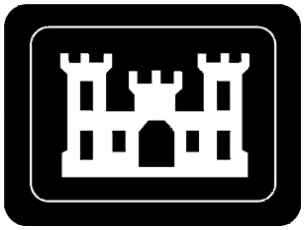
FINAL

FUSRAP FEASIBILITY STUDY REPORT FOR THE IOWA ARMY AMMUNITION PLANT

MIDDLETOWN, IOWA

APRIL 22, 2011



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

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FUSRAP FEASIBILITY STUDY REPORT FOR THE IOWA ARMY AMMUNITION PLANT

MIDDLETOWN, IOWA

APRIL 22, 2011

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

with assistance from:
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ACRONYMS AND ABBREVIATIONS

%	percent
^{o}C	degrees Celsius
^{o}F	degrees Fahrenheit
$	U. S. dollars
µg/L	microgram per liter
ACR	acre(s)
AEC	Atomic Energy Commission
AF	attenuation factor
ALARA	as low as reasonably achievable
ANL	Argonne National Laboratory
ANSI	American National Standards Institute
ARAR	applicable or relevant and appropriate requirement
ATSDR	Agency for Toxic Substances and Disease Registry
AUF	area use factor
BCY	bank cubic yard(s)
BERA	baseline ecological risk assessment
bgs	below ground surface
BRA	baseline risk assessment
BRAC	Base Realignment and Closure
CC	critical concentration
CEMVS PM/ED	U.S. Army Corps of Engineers, Mississippi Valley Division, Project Management/Engineering Division
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
cm/s	centimeter per second
COC	contaminant of concern
COPC	contaminant of potential concern
CR	carcinogenic risk
CSM	conceptual site model
CWCCIS	Civil Works Construction Cost Index System
CY	cubic yard
DAF	dilution attenuation factor
DCGL	derived concentration guideline level
decon	decontamination
DF	dilution factor
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
EA	each
EDTA	ethylene diamine tetraacetic acid
EPC	exposure point concentration
ERA	ecological risk assessment

ACRONYMS AND ABBREVIATIONS (Continued)

ESD	Explanation of Significant Differences
F.E. Loader	front end loader
FFA	Federal Facilities Agreement
Firing Site 12 Area	Firing Sites 9, 10, 11, and 12
Firing Site 6 Area	Firing Sites 6, 7, 8, and 15
FRTR	Federal Remediation Technologies Roundtable
FS	Feasibility Study
FSA	Firing Sites Area
ft	feet
ft^2	square feet
FUSRAP	Formerly Utilized Sites Remedial Action Program
GWS	gamma walkover survey
HHRA	human health risk assessment
HI	hazard index
HMX	octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocane
HOOH	home office overhead
HQ	hazard quotient
hr	hour
HTRW	Hazardous, Toxic and Radioactive Waste
IA	Iowa
IAAAP	Iowa Army Ammunition Plant
in	inch
INEEL	Idaho National Engineering and Environmental Laboratory
IRP	Installation Restoration Program
ITRC	Interstate Technology and Regulatory Council
JMC	U.S. Army Joint Munitions Command
JOOH	job office overhead
LAP	load, assemble, and pack
lb	pound
lcy	loose cubic yard(s)
LLRW	low-level radioactive waste
LLW	low-level waste
LS	lump sum
LUC	land use control
m	meter
m^2	meters square
mil	one thousandth (10^{-3}) of an inch
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MMR	Military Munitions Rule
MNA	monitored natural attenuation
mrem/yr	millirem per year
MSC	Manufacturing Sciences Corporation
mSv	millisievert
NA	not applicable

ACRONYMS AND ABBREVIATIONS (Continued)

NABIR	Natural and Accelerated Bioremediation Research
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NRC	U.S. Nuclear Regulatory Commission
O&M	operation and maintenance
OMB	Office of Management and Budget
ORNL	Oak Ridge National Laboratory
OU	operable unit
pc	piece
PCB	polychlorinated biphenyl
pCi/g	picocuries per gram
PCOC	potential contaminant of concern
PNNL	Pacific Northwest National Laboratory
PP	Proposed Plan
ppm	parts per million
PRG	preliminary remediation goal
PRP	Potentially Responsible Party
QA/QC	Quality Assurance/Quality Control
RA-WBS	Remedial Action – Work Breakdown Structure
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RDX	cyclotrimethylenetrinitramine
Redox	oxidation-reduction
RESRAD	Residual Radioactive Material
RG	remediation goal
RI	remedial investigation
ROD	Record of Decision
S&A	Supervision and Administration
S/S	solidification/stabilization
SGS	Segmented Gate System
SNL	Sandia National Laboratories
TCLP	toxicity characteristic leaching procedure
TEDE	total effective dose equivalent
TNT	2,4,6-trinitrotoluene
TR	target risk
U	uranium
UOM	unit of measure
UPB	Unit Price Book
USACE	U.S. Army Corps of Engineers
USACHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
USAEC	U.S. Army Environmental Center
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
U.S.C.	U.S. Code
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
UUUE	unlimited use and unrestricted exposure

ACRONYMS AND ABBREVIATIONS (Continued)

UXO	unexploded ordnance
WAC	waste acceptance criteria
WHO	World Health Organization
WP	work plan
yr	year

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EXECUTIVE SUMMARY

The U.S. Army Corps of Engineers (USACE), St. Louis District has prepared this Feasibility Study (FS) to identify remedial alternatives for the areas designated in the Formerly Utilized Sites Remedial Action Program (FUSRAP) at the Iowa Army Ammunition Plant (IAAAP). The FUSRAP was initiated by the Atomic Energy Commission (AEC) in 1974 to identify, remediate, or otherwise control sites where residual radioactivity remains from operations conducted for the AEC during the early years of the nation's atomic energy program.

