, no direct contact to soil contaminants can occur. The most likely scenario is for indirect exposures to soil contaminants via the ingestion of insect prey that have been impacted by contaminated soil. Figure 2-8 presents the ingestion of insects impacted by contaminated soil as the only complete ecological exposure pathway evaluated in the BRA.

2.5.2.2 Structural Conceptual Site Model

FUSRAP structures were investigated for the presence of DU as part of the RI. Additional interior radiological measurements were made at Line 1 structures during the 2009 Supplemental Investigation. The interior surfaces at Line 1 structures cannot be linked to soil contamination; therefore, the evaluations of exposure pathways associated with Line 1 structures cannot be evaluated in the CSM for soil and soil-dependent pathways that is presented in Figure 2-8.

FUSRAP structures in which elevated readings were measured are unoccupied, have restricted access, and remain locked at all times; therefore, there are no individuals being exposed. However, if the buildings were to be re-activated in the future under baseline conditions, the typical industrial site worker (i.e., who is not a maintenance or construction worker) would not be expected to directly contact structural surfaces/components for which elevated gross alpha and beta activities were reported (e.g., a steel grate covering a floor sump in Line Building 1-11 and the air filters in an air handling unit located in Line 1 Building 1-63-6). The most likely individuals who could become exposed to any contaminated surfaces would be site maintenance workers or construction workers. Ingestion, inhalation, and external radiation exposures to structural components by maintenance and construction workers during the cleaning or removing and replacing of those components are the only potentially complete exposure pathways evaluated in the BRA. However, these pathways are likely to be insignificant because such exposures would be short in duration and even further reduced by the use of personal protective equipment.

2.5.3 Sampling Strategy for the RI

RI field activities for the FUSRAP areas were conducted between October 23, 2006, and October 18, 2007. Field activities for the Supplemental RI were completed in April 2009.

A variety of field investigation methods were utilized to investigate the nature and extent of contamination in the FUSRAP areas during the RI. Primary investigation methods consisted of:

- *Gamma Radiation Walkover Surveys:* Gamma walkover surveys (GWS) were conducted in outdoor portions of areas that had the potential to be impacted by DU. GWS were conducted using a sodium iodide gamma scintillation detector coupled with a Global Positioning System (GPS) unit in order to record both gamma radiation readings and geographic position data. Surveys were focused on areas most likely to have elevated levels of radioactivity such as areas adjacent to loading docks, along driveways, roadsides, and rail lines, as well as localized topographical low points such as ditches and depressions. In general, survey coverage was greater near expected sources of radiological contamination and decreased with distance from the expected source. This approach concentrated the greatest effort in the areas of highest risk and provided some coverage over other portions of the property.
- *Radiological Structure Surveys:* Structures with the potential to contain the presence of radiological (DU) contamination were surveyed. The structure surveys included scanning for total beta surface activity as well as taking fixed point measurements for total alpha and beta activity. In addition, collection of swipe samples for measurement of removable alpha and beta activity was conducted. Surveys were biased towards areas having the

highest potential for radiological contamination such as entrances and exits, ventilation components, high traffic areas, cracks, floor drains, and loading/unloading areas.

- *Surface and Subsurface Soil Sampling:* Soil sampling was performed to assess both radiological and non-radiological constituents within the RI areas. In general, soil samples were biased toward areas judged to have higher potential for contamination than the surrounding area such as areas adjacent to loading docks, rail lines, driveways, roadsides, topographical low points, and areas where GWS has indicated elevated radioactivity.

Results of the RI field activities, as well as results of previous investigations, are presented in the FUSRAP RI Report (USACE 2008). A brief summary of the results are provided below.

2.5.4 Known and Suspected Sources of Contamination

The known and suspected sources of the DU contamination at the FUSRAP areas are associated with historic AEC weapon-assembly operations conducted at portions of the IAAAP from 1947 to 1975. DU was found as fragments and particles in soil at the Firing Site 6 Area and the Firing Site 12 Area. The DU that is present at the Firing Site 6 area is a product of the testing of munitions containing DU during past AEC operations at the site. The DU contamination at the Firing Site 12 Area appears to be the result of specialized tests called hydro-shots that the AEC conducted between 1965 and 1973. Hydro-shots used DU as a surrogate for weapons-grade material. Migration of contamination away from these source materials at the FSA has impacted the underlying soils to a depth of approximately 2 ft bgs. AEC operations conducted prior to 1975 at Line 1 are the likely source of the DU contamination present as particles embedded in and/or adhered to Line 1 structural surfaces. These operations included the machining of DU (USEPA et al. 2006). The DU from these operations may have been dispersed by the air onto nearby structural surfaces. The results from soil sampling at Yards C, G, and L for DU had no exceedances of the RI screening level.

Explosives and metals were identified as chemicals of potential concern at Yards C, G, and L. The suspected sources of these chemicals are the manufacturing, assembling, and storage practices at the IAAAP that resulted in their release to the environment in some areas. The results from soil sampling for chemicals at Yards C, G, and L indicated that chemical contamination was not present at Yards C, G, or L above the RI screening levels (i.e., USEPA industrial risk-based levels).

2.5.5 Types of Contaminants and Affected Media

The principal contaminant in OU-8 is DU, present as either fragments or particles in soil and as particles embedded in, or adhered to structures. Based on the fate and transport characteristics of DU at the IAAAP FUSRAP areas, DU fragments and particles are expected to be relatively immobile in the clay-rich soil of the IAAAP, with potential atmospheric, surface runoff, and ground-water migration pathways being insignificant. Evaluations of the environmental fate and transport properties of DU at the IAAAP FUSRAP areas are discussed in detail in Section 2.5.7. Migration of DU to offsite areas (i.e., outside the FSA) has not occurred nor is it expected to be significant in the foreseeable future. However, on-site radiological exposures can potentially occur to individuals working at the IAAAP and were therefore, evaluated in the BRA, as summarized in Section 2.7. Potential health impacts from exposure to radiation from the three radionuclides comprising DU [uranium-234 (U-234), uranium-235 (U-235) and uranium-238 (U-238)] were calculated and expressed as dose, as well as the risk of developing cancer (see Section 2.7.2.3). The results of the dose and risk assessment are summarized in Section 2.7.2.4.

The results of the RI indicate that DU contamination is present in soil at the FSA to a depth of approximately 2 ft bgs and is primarily associated with locations where DU fragments were also found. The total volume of DU-contaminated soil at the FSA is estimated to be 16,941 in-situ cubic yards (CY). More detailed information concerning the volumes of DU-contaminated soil at the FSA is provided in Section 2.8.4 (Table 2-5). No DU contamination was found at Yards C, G, or L or at Warehouse 3-01 above the RI screening levels. The primary medium of concern at Line 1 is structures that have become contaminated with DU as a result of prior AEC activities. The contaminated structures include a grate over a sump in Building 1-11 and the air filters in an air handling unit in Building 1-63-6, both of which are located within inactive areas of Line 1.

DU is a "source material" as defined by Section 11(z) of the Atomic Energy Act, as Amended (Public Law 83-703). Wastes containing source materials exceeding 165 picocuries per gram (pCi/g) U-238 are classified as Class A low-level radioactive waste (LLRW).

Chemical contaminants, including explosives and metals, were evaluated at Yards C, G, and L. However, based on the evaluated human health and ecological exposure scenarios that assumed current and reasonable/foreseeable future industrial land use, no potential risks exceeding USEPA target risk criteria were determined for chemical contamination at Yards C, G, and L.

2.5.6 Nature and Extent of Contamination

This section provides a brief summary of the nature and extent of contamination at the FUSRAP IAAAP sites. The location of soil and structures containing concentrations of DU above the RI screening levels (i.e., industrial risk levels) are described below. A more complete description can be found in the FUSRAP RI Report (USACE 2008) and the FUSRAP FS (USACE 2011b).

2.5.6.1 Soil

DU contamination was observed in soil samples collected at the FSA. FUSRAP RI results showed that the extent of soil contamination of DU was generally limited to soil directly beneath DU fragments that were observed in the field to be oxidizing to an approximate depth of 2 ft.

Using GWSs, visual observations, and soil sampling, DU fragments were found in small localized areas at the Firing Sites 1 and 2 Area, the Firing Sites 3, 4, and 5 Area, and at the Firing Site 6 Area, with contamination being limited to approximately 1 m^2 surrounding the fragments.

Using GWSs, visual observations, and soil sampling, the presence of DU fragments was found across the Firing Site 12 Area in all directions from ground zero. These investigations indicated DU fragments were concentrated primarily within a 100-meter (m) radius of ground zero. DU fragments were found beyond the 100 m radius but the quantity of identified fragments decreased with distance from ground zero. Investigations extended to a distance of approximately 175 m from ground zero; however, GWS coverage was limited in some areas due to heavy vegetative ground cover and underbrush.

Surface sediment samples (0 to 0.5 ft bgs) were obtained from depositional areas along Long Creek and its tributaries to assess the possibility of migration of potential contaminants from the FSA. Long Creek runs through the FSA, with a portion being downgradient of the Firing Site 6 Area. The sediment sample results did not exceed the RGs and indicated no surface migration or transport of DU from the FSA (USACE 2008).

No DU or chemical contamination was found at Yards C, G, or L above the RI screening levels.

2.5.6.2 Structural Surfaces

During the RI, radiological surveys of structural surfaces were conducted at Line 1; the FSA; Yards L, C and G; and Warehouse 3-01.

Forty-one interior building surveys were conducted at Line 1, which investigated for gross alpha/beta activities during the RI. Surveys indicated that small interior surfaces of some structural components at two buildings (Buildings 1-11 and 1-63-6) exhibited discrete areas of radiation that exceeded the structural DU RG, which was derived during the FS, as discussed in Section 2.8.3.

Within the FSA, the building surveys included buildings at Firing Sites 1, 2, 3, 4, and 5, and the Firing Site 12 bunker. The FUSRAP RI Report indicated that all gross alpha and beta (total) readings were below the structural DU RG for all exposed interior surfaces (i.e., surfaces not covered by soil).

At Yards C, G, and L and at Warehouse 3-01, all gross alpha and beta (total) readings were below the structural DU RG.

2.5.7 Contaminant Fate and Transport

This section provides a brief overview of some of the relevant factors governing DU fate and transport in the surface and subsurface at the FUSRAP areas at the IAAAP. It discusses some of the chemical properties of DU relevant to contaminant fate and transport and also deals with site-specific parameters that affect potential contaminant migration pathways at the FSA.

2.5.7.1 Fate and Transport Properties of DU

DU typically contains about 99.799, 0.200, and 0.001 percent by weight U-238, U-235, and U-234, respectively, with corresponding activity percentages of 90.14, 1.45, and 8.40, respectively. All three isotopes are radioactive and produce decay products upon radioactive disintegration. However, because of the long half-life of U-238 (4.468 x 10^9 years), decay is not particularly relevant to DU fate and transport in the environment. Although the radiological properties of uranium isotopes differ considerably, their chemical behavior is essentially identical (USEPA 2006).

As an environmental contaminant, DU most frequently occurs as the metal and as a number of solid oxides, which may include those arising from oxidation of the metal. The overall mobility of uranium in the environment is determined by its oxidation state, with the hexavalent and tetravalent states the most common in the environment. These oxides are only sparingly soluble, but will gradually form hydrated uranium oxides in moist conditions. In its hexavalent state, uranium is usually more soluble and travels with water; however, in the tetravalent state, uranium is insoluble and relatively immobile.

DU was found to be present in soil at the FSA (generally between 0 to 2 ft bgs) and on structural surfaces at Line 1. On structural surfaces, DU particles were found to be embedded in the surface and/or adhered to the surface. In soil, DU was found as oxidized and non-oxidized fragments and particles. The oxidation rate of the DU particles varies, depending on fragment size, pH, humidity, soil moisture content, soil chemistry, soil oxygen content, and the presence of other metals in the soil.

Upon weathering, non-oxidized small particles may be adsorbed to clay minerals and organic matter. At the FUSRAP areas, absorption of uranium by clay-rich soil tends to retard environmental transport. At the IAAAP, the surface soil generally consists of between 95 to 100 percent fine-grained materials (silt and clay). In those areas of the IAAAP where the Clinton silty clay loam is present (such as Firing Site 12), up to 42 percent of the fine-grained material is clay-sized.

2.5.7.2 Potential Contaminant Migration Pathways

The contaminant migration pathways at the FUSRAP areas involve historic releases of DU to soils and structural surfaces with potential transport of contaminated particles by wind erosion, run-off of precipitation in contact with contaminated soils into surrounding surface water bodies, and potential leaching of DU from the shallow soil into underlying ground water with subsequent downgradient transport.

<u>Air Transport</u>: Wind dispersion of DU particles from the surficial soil under dry conditions is possible. The closest IAAAP boundary to the FSA is the boundary directly west of that area, approximately 6000 ft (over 1800 m) away. Given the distance and resultant atmospheric dispersion, it is highly likely that DU would be diluted to levels below levels of potential health concern by the time the winds reached the installation boundary (ATSDR 2003). Based on the presence of heavy vegetation and the large distance from the FUSRAP areas to off-site receptors, airborne migration of DU to off-site areas is deemed to be minimal.

<u>Ground-Water Transport</u>: The shallow aquifer at the IAAAP consists predominantly of clay-rich glacial till (Kellerville Till) that exhibits low hydraulic conductivities. The water table surface in the shallow till averages eight ft bgs at the FSA, and flow is generally toward the surrounding surface water bodies (the western and northern branches of Long Creek). The low permeability of the clay-rich till limits the lateral and vertical migration of contaminants via ground water. In addition, because uranium is strongly adsorbed by the clay minerals in the Kellerville Till, it is gradually removed from ground water as it migrates downgradient.

Ground-water monitoring data indicate that uranium has leached to ground water beneath the FSA but there is no indication it has migrated off the FSA. Uranium was detected at a maximum concentration of 345 micrograms per liter (µg/L) in a shallow monitoring well JAW-32, located beneath the Firing Site 12 Area (Tetra Tech 2007). The ground-water contamination at the IAAAP is considered outside the scope of FUSRAP and is being addressed pursuant to the 1990 FFA (U.S. Army and USEPA 1990). In November 2003, the USACE conducted ground-water and surface-water sampling in off-site areas to address concerns about possible impacts to off-site ground water and surface water resulting from past AEC activities at IAAAP. The samples were analyzed for both total and isotopic uranium. The conclusion drawn from these analyses was that isotopic ratios were not consistent with those expected of DU and that low levels of uranium detected were likely to be naturally occurring. All uranium levels were below the human health risk-based screening level (URS 2004). Therefore, DU contamination at the FSA has not resulted in the migration of uranium to off-site areas via ground water.

<u>Surface-Water Transport</u>: In order to assess the possibility of overland migration of contaminants from the FSA, surface sediment samples (0 to 0.5 ft) were collected from depositional areas along Long Creek and its tributaries. Long Creek runs through the FSA, with a portion being downgradient of the Firing Site 6 area. The sediment sample results did not exceed the screening level values and indicated no surface migration or transport of DU from the FSA (USACE 2008).

In summary, the DU chunks and fragments in soil at the FSA are relatively immobile. Upon weathering, DU is likely to strongly adsorb to the clay-rich soil. Based on data from shallow ground-water monitoring wells at the FSA, uranium has leached vertically into the shallow ground water underlying the Firing Site 12 area, but significant lateral migration is not occurring.

The extent of the ground water contamination at the FSA is limited and is being addressed by the U.S. Army in accordance with the 1990 FFA (U.S. Army and USEPA 1990). The results of sampling of ground water and surface water in off-site areas downgradient of the FSA, as well as the results of sediment sampling conducted in the depositional areas of Long Creek and its tributaries, indicate that off-site migration of DU from the FSA via wind, overland runoff, or ground-water transport is not occurring.

2.6 CURRENT AND POTENTIAL FUTURE LAND AND WATER USES

2.6.1 Current and Potential Future Land Use

The current land use of the developed portions of the IAAAP is industrial/military with some outgrants for commercial agriculture. Undeveloped portions of the IAAAP, including Mathes Lake, have recreational uses (e.g., hunting and fishing).

Most of the land surrounding IAAAP is agricultural cropland and pastureland. Small businesses (general stores and gas stations) and low-density residential communities are also located around the periphery of the installation (CH2M Hill 2007).

No significant changes in land use are anticipated. The likely potential future land use for the IAAAP is industrial/military. Exceptions to the anticipated industrial/military use include existing agriculture outgrants and recreational use in undeveloped portions of the IAAAP. The future production and/or testing/destruction of weapons containing DU is not expected at the FUSRAP areas.

2.6.2 Current and Potential Future Water Use

Ground water beneath the IAAAP is not currently used as a drinking water supply. Drinking water has been provided to the IAAAP by the City of Burlington municipal supply since 1977. No changes in ground-water use at the IAAAP are anticipated.

There have been seven water supply wells at the facility. Four of the wells were installed in 1942 for backup use and were never used due to lack of need and poor water quality. These wells were abandoned in 2001. The three remaining water supply wells are relatively deep (well depths range from approximately 90 to 500 ft deep) and are used for non-potable purposes only.

For off-site areas immediately adjacent to the IAAAP, the Army has connected most residents to the Rathbun Rural Water System as a result of their ongoing remediation efforts to address ground water under their (non-FUSRAP) ROD for OU #3. This is anticipated to continue into the future.

2.7 SUMMARY OF SITE RISKS

The BRA estimated what risks soils and structures in the FUSRAP areas pose if no action (e.g., remediation) were taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. This section provides 1) a brief summary of the relevant portions of the human health risk assessment, 2) a brief summary of the streamlined ecological risk assessment (ERA), and 3) the basis for taking action. Both the human health risk assessment and streamlined ERA comprised the BRA that was prepared as part of the FUSRAP RI Report (USACE 2008). The BRA evaluated exposures to DU in soil and structures and chemicals in soil at the FUSRAP areas. No DU or chemical contamination was found at Yards C, G, or L above the RI screening levels (i.e., industrial risk levels). DU contamination was found associated with structures at Line 1 (i.e., the steel grate at Building

1-11 and air filters at Building 1-63-6). DU, explosives, and metals contamination was found above RI screening levels in soil at the FSA. However, as discussed in Section 2.4, the focus of this FUSRAP response at the FSA is limited to the removal of source material containing DU, in accordance with the December 2006 Dispute Resolution Agreement (U.S. Army 2006). That agreement reflects the application of the MMR (See 40 *CFR* 266.200 et. seq.) to the determination of the scope of FUSRAP authority on the FSA. Based on the removal of explosive constituents and metals contamination at the FSA from the scope of this response, and the finding that no potential risks exceeding USEPA target risk criteria are present at Yard C, G, and L, DU is the only COC being addressed by the FUSRAP Selected Remedy. Therefore, this section discusses DU as being the only COC identified in the BRA, and focuses on associated exposure pathways, dose, and risk that are driving the need for the Selected Remedy, in accordance with USEPA (1999a) guidelines.

2.7.1 Data Evaluation

Prior to conducting the BRA, existing data were evaluated to determine whether they are of adequate quality for use in quantifying radiological risk and dose. Data judged to be of adequate quality were further reviewed to determine whether detection limits were sufficiently low for the intended risk assessment. Data quality is generally assured through the implementation of standard operating procedures during sample collection and sample analysis, quality control checks, and data review and validation.

The IAAAP database consists of analytical results for samples collected from May 2001 through October 2007, as well as data collected during the 2009 Supplemental Investigation. All data collected during 2001 through 2007 for the FUSRAP RI and for the 2009 Supplemental Investigation were reviewed and validated to ensure that the data quality was sufficient for quantifying risk; however, only the data collected from the RI were used to develop the BRA. DU soil data collected during the 2009 Supplemental Investigation were biased toward known areas of DU contamination and were used primarily to delineate those areas of contamination. As expected, the biased sample results from the Supplemental Investigation (which targeted actual DU fragments) are elevated over those obtained during the RI. Combining the DU soil data collected during the RI with the biased Supplemental Investigation data would have artificially increased the doses and risks over those estimated during the BRA, which themselves exceed target dose and risk criteria, but would not change the outcome of the BRA results. Therefore, the 2009 Supplemental Investigation data for DU were not applied to the BRA.