The IAAAP is an active, government-owned, contractor-operated facility that occupies approximately 19,000 acres in Des Moines County near Middletown, Iowa. Since 1941, the IAAAP has produced projectiles, mortar rounds, warheads, demolition charges, and other munitions components for the U.S. Department of Defense (DoD) (and its predecessor, the War Department) as part of its load, assemble, and pack operations. From 1947 to 1975, portions of the IAAAP facility were under the control of the AEC for weapon-assembly operations. Over the years, the IAAAP production and testing operations led to contamination of on-site environmental media. This FS specifically evaluates remedial alternatives for reducing potential human health risk from exposures to contaminated soil and structures at the areas associated with previous AEC activities. There are no potential ecological risks from soil contaminants at the FUSRAP areas. Depleted uranium (DU) is present on the Firing Site Area (FSA) and will be included in the USACE response under FUSRAP in accordance with the December 2006 Dispute Resolution Agreement executed by the Department of the Army and the U.S. Environmental Protection Agency (USEPA) Regional Administrator for Region 7 (U.S. Army 2006). That agreement reflects the application of the Military Munitions Rule [(MMR) See 40 *Code of Federal Regulations (CFR)* §266.200 et. seq.] to the determination of the scope of FUSRAP authority on the firing sites. That is, there is no requirement to respond to explosive constituents and metals contamination on an operational range associated with the range operations. However, because the DU that is present in the FSA is a product of historic AEC operations at this site which are no longer conducted, and DU is not currently used at the FSA on the IAAAP, it may be included in the USACE response in a manner that is consistent with USACE FUSRAP authority.

The soils in the FSA may contain materials that if excavated as part of a remedial action may require handling as a hazardous waste pursuant to the MMR and therefore will be handled as hazardous substances. Any reference to handling/disposal of chemical, metal, or explosive contamination in the FSA 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.

SUMMARY OF REMEDIAL INVESTIGATION AND BASELINE RISK ASSESSMENT

The remedial action alternatives identified and evaluated as part of this FS are based on 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 2008a). The Remedial Investigation (RI) Report presents the findings of soil, sediment, and building characterization activities conducted by the USACE, St. Louis District, at the IAAAP from 2000 through 2007 and the results of a baseline risk assessment (BRA). Additional characterization activities were conducted in 2009 and are described in the Supplemental Investigation Report, which is presented in Appendix A to this FS Report.

Human health dose and risks were calculated and evaluated in the BRA for the potential maximally exposed individual under an industrial land use scenario. The IAAAP is currently an industrialized military installation with limited access to the property. The expected future use of the property is a DoD military installation with industrial (and military) use. Consequently, the BRA identified the IAAAP site industrial worker (i.e., "site worker") and site construction worker as potential receptors based on the complete exposure pathways identified in the conceptual site model under current and future for industrial land use scenarios. These scenarios are consistent with the two existing IAAAP Records of Decision (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 1998a).

In the BRA, the only identified radiological contaminant of concern (COC) was DU. In soil, the DU was found as fragments and particles. DU was also found as particles embedded in and/or adhered to Line 1 structural surfaces. The only chemical COCs identified in soil as exceeding the USEPA's carcinogenic risk (CR) and noncarcinogenic hazard index (HI) criteria for chemical exposures were: 2,4,6-trinitrotoluene (TNT), cyclotrimethylenetrinitramine (RDX), and chromium.

A streamlined Ecological Risk Assessment (ERA) also was performed to evaluate soil chemical exposures to the Indiana bat *(Myotis sodalis),* which is a federally listed endangered species observed utilizing forested areas of the IAAAP. The ERA is presented in Appendix B to this FS Report. The results of the ERA indicate that there are no risks to the Indiana bat.

Based on the evaluated human health (radiological and chemical) and ecological exposure scenarios that assumed current and reasonable/foreseeable future industrial land use in the BRA, chemical and radiological COCs in soil or on structures have been identified for the following FUSRAP areas, with the potentially affected receptors presented in parentheses:

- Line 1 Structures
  - DU (site worker and construction worker).
- Firing Sites 1 and 2 (soil):
  - DU (site worker and construction worker).
- Firing Sites 3, 4, and 5 (soil):
  - DU (site worker and construction worker).
- Firing Site 6 Area (soil):
  - DU (site worker and construction worker),
  - Chromium (site worker and construction worker),
  - RDX (site worker), and
  - TNT (site worker and construction worker).
- Firing Site 12 Area (soil and structures):
  - DU (site worker and construction worker).

Based on the evaluated human health (radiological and chemical) 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 the FUSRAP areas presented in the following set of bullets:

- Firing Site 14 soil,
- FSA structures (except the Firing Site 12 Area),

- Yard C soil and structures,
- Yard G soil and structures,
- Yard L (areas surrounding Warehouses L-37-1, L-37-2, and L-37-3), and
- Warehouse 3-01 structure.