Qualifiers pertaining to uncertainty in the identity or the reported concentration of an analyte were assigned to certain analytical data by the laboratories or by chemists performing data validation. Additionally, all data were assessed in a Quality Control Summary Report for technical defensibility and usability, particularly with regard to meeting data quality objectives established in the RI Work Plan (USACE 2007), along with acceptable sensitivity, precision, and accuracy requirements. Validation reports and the Quality Control Summary Report for data used in the BRA are presented in Appendix B of the FUSRAP RI/BRA Report (USACE 2008).

2.7.2 Human Health Risks

The human health risk assessment estimated and presented radiological doses and cancer risks for exposures to DU. Doses and risks for DU were determined individually for the three radionuclides comprising DU: U-234, U-235, and U-238. Additionally, both cancer and toxic (non-cancer) risks were estimated and presented for chemical exposures. The overall approach used for the human health risk assessment was based on the USEPA's (1989) guidance entitled:

Risk Assessment Guidance for Superfund Volume I, Human Health Evaluation Manual (Part A) (RAGS Part A). The human health risk assessment consisted of 4 major components:

1. Identification of COCs: Identifies those contaminants which are of significant concern;
2. Exposure Assessment: Identifies actual or potential exposure pathways, the potentially exposed populations, and the extent of possible exposures;
3. Toxicity Assessment: Considers the types and magnitudes of adverse health effects associated with exposure to the COCs; and
4. Risk Characterization (including an uncertainty analysis): Integrates the three other components to summarize the potential and actual risks posed by the COCs at the site.

2.7.2.1 Identification of Contaminants of Concern for the Human Health Risk Assessment

a) **Soil:** During the BRA, DU was identified as the only FUSRAP COC. Within the FUSRAP area soils, DU was found only at the FSA. DU was not identified as a soil COC in the other evaluated FUSRAP areas. DU was visibly observed as fragments in soil, and the three radiological isotopes comprising DU were detected during laboratory analyses of soil samples collected from the FSA. Elevated gamma walkover measurements were observed to be above background, and laboratory results reported for the three DU isotopes showed exceedances of the screening level (56 pCi/g) throughout the FSA. Doses and cancer risks were estimated to be above target criteria for current and future site worker and future construction worker exposures to DU at the FSA. Although chemical cancer and non-cancer risks were also estimated to exceed target criteria, only DU was carried forward as the soil COC for the FSA in accordance with the 2006 FFA (USEPA et al. 2006) and the December 2006 Dispute Resolution Agreement (U.S. Army 2006), which reflects the application of the MMR (40 *CFR* 266.200 et. seq.).

b) **Structures:** DU was identified as a COC on a steel grate covering a floor sump in Line 1 Building 1-11 and on air filters in an air handling unit located in Line 1 Building 1-63-6. The determination was made as a result of gross activity exceedances of a site-specific, risk-based RG derived for the FS Report (USACE 2011b).

Table 2-1 presents summary statistics for DU (U-234, U-235, and U-238) in soil that were collected from the FUSRAP areas from May 2001 through October 2007, and used to evaluate dose and risk in the BRA. Summary statistics include minimum and maximum detected concentrations in pCi/g, their frequency of detection at different properties, and their exposure point concentrations (EPCs).

The EPC is an upper-bound concentration estimated for each DU isotope, which is assumed to be representative of exposures to DU-contaminated soil or structures via a specific exposure route. The EPC is used to quantify potential dose and cancer risks for each of the DU isotopes. The type of statistical measure it represents is also identified in Table 2-1. USEPA recommends use of (1) the maximum concentration detected if there are a small number of samples (i.e., less than 8) or (2) the lesser of the 95th percentile upper confidence limit of the mean concentration (95 percent UCL) and the maximum detected concentrations as the EPC.

Table 2-1. Summary of Contaminants of Concern and Soil Exposure Point Concentrations

Scenario Timeframe: Current and Future
Medium: Soil
Exposure Medium: Soil

Exposure Point [a]	COC [b]	Site Concentration Detected [c]		Units	Frequency of Detection	Mean Background	Background Units	EPC [d]	EPC Units	Statistical Measure
		Minimum	Maximum							
FSA Soil	U-234	0.15	433	pCi/g	26/32	1.27	pCi/g	211.23	pCi/g	95% UCL
	U-235	0.09	39.6	pCi/g	28/115	0.04	pCi/g	5.65	pCi/g	95% UCL
	U-238	0.282	2401	pCi/g	109/115	1.42	pCi/g	622.58	pCi/g	95% UCL

[a] The only FUSRAP area where DU was identified as a COC is the FSA. Other areas evaluated where DU was not determined to be a COC include Yard C, Yard E, Yard F, Yard G, Yard L and the Area West of Line 5B.

[b] The soil COC DU is comprised of three uranium isotopes that were evaluated during the BRA: U-234, U-235, and U-238.

[c] The detected concentrations presented in the table, along with frequencies of detection and EPCs, are those used to calculate dose and risk in the BRA and do not include 2009 Supplemental Investigation data.

[d] EPC is calculated as the lesser of the maximum detected concentration versus the 95% UCL, then minus the mean site-specific background value.

Although the FSA is comprised of five smaller firing site areas, radiological exposures to DU-contaminated soil were evaluated by combining the data for all firing sites, over all sample depths, to determine FSA-wide EPCs for the DU isotopes. The EPCs for structures were not calculated based on 95 percent UCLs versus maximum detected concentrations. Rather, each individual result from the radiological structural surveys was evaluated relative to conservative, non-site-specific screening levels in the RI/BRA and a site-specific RG derived in the FS Report.

2.7.2.2 Exposure Assessment

The purpose of the exposure assessment is to estimate the nature, extent, and magnitude of potential receptors' exposure to COCs that are present at or migrating from the site, considering both current and potential future land and resource use at the site. Components of the CSM (e.g., identification of potential receptors, exposure pathways, and exposure media) were used in performing the exposure assessment.

Exposure scenarios are used to assess potential risk. Scenarios are developed by modeling the potential receptor's exposure given a specific concentration of the contaminant (the EPC) and specific exposure parameters (e.g., body surface area, duration on site, frequency of exposure, breathing rate, etc.) for each anticipated exposure pathway. The overall risk to each receptor is the sum of the risks associated with each exposure pathway.

As indicated in the soil CSM (see Section 2.5.2.1.1 and Figure 2-8), potentially exposed populations/receptors are adult site industrial workers and construction workers in the FUSRAP areas. Soil exposure pathways consist of: incidental ingestion of DU-contaminated soil, inhalation of DU-contaminated soil particulates that become airborne, and direct external radiation exposures to DU contaminated soil. Additionally, below-grade structural surfaces exist at the FSA that could potentially be in direct contact with DU-contaminated soil (e.g., Firing Site 12 bunker). Potential contamination of these surfaces will be addressed during remediation of the FSA.

The occurrence of potential trespassing and recreational use (e.g., hunting) at the IAAAP property was considered in the BRA, but these activities occur infrequently because of access restrictions, as well as the physical characteristics of each area therein. Commercial agricultural activities occur only within Yard C of the FUSRAP areas. Such commercial operations are comparable to industrial land use and therefore exposures to commercial ranchers/farmers in Yard C were determined to be insignificant.

As indicated in the structural CSM (see Section 2.5.2.1.2) for DU-contaminated surfaces not impacted by soil, potentially exposed individuals are site workers who directly contact a steel grate covering a floor sump in Line 1 Building 1-11 and the air filters in an air handling unit located in Line 1 Building 1-63-6. Exposure pathways associated with these structures include ingestion, inhalation and external radiation.

The BRA evaluated USEPA's reasonable maximum exposure (RME) for each receptor scenario for the FSA. The RME exposure is the highest exposure that is reasonably expected to occur at a site. RMEs were estimated for individual pathways. Because the FUSRAP receptor scenarios at the FSA (i.e., site workers or construction workers) are assumed to include exposures via more than one pathway, the combination of exposure across pathways represented an RME. Each intake variable in the exposure assessment equation has a range of receptor-specific values. In order to evaluate the RME scenario, upper-bound values for those ranges were selected for each intake variable used to evaluate exposures to each receptor. The combination of all intake variables resulted in an estimate of RME for that receptor pathway, based on quantitative information, professional judgment and site information. In the RI/BRA Report, numeric RME values for intake variables, along with other non-exposure related variables, were entered into the Residual Radioactive Material (RESRAD) computer code (Version 6.3) to calculate dose and risk associated with DU-contaminated soil. Specific exposure parameters used standard default values recommended by USEPA's RAGs Part A guidance document and USEPA's (1997) Exposure Factor Handbook to the extent that such parameters were available. Where USEPA standard parameters were not available, site-specific parameters were used. (See Table 6-4 in the FUSRAP RI/BRA Report for more detailed information). All input values used in the radiological dose and risk assessment of DU for site workers and construction workers are presented in the RESRAD output files contained in Appendix F of the RI/BRA Report.

2.7.2.3 Toxicity Assessment

The toxicity assessment results in the selection of appropriate toxicity values for calculating estimates of potential health risks associated with exposure. This is accomplished by reviewing the available information on the toxicity of the COCs and summarizing the factors pertinent to the exposures being assessed.

Health impacts from exposure to radiation and radionuclides are expressed as the risk of developing cancer. Because DU is comprised of U-234, U-235, and U-238, DU is identified and evaluated as a carcinogen in this Radiological Risk and Dose Assessment. Cancer risks from exposures to DU isotopes were estimated using USEPA slope factors (SFs) developed for inhalation, ingestion, and external radiation exposure routes. These SFs are presented in Table 2-2. External radiation SFs were used to convert exposure to radionuclides via the external radiation pathway to risk.

SFs for radionuclides are derived based on the following, as outlined in USEPA's (1996) *Radiation Exposure and Risk Assessment Manual*:

- the radiological endpoint is fatal cancer;
- radiological risk estimates are based primarily on human data; and
- radiological risk estimates are based on the central estimate of the mean.

A dose conversion factor for radiological exposures was used to calculate lifetime committed effective dose equivalents. Radiological doses were calculated to ensure compliance with applicable or relevant and appropriate requirements (ARARs) to be identified for radiological contamination. Section 2.8.2.1 below discusses use of NRC regulations as an ARAR. For a licensed site to be released for unrestricted use, 10 *CFR* 20 Subpart E requires the radiological dose to be less than 25 millirem per year (mrem/yr). DU consists of U-234, U-235, and U-238 isotopes, of which U-234 and U-238 are in secular equilibrium, with more than 99 percent of the DU being U-238. The decay chain for U-238 is presented in Figure 2-9.

Retention of uranium in organs of the body is described by a two-compartment model. Of the material entering the blood, 0.2 percent is transferred to mineral bone and retained with a biological half-life of 20 days, and 0.023 percent is transferred to mineral bone and retained with a biological half-life of 5,000 days. For transfer to kidneys, 0.12 percent is retained with a biological half-life of 6 days and 0.00052 percent is retained with a biological half-life of 1,500 days. The remainder of uranium leaving the blood is assumed to be directly excreted. Long-lived uranium isotopes (U-234, U-235 and U-238) are assumed to be uniformly distributed throughout the volume of mineral bone following their deposition.

Table 2-2. Cancer Slope Factors for DU Isotopes

COC	Slope Factor	Slope Factor Units	Effect	Source	Date
Pathway:	**Ingestion**				
U-234	1.58E-10	risk/pCi	Morbidity	FGR 13 [a]	1999
U-235 (+D) [b]	1.63E-10	risk/pCi	Morbidity	FGR 13	1999
U-238 (+D)	2.10E-10	risk/pCi	Morbidity	FGR 13	1999
Pathway:	**Inhalation**				
COC	**Slope Factor**	**Slope Factor Units**	**Effect**	**Source**	**Date**
U-234	1.14E-08	risk/pCi	Morbidity	FGR 13	1999
U-235 (+D)	1.01E-08	risk/pCi	Morbidity	FGR 13	1999
U-238 (+D)	9.35E-09	risk/pCi	Morbidity	FGR 13	1999
Pathway:	**External Radiation**				
COC	**Slope Factor**	**Slope Factor Units**	**Effect**	**Source**	**Date**
U-234	2.52E-10	risk/yr per pCi/g	Morbidity	FGR 13	1999
U-235 (+D)	5.43E-07	risk/yr per pCi/g	Morbidity	FGR 13	1999
U-238 (+D)	1.14E-07	risk/yr per pCi/g	Morbidity	FGR 13	1999

[a] USEPA 1999b.

[b] "+D" Indicates that risks from short-lived radioactive decay products are included in the slope factor.

2.7.2.4 Risk Characterization

In the risk characterization, values for the parameters estimated in the exposure assessment, along with other fate and transport variables were entered into the RESRAD model (Version 6.3) to estimate radiological dose (mrem/yr) resulting from exposures of site workers and construction workers to DU-contaminated soil via the complete pathways identified in the CSM. Additionally, the appropriate SFs identified in the toxicity assessment were entered into RESRAD to estimate potential cancer risk from exposures to DU-contaminated soil. RESRAD is a computer code developed at Argonne National Laboratory for the DOE to determine site-specific radiation guidelines and dose to a hypothetical on-site receptor at sites that are contaminated with residual radioactive materials. This model uses dose conversion factors for external gamma, inhalation and ingestion to estimate dose, and SFs to convert soil concentration to risk.

Table 2-3 presents the radiological dose and excess lifetime cancer risks estimated for each receptor due to exposures to DU-contaminated soil at the FSA. Results for the other FUSRAP areas that were evaluated are not presented in the table because they were less than the target dose and risk criteria of 25 mrem/yr and 1.0E-06, respectively. Table 2-3 presents the maximum total dose and cancer risk estimated to occur across all exposure pathways over a 1,000-year evaluation period.

Table 2-3. Radiological Dose and Cancer Risk Summary for Exposures to Depleted Uranium in Firing Sites Area Soil

Property	Site Worker		Construction Worker	
	Maximum Total Dose (mrem/yr)	Maximum Total Risk	Maximum Total Dose (mrem/yr)	Maximum Total Risk [1]
FSA	27	4E-04	36	2E-05

[1] Although the construction worker dose is generally higher than the industrial worker dose, the construction worker risk is generally less than the industrial worker risk. This is due to the difference in exposure periods (i.e., 25 years for the industrial worker versus 1 year for the construction worker).

Based upon the risk and dose results listed in Table 2-3, if no further action occurs at the FSA, dose would exceed both the 25 mrem/yr dose limits for both the site worker and construction worker scenarios and risk would exceed the CERCLA risk range (1E-06 to 1E-04) for the site worker scenario.

Given the above dose and risk results for DU (i.e., U-238, U-235, and U-234) in FSA soil, it was determined that remedial actions are necessary to address DU-contaminated soil in the FSA.

2.7.2.5 Sources of Uncertainty

There are a number of factors that contribute uncertainty to the estimates of human exposure (dose) and risk presented above. However, all uncertainties inherent in the evaluations, methods, and reporting of doses and risks during the human health risk assessment are generally applied in manner that does not result in an underestimation of doses and risks, thereby introducing health conservatism into the results. Uncertainties pertinent to the evaluations of DU exposures during the human health risk assessment, and their impacts in over- or underestimating risk results for the evaluated exposure scenarios are discussed in the following subsections.

2.7.2.5.1 Uncertainties Associated with Biased Soil Sampling

The sampling scheme used to collect soil samples at the IAAAP sites during the RI was primarily based on obtaining biased samples from areas of historical operations, the locations likely to find DU observed/detected during previous investigations, and additional sampling locations selected in order to adequately determine nature and extent of contamination and to fulfill data requirements.

Because much of the RI sampling was biased toward areas of likely contamination, the EPCs calculated during the human health risk assessment based on the biased datasets are likely to be higher than those that would be calculated based on a non-biased sampling strategy (e.g., random sampling, systematic random sampling from grid, etc.). Consequently, the human health doses and risks are considered to be higher and more health-conservative.

2.7.2.5.2 Uncertainties Associated with the Evaluation of Data

Although the data evaluation process used during the RI adhered to established procedures and guidance, it also required making decisions and developing assumptions on the basis of historical information, disposal records, process knowledge, and best professional judgment about the data. Uncertainties are associated with all such assumptions.

Some unavoidable uncertainty is associated with the DU concentrations detected and reported by the analytical laboratory. The quality of the analytical data used in the human health risk assessment depends on the adequacy of the set of procedures that specifies how samples are selected and handled and how strictly these procedures are followed. Quality assurance/quality control procedures within the laboratories are used to minimize uncertainties; however, sampling errors, laboratory analysis errors, and data analysis errors can occur.

2.7.2.5.3 Uncertainties Associated with the Determination of Exposure Point Concentrations

Uncertainty is also introduced through the process of estimating representative exposure concentrations in the analyzed exposure media. Analytical results are used to calculate a mean concentration and the 95 percent UCL on the mean concentration. The lesser of the maximum detected concentration and the 95 percent UCL was used as the EPC for the human health risk assessment.

Moderate uncertainty can be introduced in the data aggregation process for estimating a representative exposure concentration of DU isotopes in soil at the FUSRAP areas. USEPA's ProUCL program (version 4.0) used during the RI/BRA applied statistical tests to determine the distribution that best describes the soil dataset within each area of concern. ProUCL then reports the 95 percent UCL associated with the distribution type that best describes the dataset of interest. 95 percent UCLs are calculated using both detected and non-detect results (the latter being activity concentrations of DU isotopes reported to be below the corresponding detection limits). The soil EPC for each DU isotope in each FUSRAP area was determined to be the lesser of the maximum detected concentration versus the calculated 95 percent UCL, minus the mean background concentration. This method may moderately overestimate the exposure concentration.

2.7.2.5.4 Uncertainties Associated with the Radiological Dose and Risk Assessment

Quantification of radiological exposure to DU in soil assumed that exposure could occur via the following exposure pathways: ingestion of DU-contaminated soil, inhalation of DU-contaminated dusts, and external radiation, per the CSM. Several uncertainties associated with the various components of the exposure assessment include uncertainties about the exposure pathway equations, exposure parameters, land use scenarios, representative exposure concentrations, and sampling and analysis of the media.

For each primary exposure pathway chosen for analysis, exposure parameters were selected to provide a conservative, yet reasonable, estimate of potential risks to each receptor. Site-specific measurements and data were used, as appropriate, to describe site conditions as accurately as possible. Where site-specific data were not available, parameter values were chosen to provide reasonably conservative estimates of risk, or standard default values recommended by the *Exposure Factors Handbook* (USEPA 1997) were used. The model assumes that contamination is always spread over a large area with no cover material. Final status surveys and post-remediation risk/dose assessments for each investigative area will consider property-specific characteristics such as surface area and depth below ground surface.

The accuracy of exposure calculations is ultimately limited to the accuracy of the site data and risk models. The data used in the assessment included results from several investigations. The data in the assessment was used assuming the best knowledge of the distribution of contaminants in site soils with the goal of providing conservative, yet reasonable, estimates of risk. The models used to calculate risks and doses are approved by USEPA and are assumed to provide a reasonable prediction of site exposures.

Lifetime cancer risk estimates are provided for exposure to chemical contaminants and are compared to the CERCLA target risk range of 1E-06 to 1E-04. Radiological risk SFs have been developed primarily using data from groups such as the Japanese atomic bomb survivors. These individuals received large doses of radiation over a short period of time. By contrast, potential receptors in this assessment receive relatively small radiological doses over a long period of time. Although cancerous effects have only been detected at doses several orders of magnitude larger than those estimated at the IAAAP, it is assumed that the slope factors apply to both large and small radiological doses.

A series of reports published by the National Research Council's Committee on the Biological Effects of Ionizing Radiation (BEIR) lists additional uncertainties resulting from the use of SFs for radionuclides. BEIR reports point out that cancer risks from exposure to radionuclides at environmental levels (typical background radiation produces approximately 300 mrem/yr) are very difficult to distinguish from background cancer rates. In addition, the calculation of SFs is based on radium dial painter studies, atomic bomb survivor studies, etc., each considering doses many orders of magnitude higher than those received at environmental levels. The applicability of the linear no-threshold model has been debated by many professional societies. However, the linear no-threshold model (i.e., assuming risk is linear with exposure and is possible for even the smallest doses) has been adopted by all relevant United States regulating agencies. Using this model, risks at environmental levels are calculated even at dose levels a small fraction of background.

The assumption that all modeled receptors are equally likely to be exposed produces conservative dose and risk results. That is, contamination on some areas may cover a small surface area (which would lower dose estimates) and may only reasonably expose a subset of individuals (e.g., utility workers). Area-specific and receptor-specific calculations will be part of the final status survey process.

DU consists of U-234, U-235, and U-238. As the DU oxidizes into the surrounding soil, the U components go through several chemical stages during an oxidation process. During this process, the chemical form of uranium may be any one of three solubility classes: D, W and Y with Class D being the most soluble and Class Y being the least soluble. RESRAD assumes by default that all radionuclides are present as Class Y because Class Y would cause the calculated dose and risk estimates to be higher. RESRAD models can be adjusted to reflect the site-specific conditions, if appropriate. To be conservative (i.e., to assure that the calculated dose and risk are not underestimated), all radionuclides are modeled with a Class Y solubility (the RESRAD default).

2.7.3 Ecological Risks

A streamlined ERA was also performed as part of the BRA and refined in the FS. The most sensitive receptor/pathway combination was soil chemical exposures to the Indiana bat, a federally-listed endangered species found to be utilizing habitats at IAAAP during the summer months. The Indiana bat is not expected to directly contact DU fragments or incidentally ingest DU-contaminated soil in the FUSRAP areas during foraging activities, which occur within the months of April to October. This is because of the roosting and foraging habits of the bats during the summer months. Indiana bats roost in trees in riparian, bottomland, and upland forests. Pregnant females form small maternity colonies under exfoliating bark of dead or dying trees. The bats forage between dusk and dawn and feed exclusively on flying insects (primarily moths), beetles, and aquatic insects. Indiana bats forage over a variety of habitat types but prefer to forage in and around the tree canopy of both upland and bottomland forest or along the riparian corridors of small streams.

Because of their foraging habits and the extremely low potential for Indiana bats to ingest and bioaccumulate DU from soil via insect ingestion, this exposure pathway was determined to be incomplete, and was not evaluated for DU in the streamlined ERA. However, the bat is considered to be a more sensitive receptor to the bioaccumulation of chemicals (i.e., metals and explosives) and was therefore, evaluated for chemical exposures in the streamlined ERA.

Potential risks to the Indiana bat from chemical exposures were determined by EPC exceedances of ecological critical concentrations derived specifically for the Indiana bat, based on a model that assumes the bat ingests insect prey that have bioaccumulated chemical contaminants from the Firing Site 6 Area. Based on the results of the evaluations conducted as part of the streamlined ERA, it has been concluded that chemicals in soil at the FUSRAP areas do not pose potential risks to the Indiana bat or other ecological receptors.

2.7.4 Basis for Action

The response actions selected in this ROD are necessary to protect public health or welfare or the environment from actual or threatened releases of DU into the environment at the FSA and Line 1 at the IAAAP.

2.8 REMEDIAL ACTION OBJECTIVES

Remedial Action Objectives (RAOs) are specific goals for protection of human health and the environment that are developed to guide the identification of ARARs, the development of RGs, and the subsequent development, evaluation, and selection of remedial action alternatives. In accordance with the NCP [40 *CFR* 300.430 (e)(2)(i)], RAOs must specify contaminants and media of concern, potential exposure pathways, and RGs. RAOs describe what the remedial action alternatives need to accomplish to be protective of human health and the environment. Protective levels are those concentrations, represented by chemical-specific ARARs or RGs, that do not increase an individual's lifetime cancer risk by more than 1 in 10,000 (1.0E-4), which is the upper bound of the CERCLA risk range. RAOs must be developed in consideration of ARARs established for media of concern and COCs based on readily available information (e.g., reference doses). If ARARs are not available or are not sufficiently protective due to multiple contaminants or multiple pathways, then RGs are based on site-specific risk-based remediation levels. This section presents the RAOs, ARARs, and RGs that are used for the development and evaluation of the remedial action alternatives.

2.8.1 Remedial Action Objectives

Based upon the current and expected future industrial/military land use of the IAAAP, in conjunction with human health doses and risks estimated for the IAAAP site worker and construction worker at the FUSRAP areas, the following RAOs were developed:

- Prevent ingestion, dust inhalation, and external gamma radiation exposures to isotopes of DU in the FSA soil that could otherwise result in cumulative carcinogenic risks (CRs) exceeding 1.0E-04 and radiological doses exceeding 25 mrem/yr for receptors under the current (industrial) and expected future (industrial) land use scenarios.
- Prevent radiation exposures from DU particles embedded in and/or adhered to structural surfaces or components of the Line 1 buildings that could otherwise result in cumulative CRs in exceedance of 1.0E-04 and a total effective dose equivalent (TEDE) exceeding 25 mrem/yr.

Achievement of the soil and structural RAOs will reduce potential doses and risks to the IAAAP site worker and construction worker to levels below target criteria (25 mrem/yr and 1.0E-04, respectively). The following subsections discuss the identification of ARARs and development of RGs for soil and structural surfaces in order to facilitate attainment of the above-stated RAOs.

2.8.2 Applicable or Relevant and Appropriate Requirements

ARARs were identified for the FUSRAP areas in order to facilitate the development of remedial action alternatives. Section 121(d)(2) of CERCLA establishes an ARAR standard for remedial action with respect to any hazardous substance, pollutant, or contaminant that would remain on-site. Remedial actions, upon completion, must achieve a level or standard of control that at least attains legally applicable or relevant and appropriate standards, requirements, criteria, or limitations under federal environmental law. The actions must also meet any promulgated standard, requirement, criteria, or limitation under a state environmental or facility siting law proposed by the state that is more stringent than any federal standard, requirement, criteria, or limitation. These standards apply unless such standard, requirement, criteria, or limitation is waived in accordance with Section 121(d)(4). ARARs established for the FUSRAP areas of the IAAAP represent chemical-, location-, and action-specific requirements and are presented in detail in the FS Report and are presented here.

2.8.2.1 Chemical-Specific ARARs

The following ARARs have been identified for DU-contaminated soil and structural surfaces.

<u>Title 10, *CFR*, Part 20, Subpart E, Sections 20.1403(b) and 20.1403(e):</u>
These standards are generally applicable to U.S. Nuclear Regulatory Commission (NRC) licensed facilities. The FUSRAP residuals were generated from AEC activities that occurred prior to the establishment of NRC licensing requirements. In addition, the IAAAP does not have an NRC license. The fabrication of DU shells at the IAAAP was originally conducted under an NRC source material license (SUC-1381), but the license was transferred from NRC jurisdiction to the State of Iowa (Iowa Department of Public Health license 0290-1-29-SM1) in 2000. Therefore, these standards are not applicable at the IAAAP. However, USACE has identified these standards as relevant and appropriate because the constituents, the activities, and the type

of place regulated by these standards are sufficiently similar to the FUSRAP areas containing radiological constituents (i.e., DU). The standards in 10 *CFR* Part 20 Subpart E that are relevant and appropriate include Sections 20.1403(b) and 20.1403(e), which define standards for release under restricted conditions, noting that release under restricted conditions is acceptable if:

- 20.1403(b): "The licensee has made provisions for legally enforceable institutional controls that provide reasonable assurance that the TEDE from residual radioactivity distinguishable from background to the average member of the critical group will not exceed 25 mrem [0.25 millisievert (mSv)] per year";
- 20.1403(e): "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 (ALARA) and would not exceed either–

  (1) 100 mrem (1 mSv) per year; or
  (2) 500 mrem (5 mSv) per year provided that the licensee–

    (i) Demonstrates that further reductions in residual radioactivity necessary to comply with the 100 mrem/y [year] (1 mSv/y) value of paragraph (e)(1) of this section are not technically achievable, would be prohibitively expensive, or would result in net public or environmental harm.

    (ii) Makes provisions for durable institutional controls;

    (iii) Provides sufficient financial assurance to enable a responsible government entity or independent third party, including a governmental custodian of a site, both to carry out periodic rechecks of the site no less frequently than every 5 years to assure that the institutional controls remain in place as necessary to meet the criteria of Sec. 20.1403(b) and to assume and carry out responsibilities for any necessary control and maintenance of those controls."

ALARA involves making every reasonable effort to maintain exposures to radiation as far below the dose limits as is practical, taking into account the state of technology as well as societal and economic factors.

2.8.2.2 Location-Specific ARARs

<u>The Endangered Species Act [16 U.S. Code §1538(a)(1), (1973)]:</u> This act provides for the conservation of threatened and endangered plants and animals and the habitats upon which they depend. A federally listed endangered species, the Indiana bat, has been documented as utilizing areas within the geographic boundary of the IAAAP during the summer months. Therefore, the following requirements are relevant and appropriate for remedial actions within the FUSRAP areas of the IAAAP:

- 16 U.S. Code §1538(a)(1), which identifies the Endangered Species Act-prohibited acts for endangered species.

2.8.2.3 Action-Specific ARARs

<u>Title 10, *CFR* Part 20, Subpart B, Radiation Protection Programs, Section 20.1101(d):</u> The provisions of Section 20.1101(d) are relevant and appropriate to actions involving releases of airborne radioactive materials during remediation. These provisions impose a constraint on air

emissions of radioactive material to the environment, excluding Radon-222 and its daughters, such that the highest individual dose to the public will not exceed 10 mrem (0.1 mSv) per year.

2.8.3 Derivation of Remediation Goals

For the FUSRAP areas, RGs are soil or structural surface concentrations for DU that, if allowed to remain in place, would not result in adverse human health or environmental impacts under the exposure scenarios evaluated in the BRA. Based on the results of the BRA, RGs were developed for protection of human health under an industrial land use scenario, based on potential industrial site worker exposures to DU in soil at the FSA and DU for FUSRAP structures at Line 1 (i.e., “industrial RGs”). These scenarios are consistent with two existing IAAAP RODs (USAEC 1998; USACE 1998).

The purpose and application of the soil RGs is to allow the direct comparison of RGs to corresponding sample data acquired for each FUSRAP area to determine those individual sample locations and depths at which RGs are exceeded. Knowing the horizontal and vertical extent of the contamination allowed for the estimation of soil volumes and structural surface area for remediation and facilitates evaluations of general response actions and remedial alternatives in the FS.

Table 2-4 presents a summary of the soil and structural RGs derived for the FUSRAP areas of the IAAAP. The industrial RGs listed in Table 2-4 comply with ARARs, are protective of human health and environment, and are consistent with the NCP. All industrial RGs proposed are risk-, or ARAR-based concentrations. Soil and structural industrial RGs for DU were derived for the FS Report (USACE 2011b) using the RESRAD model (Version 6.4) and RESRAD-BUILD model (Version 3.4), respectively, and selected as the lower of risk-based and dose-based values. Both the risk- and dose-based values were derived based on the known activity percentages of the uranium isotopes in DU. Industrial RGs were derived for DU-contaminated soil at the FSA and FUSRAP structures.

Table 2-4. Soil and Structural Remediation Goals for the Formerly Utilized Sites Remedial Action Program Areas

COC	Soil RG (pCi/g)	Structures RG (dpm/100 cm^2)[1]
DU	150	23,000

[1] disintegrations per minute per 100 square centimeters

Due to the natural variability in activity percentages present in DU, all confirmatory soil samples will be processed by alpha spectroscopy analysis to determine the isotopic concentrations of all three uranium isotopes present in DU (U-238, U-235, and U-234). The actual concentrations reported in each survey area will be used to calculate the actual dose/risk associated with the residual DU.

2.8.4 Estimated Volume of Material and Structural Area Exceeding Remediation Goals

Site conditions, the nature and extent of contamination, and DU RGs were taken into consideration to estimate the volume of soil and the area of structures to be addressed by the remedial actions.

The primary media of concern at the FSA are surface and subsurface soil that are DU-contaminated as a result of AEC activities. The estimated volumes of soil exceeding the RG are presented in Table 2-5 and shown in Figure 2-10. Surface soil was assumed to be the total volume of soil from 0 to 1 ft in depth. Subsurface soil is estimated to be the total volume of soil greater than 1 ft in depth to an approximate depth of 2 ft as defined by the extent of contamination. For locations where isolated DU fragments were found (i.e., Firing Sites 1 and 2), soil volumes were conservatively estimated as 1 CY at each Firing Site grouping. At the Firing Site 12 Area, volume estimates were based on the horizontal and vertical extents of contamination with a graded approach due to the presence of many isolated DU fragments and non-contiguous DU-contamination at greater distances from the testing pad (Figure 2-10). The total volume calculated for the Firing Site 12 Area consists of 100 percent of the soil to a depth of 1 ft and 25 percent of the soil between 1 and 2 ft within a 100 m radius from the testing pad. For distances greater than 100 m from the testing pad (up to a 175 m radius), the total volume includes an estimate of 5 percent of the soil to a depth of 1 ft.

Table 2-5. Estimated In-situ Volume of Soil Exceeding the RG for DU

Location	Surface Soil Volumes 0 to 1 ft (CY)	Subsurface Soil Volumes 1 to 2 ft (CY)	Total Soil Volumes (CY)
Firing Sites 1 and 2[1]	1	0	1
Firing Sites 3, 4, and 5[1]	1	0	1
Firing Site 6 Area[1]	1	0	1
Firing Site 12 Area	13,809	3,129	16,938
Total Volume	**13,812**	**3,129**	**16,941**

[1] Only has isolated DU fragments

During soil remediation, any below-grade building surfaces that are exposed would be surveyed to assess whether decontamination is necessary. An estimated 475 square feet of surface area may be radiologically contaminated and require cleaning based on the entire perimeter of the building being contaminated to a depth of 2 ft below-grade.

The primary medium of concern at Line 1 is structures that have become radiologically contaminated as a result of prior AEC activities at the IAAAP. Structures with surface radioactivity above the RG that were identified during the RI include a steel grate covering a floor sump located at Building 1-11 and the air filters in an air-handling unit at Building 1-63-6. The estimated area of structural material requiring remediation at Line 1 is approximately 46 square feet.

2.9 DESCRIPTION OF THE ALTERNATIVES

This section presents a detailed description of the remedial action alternatives. Four remedial alternatives for soil and three remedial alternatives for structures were developed and evaluated in the FS. The alternatives range from no action to complete removal and treatment of the DU-contaminated media.

2.9.1 Alternative 1, No Action for Soil

Alternative 1, No Action for Soil, is required by the NCP [40 *CFR* §300.430(e)(6)] to provide a baseline to compare with the other remedial alternatives.

Remedy Components: This alternative assumes that no response actions would be implemented to address contaminated soil at the IAAAP FUSRAP areas. Contaminated soil would be left in place, the existing land use controls (e.g., use restrictions and outgrants administered by the U.S. Army as part of its land management responsibilities) would not be maintained, and no additional measures would be implemented to control exposures to the contaminated media.

ARARs: The key chemical-specific ARARs for Alternative 1 are 10 *CFR* §20.1403(b) and (e).

- Alternative 1 would not comply with 10 *CFR* §20.1403(b), which requires that the remedy include provisions for legally enforceable institutional controls that would limit the dose to the average member of the critical group to 25 mrem/yr.
- Alternative 1 would not comply with the restricted release conditions given in 10 *CFR* 20.1403(e), which require that the annual dose to an average member of the critical group not exceed 100 mrem/yr if land use controls are no longer present. Alternative 1 also would not comply with the requirement that the remedy achieve doses that are ALARA.

There are no location- or action-specific ARARs for Alternative 1.

Long-term Reliability of Remedy: Alternative 1 includes no long-term measures to prevent exposures or spread of contamination. Although existing controls (e.g., use restrictions and outgrants administered by the U.S. Army as part of its land management responsibilities) could provide limited control over exposure to DU-contaminated soil, this alternative assumes that controls would not be maintained and provides no additional controls to prevent exposure to contaminants.

Untreated Waste or Treatment Residuals Requiring Disposal or Containment: Alternative 1 would leave all of the DU-contaminated soil in place and would not result in any wastes or residuals.

Estimated Implementation Timeframe: This element is not applicable to Alternative 1 because no remediation activities would be implemented.

Estimated Time to Achieve RAOs: Alternative 1 would not achieve RAOs.

Cost: There are no costs for Alternative 1.

Expected Outcome: Because no remedial action would be taken, the risks from direct contact, ingestion, and inhalation would continue and could increase because current access control measures would not be maintained. The potential for human exposure to DU and the potential for off-site migration could increase over time as a result of disturbances by humans and natural processes.

2.9.2 Alternative 2, Land Use Controls for Soil

Alternative 2 includes the use of land use controls for soil at the FUSRAP areas and would be protective as long as the controls are in place. The NCP [40 *CFR* §300.430(a)(1)(iii)(D)] states that “institutional controls shall not substitute for active response measures … as the sole remedy unless active measures are determined not be practicable, based on the balancing of trade-offs among alternatives that is conducted during the selection of [the] remedy.” Alternative 2 was developed to evaluate the effects of the implementation of land use controls and allow comparison of a complete range of alternatives.

Remedy Components:

- Land Use Controls: The land use controls currently in place at the IAAAP (including use restrictions and outgrants administered by the U.S. Army as part of its land management responsibilities) would be maintained. Additional land use controls would be required and implemented for those areas where DU exceeds the industrial RG (i.e., Firing Sites 1 and 2; Firing Sites 3, 4, and 5; the Firing Site 6 Area; and the Firing Site 12 Area). The land use controls for these areas would include use restrictions to limit activities that could disturb soil and additional access restrictions to contaminated areas. This would provide additional protection by limiting direct exposure to contaminated soil and ground water. Fencing, signage, and/or security measures could be imposed at specific portions of the FUSRAP areas. Land use controls could also include restrictions that would be identified in public records.
- Five-Year Reviews: Five-year reviews would be conducted in accordance with CERCLA 121(c) for FUSRAP areas where contaminants are left above levels acceptable for UUUE. Industrial land use would be verified during each five-year review.

ARARs: The key chemical-specific ARARs for Alternative 2 are 10 *CFR* §20.1403(b) and (e).

- Alternative 2 would comply with 10 *CFR* §20.1403(b). Implementation of land use controls would achieve a dose rate that limits the annual dose to an average member of the critical group to 25 mrem/yr.
- Alternative 2 would not meet the restricted release conditions given in 10 *CFR* 20.1403(e), which require that the annual dose to an average member of the critical group not exceed 100 mrem/yr if land use controls are no longer present. Inability to meet the threshold criteria of compliance with ARARs is a significant problem with this alternative.

There are no location- or action-specific ARARs for Alternative 2.

Long-term Reliability of Remedy: Alternative 2 is reliable for the long term if land use controls are properly maintained and enforced. The land use controls would have to be maintained for a considerable period of time to prevent unauthorized and/or inappropriate use of the site. To avoid loss of controls, Alternative 2 includes requirements to verify the maintenance of the land use controls through the CERCLA five-year review process.

Untreated Waste or Treatment Residuals Requiring Disposal or Containment: Alternative 2 would leave all of the DU-contaminated soil in place and would not result in any wastes or residuals.

Estimated Implementation Timeframe: Land use controls could be implemented in less than 1 year.

Estimated Time to Achieve RAOs: Alternative 2 would achieve RAOs immediately upon implementation of land use controls.

Cost: The estimated total 30-year cost of Alternative 2 is 2,114,700 U.S. dollars ($). The total cost differs from the PP due to arithmetic error in the PP. The total costs include capital costs of $244,200 (for preparation of the land use control plan and implementation of land use controls) and O&M costs of $1,870,500 (for utility radiological support, five-year reviews, and the cost of maintaining and monitoring the land use controls). The costs also may include material costs if additional signage or fencing is installed. The present worth of this alternative is approximately $1,111,100 at a 7 percent discount rate. The NCP [40 CFR §300.430(e)(9)(iii)(G)] requires present worth to be used. A present worth analysis allows for a cost comparison of alternatives having different capital and O&M costs that would be incurred in different time periods on the basis of a single cost figure, with the conversion of all costs to the present, for each alternative.

Alternative 2 Cost Summary	
Capital Cost	$244,199
Operation and Maintenance (O&M) Cost	$1,870,546
Total Cost (30 years)[1]	$2,114,744
Present Worth Cost (7.0% discount factor)[2]	$1,111,087

[1] Total Cost for Alternative 2 differs from PP due to arithmetic error in the PP.
[2] 7.0% discount rate is in accordance with NCP (55 FR 8722).

Expected Outcome: Under Alternative 2, industrial land use would continue. Existing land use controls would continue (including use restrictions and outgrants administered by the U.S. Army as part of its land management responsibilities). The remedial action would attain acceptable risk levels through the implementation and maintenance of additional land use controls that would eliminate or reduce exposures to DU-contaminated soil. Continued industrial land use would be verified through the five-year review process.