The land use at all FUSRAP areas is expected to remain industrial and therefore, is not expected to become compatible with conditions allowing for unlimited used and unrestricted exposure (UUUE).

Line 1 and West Burns Pads Area (South of the Road): The results of the RI conducted by USACE also concluded that the soil at Line 1 and the West Burn Pads Area (South of the Road) was not radiologically contaminated and therefore was adequately addressed under the two existing IAAAP RODs. [These RODs addressed all non-radiological contamination at the Line 1 and West Burn Pads Area (South of the Road).]

Additional Areas: Three additional areas, consisting of portions of Yard E, Yard F, and the Area West of Line 5B, were radiologically investigated during the FUSRAP RI and found to be non-impacted. As a result, these areas require no further FUSRAP action.

REMEDIAL ACTION OBJECTIVES AND REMEDIATION GOALS

The FS establishes remedial action objectives (RAOs), which are statements that identify the overall goals for human health and environmental protection. The goals are identified to reduce or mitigate exposures to contaminated media through the evaluation, development, and implementation of a range of possible remedial alternatives. RAOs for the FUSRAP areas specify the COCs, contaminated media, and the complete exposure pathways identified in the conceptual site model to be addressed by remediation. RAOs also specify applicable or relevant and appropriate requirements (ARARs) and risk-based criteria to be achieved by residual concentrations as represented by derived numerical remediation goals (RGs). The RAOs for the IAAAP FUSRAP areas are:

- Prevent ingestion, dust inhalation, and external gamma radiation exposures to isotopes of DU in the FSA soil that could otherwise result in cumulative CRs exceeding 1×10^{-4} and radiological doses exceeding 25 millirem per year (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 1×10^{-4} and a total effective dose equivalent exceeding 25 mrem/yr.

Industrial RGs for soil and structures (Table ES-1) were developed based on the results of the BRA (USACE 2008a), the RAOs, and a review of potential chemical-specific ARARs. The human health RG for DU in soil was selected as the lesser of the derived concentration guideline levels based on a target dose of 25 mrem/yr and the USEPA target CR of 1×10^{-4} for industrial site worker exposures to DU. The industrial structural surface RG for DU was derived as the lesser of a dose-based derived concentration guideline level targeting a cumulative dose limit of 25 mrem/yr or a risk-based derived concentration guideline level of 1×10^{-4}.

It should be noted that the RAOs do not include the remediation of radionuclides and chemicals already present in ground water as this is outside the scope of FUSRAP at the IAAAP. Ground-water contamination is being addressed by the U.S. Army.

Table ES-1. Remediation Goals for Human Health

Contaminants of Concern	RG
Soil	
DU	150 pCi/g [a]
Structures	
DU	23,000 dpm/100 cm^2

[a] Industrial human health risk-based RG for soil.
dpm/100 cm^2 = disintegrations per minute per 100 square centimeters; pCi/g = picocuries per gram.

SUMMARY OF REMEDIAL ALTERNATIVES

The purpose of this FS is to develop and evaluate remedial alternatives in order to meet the FUSRAP RAOs. The process of developing remedial alternatives included the identification of potential remedial technologies and process options of both conventional and innovative technologies. The remedial technologies and process options were then subjected to an initial screening based on their ability to satisfy the RAOs and the feasibility of technical implementation at the IAAAP. Several technologies and process options were screened out as a result of this initial evaluation.

The retained technologies and process options were combined to form four remedial action alternatives for soil and three remedial action alternatives for structures. Emphasis was placed on the development of remedial alternatives that ensure adequate protection of human health and the environment; achieve ARARs; and permanently and significantly reduce the volume, toxicity, mobility, or exposure of site-related contaminants. The FUSRAP area alternatives are as follows:

- **Remedial Alternatives for Soil:**
  - **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, and
  - **Alternative 4:** Excavation of Depleted Uranium Contaminated Soil with Physical Treatment and Off Site Disposal.
- **Remedial Alternatives for Structures:**
  - **Alternative S1:** No Action for Structures,
  - **Alternative S2:** Land Use Controls for Structures, and
  - **Alternative S3:** Decontamination/Replacement of Structures.

Remedial Alternatives for Soil

The following alternatives were evaluated to address the contamination in soil. Each alternative would need to be combined with one of the alternatives for structures to create a remedial action addressing soil and structural surface contamination at the FUSRAP areas.

Alternative 1: No Action for Soil

Under Alternative 1, no remedial actions would be implemented at the FUSRAP areas. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) [40 *CFR* §300.430(e)(6)] requires a no action alternative be evaluated as a baseline for comparison to

other remedial alternatives. Contaminated soil would be left in place, the existing IAAAP 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 soil.

Alternative 2: Land Use Controls for Soil

Alternative 2 includes land use controls to reduce the potential for exposure to contaminated soil. This alternative involves leaving contamination in place above the industrial RG for soil and is protective of human health as long as industrial land use continues. Land use controls, including access and use restrictions, would be used in areas where DU is present in soil at concentrations exceeding the RG. Existing controls include use restrictions and outgrants administered by the U.S. Army as part of its land management responsibilities. Under this alternative, additional land use controls would be implemented, which would include specific prohibitions against any actions that would disturb the soil at the FSA. Alternative 2 is one of the least costly alternatives because the contaminated soil would be left on-site. Five-year reviews would be conducted, pursuant to Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), for areas that are contaminated at levels not allowing for UUUE. Each five-year review would verify the continued industrial land use of the IAAAP and FUSRAP areas.