2.9.3 Alternative 3, Excavation of Depleted Uranium Contaminated Soil with Off-Site Disposal

Alternative 3 involves excavation of soil exceeding the DU RG and off-site disposal. None of the excavated material would be treated after excavation. Alternative 3 also includes five-year reviews during which industrial land use would be verified. Continued industrial land use would be supported by use restrictions and outgrants administered by the U.S. Army as part of its land management responsibilities.

Remedy Components:

- Excavation: Surface and subsurface soil would be excavated to an estimated depth of 2 ft at those areas where soil concentrations exceed the industrial RG for DU. These areas are: Firing Sites 1 and 2; Firing Sites 3, 4, and 5; the Firing Site 6 Area; and the Firing Site 12 Area. No excavation activities would be required at Yards C, G, and L and Firing Site 14. The estimated total volume of soil that would be excavated is 16,941 in-situ CY. The excavated materials would be staged at a soil staging area prior to loading unto long-haul trucks or similar for off-site disposal. Below-grade structural surfaces that become exposed during soil excavation at the FSA would be surveyed for the presence of DU-contaminated soil. If DU-contaminated soil is found adhered to these surfaces, the structural surface would be decontaminated. If the structural surface cannot be decontaminated, the surface would be sealed and abandoned with land use controls or demolished and removed without replacement.
- Off-Site Disposal: Soil exceeding the industrial RG would be disposed of by transfer to a properly permitted off-site disposal facility. Approximately 22,023 ex-situ CY would be shipped off-site for disposal. Transportation of contaminated soil and debris would use Department of Transportation (DOT) approved “super sacks,” specially lined dump trucks, rail cars, or inter-model containers.
- Final Status Survey Evaluation: Post excavation soil samples and gamma walkover surveys would be collected using *Multi-Agency Radiation Site Survey and Investigation*

Manual (MARSSIM) (DoD 2000) based protocols to confirm that the remaining soil achieves the DU RG.

- Site Restoration: Backfilling of excavated areas with soil meeting the DU RG, grading, re-vegetation, and temporary storage are included.
- Five-Year Reviews: CERCLA 121(c) Five-year reviews are required under this alternative for FUSRAP areas that exceed UUUE. Industrial land use would be verified during each five-year review.

ARARs: The key chemical-specific ARARs for Alternative 3 are 10 *CFR* §20.1403(b) and (e).

- Alternative 3 would comply with 10 *CFR* §20.1403(b). Implementation of Alternative 3 would achieve a dose rate that limits the annual dose to an average member of the critical group to 25 mrem/yr.
- Alternative 3 would meet the restricted release conditions given in 10 *CFR* 20.1403(e), which require that the annual dose to an average member of the critical group not exceed 100 mrem/yr if land use controls are no longer present.

Alternative 3 also would comply with the following location- and action-specific ARARs:

- Endangered Species Act: 16 U.S.C §1538(a)(1): A federally listed endangered species, the Indiana bat, may be found as a transient species within the FUSRAP areas of the IAAAP. Therefore, these requirements are location-specific ARARs for Alternative 3. Alternative 3 is not expected to impact the habitat used by the Indiana bat. Some noise disturbance due to construction activities is likely to occur, but it is not expected to disturb the Indiana bat during critical periods of roosting.
- Radiation Protection Programs, 10 *CFR* §20.1101(d): The provisions of Section 20.1101(d) are action-specific ARARs for actions involving releases of airborne radioactive materials during remediation. These provisions impose a constraint on air emissions of radioactive material to the environment, excluding Radon-222 and its daughters, such that the highest individual dose to the public will not exceed 10 mrem (0.1 mSv) per year.

Long-term Reliability of Remedy: Alternative 3 is reliable in the long-term. Surface and subsurface soil would be excavated at those areas where soil concentrations exceed the industrial RG for DU, and continued industrial land use would prevent unauthorized and/or inappropriate use of the site. Industrial land use would be verified through the five-year review process.

Untreated Waste or Treatment Residuals Requiring Disposal or Containment: Approximately 22,023 ex-situ CY of waste would be shipped off-site for disposal. DU is a “source material” as defined by Section 11(z) of the Atomic Energy Act. Wastes containing source materials exceeding 165 pCi/g U-238 are classified as Class A LLRW. Such wastes would be disposed of by transfer to an NRC- or a state-licensed LLRW disposal facility. Given the industrial soil RG of 150 pCi/g for DU, it is assumed that most soil exceeding the RG would be disposed of by transfer to a Class A LLRW disposal site.

In general, the RI sampling does not indicate that chemical contamination or unexploded ordnance (UXO) is co-mingled with the DU. However, if co-mingled contamination is found during waste characterization sampling/analysis; chemical contaminants would be disposed of by transfer to a properly permitted off-site disposal facility. UXO-qualified personnel will provide the required equipment and instruments as necessary to properly address any UXO encountered during remediation in accordance with Engineer Pamphlet EP 75-1-2, *Unexploded Ordnance*

(UXO) Support During Hazardous, Toxic, and Radioactive Waste (HTRW) and Construction Activities (USACE 2000). All waste transport for off-site disposal would be compliant with existing DOT regulations.

Estimated Implementation Timeframe: It would take 675 days to implement Alternative 3.

Estimated Time to Achieve RAOs: It would take 675 days to achieve RAOs.

Cost: The estimated total 30-year cost of Alternative 3 is $51,547,000. The total cost differs from the PP due to arithmetic error in the PP. The capital costs are estimated at $50,295,400 and the total O&M costs are estimated to be $1,251,800. The present worth of this alternative is $45,985,300 at a 7 percent discount rate.

Alternative 3 Cost Summary	
Capital Cost	$50,295,375
O&M Cost	$1,251,777
Total Cost (30 years)[1]	$51,547,151
Present Worth Cost (7.0% discount factor)	$45,985,254

[1] Total Cost for Alternative 3 differs from PP due to arithmetic error in the PP.

Expected Outcome: Alternative 3 would achieve the industrial RG for DU and therefore would provide a high degree of overall protection of human health and the environment. Continued industrial land use would prevent unauthorized and/or inappropriate use of the site and would be verified through the five-year review process. Soil that does not meet the RG would be placed in a properly permitted off-site disposal facility that would provide for protective management and appropriate monitoring of potential releases of any residual contaminants.

2.9.4 Alternative 4, Excavation of Depleted Uranium Contaminated Soil with Physical Treatment and Off-Site Disposal

Alternative 4 involves removal of DU-contaminated soil by excavation, treatment using physical treatment technologies (e.g., soil sorting and radiological scanning), and off-site disposal. An on-site pilot-scale demonstration of the physical treatment technology would be conducted prior to full-scale remediation activities to refine the design of the system. Waste characterization sampling would be performed to determine the proper disposition of the waste. Soil exceeding the DU RG would be disposed of in a permitted off-site disposal facility. Alternative 4 also includes five-year reviews during which industrial land use would be verified. Continued industrial land use would be supported by use restrictions and outgrants administered by the U.S. Army as part of its land management responsibilities.

Remedy Components:

- Excavation: Surface and subsurface soil would be excavated to an estimated depth of 2 ft at those areas where soil concentrations exceed the industrial RG for DU. These areas are: Firing Sites 1 and 2; Firing Sites 3, 4, and 5; the Firing Site 6 Area; and the Firing Site 12 Area. No excavation activities would be required at Yards C, G, and L and Firing Site 14. The estimated total volume of soil that would be excavated is 16,941 in-situ CY. The excavated materials would be staged at a soil staging area prior to treatment and/or loading unto long-haul trucks or similar for off-site disposal. Below-grade structural surfaces that become exposed during soil excavation at the FSA would be surveyed for the presence of DU-contaminated soil. If DU-contaminated soil is found adhered to these surfaces, the structural surface would be decontaminated. If the structural surface cannot be decontaminated, the surface would be sealed and abandoned with land use controls or demolished and removed without replacement.

- Physical Treatment: Under Alternative 4, approximately 22,023 ex-situ CY of DU-contaminated material excavated from the FSA would be treated using physical treatment technologies (e.g., soil sorting and radiological scanning). The soil sorting method that would be used at the IAAAP includes a radionuclide detecting system capable of analyzing and separating soil based on specific radionuclide criteria. The effectiveness of soil sorting is influenced by the types of soil to be treated, the levels of radioactivity present, the moisture content of the soil, and the particle sizes of the soil itself. The Clinton silt loam and Clinton silty clay loam encountered at the Firing Site 12 Area (which represent the majority of soil to be remediated under this alternative) consist of a high percentage (>95 percent) of fine-grained particles, of which between 16 to 42 percent is clay-sized material (Natural Resources Conservation Service 2009). The estimated average volume reduction expected for this type of soil is 20 percent based on the results of studies on similar fine-grained soil [Idaho National Engineering and Environmental Laboratory (INEEL) 1999; Sandia National Laboratories 1999]. Materials meeting the DU RG may be used as backfill, as appropriate. Costs associated with an on-site pilot-scale demonstration of the soil sorting technology are included as a precursor to full-scale remediation activities.
- Off-Site Disposal: Soil exceeding the industrial RG would be disposed of by transfer to a properly permitted off-site disposal facility. Approximately 17,616 ex-situ CY of DU-contaminated soil would be shipped off-site for disposal. Transportation of contaminated soil and debris would use DOT-approved “super sacks,” specially lined dump trucks, rail cars, or inter-model containers.
- Final Status Survey Evaluation: Post excavation soil samples and gamma walkover surveys would be collected using MARSSIM (DoD 2000) based protocols to confirm that the remaining soil achieves the DU RG.
- Site Restoration: Backfilling of excavated areas with soil meeting the DU RG, grading, re-vegetation, and temporary storage are included.
- Five-Year Reviews: CERCLA 121(c) Five-year reviews are required under this alternative for FUSRAP areas that exceed UUUE. Industrial land use will be verified during each five-year review.

ARARs: The key chemical-specific ARARs for Alternative 4 are 10 *CFR* §20.1403(b) and (e).

- Alternative 4 would comply with 10 *CFR* §20.1403(b). Implementation of Alternative 4 would achieve a dose rate that limits the annual dose to an average member of the critical group to 25 mrem/yr.
- Alternative 4 would meet the restricted release conditions given in 10 *CFR* 20.1403(e), which require that the annual dose to an average member of the critical group not exceed 100 mrem/yr if land use controls are no longer present.

Alternative 4 also would comply with the following location- and action-specific ARARs:

- Endangered Species Act: 16 U.S.C §1538(a)(1): A federally listed endangered species, the Indiana bat, may be found as a transient species within the FUSRAP areas of the IAAAP. Therefore, these requirements are location-specific ARARs for Alternative 4. Alternative 4 is not expected to impact the habitat used by the Indiana bat. Some noise disturbance due to construction activities is likely to occur, but it is not expected to disturb the Indiana bat during critical periods of roosting.

- Radiation Protection Programs, 10 *CFR* §20.1101(d): Alternative 4 will limit air emissions of radioactive material to the environment, excluding Radon-222 and its daughters, such that the highest individual dose to the public will not exceed 10 mrem (0.1 mSv) per year.

Long-term Reliability of Remedy: Alternative 4 is reliable in the long-term. Surface and subsurface soil would be excavated at those areas where soil concentrations exceed the industrial RG for DU and continued industrial land use would prevent unauthorized and/or inappropriate use of the site. Industrial land use would be verified through the five-year review process.

Untreated Waste or Treatment Residuals Requiring Disposal or Containment: Approximately 17,616 ex-situ CY of DU-contaminated soil would require off-site disposal. Wastes containing source materials exceeding 165 pCi/g U-238 are classified as Class A LLRW. Such wastes would be disposed of by transfer to an NRC- or a state-licensed LLRW disposal facility. Given the industrial soil RG of 150 pCi/g for DU, it is assumed that most soil exceeding the RG would be disposed of by transfer to a Class A LLRW disposal site.

In general, the RI sampling does not indicate that chemical contamination or UXO is co-mingled with the DU. However, if co-mingled contamination is found during waste characterization sampling/analysis; chemical contaminants would be disposed of by transfer to a properly permitted off-site disposal facility. UXO-qualified personnel would provide the required equipment and instruments as necessary to properly address any UXO encountered during remediation in accordance with Engineer Pamphlet EP 75-1-2 (USACE 2000). All waste transport for disposal would be off-site compliant with existing DOT regulations.

Estimated Implementation Timeframe: It would take 675 days to implement Alternative 4.

Estimated Time to Achieve RAOs: It would take 675 days to achieve RAOs.

Cost: The estimated total 30-year cost of Alternative 4 is $45,172,000. The capital costs are estimated at $44,029,200 and the total O&M costs are estimated to be $1,142,900. The present worth of this alternative is $40,275,500 at a 7 percent discount rate.

Alternative 4 Cost Summary	
Capital Cost	$44,029,169
O&M Cost	$1,142,864
Total Cost (30 years)	$45,172,033
Present Worth Cost (7.0% discount factor)	$40,275,497

Expected Outcome: Alternative 4 would achieve the industrial RG for DU and therefore would provide a high degree of overall protection of human health and the environment. Continued industrial land use would prevent unauthorized and/or inappropriate use of the site and would be verified through the five-year review process. Soil that does not meet the RG would be placed in a properly permitted off-site disposal facility that would provide for protective management and appropriate monitoring of potential releases of any residual contaminants.

2.9.5 Alternative S1, No Action for Structures

Alternative S1, No Action for Structures, provides a baseline to compare with the other remedial alternatives and is required by the NCP [40 *CFR* §300.430(e)(6)].

Remedy Components: This alternative assumes that no response actions would be implemented to address contaminated structures at the FUSRAP areas. The contaminated structures would be left in place, the existing land use controls (e.g., use restrictions and outgrants administered by the U.S. Army as part of its land management responsibilities) would not be maintained, and no additional measures would be implemented to control exposures to the contaminated structures.

ARARs: The key chemical-specific ARARs for Alternative S1 are 10 *CFR* §20.1403(b) and (e).

- Alternative S1 would not comply with 10 *CFR* §20.1403(b). It does not achieve a dose rate that limits the annual dose to an average member of the critical group to 25 mrem/yr.
- Alternative S1 would not meet the restricted release conditions given in 10 *CFR* 20.1403(e), which require that the annual dose to an average member of the critical group not exceed 100 mrem/yr if land use controls are no longer present. Alternative S1 also would not comply with the requirement that the remedy achieve doses that are ALARA.

There are no location- or action-specific ARARs considered under Alternative S1.

Long-term Reliability of Remedy: Alternative S1 includes no long-term measures to prevent exposures or spread of contamination. Although existing controls (e.g., use restrictions and outgrants administered by the U.S. Army as part of its land management responsibilities) could provide limited control over exposure to DU, this alternative assumes that controls would not be maintained and provides no additional controls to prevent exposure to contaminants.

Untreated Waste or Treatment Residuals Requiring Disposal or Containment: No wastes or residuals would be generated under Alternative S1.

Estimated Implementation Timeframe: This element is not applicable to Alternative 1 because no remediation activities would be implemented.

Estimated Time to Achieve RAOs: Alternative S1 would not achieve RAOs.

Cost: There are no costs for Alternative S1.

Expected Outcome: Because no actions would be taken, the risks from direct contact, ingestion, and inhalation would continue and could increase because current access control measures would not be maintained. The potential for human exposure to DU-contaminated structures and the potential for off-site migration could increase over time as a result of disturbances by humans and natural processes.

2.9.6 Alternative S2, Land Use Controls for Structures

Alternative S2 includes the use of land use controls for IAAAP structures at the FUSRAP areas and would be protective as long as the controls are in place. This alternative involves leaving contamination in place above the industrial RG. It would impose additional land use controls to reduce the potential for exposures to DU-contaminated structures. Alternative S2 was developed to allow comparison of a complete range of alternatives in the FS.

Remedy Components:

- Land Use Controls: Additional land use controls that would be implemented under this alternative include restricted use of structures or establishment of no-entry zones. Several land use controls are already in place at the IAAAP, including use restrictions and outgrants administered by the U.S. Army as part of its land management responsibilities.

- Five-Year Reviews: Five-year reviews would be conducted in accordance with CERCLA 121(c) for areas where contaminants are left above levels acceptable for UUUE. Industrial land use will be verified during each five-year review.

ARARs: The key chemical-specific ARARs for Alternative S2 are 10 *CFR* §20.1403(b) and (e).

- Alternative S2 would comply with 10 *CFR* §20.1403(b). Implementation of land use controls would achieve a dose rate that limits the annual dose to an average member of the critical group to 25 mrem/yr.
- Alternative S2 would not meet the restricted release conditions given in 10 *CFR* 20.1403(e), which require that the annual dose to an average member of the critical group not exceed 100 mrem/yr if land use controls are no longer present. Inability to meet the threshold criteria of compliance with ARARs is a significant problem with this alternative.

There are no location- or action-specific ARARs for Alternative S2.

Long-term Reliability of Remedy: Alternative S2 is reliable for the long term if land use controls are properly maintained and enforced.

Untreated Waste or Treatment Residuals Requiring Disposal or Containment: No wastes or residuals would be generated under Alternative S2.

Estimated Implementation Timeframe: Land use controls could be implemented in less than 1 year.

Estimated Time to Achieve RAOs: Alternative S2 would achieve RAOs immediately upon implementation of land use controls.

Cost: The estimated total 30-year cost of Alternative S2 is $249,000. The total cost differs from the PP due to arithmetic error in the PP. The capital costs are estimated at $15,370 and the total O&M costs are estimated to be $233,630. The present worth of this alternative is $144,720 at a 7 percent discount rate.

Alternative S2 Cost Summary	
Capital Cost	$15,373
O&M Cost	$233,629
Total Cost (30 years)[1]	$249,002
Present Worth Cost (7.0% discount factor)	$114,722

[1] Total Cost for Alternative S2 differs from PP due to arithmetic error in the PP.

Expected Outcome: Under Alternative S2, industrial land use would continue. Existing land use controls (including use restrictions and outgrants administered by the U.S. Army as part of its land management responsibilities) would continue. The remedial action would attain acceptable risk levels through the implementation and maintenance of additional land use controls to eliminate or reduce exposures to DU-contaminated structures. Continued industrial land use would be verified through the five-year review process.

2.9.7 Alternative S3, Decontamination/Replacement of Structures

Alternative S3 involves physical decontamination of DU-contaminated structural surfaces and/or replacement of structural components. The RG for these structural surfaces is 23,000 disintegrations per minute per 100 square centimeters (dpm/100 cm^2). Alternative S3 also includes five-year reviews during which industrial land use would be verified. Continued industrial land use would be supported by use restrictions and outgrants administered by the U.S. Army as part of its land management responsibilities.

Remedy Components:

- Physical Decontamination: DU-contaminated surfaces, such as the steel floor grate covering the sump at the Line 1 Building 1-11, would be decontaminated using high pressure water methods and allowed to dry. Areas would be radiologically surveyed to document the residual radioactivity. If found to be above the industrial RG for structural surfaces, then additional decontamination methods would be employed including high pressure water with detergent cleansers, grit blasting, or scabbling until residual radioactivity meets the industrial RG.
- Replacement: Under this alternative, the contaminated air filter at Line 1 Building 1-63-6 would be removed and replaced. The steel floor grate covering the sump at the Line 1 Building 1-11 would be decontaminated and, if methods fail to successfully decontaminate the grate, it would also be replaced. Structural components (such as the air filters) that are contaminated with DU would be disposed of in a method consistent with DU-contaminated soil.
- Final Status Survey Evaluation: Post remedial action radiological surveys would be conducted using MARSSIM (DoD 2000) based protocols to confirm that the structures achieve the DU RG.
- Five-Year Reviews: CERCLA 121(c) Five-year reviews are required under this alternative for FUSRAP structures that exceed UUUE. Industrial land use will be verified during each five-year review.

ARARs: The key chemical-specific ARARs for Alternative S3 are 10 *CFR* §20.1403(b) and (e).

- Alternative S3 would comply with 10 *CFR* §20.1403(b). Implementation of Alternative S3 would achieve a dose rate that limits the annual dose to an average member of the critical group to a maximum of 25 mrem/yr.
- Alternative S3 would comply with the restricted release conditions given in 10 *CFR* 20.1403(e), which require that the annual dose to an average member of the critical group not exceed 100 mrem/yr if land use controls are no longer present.

There are no location- or action-specific ARARs for Alternative S3.