Alternative 3: Excavation of DU-Contaminated Soil with Off Site Disposal

The specific components of Alternative 3 include excavation of DU-contaminated soil where it exceeds the industrial RG for DU (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 estimated total volume of soil that would be excavated is 16,941 in-situ cubic yards. There is no physical treatment of DU prior to off-site disposal. Soil exceeding the industrial RG would be disposed of by transfer to a properly permitted off-site disposal facility.

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. Personnel qualified in the removal of unexploded ordnance (UXO) will provide the required equipment and instruments as necessary to properly address any UXO encountered during remediation in accordance with Engineer Pamphlet 75-1-2, *UXO Support During Hazardous, Toxic and Radioactive Waste (HTRW) and Construction Activities*. All waste transport for off-site disposal will be compliant with existing Department of Transportation regulations.

No excavation activities would be required at Yards C, G, and L and Firing Site 14.

Industrial land use will be continued for the foreseeable future and verified with the CERCLA 121(c) five-year reviews, which are required under this alternative for those areas that do not achieve UUUE.

Alternative 4: Excavation of DU-Contaminated Soil with Physical Treatment and Off Site Disposal

Alternative 4 includes excavation of DU-contaminated soil (as identified above). DU-contaminated soil would be treated using the physical method of soil sorting (e.g., soil sorting and radiological scanning). An on-site pilot-scale demonstration of the physical treatment system would be conducted prior to full-scale remediation activities. Soil exceeding the industrial RG would be disposed of by transfer to a properly permitted off-site disposal facility.

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. Personnel qualified in the removal of UXO will provide the required equipment and instruments as necessary to properly address any UXO encountered during remediation in accordance with Engineer Pamphlet 75-1-2. All waste transport for off-site disposal will be compliant with existing Department of Transportation regulations.

No excavation activities would be required at Yards C, G, and L and Firing Site 14.

Industrial land use will be continued for the foreseeable future and verified with the CERCLA 121(c) five-year reviews, which are required under this alternative for those areas that do not achieve UUUE.

Remedial Alternatives for Structures

The following alternatives were evaluated to address the DU contamination on structures. Each alternative would need to be combined with one of the previously identified alternatives for soil contamination to create a remedial action addressing soil and structural surface contamination at the FUSRAP areas.

Alternative S1: No Action for Structures

Under Alternative S1, no remedial actions would be implemented for the contaminated structures exceeding the industrial RG at the FUSRAP areas. The NCP [40 *CFR* §300.430(e)(6)] requires a no action alternative be evaluated as a baseline for comparison to other remedial alternatives. The contaminated structures would be left in place, the existing IAAAP 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.

Alternative S2: Land Use Controls for Structures

Alternative S2 includes the use of land use controls for structures and is protective as long as the controls are in place. This alternative involves leaving contamination in place above the industrial RG. It imposes additional land use controls to reduce the potential for exposure to contaminated structures (as well as maintaining existing industrial land use). Under this alternative, land use controls would be added, which would include restricted use of structures or establishment of no-entry zones.

Five-year reviews would be conducted in accordance with CERCLA 121(c) for areas where contaminants are left above levels acceptable for UUUE.

Alternative S3: Decontamination/Replacement of Structures

Alternative S3 includes using physical methods (such as high pressure washing, cleansing, grit blasting, or scabbling) to remove contamination from structural surfaces and/or the replacement of the structural components. Structural surfaces would be decontaminated until residual radioactivity meets the industrial RG. Structural surfaces would be surveyed after remediation to measure residual radioactivity. Industrial land use would continue for the foreseeable future.

Based on elevated gross alpha and beta activities, 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 currently located within inactive areas of Line 1, exceeded the DU RG for structures. Under Alternative S3, the contaminated air filters would be removed and replaced and the steel floor grate covering the

sump would be decontaminated and, if methods fail to successfully decontaminate the grate, it would 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.

Structures would be included in five-year reviews if they exceed levels appropriate for UUUE. Industrial use would be verified during the five-year reviews.

DETAILED EVALUATION OF ALTERNATIVES

The FUSRAP area alternatives were evaluated using the nine CERCLA evaluation criteria established in Section 300.430(e)(9)(iii) of the NCP. The nine criteria are grouped into three categories (i.e., threshold, balancing, and modifying criteria) based on their level of relative importance.

Threshold Criteria

Threshold criteria include *Overall Protection of Human Health and the Environment* and *Compliance with ARARs* and must be satisfied for a remedial action alternative to be considered a viable remedy. On the basis of the detailed evaluation, each of the soil alternatives, except Alternative 1, is protective of human health. Alternatives 3 and 4 rely on soil removal to provide an effective and permanent remedy for the FUSRAP areas. For Alternatives 2, 3, and 4, human health is protected as long as land use remains industrial. Alternatives 1 and 2 result in the highest levels of contamination remaining on-site. Alternatives 3 and 4 provide the greatest long-term protection to human health because soil is removed to achieve the DU RG. Alternatives 3 and 4 comply with all ARARs; however Alternatives 1 and 2 do not comply with chemical-specific ARARs. Alternative 2 does not comply with 10 CFR 20.1403(e)(1), which requires that residual radioactivity at the site be reduced so that if the institutional controls were no longer in effect, the annual dose to an average member of the critical group is ALARA and would not exceed 100 mrem/yr.