Long-term Reliability of Remedy: Alternative S3 would permanently reduce the levels of residual radioactivity on structural surfaces. It also would reduce the amount of material (e.g., equipment, construction, and related debris) requiring further treatment or disposal.

Untreated Waste or Treatment Residuals Requiring Disposal or Containment: Waste generated under Alternative S3 includes structural material and components that are contaminated with DU above the RG and decontamination water. Decontamination activities at outdoor locations may temporarily create nonpoint source surface-water discharges; all of these impacts would be managed in compliance with the substantive requirements of applicable laws and regulations. The decontamination water would be treated with the storm water collected and treated at the soil staging area. Structures that are contaminated with DU would be disposed of in a method consistent with DU contaminated soil.

Estimated Implementation Timeframe: It would take less than 1 year to implement Alternative S3.

Estimated Time to Achieve RAOs: It would take less than 1 year to achieve RAOs.

Cost: The estimated total 30-year cost of Alternative S3 is $102,960. The capital costs are estimated at $30,500 and the total O&M costs are estimated to be $72,460. The O&M costs consist of project management costs and the costs for preparing six five-year reviews over the 30 year costing period. The present worth of this alternative is $58,477 at a 7 percent discount rate.

Alternative S3 Cost Summary	
Capital Cost	$30,500
O&M Cost	$72,461
Total Cost (30 years)	$102,961
Present Worth Cost (7.0% discount factor)	$ 58,477

Expected Outcome: Alternative S3 would achieve the RG for DU on structures and therefore would provide a high degree of overall protection of human health and the environment. Structural components that do not meet the RG would be placed in a properly permitted off-site disposal facility that would provide for protective management and appropriate monitoring of potential releases of any residual contaminants. Continued industrial land use would prevent inappropriate use of structures and would be verified through the five-year review process.

2.10 COMPARATIVE ANALYSIS OF THE ALTERNATIVES

This section of the ROD summarizes the comparative analysis of alternatives presented in the detailed analysis section of the FS Report. First, a descriptive summary of each of the nine criteria is presented. Then, an explanation of how each of the alternatives compare to each other relative to each criterion is presented.

2.10.1 Summary of the CERCLA Criteria

The remedial alternatives have undergone detailed comparative analysis using the nine CERCLA criteria discussed in the following paragraphs. The comparative analysis provides a means by which remedial alternatives can be directly compared to one another with respect to common criteria.

2.10.1.1 Threshold Criteria

Overall protection of human health and the environment and compliance with ARARs are "threshold criteria" that any remedial alternative must meet before being considered for implementation.

- ***Overall Protection of Human Health and the Environment –*** describes how the alternative, as a whole, achieves and maintains protection of human health and the environment. Overall protectiveness is based largely on the degree of confidence that a remedy can achieve and maintain media-specific cleanup goals or reduce the potential for human exposure.
- ***Compliance with ARARs –*** addresses whether a remedy would meet the site ARARs. Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility siting laws that specifically address a hazardous

substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those State standards that are identified by a state in a timely manner and that are more stringent than Federal requirements may be applicable. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only those State standards that are identified by a state in a timely manner and that are more stringent than Federal requirements may be relevant and appropriate.

2.10.1.2 Primary Balancing Criteria (identifies major trade-offs among alternatives)

Long-term effectiveness, reduction of toxicity, mobility, or volume through treatment, short-term effectiveness, implementability, and cost are referred to as "balancing criteria." These represent the primary selection criteria for alternatives determined to be protective of human health and the environment and in compliance with ARARs.

- ***Long-Term Effectiveness and Permanence –*** addresses residual risk (i.e., risk remaining after implementation of the alternative) and the ability of an alternative to protect human health and the environment over time once RGs have been met.
- ***Short-Term Effectiveness and Environmental Impacts –*** addresses 1) the impacts to the community and site workers during remediation including the amount of time required to achieve RGs and 2) the environmental effects of implementing the remedial action.
- ***Reduction of Toxicity, Mobility, or Volume through Treatment –*** addresses 1) the ability of the alternative to reduce the volume, toxicity, or mobility of the waste and 2) the irreversibility of the treatment process and the type and quantity of residuals remaining after treatment.
- ***Implementability –*** addresses the technical and administrative feasibility of an alternative, including the availability of materials and services required for remediation. Technical feasibility assesses the ability to construct and operate a technology, the reliability of the technology, the ease in undertaking additional remedial actions, and the ability to monitor the effectiveness of the alternative. Administrative feasibility is addressed in terms of the ability to obtain approval from federal and state agencies and the degree of difficulty in implementation of land use controls and institutional controls.
- ***Cost –*** compares the differences in cost, including capital, operation, and maintenance costs.

2.10.1.3 Modifying Criteria

Finally, the remedial alternatives are evaluated against the two modifying criteria described below on the basis of comments received during the public comment period for the FS and PP.

- ***State Acceptance –*** an evaluation of whether the State agrees with, opposes, or has no comment on the preferred alternative.
- ***Community Acceptance –*** addresses the public's issues and concerns regarding each of the alternatives.

2.10.2 Comparison of the Alternatives Using the CERCLA Criteria

During the FS process, the alternatives were evaluated against the two Threshold Criteria and the five Primary Balancing Criteria. A summary of the results of this comparative analysis for the four alternatives for soil and the three alternatives for structures are presented in Table 2-6 and Table 2-7, respectively. The evaluation against the two modifying criteria (State and Community Acceptance) was conducted at completion of the public comment period and is summarized in Section 2.10.2.8.

2.10.2.1 Overall Protection of Human Health and the Environment

On the basis of the detailed evaluation, each of the soil alternatives, except Alternative 1, is protective of human health. Alternatives 3 and 4 provide the greatest long-term protection to human health because soil is removed to achieve the DU RG. Alternatives 1 and 2 result in the highest levels of contamination remaining on-site. For Alternatives 2, 3, and 4, human health is protected as long as land use remains industrial.

Each of the remedial alternatives for structures, except Alternative S1, is protective of human health. Alternative S3 (decontamination/replacement of structures) provides the greatest overall protection to human health and the environment because contamination on structural surfaces is removed. Alternative S2 involves the use of land use controls and is effective in reducing potential human exposure to DU-contaminated structures through access restrictions. Alternative S1 does not prevent potential exposures to contaminated structures.

2.10.2.2 Compliance with ARARs

Section 121(d) of CERCLA and the NCP [40 *CFR* 300.430(f)(1)(ii)(B)] require that remedial actions at CERCLA sites at least attain legally applicable or relevant and appropriate Federal and State requirements, standards, criteria, and limitations which are collectively referred to as "ARARs", unless such ARARs are waived under CERCLA section 121(d)(4). (See Section 2.10.1 for additional explanation of ARARs.) Compliance with ARARs addresses whether a remedy will meet all of the applicable or relevant and appropriate requirements of other Federal and State environmental statutes or provides a basis for invoking a waiver.

The ARARs for each of the remedial alternatives are listed in Section 2.9.

Alternatives 3 and 4 comply with all ARARs. Alternatives 3 and 4 meet the provisions for restricted use defined in 10 *CFR* 20.1403(b) and (e). Alternatives 1 and 2 do not comply with chemical-specific ARARs.

Alternative S3 (decontamination/replacement of structures) complies with ARARs. It would reduce potential future doses below the 25-mrem/yr level. The two remaining remedial alternatives for structures, S1 (no action) and S2 (land use controls), do not comply with ARARs.

2.10.2.3 Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence addresses the expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup levels have been met.

Table 2-6. Summary of Detailed Analysis of Alternatives for Soil

Criteria	Alternative 1: No Action for Soil	Alternative 2: Land Use Controls for Soil	Alternative 3: Excavation of Depleted Uranium Contaminated Soil with Off-Site Disposal	Alternative 4: Excavation of Depleted Uranium Contaminated Soil with Physical Treatment and Off-Site Disposal
Overall Protection				
Human Health	Not protective.	Protective. Land use controls provide protectiveness.	Protective. Removal of DU-contaminated soil provides protectiveness.	Protective. Removal of DU-contaminated soil provides protectiveness.
Environment	Protective.	Protective.	Protective.	Protective.
Compliance With ARARs				
Chemical-Specific	Not compliant.	Not compliant. Does not achieve the restricted release conditions given in 10 *CFR* 20.1403.	Compliant.	Compliant.
Action-Specific	NA.	NA.	Compliant.	Compliant.
Location-Specific	NA.	NA.	Compliant.	Compliant.
Long-Term Effectiveness and Permanence				
Magnitude of Remaining Risk	Medium. Residual risk exceeds USEPA risk range due to waste remaining in current configuration, thereby allowing for potential exposure.	Medium. Land use controls would limit exposures to residual contamination for current anticipated land uses.	Low. Remaining risks at the FUSRAP areas are below industrial land use standards.	Low. Remaining risks at the FUSRAP areas are below industrial land use standards.
Adequacy of Controls	None provided.	Good. Long-term expected use as military installation.	Very good – limited areas require long-term controls.	Very good – limited areas require long-term controls.
Reliability of Controls	None provided.	Land use controls are reliable over the long term under continued industrial land use.	Land use controls are reliable over the long term under continued industrial land use.	Land use controls are reliable over the long term under continued industrial land use.
Long-Term Management	None provided.	Five-year review, maintenance of existing installation land use controls, and implementation of additional land use controls at FUSRAP areas.	Continued industrial land use, along with five-year reviews, during which industrial land use would be verified.	Continued industrial land use, along with five-year reviews, during which industrial land use would be verified.

Table 2-6. Summary of Detailed Analysis of Alternatives for Soil (Continued)

Criteria	Alternative 1: No Action for Soil	Alternative 2: Land Use Controls for Soil	Alternative 3: Excavation of Depleted Uranium Contaminated Soil with Off-Site Disposal	Alternative 4: Excavation of Depleted Uranium Contaminated Soil with Physical Treatment and Off-Site Disposal
Reduction of Toxicity, Mobility, or Volume Through Treatment				
Reduction of Toxicity, Mobility, or Volume	None.	None.	None.	Volume of soil requiring disposal would be reduced by approximately 20 percent by physical treatment (soil sorting and radiological scanning).
Short-Term Effectiveness				
Protection of Community	No additional short-term risk to community due to no action taken.	No additional short-term risk to community.	Slight potential for an increase in short-term risk from excavation and transportation activities. However, risks could be controlled by mitigative measures.	Slight potential for an increase in short-term risk from excavation, treatment, and transportation activities. However, risks could be controlled by mitigative measures.
Protection of Site Workers	No additional short-term occupational risk to site workers.	No additional short-term occupational risk to site workers.	Short-term occupational risk to site workers from excavation and transportation activities could be reduced by mitigative measures.	Short-term occupational risk to site workers from excavation, treatment, and transportation activities could be reduced by mitigative measures.
Environmental Impacts	No additional impacts in the short-term.	No additional short-term impacts to ecosystem.	Short-term impacts to ecosystem. Long-term benefit.	Short-term impacts to ecosystem. Long-term benefit.
Time until RAOs are achieved	RAOs would not be achieved.	Less than 1 year.	675 days.	675 days.
Implementability				
Technical Feasibility	Feasible.	Feasible.	Feasible.	Feasible.
• Ability to construct and operate.	No construction or operation.	Land use controls are generally easy to implement.	Would be easily implemented. Uses common methods for excavation and off-site disposal.	Would be easily implemented. Uses common methods for excavation, treatment, and off-site disposal.
• Availability of equipment, specialists, and materials.	None required.	No special equipment, materials, or specialists required.	Aside from mitigative measures needed to reduce short-term site worker exposures to DU during excavation and transportation activities, no special equipment, materials, or specialists required to conduct excavation and off-site disposal.	Aside from mitigative measures needed to reduce short-term site worker exposures to DU during excavation and transportation activities, no special equipment, material, or specialists required to conduct excavation, treatment and off-site disposal.

Table 2-6. Summary of Detailed Analysis of Alternatives for Soil (Continued)

Criteria	Alternative 1: No Action for Soil	Alternative 2: Land Use Controls for Soil	Alternative 3: Excavation of Depleted Uranium Contaminated Soil with Off-Site Disposal	Alternative 4: Excavation of Depleted Uranium Contaminated Soil with Physical Treatment and Off-Site Disposal
Implementability (Continued)				
• Ease of doing more action if needed. • Ability to monitor effectiveness.	NA. No monitoring.	Easy to implement additional land use controls. Five-year review process will monitor effectiveness of land use controls.	Can easily handle additional volumes. Five-year review process will monitor continued industrial land use.	Can easily handle additional volumes. Five-year review process will monitor continued industrial land use.
Administrative Feasibility • Ability to obtain approvals and coordinate with other agencies.	Feasible. No coordination required, but unlikely to be approved.	Feasible. No administrative problems are anticipated for implementing land use controls.	Feasible. There would be administrative challenges in coordinating remediation activities at the FSA, due to its use as an operational range.	Feasible. There would be administrative challenges in coordinating remediation activities at the FSA, due to its use as an operational range.
Cost				
Capital Cost	$0	$244,200	$50,295,400	$44,029,200
O&M Cost	$0	$1,870,500	$1,251,800	$1,142,900
Total Cost	$0	$2,114,700[1]	$51,547,200[1]	$45,172,000
Present Worth Cost	$0	$1,111,100	$45,985,300	$40,275,500
State and Community Acceptance				
State Acceptance	Not Acceptable.	Not Acceptable. Not a permanent solution.	Acceptable.	Acceptable.
Community Acceptance	Not Acceptable.	Not Acceptable.	Acceptable.	Acceptable.

NA = Not applicable
[1] Total Cost for Alternatives 2 and 3 differ from PP due to arithmetic error in the PP.

Table 2-7. Summary of Detailed Analysis of Alternatives for Structures

Criteria	Alternative S1: No Action for Structures	Alternative S2: Land Use Controls for Structures	Alternative S3: Decontamination/ Replacement of Structures
Overall Protection			
Human Health	Not protective.	Protective. Land use controls provide protectiveness.	Protective. Decontamination or removal and replacement of structural components as necessary will reduce or eliminate potential exposures to radiological contamination.
Environment	Protective.	Protective.	Protective.
Compliance With ARARs			
Chemical-Specific	Not compliant.	Not compliant. Does not achieve the restricted release conditions given in 10 *CFR* 20.1403.	Compliant.
Action-Specific	NA.	NA.	NA.
Location-Specific	NA.	NA.	Compliant.
Long-Term Effectiveness and Permanence			
Magnitude of Remaining Risk	Medium. Residual risk exceeds USEPA risk range due to waste remaining in current configuration, thereby allowing for potential exposure.	Low. Land use controls would limit exposures to residual contamination for current anticipated land uses.	Very low to none. Decontamination is expected to reduce radiological surface contamination to background levels. Removal and replacement would also eliminate radiological risk.
Adequacy of Controls	None provided.	Good. Long-term expected use as military installation.	Very good. No additional controls would be needed for structures.
Reliability of Controls	None provided.	Very reliable.	Very reliable.
Long-Term Management	None provided.	Continued industrial land use, along with five-year reviews, during which industrial land use would be verified, and implementation of additional land use controls at FUSRAP areas.	Continued industrial land use, along with five-year reviews, during which industrial land use would be verified.
Reduction of Toxicity, Mobility, or Volume Through Treatment			
Reduction of Toxicity, Mobility, or Volume	None.	None.	None.

Table 2-7. Summary of Detailed Analysis of Alternatives for Structures (Continued)

Criteria	Alternative S1: No Action for Structures	Alternative S2: Land Use Controls for Structures	Alternative S3: Decontamination/ Replacement of Structures
Short-Term Effectiveness			
Protection of Community	No additional short-term risk to community due to no action taken.	No additional short-term risk to community.	Slight potential for an increase in short-term risk from construction and transportation activities. However, risks could be controlled by mitigative measures.
Protection of Site Workers	No additional short-term occupational risk to site workers.	No additional short-term occupational risk to site workers.	Radiological risks to site workers could be reduced by mitigative measures.
Environmental Impacts	No additional impacts in the short-term due to no action taken.	No additional short-term impacts to ecosystem.	No short-term or long-term impacts. Long-term benefit.
Time until RAOs are achieved	RAOs would not be achieved.	Less than 1 year.	Less than 1 year.
Implementability			
Technical Feasibility	Feasible.	Feasible.	Feasible.
• Ability to construct and operate.	No construction or operation.	Land use controls are generally easy to implement.	Easy to implement.
• Availability of equipment, specialists, and materials.	None required.	No special equipment, material, or specialists required.	Decontamination equipment and trained personnel are readily available.
• Ease of doing more action if needed.	NA.	Easy to implement additional controls.	Can easily handle additional structural materials if needed.
• Ability to monitor effectiveness.	No monitoring.	Five-year review process ensures that the land use controls continue to be effective.	Five-year review process verifies continued industrial use.
Administrative Feasibility • Ability to obtain approvals and coordinate with other agencies.	Feasible. No coordination required, but unlikely to be approved.	Feasible. No administrative problems are anticipated.	Feasible. No administrative problems are anticipated.
Cost			
Capital Cost	$0	$15,400	$30,500
O&M Cost	$0	$233,600	$72,500
Total Cost	$0	$249,000[1]	$103,000
Present Worth Cost	$0	$114,700	$ 58,500
State and Community Acceptance			
State Acceptance	Not Acceptable.	Not Acceptable. Not a permanent solution.	Acceptable.
Community Acceptance	Not Acceptable.	Not Acceptable.	Acceptable.

NA = Not applicable
[1] Total Cost for Alternative S2 differs from PP due to arithmetic error in the PP.

Each alternative, except the no action alternatives (Alternatives 1 and S1), provide some degree of long-term protection. Alternatives 3 and 4 are the most effective and permanent soil remedies because they involve removal of DU-contaminated soil from the site to achieve the RG. Industrial land use would continue to maintain reliable protection of human health. Alternative 2, which relies solely on land use controls to reduce exposures, has a lesser degree of long-term effectiveness and permanence than remedies that remove DU contamination from the site. The least permanent soil alternative is Alternative 1 because contaminated soil would not be removed or treated and no additional land use controls would be implemented.

The most permanent alternative for structures is Alternative S3. DU-contamination on surfaces would be removed to levels below the RG. Alternatives S1 and S2 for structures are less permanent and effective because DU-contaminated surfaces would not be decontaminated or removed.

2.10.2.4 Reduction of Volume, Toxicity, or Mobility Through Treatment

Reduction of toxicity, mobility or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy.

Alternative 4 provides a reduction in contaminant volume through treatment. Physical treatment (e.g., soil sorting and radiological scanning) could reduce the overall volume of soil (by approximately 20 percent) requiring disposal. Using treatment to achieve contaminant levels acceptable for disposal at a solid or hazardous waste disposal facility would reduce the volume of material requiring disposal at the LLRW facility. The remaining alternatives for soil and structures do not use treatment to reduce the toxicity, mobility, or volume of contaminants at the site.

2.10.2.5 Short-Term Effectiveness

Short-term effectiveness addresses the effects of the alternative during the construction and implementation phase until RAOs are met. Under this criterion, alternatives are evaluated with respect to the following factors: (1) protection of the community during remedial actions, (2) protection of workers during remedial actions, (3) environmental impacts, and (4) time until RAOs are achieved.

Among the alternative for soil, Alternatives 1 and 2 provide the highest short-term effectiveness because no remedial activities would be conducted that have the potential to impact the health and safety of workers, the surrounding communities, or the environment. Alternatives 3 and 4 include the excavation and disposal of contaminated soil off-site and therefore, have increased short-term risks to the workers conducting the excavation, transport, and disposal activities. Worker safety could be managed using appropriate personal protection and safety measures. Off-site migration of airborne contaminants could be minimized by using dust suppression controls and monitoring. Short-term risks to the public as a result of airborne contamination would be minimal under Alternatives 3 and 4.

Short-term negative impacts to the environment may occur as a result of soil excavation conducted for Alternatives 3 and 4. Excavation potentially destroys animals and plants at the location, potentially destroys habitat or food available to animals at the location, and may temporarily create nonpoint source surface-water discharges. All of these impacts would be managed in compliance with the substantive requirements of applicable laws and regulations and, therefore, are not considered to be significant obstacles to the implementation of these remedial alternatives. Alternatives 3 and 4 are also not expected to impact the habitat used by the

Indiana bat. Some noise disturbance due to construction activities is likely to occur, but it is not expected to disturb the Indiana bat during critical periods of roosting.