Each of the remedial alternatives for structures, except Alternative S1, is protective of human health. Alternative S1 does not prevent potential exposures to contaminated structures. 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 S3 (decontamination/replacement of structures) provides the greatest overall protection to human health and the environment because contamination on structural surfaces is removed. Two of the remedial alternatives for structures, S1 (no action) and S2 (land use controls), do not comply with ARARs. Alternative S3 (decontamination/replacement of structures) would reduce potential future doses below the 25-mrem/yr level and would achieve doses that are as low as reasonably achievable.

Primary Balancing Criteria

Primary balancing criteria include *Long-Term Effectiveness and Permanence; Short-Term Effectiveness and Environmental Impacts; Reduction of Toxicity, Mobility, or Volume through Treatment; Implementability;* and *Cost.* The primary balancing criteria identify major trade-offs among alternatives.

Alternatives 3 and 4 are the most effective and permanent soil remedies because they involve the removal of DU-contaminated soil. Alternative 2 relies solely on land use controls to reduce exposures and has a lesser degree of long-term effectiveness and permanence. The least permanent 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 contaminated surfaces would not be decontaminated or removed.

Alternative 4 provides a reduction in contaminant volume and mobility through treatment. The remaining alternatives (Alternatives 1, 2, 3, S1, S2, and S3) do not use treatment to reduce the toxicity, mobility, or volume of contaminants in the media.

With respect to short-term effectiveness, Alternatives 1 and 2 rate higher than Alternatives 3 and 4 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 present at the location, potentially destroys habitat or food available to animals, and may temporarily create non-point 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.

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 high 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.

The estimated total 30-year costs in U.S. dollars ($) for the soil alternatives are listed in Table ES-2.

Table ES-2. Comparison of Costs for Remedial Alternatives for the Formerly Utilized Sites Remedial Action Program Areas

Alternatives for Soil	
Alternative	**Estimated Cost**
1	$0
2	$2,332,013
3	$50,401,517
4	$45,172,033

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. Alternative S1 is rated the lowest in administrative implementability. Alternative S2 involves the implementation of land use controls and so is administratively more complex than Alternative S3.

The estimated total 30-year costs for the structures alternatives are listed in Table ES-3.

Table ES-3. Comparison of Costs for Remedial Alternatives for the Formerly Utilized Sites Remedial Action Program Areas

Alternatives for Structures	
S1	$0
S2	$285,772
S3	$102,961

Modifying Criteria

State and community acceptance of the alternatives will be established as part of the CERCLA public participation process. A summary of the remedial alternatives and the preferred remedy will be presented in the Proposed Plan, which will be available for public review during the public comment period. Community acceptance will be evaluated following review of comments on the FS and Proposed Plan received during the public comment period.

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1.0 INTRODUCTION

The Iowa Army Ammunition Plant (IAAAP) (formerly the Iowa Ordnance Plant) is an active, government-owned, contractor-operated facility that occupies approximately 19,000 acres in Des Moines County near Middletown, Iowa. The IAAAP is located approximately 10 miles west of Burlington, Iowa, and the Mississippi River (Figure 1-1). The IAAAP is under the command of the U.S. Army Joint Munitions Command (JMC), Rock Island, Illinois. Since 1941, the IAAAP's mission to load, assemble, and pack (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 Atomic Energy Commission (AEC) for nuclear weapons and non-nuclear additional weapon-assembly operations. Throughout the remaining years, the IAAAP tested, assembled, and disassembled a wide variety of weapons. Entities that have operated the IAAAP include Day & Zimmerman Corporation (1941 to 1946); the U.S. Army (1946 to 1951); Mason and Hanger Corporation (1951 to 1998); and American Ordnance, LLC (since 1998). Over the years, some IAAAP operations led to contamination of on-site environmental media.

1.1 REGULATORY OVERVIEW

The Formerly Utilized Sites Remedial Action Program (FUSRAP) was initiated by the AEC in 1974 to identify, remediate, or otherwise control sites where residual radioactivity remains from operations conducted for the AEC during the early years of the nation's atomic energy program. Congress transferred the responsibility for administration and execution of cleanup at eligible FUSRAP areas from the U.S. Department of Energy (DOE) to the U.S. Army Corps of Engineers (USACE) in 1997.

On July 14, 1989, the IAAAP was proposed for inclusion on the U.S. Environmental Protection Agency's (USEPA's) National Priorities List pursuant to Section 105 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986 due to surface water contaminated with explosives leaving the IAAAP boundary. The IAAAP was added to the National Priorities List in August 1990. In September 1990, the U.S. Army and USEPA Region VII entered into a Federal Facilities Agreement (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 U.S. Department of Defense (DoD) Installation Restoration Program (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, 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 USACE to be under FUSRAP and, therefore, were subsequently removed from the DoD IRP (U.S. Army 2007).