Alternatives S1 and S2 would not involve any remedial actions; therefore, there would be no short-term impacts to workers or to the environment. Alternative S3 would involve some short-term risks associated with worker safety during decontamination activities. Worker safety would be managed in compliance with the substantive requirements of applicable laws and regulations and using appropriate personal protection and safety measures.

2.10.2.6 Implementability

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are considered.

All four remedial alternatives for soil are technically feasible to implement. Alternative 1 is the easiest alternative to implement from a technical standpoint, while Alternative 2 is rated higher than the remaining alternatives in implementability because no active remediation would be required. Alternatives 3 and 4 are rated lower in technical implementability due to the technical difficulties that are associated with the excavation, treatment (Alternative 4 only), transportation, and disposal of soil and the time/coordination involved in implementing these alternatives. There would be a slightly higher degree of difficulty in implementing Alternative 4 due to the additional technical requirements for conducting the treatment activities.

Alternative 2 involves the implementation of additional land use controls and so is administratively more complex than the other alternatives. However, no significant difficulties are anticipated in implementing and obtaining approvals for the land use controls so it is rated highest in administrative implementability. The administrative implementability of Alternative 1 is rated low as it is likely that there would be difficulties in obtaining approval of a no action alternative from the regulatory agencies. Alternatives 3 and 4 are also rated low in administrative implementability because they involve the remediation of DU-contaminated soil at the FSA. There is limited access to the FSA (particularly the Firing Site 6 Area) because it is an operational range. There could be administrative challenges in scheduling and coordinating remediation activities to avoid causing significant delays or cancelation of essential operational range activities. Disposal of wastes at a properly permitted off-site facility is considered implementable.

All three remedial alternatives for structures are technically feasible. Alternatives S1 and S2 are the easiest to implement because no active remediation is performed. Although Alternative S3 has a slightly higher degree of difficulty, it is highly implementable. The materials and services for removal of surface contamination as part of Alternative S3 are readily available.

2.10.2.7 Cost

The estimated costs are based on historical costs incurred in previous FUSRAP actions, quotes from suppliers, generic unit costs, vendor information, conventional cost-estimating guides, and other information. The cost estimates were developed in Fiscal Year 2010 dollars, and are believed to be accurate within a range between minus 30 percent and plus 50 percent of actual costs. The actual costs for these actions could be higher than estimated because of unexpected site conditions and the potential for delays in taking action. The cost estimates include a 30-year performance period for ongoing actions, such as monitoring and maintenance. Costs for each alternative, itemization of individual components, and the sensitivity analysis for each alternative may be found in Appendix E of the FS Report. The present worth cost for the alternatives are provided in Table 2-8. The least expensive soil alternative is Alternative 1 (No Action), followed by Alternatives 2 and 4, with Alternative 3 being the most expensive. The least expensive structure alternative is Alternative S1 (No Action), followed by Alternative S3, with Alternative S2 being the most expensive.

Table 2-8. Present Worth Costs for the Remedial Alternatives

Alternative	Present Worth Cost
Alternatives for Soil	
1. No Action for Soil	$0
2. Land Use Controls for Soil	$1,111,087
3. Excavation of Depleted Uranium Contaminated Soil with Off-Site Disposal	$45,985,254
4. Excavation of Depleted Uranium Contaminated Soil with Physical Treatment and Off-Site Disposal	$40,275,497
Alternatives for Structures	
S1. No Action for Structures	$0
S2. Land Use Controls for Structures	$114,722
S3. Decontamination/Replacement of Structures	$58,477

2.10.2.8 State and Community Acceptance

The evaluation of State and Community Acceptance was completed after the close of the public comment period on the PP (USACE 2011a). A list of the submitted comments and USACE's responses are contained in the Responsiveness Summary (Section 3.0 of this document). USACE has taken State and Community recommendations into consideration and reflected them in this ROD.

The public generally expressed a preference for complete removal of DU contaminated materials from the FUSRAP areas, thereby supporting USACE's selection of Alternatives 4 and S3 as the final selected remedial alternatives for soil and structures, respectively. Other than the removal of DU contamination, the public expressed no other concerns regarding USACE's Selected Remedy and did not request any additional information.

The Iowa Department of Public Health, Bureau of Radiological Health concurred that the Draft Final documents (FS and PP) may now be considered final (Iowa Department of Public Health 2011).

2.10.2.9 Summary of Comparative Analysis

Alternative 4, Excavation of DU-Contaminated Soil with Physical Treatment and Off-Site Disposal, provides the best balance of trade-offs among the soil alternatives when evaluated against the balancing criteria. Alternative 4 provides the greatest degree of long-term effectiveness and permanence. It can be done at a reasonable cost, is relatively easy to implement, and results in low residual risk and low short-term risks. The statutory preference for treatment stipulated in the NCP [40 *CFR* §300.430(f)(5)(ii)(F)] is addressed by the soil screening technology component of Alternative 4, which would reduce the volume requiring off-site disposal. Alternative 3 also is cost-effective, relatively easy to implement, and results in low residual risk and low short-term risks, but it does not satisfy the statutory preference for treatment. Alternative 2 achieves protectiveness through land use controls, and so has higher residual risk and is less permanent than Alternatives 3 and 4. The no action alternative (Alternative 1) does not achieve overall protectiveness and so was eliminated from consideration.

Alternative S3, Decontamination/Replacement of Structures, provides the best balance of trade-offs among the structure alternatives when evaluated against the balancing criteria. It can be done at a reasonable cost, is relatively easy to implement, results in low residual risk, and low short-term risks. Alternative S2 achieves protectiveness through the implementation of land use controls, and so results in higher residual risk and lower effectiveness and permanence than Alternative S3. In addition, Alternative S2 is less cost-effective than Alternative S3 due to the cost of implementing and supporting the land use controls. The no action alternative (Alternative S1) does not achieve overall protectiveness and so was eliminated from consideration.

2.11 PRINCIPAL THREAT WASTES

The NCP establishes an expectation that treatment will be used to address the principal threats posed by the site wherever practicable. USEPA defines principal threat wastes as "source materials that are considered to be highly toxic or extremely mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur. Principal threat wastes include drummed wastes, non-aqueous phase liquids, highly mobile liquids (e.g., solvents), or materials having high concentrations of toxic compounds" (USEPA 1991). Principal threat wastes do not exist at the FUSRAP areas, because no drummed wastes, non-aqueous-phase liquids, or highly toxic or highly mobile contaminants are present.

2.12 SELECTED REMEDY

The Selected Remedy for soil and structures at the FUSRAP areas is Alternative 4, Excavation of DU-Contaminated Soil with Physical Treatment and Off-Site Disposal, along with Alternative S3, Decontamination/Replacement of Structures. The specific components of Alternative 4 include excavation of soil exceeding the DU RG, physical treatment (by soil sorting and radiological scanning), and off-site disposal of DU-contaminated soil. The specific components of Alternative S3 include physical decontamination of DU-contaminated structural surfaces and/or replacement of the structural components. The Selected Remedy acknowledges continued land use controls to prevent inappropriate use of the site and CERCLA five-year reviews to verify that industrial land use continues.

The details of the Selected Remedy are further explained in Section 2.12.2. See Section 2.14 for an explanation of clarifications resulting from the public review.

2.12.1 Rationale for the Selected Remedy

Based on information currently available, the USACE concludes the Selected Remedy (Alternatives 4 and S3) meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the balancing criteria. Alternatives 4 and S3 also have general support from the state and affected community.

Under Alternatives 4 and S3, excavation of soil and decontamination/removal of structures would successfully reduce the potential human health risks associated with potential exposures to DU by site workers and construction workers at the IAAAP. Alternatives 4 and S3 are protective of the environment, as no risks to potential ecological receptors were identified and COCs are not migrating off-site.

The use of physical treatment as one of the components of Alternative 4 addresses the statutory preference for treatment stipulated in the NCP. Physical treatment by soil sorting and radiological scanning of DU-contaminated soil would reduce the volume of soil proposed for off-site disposal. Because DU may remain on-site at the FSA and Line 1 and chemical soil contamination will remain on-site at Yards C, G, and L at concentrations not allowing for UUUE, the Selected Remedy also includes CERCLA five-year reviews to ensure protectiveness of human health under industrial land use.

After evaluating these alternatives pursuant to the criteria described in the NCP [40 *CFR* Section 300.430(e)(9)(iii)], USACE believes it is protective of human health and the environment because the removal of DU-contaminated soil and decontamination or removal of DU-contaminated structures would permanently reduce the volume, toxicity, and mobility of the contaminated media. All site risks will be reduced to levels protective of industrial land use. Alternatives 4 and S3 achieve the previously stated RAOs:

- Prevent ingestion, dust inhalation, and external gamma radiation exposures to isotopes of DU in the FSA soil that could otherwise result in cumulative CRs exceeding1.0E-04 and radiological doses exceeding 25 mrem/yr for receptors under the current (industrial) and expected future (industrial) land use scenarios.
- Prevent radiation exposures from DU particles embedded in and/or adhered to structural surfaces or components of the Line 1 buildings that could otherwise result in cumulative CRs in exceedance of 1.0E-04 and a TEDE exceeding 25 mrem/yr.

Additionally, Alternatives 4 and S3 provide the best balance of trade-offs among the other alternatives with respect to the balancing criteria. The Selected Remedy satisfies the following statutory requirements of CERCLA 121(b):

1) be protective of human health and the environment,
2) comply with ARARs (or justify a waiver),
3) be cost-effective,
4) utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable, and
5) satisfy the preference for treatment as a principal element or justify not meeting the preference.

The selected remedy incorporates the reasonably anticipated future land use (industrial/military) in determining the appropriate level of cleanup. The industrial RGs are fully protective of human health and the environment and can be achieved more quickly, with cost incursion, than levels that would allow for UUUE.

2.12.2 Description of the Selected Remedy

Major Components of the Selected Remedy	
Alternative 4 (Soil)	• Excavate DU-contaminated soil to meet the industrial RG at Firing Sites 1 and 2; Firing Sites 3, 4, and 5; Firing Site 6 Area; and Firing Site 12 Area.
	• No excavation would be conducted at Yards C, G, and L and Firing Site 14.
	• Treat DU-contaminated soil from Firing Sites 1 and 2; Firing Sites 3, 4, and 5; Firing Site 6 Area; and Firing Site 12 Area (Physical Method – Soil Sorting).
	• Dispose of materials exceeding the DU RG at properly permitted off-site facility. Materials meeting the DU RG may be used as backfill, as appropriate.
	• Site restoration including backfilling, grading and re-vegetation.

Major Components of the Selected Remedy (Continued)	
Alternative S3 (Structures)	• Decontaminate structural surfaces and/or replace structural components (e.g., Building 1-11 floor grate and Building 1-63-6 air filters) to achieve the industrial RG for structures.
	• Dispose of DU-contaminated materials at properly permitted off-site facilities.
Components Common to Alternatives 4 and S3	• Continued industrial land use supported by use restrictions and outgrants administered by the U.S. Army as part of its land management responsibilities.
	• Five-year reviews for all areas exceeding UUUE, which would verify industrial land use.

The specific components of the Selected Remedy are described in the paragraphs below.

2.12.2.1 Excavation

Surface and subsurface soil would be excavated at those areas where soil concentrations exceed the industrial RG for DU (estimated depth of 2 ft). Pre-remedial design sampling may be completed in order to support the design and better manage construction schedules. These areas are: Firing Sites 1 and 2; Firing Sites 3, 4, and 5; the Firing Site 6 Area; and the Firing Site 12 Area. No excavation activities would be required at Yards C, G, and L and Firing Site 14. The estimated total volume of soil that would be excavated is 16,941 in-situ CY. Below-grade structural surfaces that become exposed during soil excavation at the FSA would be surveyed for the presence of DU-contaminated soil. If DU-contaminated soil is found adhered to these surfaces, the structural surface would be decontaminated. If the structural surface cannot be decontaminated, the surface would be sealed and abandoned with land use controls or demolished and removed without replacement.

The RGs are summarized below in Table 2-9. See Section 2.8.3 for an explanation of the basis for these RGs.

Table 2-9. Soil and Structural Remediation Goals for the Formerly Utilized Sites Remedial Action Program Areas

COC	Soil RG (pCi/g)	Structures RG (dpm/100 cm^2)
DU	150	23,000

Soil will be excavated using conventional techniques. Supporting technologies will be used to prevent the spread of contamination. These include re-vegetation, dust mitigation, storage pile covers, sedimentation basins, and dewatering. Field screening surveys will be implemented, as appropriate, to ensure removal of DU concentrations exceeding the RG while reducing over excavation of clean soil. Grading will be performed to provide acceptable surface water drainage. Conventional material handling techniques will be implemented. Contaminated material exceeding RGs will be shipped to a properly permitted off-site disposal facility.

Final status surveys consistent with MARSSIM (DoD 2000) will be conducted to ensure that excavation meets the soil RG for DU. A post-remedial action risk assessment will be performed upon completion of remedial activities to ensure that the final condition is consistent with the objectives of this remedy.

2.12.2.2 Treatment

The Selected Remedy uses physical treatment technologies to reduce the volume of soil requiring off-site disposal. Physical treatment is expected to achieve a 20 percent volume reduction in soil requiring off-site disposal, resulting in cost savings that more than offset the cost of the treatment. Approximately 22,023 ex-situ CY of DU-contaminated soil excavated from the FSA would be treated using soil sorting and radiological scanning. An expansion factor of 1.3 was used to convert in-situ volume to ex-situ volume. The soil sorting method that would be used at the IAAAP includes a radionuclide detecting system capable of analyzing and separating soil based on specific radionuclide criteria. An on-site pilot-scale demonstration of the physical treatment technology would be conducted prior to full-scale remediation activities. Sampling would be performed to determine the proper disposition of the waste and to verify removal of soil exceeding the RG.

The effectiveness of soil sorting is influenced by the types of soil to be treated, the levels of radioactivity present, the moisture content of the soil, and the particle sizes of the soil itself. As noted in Section 2.9.4, the majority of the soil encountered at the Firing Site 12 Area is expected to consist of a high percentage of clay-sized material. The estimated average volume reduction expected for this type of soil is 20 percent based on the results of studies on similar fine-grained soil. Costs associated with an on-site pilot-scale demonstration of the soil sorting technology are included as a precursor to full-scale remediation activities.

Because the remediation of ground water is outside the scope of this remedial action, only ground water that comes into contact with contaminated soil in excavation areas will be addressed. Ground water and storm water that comes into contact with excavation areas will be removed and, if required, treated to meet the substantive requirements of applicable laws and regulations prior to release, thereby reducing the toxicity of the water discharged from the site. Water encountered during excavation activities will be managed in accordance with water management plans developed as part of the remedial action design and work plans.

2.12.2.3 Physical Decontamination of Structures

DU-contaminated surfaces, such as the steel floor grate covering the sump at the Line 1 Building 1-11, would be decontaminated using high pressure water methods and allowed to dry. Areas would be radiologically surveyed to document the residual radioactivity. If found to be above the industrial RG for structural surfaces, then additional decontamination methods would be employed including high pressure water with detergent cleansers, grit blasting, or scabbling until residual radioactivity meets the industrial RG.

Impacted structures will be fully investigated using procedures that are compatible with MARSSIM (DoD 2000) as necessary to document attainment of RG for DU on structures as specified in the ROD. Portions of structures that cannot be economically decontaminated may be removed and/or replaced. Contaminated portions of such structures would be disposed of as radioactive waste at a properly permitted disposal site.

2.12.2.4 Replacement of Structural Components

Decontamination of DU-contaminated components such as air filters is not feasible and is not cost effective. Under this alternative, the DU-contaminated air filter at Line 1 Building 1-63-6 would be removed and replaced. The steel floor grate covering the sump at the Line 1 Building 1-11 would be decontaminated and, if methods fail to successfully decontaminate the grate, it would be replaced. Structural components that are contaminated with DU would be disposed of as radioactive waste at a properly permitted disposal site.

2.12.2.5 Transport and Off-Site Disposal

Soil and structural materials exceeding the industrial RGs would be disposed of by transfer to a properly permitted off-site disposal facility. Approximately 80 percent (17,616 ex-situ CY) of the DU-contaminated soil would be shipped off-site for disposal. Transportation of contaminated soil and debris would use DOT-approved “super sacks,” specially lined dump trucks, rail cars, or inter-model containers. Absorbers and other conditioning will be used, as necessary, to comply with the transportation and disposal requirements. Rubble and similar materials would be sized as necessary for disposal. All waste transport for off-site disposal will be compliant with existing DOT regulations.

Wastes containing source materials exceeding 165 pCi/g U-238 are classified as Class A LLRW. Such wastes would be disposed of by transfer to an NRC- or a state-licensed LLRW disposal facility. Given the industrial soil RG of 150 pCi/g for DU, it is assumed that most soil exceeding the RG would be disposed of by transfer to an LLRW disposal site.

In general, the RI sampling does not indicate that chemical contamination or UXO is co-mingled with the DU. However, if co-mingled contamination is found during waste characterization sampling/analysis; chemical contaminants would be disposed of by transfer to a properly permitted off-site disposal facility. UXO-qualified personnel will provide the required equipment and instruments as necessary to properly address any UXO encountered during remediation in accordance with Engineer Pamphlet EP 75-1-2 (USACE 2000).

2.12.2.6 Site Restoration

Materials meeting the DU RG may be used as backfill, as appropriate. Site restoration activities will include backfilling of excavated areas with clean soil, grading, and re-vegetation.

2.12.2.7 Continued Land Use Controls

Continued industrial land use would be supported by use restrictions and outgrants administered by the U.S. Army as part of its land management responsibilities.

2.12.2.8 Five-Year Reviews

CERCLA 121(c) five-year reviews are required under this alternative for FUSRAP areas that exceed UUUE. Therefore, a statutory review will be conducted within five years after initiation of the remedial action and at least once every five years thereafter to ensure that the remedy continues to be protective of human health and the environment. Industrial land use will be verified during each five-year review. If the five-year review indicates that the remedy is no longer protective, the facts will be evaluated and appropriate response measures will be taken. The five-year review process will continue until hazardous substances, pollutants, or contaminants no longer remain on the FUSRAP areas above levels that allow for UUUE.

2.12.3 Estimated Remedy Cost

The total cost for the Selected Remedy (Alternatives 4 and S3) was evaluated based on the best available information and over a 30-year costing period. The total cost for the Selected Remedy is $45,275,000. The capital, annual O&M, and total present worth costs for the duration of the evaluation period (30 years) and the discount rate (7 percent) are provided in Table 2-10 and Table 2-11.

It should be noted that the information in this cost estimate summary table is based on the best available information regarding the anticipated scope of the remedial alternative. Table 2-10 provides the cost estimate for the Selected Remedy. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a memorandum in the

Administrative Record, an Explanation of Significant Differences, or a ROD amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within -30 to +50 percent of the actual project cost.

Table 2-10. Costs for the Selected Remedy

Account No.	ITEM	QUANTITY	UNIT	UNIT PRICE	ESTIMATED AMOUNT
32XXX	PROJ. MANG. & PRE-REMEDIAL ACTION				
10	Project Management	1	LS		$848,700.00
20	Investigations (PRP)	1	LS		$282,900.00
30	Remedial Design	1	LS		$2,263,100.00
40	Remedial Action Contracting	1	LS		$282,900.00
331XX	HTRW REMEDIAL ACTION (CONSTRUCT)				
01	Mobilize and Preparatory Work	1	LS		$162,649.59
02	Monitoring, Sampling, Test & Analysis	1	LS		$1,911,831.80
03	Site Work	1	LS		$446,005.01
05	Surface Water Collect & Control	1	LS		$1,565,371.84
08	Solids Collect and Containment	1	LS		$592,858.51
	Physical Treatment	1	LS		$1,557,062.15
19	Disposal (Commercial)	1	LS		$21,798,266.06
20	Site Restoration	1	LS		$ 32,931.86
21	Demobilization	1	LS		$207,170.74
	High Pressure Water Washing	1	LS		$11,339.27
	Remove & Replace Air Filters and Floor Grate	1	LS		$1,425.18
	Transportation & Disposal of Building Decon	1	LS		$1,218.58
332XX	ENGINEERING DURING CONSTRUCTION				
01	Engineering During Construction	1	LS		$282,900.00
333XX	CONSTRUCTION MANAGEMENT				
01	Construction Management	1	LS		$1,697,300.00
34XXX	POST-REMEDIAL ACTION				
20	Operation, Maintenance. & Monitoring	1	LS		$240,000.00
		SUBTOTAL:			$34,185,930.59
		CONTINGENCIES:			$9,405,166.54
		ESCALATION:			$1,683,897.41
			TOTAL COST		**$45,274,994.53**

LS- Lump sum

Table 2-11. Present Worth Analysis for the Selected Remedy

Project Life Cycle Discount Factor - 7.0%					
Year	**Capital Costs ($)**	**O&M Costs ($)**	**Total Cost (Capital + O&M)**	**Discount Factor at 7.0%**	**Present Worth at 7.0% ($)**
0		0	0	1	0
1	22,045,085	40,511	22,085,596	0.935	20,640,744
2	22,014,585	40,511	22,055,095	0.873	19,263,775
3		40,511	40,511	0.816	33,069
4		40,511	40,511	0.763	30,906
5		40,511	40,511	0.713	28,884
6		40,511	40,511	0.666	26,994
7		40,511	40,511	0.623	25,228
8		40,511	40,511	0.582	23,578
9		40,511	40,511	0.544	22,035
10		40,511	40,511	0.508	20,594
11		40,511	40,511	0.475	19,246
12		40,511	40,511	0.444	17,987
13		40,511	40,511	0.415	16,811
14		40,511	40,511	0.388	15,711
15		40,511	40,511	0.362	14,683
16		40,511	40,511	0.339	13,722
17		40,511	40,511	0.317	12,825
18		40,511	40,511	0.296	11,986
19		40,511	40,511	0.277	11,202
20		40,511	40,511	0.258	10,469
21		40,511	40,511	0.242	9,784
22		40,511	40,511	0.226	9,144
23		40,511	40,511	0.211	8,546
24		40,511	40,511	0.197	7,987
25		40,511	40,511	0.184	7,464
26		40,511	40,511	0.172	6,976
27		40,511	40,511	0.161	6,519
28		40,511	40,511	0.150	6,093
29		40,511	40,511	0.141	5,694
30		40,511	40,511	0.131	5,322
Total	**44,059,669**	**1,215,325**	**45,274,995**		**40,333,974**

Total cost only includes costs incurred for 30-year project duration.
Five-year review costs are distributed evenly across the annual O&M costs.

2.12.4 Expected Outcome of the Selected Remedy

An expected outcome of the Selected Remedy is that the FUSRAP areas will no longer present an unacceptable risk to human health and the environment. The Selected Remedy will address the low level threats associated with DU-contaminated soil and structures by excavation and treatment of DU-contaminated soil and decontamination/removal of DU-contaminated structures.

The Selected Remedy will achieve the industrial RGs for DU at the FUSRAP areas (Table 2-12). The risk-based RGs for DU-contaminated soil (150 pCi/g) and DU-contaminated structures (23,000 dpm/100 cm2) individually correspond to a target risk of 1.0E-04. In addition, the soil and structural RGs determined for DU are both individually and cumulatively protective of the total dose limit of 25 mrem/yr specified by the ARAR [10 CFR §20.1403(b)]. The estimated amount of time necessary to achieve the RGs is 675 days. This estimate is in part dependent on no access limitation being implemented by the IAAAP operating contractor, currently American Ordnance.

Table 2-12. Cleanup Levels for the FUSRAP Areas

Media	Chemical of Concern	Cleanup Level [a]	Basis for Cleanup Level	Risk at Cleanup Level (unitless)	Corresponding Radiological Dose (mrem/yr)
Soil	DU	150 pCi/g	Risk Assessment	Cancer Risk = 1E-04	8
Structures	DU	23,000 dpm/cm^2	Risk Assessment	Cancer Risk = 1E-04	18.7

[a] 25 mrem/yr is the total radiological dose targeted for DU assuming the combined activity percentages of 90.14 percent, 1.48 percent, and 8.48 percent for the respective DU isotopes (U-238, U-235, and U-234).

Continued industrial land use will prevent inappropriate use of the site and will be verified through the five-year review process.

Ground water is not currently used as a drinking water source at the IAAAP. No changes to ground-water use at the IAAAP will result from implementation of the Selected Remedy.

2.13 STATUTORY DETERMINATIONS

Under CERCLA §121(b) and the NCP, the lead agency must select remedies that are protective of human health and the environment, comply with ARARs, are cost-effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element and a bias against off-site disposal of untreated wastes. The following sections discuss how the Selected Remedy meets these statutory requirements.

2.13.1 Protection of Human Health and the Environment

The Selected Remedy will protect human health and the environment through excavation of DU-contaminated soil and decontamination/removal of DU-contaminated structures. Soil and structural materials that do not meet the RGs would be placed in a properly permitted off-site disposal facility that would provide for protective management and appropriate monitoring of potential releases of any residual contaminants. Continued industrial land use would assure continued protectiveness by preventing inappropriate use of the site, and would be verified through the five-year review process.

Excavation of DU-contaminated soil will reduce or eliminate the potential risks due to ingestion, dust inhalation, and external gamma radiation exposures to isotopes of DU in soil. Decontamination/removal of DU-contaminated structures will prevent radiation exposures from DU particles embedded in and/or adhered to structural surfaces or components. Continued industrial land use will also control risk by preventing unauthorized and/or inappropriate use of the site. Existing land use controls include use restrictions and outgrants administered by the U.S. Army as part of its land management responsibilities. Industrial land use would be verified with the CERCLA 121(c) five-year reviews, which are required for those areas that do not achieve UUUE.

The FUSRAP areas will meet the criteria for restricted release, as defined in the ARARs. The removal of DU-contaminated soil and structural material exceeding the industrial RGs from the FUSRAP areas and continued industrial land use will achieve a total residual site risk that is within the CERCLA risk range (1.0E-06 – 1.0E-04) and below the dose limit of 25 mrem/yr.

Implementation of the Selected Remedy does not pose unacceptable short-term risks. Because the remedy involves excavation and off-site disposal of DU-contaminated soil and structures, it has short-term risks to the community associated with construction and transportation activities, but the risks are small and can be controlled. The short-term risks to the workers conducting the excavation, transport, and disposal activities would be managed using appropriate personal protection and safety measures.

Implementation of the Selected Remedy does not pose unacceptable cross-media impacts. The removal of the DU-contaminated soil will prevent the migration of DU from soil to ground water and surface water. This will reduce potential risks due to dermal contact, inhalation or ingestion of surface water and ground water.

2.13.2 Compliance with Applicable or Relevant and Appropriate Requirements

The Selected Remedy is fully compliant with the ARARs. Table 2-13 summarizes the ARARs that would be achieved at all FUSRAP areas. Under the Selected Remedy, DU-contaminated soil and structures will be remediated to the industrial RGs developed pursuant to ARARs. The RGs are fully protective of human health and the environment, and achieve residual conditions consistent with industrial use. Industrial use is supported by use restrictions and outgrants administered by the U.S. Army as part of its land management responsibilities.

Table 2-13. ARARs for the Selected Remedy

Requirement	Citation	Description	ARAR Determination
10 *CFR* 20 Subpart E NRC Radiological Criteria for License Termination	10 *CFR* 20.1403 (b) and (e)	These provisions identify the criteria under which a site is acceptable for license termination under restricted conditions. 10 *CFR* 20.1403(b) requires that there be provisions for legally enforceable institutional controls that provide reasonable assurance that the TEDE from residual radioactivity distinguishable from background to the average member of the critical group will not exceed 25 mrem/yr. 10 *CFR* 20.1403(e) requires that the annual dose to an average member of the critical group is ALARA and would not exceed 100 mrem/yr if land use controls are no longer present.	Chemical-Specific ARAR. These criteria are relevant and appropriate to the cleanup of DU-contaminated soil and structures at the FUSRAP areas. They were used to develop the industrial RGs for soil and structures. The Selected Remedy will comply with these criteria through the excavation and off-site disposal of soil and structural material that exceed the industrial RGs.

Table 2-13. ARARs for the Selected Remedy (Continued)

Requirement	Citation	Description	ARAR Determination
Endangered Species Act	16 U.S.C §1538(a)(1)	These provisions prohibit the illegal taking of a federally listed endangered species. Federal agencies are required to ensure that their actions do not jeopardize the continued existence of a listed species or result in destruction of or adverse modification of its critical habitat.	Location-Specific ARAR. A federally listed endangered species, the Indiana bat, may be found as a transient species within the FUSRAP areas of the IAAAP. Therefore, these requirements are relevant and appropriate for remedial actions conducted within the FUSRAP areas. The Selected Remedy will comply with these provisions.
10 *CFR* 20 Subpart B Radiation Protection Programs	10 *CFR* 20.1101(d)	These provisions impose a constraint on air emissions of radioactive material to the environment, excluding Radon-222 and its daughters, such that the highest individual dose to the public will not exceed 10 mrem/yr.	Action-Specific ARAR. The provisions of Section 20.1101(d) are relevant and appropriate to actions involving releases of airborne radioactive materials during remediation. The Selected Remedy will comply with these provisions.

2.13.3 Cost Effectiveness

In the lead agency's judgment, the Selected Remedy is cost-effective and represents a reasonable value for the money to be spent. In making this determination, the following definition was used: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness" [NCP 40 *CFR* §300.430 (f)(1)(ii)(D)]. This was accomplished by evaluating the "overall effectiveness" of those alternatives that satisfied the threshold criteria (i.e., were both protective of human health and the environment and ARAR-compliant). Overall effectiveness was evaluated by assessing three of the five balancing criteria in combination (long-term effectiveness and permanence; reduction of toxicity, mobility, and volume through treatment; and short-term effectiveness). Overall effectiveness was then compared to costs to determine cost-effectiveness. The relationship of the overall effectiveness of this Selected Remedy was determined to be proportional to its costs and hence this alternative represents a reasonable value for the money to be spent.

The estimated total cost of the Selected Remedy (Alternatives 4 and S3) is $45,275,000.

Although Alternative 4 is more expensive than Alternative 2 ($2.1 million), Alternative 4 achieves significantly greater long-term effectiveness and permanence than Alternative 2, which includes land use controls and does not remove source material. The USACE believes that the Selected Remedy's additional cost for excavation, physical treatment, and off-site disposal provides a significant increase in protection of human health and the environment and in overall effectiveness of the remedy.

2.13.4 Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Possible

Of those alternatives that are protective of human health and the environment and comply with ARARs, USACE has determined that the Selected Remedy provides the best balance of trade-offs in terms of the five balancing criteria, while also considering the statutory preference for treatment as a principal element to the maximum extent possible. The Selected Remedy provides a permanent solution for DU-contamination present in soil and on structures at the FUSRAP areas. DU-contaminated material will be permanently removed and contained in an off-site disposal facility designed for long-term isolation and protection. Physical treatment using soil sorting and radiological scanning will be conducted to reduce the volume of contaminated material requiring disposal. Following implementation of the Selected Remedy, the FUSRAP areas will meet the criteria for restricted release, as defined in the ARARs.

2.13.5 Preference for Treatment as a Principal Element

The statutory preference for treatment as a principal element of the remedy [NCP 40 *CFR* §300.430(f)(5)(ii)(F)] is addressed by the physical treatment component of the remedy. Physical treatment involving the use of a soil sorting and radiological scanning will be conducted to reduce the volume of radioactively contaminated soil requiring off-site disposal.

2.13.6 Five-Year Review Requirements

NCP [40 *CFR* §300.430(f)(4)(ii)] states that if the Selected Remedy "results in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure" a five-year review is required. The five-year review assesses the protectiveness of the Selected Remedy. USACE will be responsible for reviews at the FUSRAP areas until transfer to DOE. As stated in the 2006 FFA (USEPA et al. 2006), USACE and DOE will review the remedial action "no less often than every five years after initiation of such remedial action to assure that human health and the environment are being protected". The 2006 FFA requires that USACE perform any reviews that take place prior to and up to two years after USEPA approval of the Remedial Action Completion Report, and the DOE will perform any five year reviews that take place more than two years after approval of the Remedial Action Completion Report.

2.14 DOCUMENTATION OF SIGNIFICANT CHANGES FROM THE PREFERRED ALTERNATIVE OF THE PROPOSED PLAN

The PP (USACE 2011a) was released for public comment on April 22, 2011. It identified Alternatives 4 and S3 as the preferred alternatives for remediation of DU-contaminated soil and structures in the FUSRAP areas. USACE has reviewed all comments submitted during the public comment period. It was determined that no significant changes to the remedy, as originally identified in the PP (USACE 2011a), were necessary or appropriate.

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3.0 RESPONSIVENESS SUMMARY OF THE RECORD OF DECISION

3.1 OVERVIEW

This Responsiveness Summary has been prepared in accordance with CERCLA, as amended by SARA, and the NCP [40 *CFR* § 300.430(f)]. This section provides USACE responses to all significant comments received on the FS and PP from the public and other stakeholders during the 30-day comment period.

On April 22, 2011, USACE released the FS and PP for public review and comment. The FS established RAOs, identified ARARs, derived soil and structural RGs, and developed and evaluated remedial alternatives in order to meet the RAOs. The PP discussed USACE's proposed action to address DU-contaminated soil and structures in the FUSRAP areas of the IAAAP. The public comment period was open from April 22 to May 23, 2011. The USACE held a public meeting on May 17, 2011, at the Comfort Suites Hotel and Conference Center in Burlington, Iowa to present the FS and PP to the public, answer questions on these documents, and accept any comments the public could provide. In order to retain a record of these verbal comments, a court reporter was present to provide a transcript of the proceedings. A copy of the transcript of the public meeting is included in the Administrative Record File. Comments received during the public comment period on the FS and PP are summarized in Section 3.2. No comments were received from the regulators or parties to the 2006 FFA during the public comment period.

3.2 SUMMARY OF COMMENTS RECEIVED AND AGENCY RESPONSES

Responses to all oral comments provided at the public meeting on May 17, 2011, are presented here and are also included in the Administrative Record for the ROD. No written comments were submitted during the public comment period.

3.2.1 Verbal Comments at Public Meeting (May 17, 2011)

3.2.1.1 Comments from Commenter 1: Vaughn Moore

My name is Vaughn Moore. I was a security officer at the IAAP. We have talked with the people out there before on this, and we would prefer that any of this material be actually dug up and removed from the premises. It should not be left lay; it should not be allowed to stay on the facility. It should be removed from the area. Almost everybody that we have contact with or have talked with over the period of time that we've been involved in this; most of them didn't even want the IDA out there. But we would prefer that anything that you find on this cleanup, that it actually be removed from the premises.

Response 1: The commenter's support for removal of all DU-contaminated wastes from the FUSRAP areas is acknowledged. The preferred alternative requires removal (and off-site disposal) of all DU-contaminated soil and building materials that would present an unacceptable risk.

3.2.1.2 Comments from Commenter 2: Mark Hagerla

I'm Mark Hagerla. I'm a lifelong resident of Des Moines County, and a former State Senator, and a business person in the area. I've been on the RAB Board since we began it; and I appreciate Sharon being here again, and her people that are under her that have supplied the information for us tonight.

This has been a long cleanup process, and I'm glad to see that FUSRAP is here and that the Atomic Energy Commission end of things is getting taken care of. I think in your Record of Decision, that you have to include, some way, things that you're going to find out there that you don't know is there – because every time we dig, you dig out there, we find things that – unknown things.

And I'd like to say Vaughn Moore and Thurman Huffman have been a great asset in providing information to the cleanup out there. And I don't want to say numbers, but there are many, many, many things that are not documented in any documents that you're going to look at, and when you're out in the field, you're going to find things that nobody knows that are there. Well, some people know they're there, but a lot of people won't talk about them. But I think it's very important that you include, in your documentation, and expect to find things that you don't have documented, and those things get taken care of.

Another concern of mine is, there's many facilities out there that have been begun to be cleaned up, and have been stopped because of lack of funding or the weather constraints. And Ron has sent me a letter and assured me, in the letter, that these things are documented, they will be, they will be continued to be cleaned up. But there's a lot of those out there that concern me that are in the areas where people are continuing to work – and that may not be the AEC's portion of things – but in the ongoing operations out there, that we don't have people going into these present buildings that have not been cleaned up because they've been in a continuing operation – that concerns are shown that these people are in safe environments, and we don't have the problems that we have had in the past. And it's unknown to most of us of what kind of controls are on the processes that are ongoing at the present time, that we don't contaminate any more than what we already have at the present time.

So those are my concerns. I think the choice that you have there, you've probably chose the best efforts to clean the property up, and since we've closed the dump sites that we have had – we don't have any burial places out there – I think there's got to be a measure to remove the stuff and take them to a place that is a controlled environment, rather than 50 years from now, when somebody comes in here and doesn't know or think about what's been going on, that we don't put people in danger when they go back on the property to do things. So thank you for being here. Thank you for the effort that you put forward. I am embarrassed that not more people show up for these kinds of things, and I don't want you to think this isn't a big deal for us in this area because this is a big deal for us. And thank you for being here.

Response 2: USACE acknowledges the commenter’s concern over unknown/undocumented site hazards at IAAAP. If unknown/undocumented site hazards are discovered during FUSRAP remedial actions, they will be evaluated in accordance with the CERCLA process to determine the appropriate action necessary.

USACE will continue to utilize the existing budget cycle to obtain funding to complete the remediation of the FUSRAP areas at the IAAAP. USACE acknowledges the commenter’s concern over potentially hazardous conditions resulting from ongoing operations at the IAAAP. However, addressing this issue is beyond the scope of the USACE FUSRAP program.

USACE acknowledges the support for full cleanup of the site and the commenter’s preference for off-site disposal in a controlled environment. As noted in the ROD, the DU-contaminated material will be removed for off-site disposal in secure, licensed facilities specifically designed for radioactive materials. These disposal facilities are remote from inhabited areas.

3.2.1.3 Comments from Commenter 3: Dean Vickstrom

I'm like Mark. I started on the RAB Board when it was implemented. This will start to get more personal. We buried a good friend of mine last Friday. He worked in the AEA; he was also a guard out there. He went through three bouts of cancer. His father worked for the AEA; he died of stomach cancer; and John's mother ended up with cancer twice, so his father took it home.

I don't want anybody else to go through this; and the only way you're going to do that is you're going to get this stuff out of there, and with some degree of confidence that it won't happen – you know, you never say never – but I think you owe it to anybody that comes out there from now on, not to put them through the same thing that these people, Vaughn and his people, have gone through. You know, these people are casualties just like anybody else, and I think we forget about that at times. So it's nice to have – "nice" is a bad word – it's good to have a group like this that's getting into these things, but I'd like to see some teeth, at some point. I think we're getting smoke blown at us at times – not by you people, but by some other people. So, keep doing what you're doing, and don't forget about these people that have gone on. Thank you.

Response 3: USACE recognizes the concern of the commenter about the potential hazards posed by the contamination at the IAAAP, and acknowledges the commenter’s support for completion of the remediation at the FUSRAP areas.

3.2.1.4 Comments from Commenter 4: Marge Foster

My name is Marge Foster, and the plant has been a great part of my life. I had two brothers that worked as millwrights; and I, myself, worked there for 15 years; and I had a sister who worked there and died of a malignant brain tumor. I started working there in ‘65 – ‘63, excuse me, and I worked on the component lines. But I also became a steward and business representative, and I spent a great deal of time with people from Line 1, the AEC; and I can't tell you how many funerals I've attended and how many people that I've tried to help get compensation for.

And I saw the memorial – I don't know how many of you have seen it, but it's extraordinary, it's absolutely beautiful; and up on the right-hand side, there's a list of people that died out there and didn't work on AEC, and I personally worked with all of them. And I get a little emotional when I think about it. I'm 79 years old, and I've been communicating with these same people since 1963. I, myself, was injured in an accident out there, and I still have my four wounds, so it's very, very important to me that we do a thorough cleanup, please. We have had way too many people that we've lost.

And Iowa is a beautiful state. I was born and raised here, and it makes me very sad to think that we've – you can't have the best of both worlds, but we have had a lot of people who made a decent living there, and it's too bad that we've lost so many because of contamination. So let's clean it up, please, and do it right, and leave it to the next generation in a safe way. Thank you.

Response 4: USACE acknowledges the commenter’s support for full cleanup of the contamination. As noted in the ROD, the Selected Remedy involves the removal of the DU-contaminated materials for off-site disposal and will be fully protective of human health and the environment.