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 was finalized on August 16, 2006, between USACE, St. Louis District; USEPA Region VII; DOE; and the state of Iowa to address FUSRAP investigatory and cleanup work at the IAAAP. The scope of this project, as defined in the FFA, "covers response actions at 7 areas associated with AEC activity." The seven areas that are defined in the FFA are Line 1; the Firing Sites Area [(FSA) consists of five subareas]; the West Burn Pads Area (South of the Road); Warehouse 3-01 (interior); Yard G; Yard C; and Yard L Areas surrounding Warehouses L-37-1, L-37-2, and L-37-3 (USEPA et al. 2006).

According to the 2006 FFA, 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 on or from the IAAAP, including such contamination associated with the seven areas identified as FUSRAP areas, are considered outside the scope of FUSRAP and shall be addressed pursuant to the 1990 (IAAAP/U.S. Army) FFA. The FFA also specified that other areas beyond those identified in the 2006 FFA may be added to the list of FUSRAP areas if it is determined that they contain contamination resulting from AEC activities (USEPA et al. 2006).

The remedial investigation (RI) was conducted by USACE, St. Louis District beginning in 2006 to define the nature and extent of contaminants in soil and structures at the FUSRAP areas. The results of the 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 2008a). Human health dose and/or risks were calculated and evaluated in the BRA for the potential maximally exposed individual under the current and expected future land use scenario. 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. Existing land use controls include use restrictions and the outgrants administered by the U.S. Army as part of its land management responsibilities. The expected future use of the property is a DoD military installation with industrial (and military) use. Therefore, the BRA identified the IAAAP site industrial worker (i.e., "site worker") and site construction worker as potential human receptors based on complete exposure pathways as identified in the conceptual site model (CSM). These scenarios are consistent with the two existing IAAAP Records of Decision (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 1998a). Additional characterization activities were conducted in 2009 in support of the FUSRAP RI and are described in the Supplemental Investigation Report in Appendix A.

The results of the RI conducted by USACE concluded that the soil at Line 1 and the West Burn Pads Area (South of the Road) was not radiologically contaminated and, therefore, these areas are being addressed under the two existing IAAAP RODs. Therefore, the soil at Line 1 and the West Burn Pads Area (South of the Road) is not included in the scope of this Feasibility Study

(FS). Structures remaining at Line 1 and used by AEC were evaluated for depleted uranium (DU) surface contamination as part of this FUSRAP RI/FS.

Three additional areas, consisting of portions of Yard E, Yard F, and the Area West of Line 5B, were identified on a map depicting "Facilities That Were Used by the Former Burlington A.E.C. Energy Research and Development Administration Plant" in the U.S. Army Toxic and Hazardous Materials Agency's (USATHAMA's) *Installation Assessment of Iowa Army Ammunition Plant, Report No. 127* (USATHAMA 1980). These three areas were investigated during the FUSRAP 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.

DU is present on the FSA and will be included in the USACE response in accordance with the FFA, §7.H (USEPA et al. 2006), and the Dispute Resolution Agreement executed by the Department of the Army and the U.S. Environmental Protection Agency (USEPA) Regional Administrator for Region VII (U.S. Army 2006). That agreement reflects that materials on operational ranges are not hazardous substances under CERCLA in accordance with 40 *Code of Federal Regulations (CFR)* §266.200, commonly known as the Military Munitions Rule (MMR). However, because the DU that is present in the FSA is a product of AEC operations of the site and DU is not currently used at the IAAAP, it can be included in the USACE response in a manner that is consistent with USACE FUSRAP authority. The soils in the FSA may contain materials that if excavated as part of a remedial action may require handling as a hazardous waste pursuant to the MMR and therefore will be handled as hazardous substances. Any reference to handling/disposal of a chemical, metal or explosive contamination in the FSA 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.

1.2 PURPOSE AND SCOPE

The purpose of this FS is to develop and assess remedial alternatives to mitigate sources of potential risk to human health and the environment due to the presence of hazardous substances in soil and structures within the FUSRAP areas of the IAAAP. Remedial action objectives (RAOs), and remediation goals (RGs) were developed to minimize threats to human health and the environment by eliminating, reducing, or otherwise mitigating the potential hazards associated with AEC-related contaminants.

The scope of this FS was to provide a complete evaluation of site conditions and alternatives available at this time for the following areas:

- Line 1 Structures,
- FSA (consisting of five subareas),
- Yard C,
- Yard G,
- Yard L (areas surrounding Warehouses L-37-1, L-37-2, and L-37-3) and,
- Warehouse 3-01.

In accordance with the FFA, ground-water and surface-water contamination on or from the IAAAP is considered outside the scope of FUSRAP. Ground-water contamination is being addressed by the U.S. Army.

This FS was conducted in accordance with USEPA's *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (USEPA 1988a). The CERCLA FS process uses the results of the FUSRAP RI and BRA to:

1) Identify RAOs that specify contaminants and media of concern, potential exposure pathways, and RGs based on applicable or relevant and appropriate requirements (ARARs) and/or protection of human health or the environment.
2) Identify applicable remediation technologies based on implementability, effectiveness, and cost.
3) Assemble suitable technologies into a range of remedial actions (alternatives) and analyze the alternatives based on overall protection of human health and the environment; compliance with ARARs; long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; cost; and state and community acceptance.