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FIGURES

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U:\CAD\IAAAP\ROD\Dwgs\Figure 2-1. Location of the IAAAP.dwg

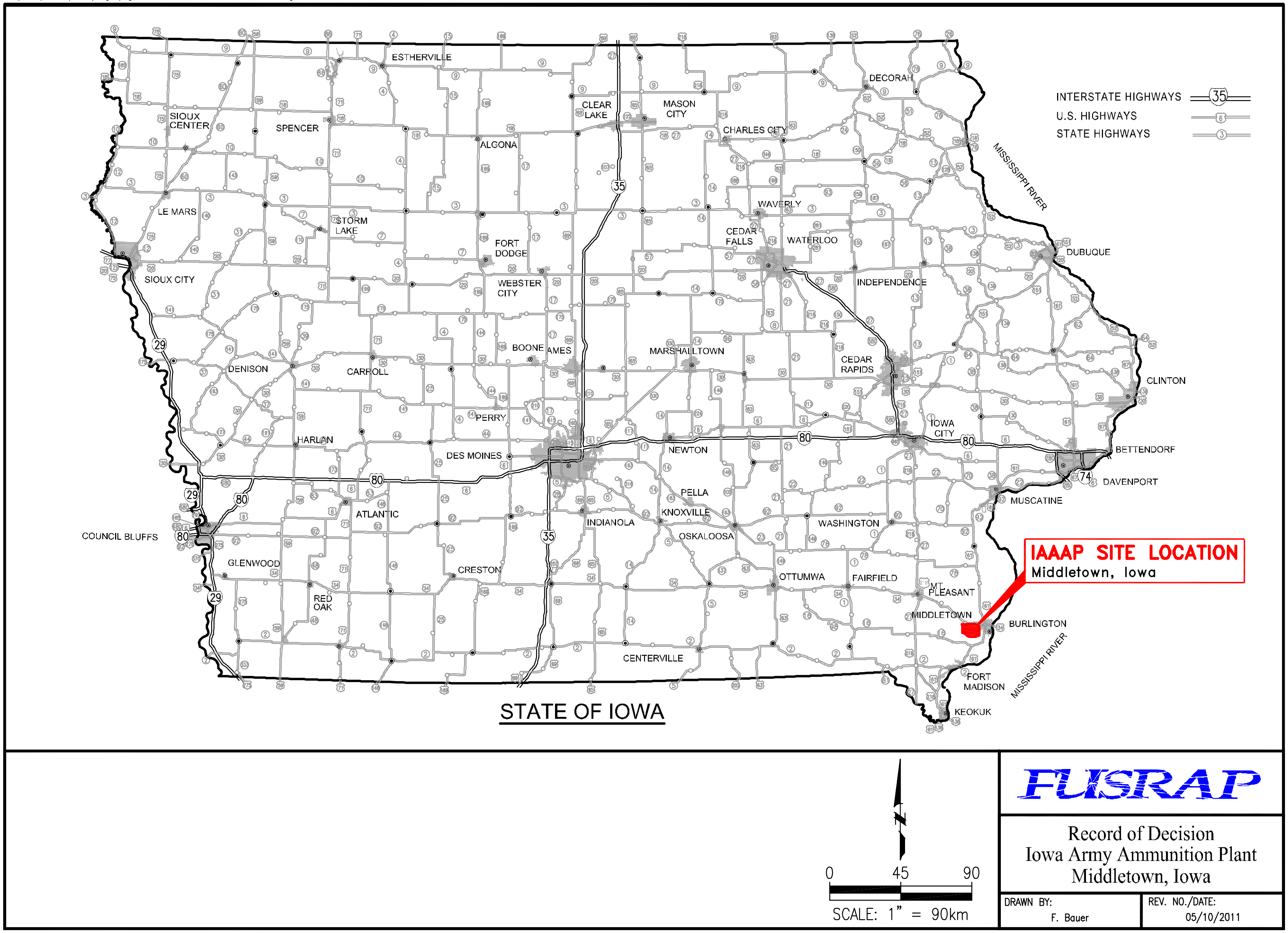

Figure 2-1. Location of IAAAP

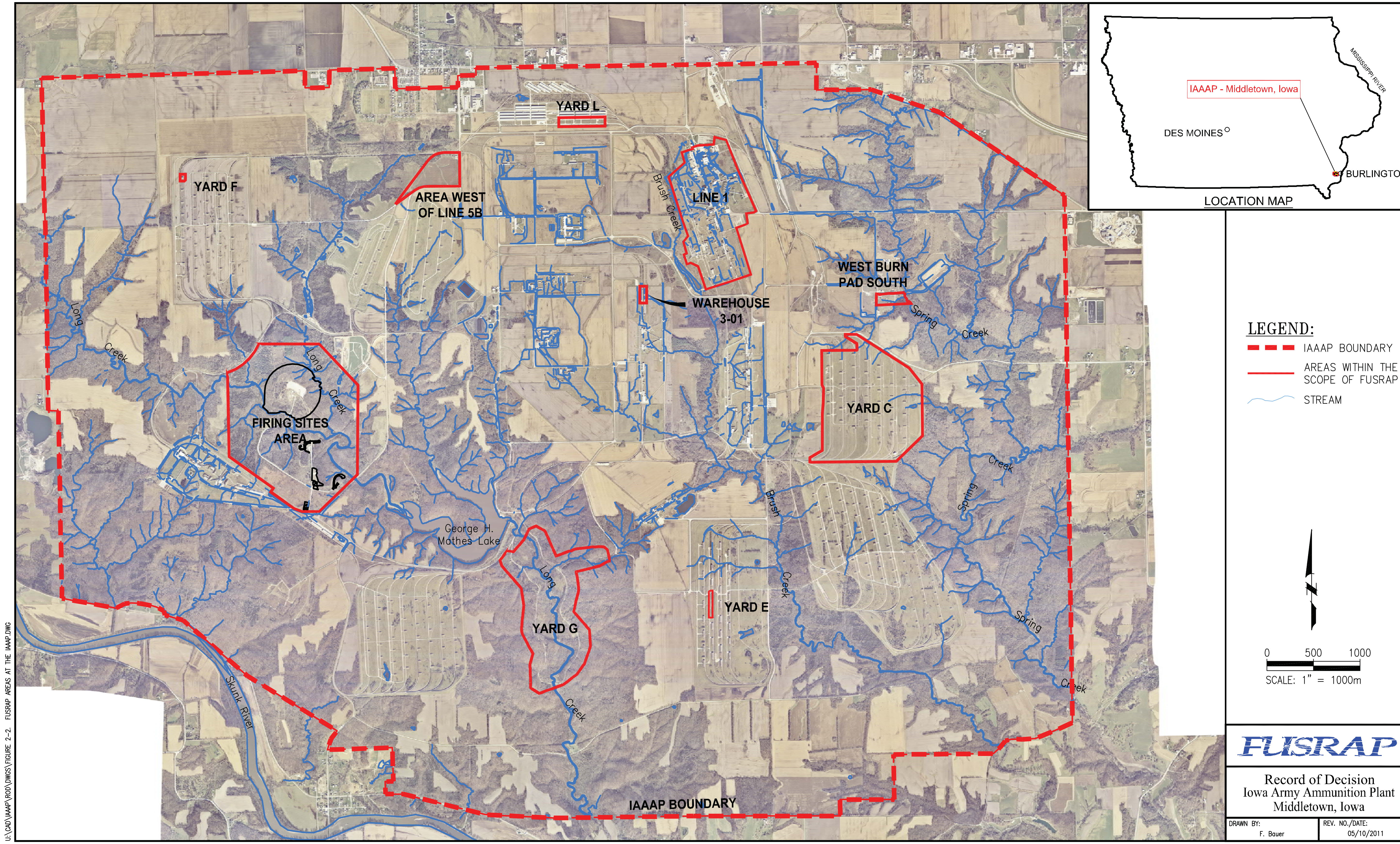

Figure 2-2. FUSRAP Areas at the IAAAP

Figure 2-3. Firing Sites Area

Figure 2-4. Firing Sites 1 and 2 Area

Figure 2-5. Firing Sites 3, 4, 5, and 14 Area

LEGEND:

— Surface Feature

— Topographic Contours

N

W E

S

Iowa-South State Plane
(NAD 83, Meters)

0 8 16 Meters

Record of Decision
Iowa Army Ammunition Plant
Middletown, Iowa

FUSRAP

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Figure 2-6. Firing Site 6 Area

LEGEND:

- Stream
- Surface Feature
- Topographic Contours

N
W E
S

Iowa-South State Plane
(NAD 83, Meters)

0 30 60 Meters

Record of Decision
Iowa Army Ammunition Plant
Middletown, Iowa

FUSRAP

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U:\GPS\IAAAP\ROD\Projects\Figure 2-7 Firing Site 12 Area.mxd

Figure 2-7. Firing Site 12 Area

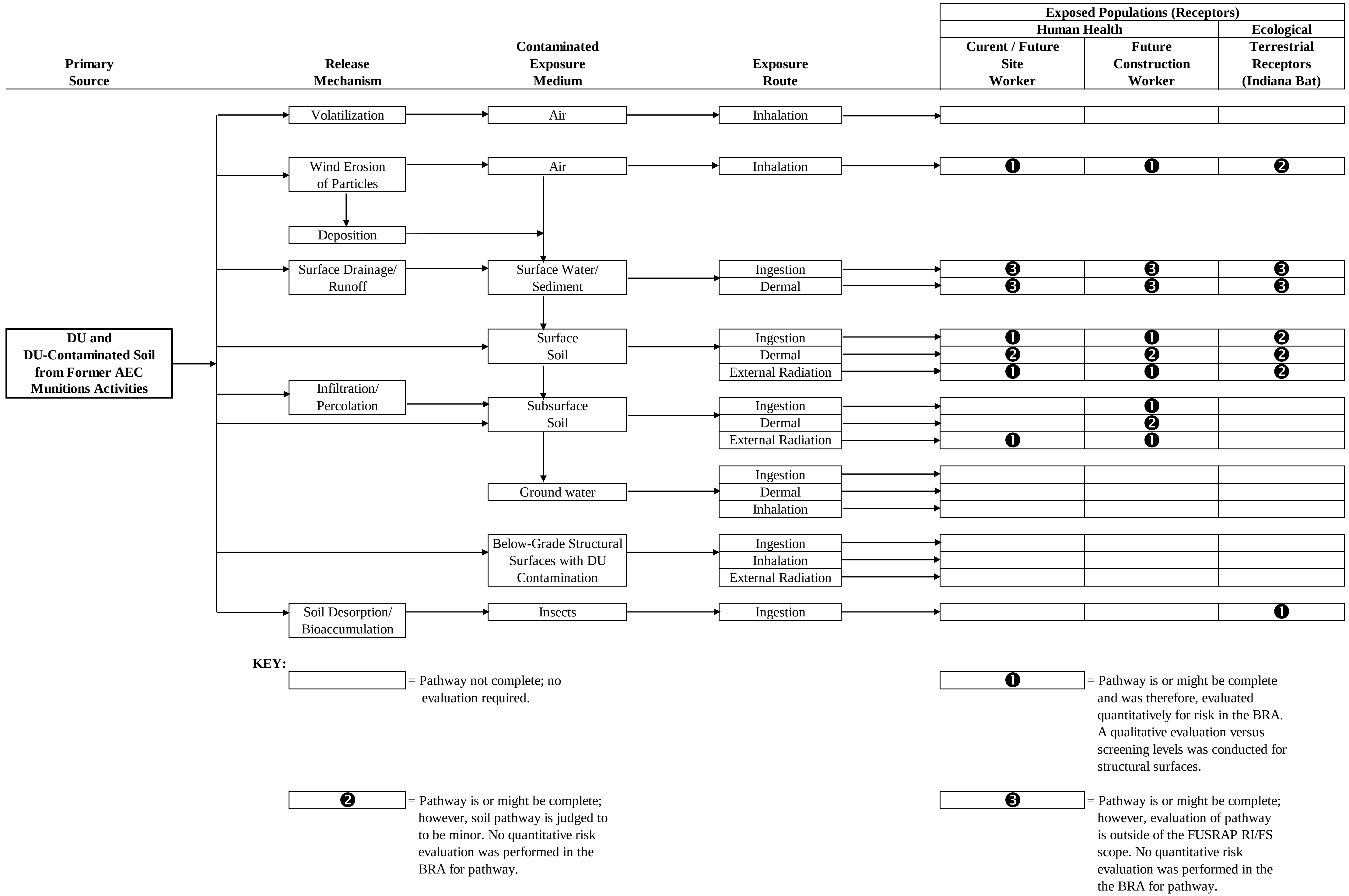

Figure 2-8. Conceptual Site Model for DU and DU-Contaminated Soil at the FUSRAP Areas of the IAAAP

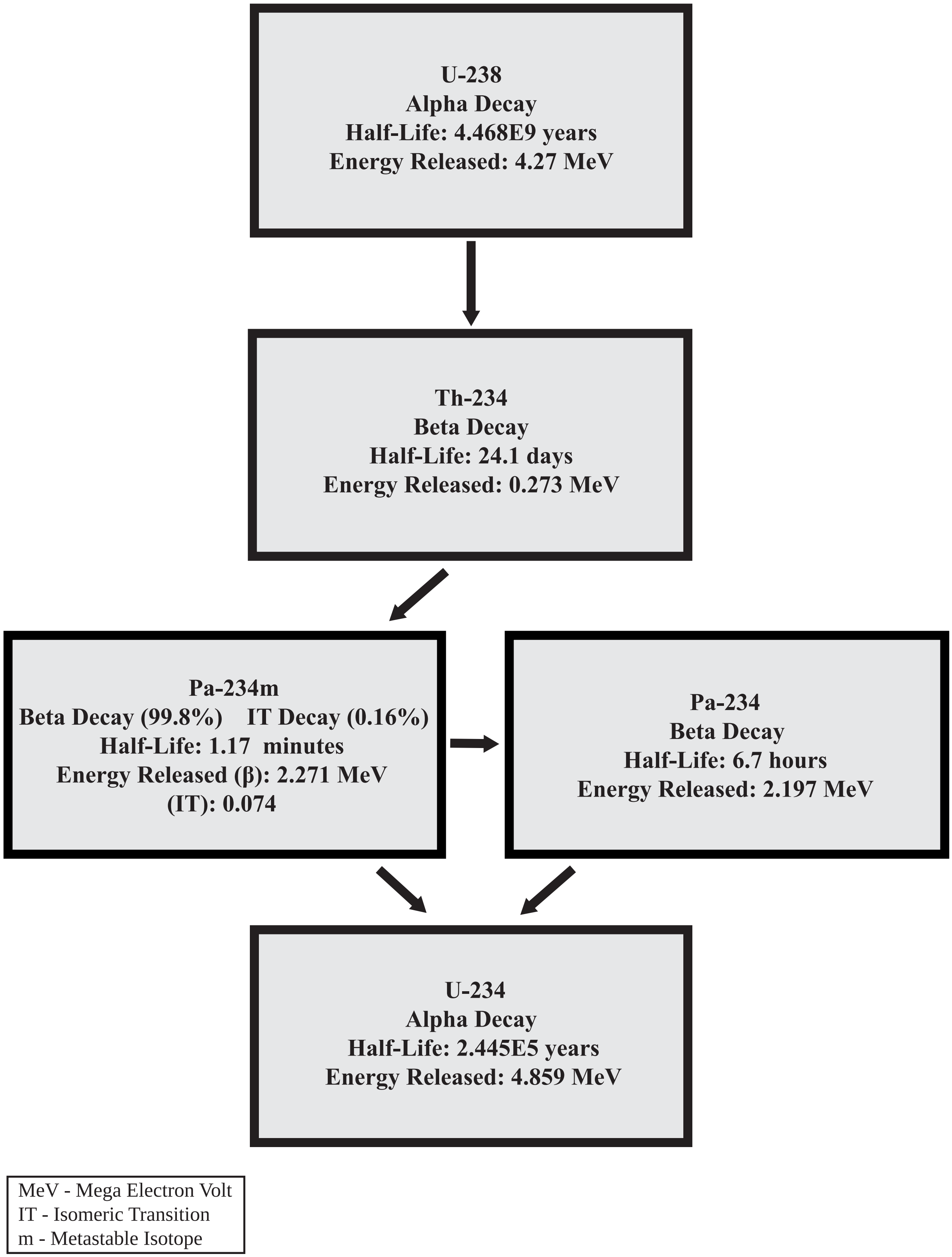

Figure 2-9. Uranium-238 Decay Chain

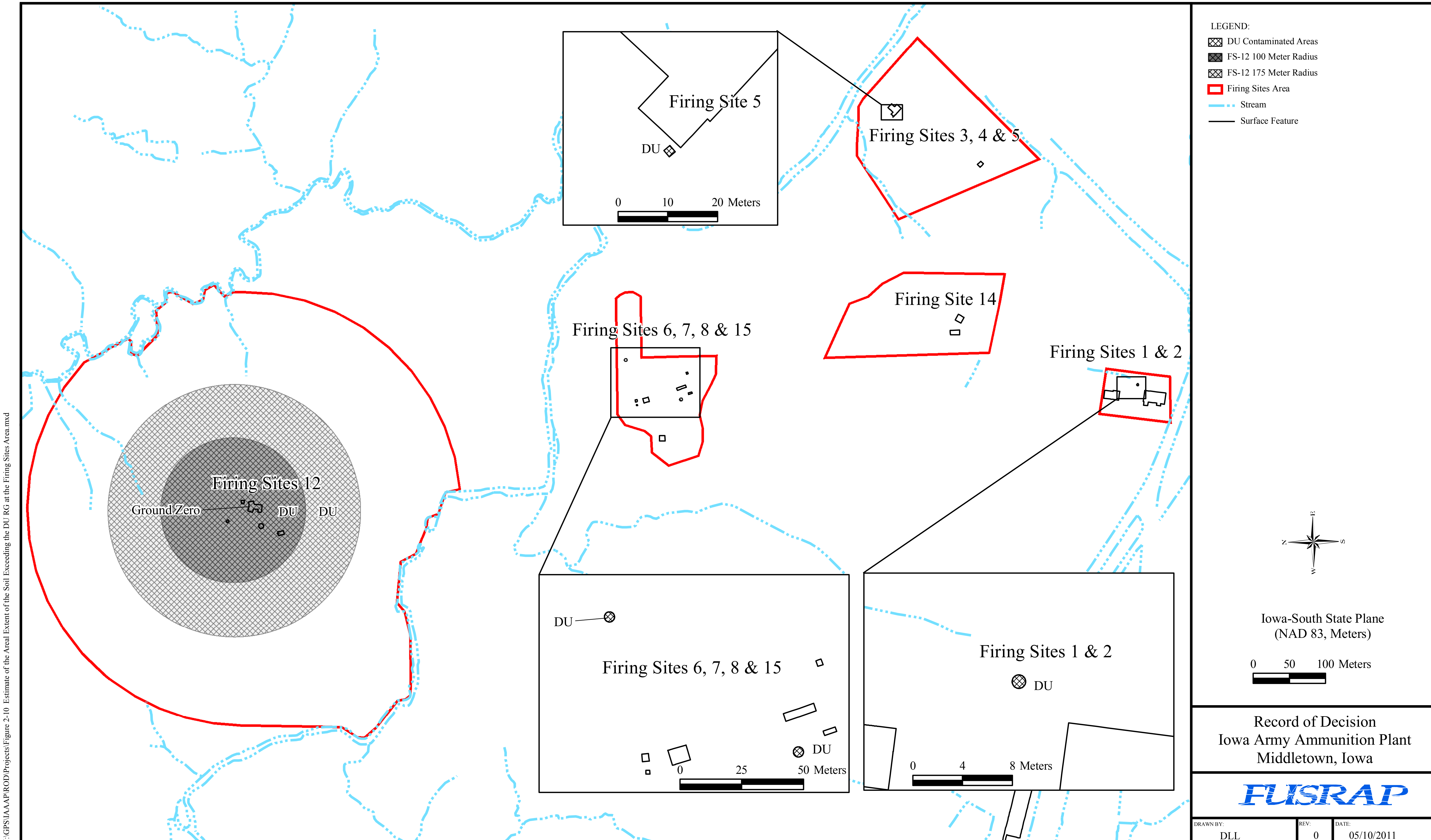

Figure 2-10: Estimate of the Areal Extent of
Soil Exceeding the DU RG at the Firing Sites Area