1.3 REPORT ORGANIZATION

Section 1 of this report presents an introduction to the IAAAP, provides a regulatory overview of the FUSRAP and CERCLA status, and identifies the purpose and scope of this study. Section 2 describes the IAAAP, its history, the affected environment, the nature and extent of contamination, and provides a summary of the findings of the RI (including the Supplemental Investigation Report) and the BRA. Section 3 identifies the RAOs and ARARs for the affected areas under FUSRAP at the IAAAP, identifies the proposed industrial RGs for the contaminants found, estimates volumes of contaminated media, and presents the initial screening of remediation technologies. Section 4 provides a description and the evaluation of the remedial action technologies and assembles the technologies into site-specific remedial action alternatives. Section 5 provides a detailed analysis of the remedial action alternatives using the CERCLA-defined criteria. Section 6 presents a comparative analysis of the alternatives and an evaluation of the alternatives in relation to CERCLA requirements for the RI/FS decisions. Section 7 contains the references used in preparation of this report. The appendices to this FS present the Supplemental Investigation Report (Appendix A), Supplemental Ecological Risk Evaluation (Appendix B), documentation for the Development of Remediation Goals (Appendices C and D), Detailed Information for Cost Analysis of the Remedial Alternatives (Appendix E) and the Ground-water Transport Calculations for the Firing Site 6 Area (Appendix F).

1.4 COORDINATION WITH OTHER AGENCIES

The U.S. Army, acting through USACE, is the lead agency for the development of this FS, in accordance with §611(a)(4) of Public Law 106-60 (Sept. 29, 1999) and the 2006 FFA (USEPA et al. 2006). USACE coordinated with USEPA Region VII and the state of Iowa prior to publication of the FS. In addition, USACE will coordinate with the U.S. Fish and Wildlife Service (USFWS) regarding potential impacts to natural resources that may occur as a result of implementation of remedial alternatives. The general public is encouraged to participate in the decision-making process for the FUSRAP efforts at the IAAAP. A Proposed Plan (PP) will be issued in accordance with CERCLA requirements to identify USACE's preferred remedial alternative from those evaluated in this FS and to solicit public input on the remedial action decision prior to the release of the ROD.

2.0 SITE DESCRIPTION

2.1 SITE LOCATION AND OPERATIONAL HISTORY

The IAAAP is an active, government-owned, contractor-operated facility engaged in LAP of large-scale ammunition, including projectiles, mortar rounds, mines, and warheads. The IAAAP has several LAP operations lines and ammunition storage yards (along with other miscellaneous operations) spread across more than 19,000 acres (Figure 2-1). All of the IAAAP land is currently owned and under the control of the U.S. Army, although portions of the facility were previously under control of other tenant organizations, including AEC. Use restrictions and outgrants administered by the U.S. Army as part of its land management responsibilities limit the IAAAP to industrial/military land use. Currently, American Ordinance LLC is the government contractor at IAAAP and manufactures a wide variety of artillery and tank munitions for the United States. Less than 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) (IAAAP 2006). Past munitions production at the IAAAP has resulted in contamination of soil and ground water and discharges of waste water containing explosives and their byproducts to surface water (USACE 1998a).

USATHAMA's installation assessment of the IAAAP indicated that, prior to the construction of the IAAAP, the area was primarily farmland (USATHAMA 1980). In November 1940, the area was acquired by the Office of the Quartermaster General as the site for the Iowa Ordnance Plant. Since operations began in 1941, the site has used explosives and lead-based initiating compounds to produce a wide variety of ordnance items. Beginning in 1949, portions of the Iowa Ordnance Plant were used by AEC to fabricate explosive components for nuclear weapons. The Line 1 Area, Warehouse 3-01, West Burn Pads Area (South of the Road), portions of the FSA, and Yards C, G, and L came under AEC's jurisdiction in 1947. Collectively, these AEC areas were operated as the Burlington Atomic Energy Commission Plant. In March 1949, it was decided that certain weapon-assembly operations (non-nuclear components) would also be conducted at the site (Poole and Harrison 1954; Mitchell 2003). The Burlington Atomic Energy Commission Plant, as well as the remaining portions of the Iowa Ordnance Plant, were collectively renamed the IAAAP in 1963.Throughout the remaining years, the IAAAP has tested, assembled, conducted surveillance of, and disassembled a wide variety of weapons.

A brief overview of each of the properties addressed by this FS is presented below. Detailed descriptions and the operational histories of these sites are presented in Appendix C of the *Remedial Investigation Work Plan for Line 1, Firing Sites Area, Yards C, G, and L, Warehouse 3-01 and the West Burn Pads Area South of the Road* (USACE 2007a).

2.1.1 Line 1 Description and Operational History

The Line 1 production facility is located within the IAAAP boundaries in the northeast portion of the property (Figure 2-1). The Line 1 area is approximately 1 mile long, covers 173 acres [700,106 square meters (m^2)], 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. Shells produced at Line 1 during this time contained a mixture of 2,4,6-trinitrotoluene (TNT) and ammonium nitrate explosives. After production ceased at the line, buildings were washed down with hot water, steam, and unknown solvents where necessary (TN and Associates, Inc. 2001). In 1945, Line 1 was placed in extended storage status.

AEC took over operations at Line 1 for weapons assembly from 1947 to 1975. Existing Line 1 buildings were modified, and new facilities were constructed to support the additional weapons-production operations. 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) (USEPA et al. 2006). In January 1950, ortho- and para-nitrotoluene were introduced during the melting process to prevent outer component cracks (TN and Associates, Inc. 2002). In addition, several Line 1 buildings were used for shipping and receiving raw materials used in assembling ordnance. AEC operations at Line 1 included machining of DU (USEPA et al. 2006).

AEC continued explosives-machining operations while producing explosives casts for weapons until the process was replaced by the pressing of plastic explosives into molds. In 1975, AEC surveyed the affected buildings for radiological contamination before releasing them back to the U.S. Army for on-going use. Portions of Line 1 are currently used for munitions production. Forty-one buildings at Line 1 that were known or suspected to be used by AEC were surveyed for radiological contamination as part of the FUSRAP RI.

2.1.2 Firing Sites Area Description and Operational History Summary

The FSA is a fenced site 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 2-1). Individual firing sites are located within the FSA and are grouped by proximity into five firing site areas (Figure 2-2) as specified below:

- Firing Sites 1 and 2;
- Firing Sites 3, 4, and 5;
- Firing Site 6 Area (Firing Sites 6, 7, 8, and 15);
- Firing Site 12 Area (Firing Sites 9, 10, 11, and 12); and
- Firing Site 14.

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. The FSA is currently an operational testing range being used by the U.S. Army to test military munitions (U.S. Army 2006). Historically, munitions containing DU were tested at the site. Munitions containing DU, however, are no longer tested at the FSA.

2.1.2.1 Firing Sites 1 and 2

The Firing Site 1 and Firing Site 2 areas are each comprised of one building, the surrounding land, and the entrance road to both areas located at the access point to the FSA (Figure 2-3). 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. No test firing has been conducted at Firing Sites 1 or 2.

Although historical investigations did not produce any evidence that radiological materials, explosives, or solvents were handled at either of these buildings (TN and Associates, Inc. 2002), Firing Sites 1 and 2 were investigated as part of the FUSRAP RI/FS because the entire FSA was under AEC's control. Because Firing Site 1 is located in close proximity to Firing Site 2, they were combined into one area to facilitate the investigation.

2.1.2.2 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 (TN and Associates, Inc. 2002). These three sites (Figure 2-4) were grouped for evaluation due to their proximity to one another and because the buildings were used for storage of munitions and radiological materials. Firing Site 5 was also a general-purpose storage magazine, but components for hydro-shots also were assembled there 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.

2.1.2.3 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 2-5). 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 Composition B (a mixture of TNT and RDX) and barium nitrate. Some other tests conducted at Firing Site 6 involved explosive components that contained a thin sheet of DU. The DU was expected to be pulverized and dispersed by the wind during these tests. The quantity of these tests conducted at Firing Site 6 is unknown. There is little known information available on Firing Site 15 due to operational security during AEC operations (USACE 2001). The Firing Site 6 Area is currently used for test firing of munitions for the IAAAP.

2.1.2.4 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 2-6), which were constructed by AEC in 1969. At Firing Site 9, an abandoned concrete underground observation bunker is present. Firing Site 11 contained an underground high explosive supply magazine, and remnants of an underground bunker were also found during a site walkover conducted by TN and Associates, Inc., in November 2000. Firing Site 12 was used as an ordnance testing area for munitions and contains a concrete observation bunker and concrete firing pad. 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).

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 for plastic-bonded explosives produced at the IAAAP. Approximately 4,000 kilograms [8,820 pounds (lbs)] of DU were associated with 701 hydro-shots used at the Firing Site 12 Area [Agency for Toxic Substances and Disease Registry (ATSDR) 2003].

Decontamination activities were conducted by the Mason and Hanger – Silas Mason Company, Inc., in 1974. This effort consisted of removing soil at ground zero to a depth of 15 feet (ft), removing the top 1 to 2 inches (in) of soil at an approximate radius of 30 to 50 ft around ground zero, and plowing a portion of the remaining Firing Site 12 Area. The contaminated soil was sent to a commercial landfill site at Sheffield, Illinois, for disposal (TN and Associates, Inc. 2002, USATHAMA 1980). AEC returned the FSA to U.S. Army control in July 1975. From 1975 to November 2000, the U.S. Army used the Firing Site 12 Area for testing conventional weapons

that did not contain DU (i.e., artillery shells, mines, and missiles). The U.S. Army halted all testing at the Firing Site 12 Area in November 2000 upon the discovery of DU. Subsequent investigations identified numerous DU fragments on or near the surface at the area. The DU contamination appears to be the result of the hydro-shots, because DU fragments found at the Firing Site 12 Area resemble portions of the DU ring used in this test. During an aerial radiological survey that was conducted over the entire IAAAP in October 2002, the Firing Site 12 Area was identified as one of several areas exhibiting elevated radioactivity.

2.1.2.5 Firing Site 14

Firing Site 14 is located in the southern portion of the FSA and was used as a test firing range by AEC (Figure 2-4). 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 Descriptions and Operational History Summaries

2.1.3.1 Yard C

Yard C is located in the eastern portion of the IAAAP and is approximately 301 acres (1,218,291 m^2) in size (Figure 2-1). 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.

In 2000, DOE performed a limited radiological survey of Yard C Building 23-53 (the main support building) and igloos 23-1, 23-2, and 23-3, and no radioactive contamination was found [Oak Ridge National Laboratory (ORNL) 2001]. No evidence was found to indicate that any releases of contaminants had occurred at Yard C. Prior to its departure in July 1975, the AEC performed a closeout survey of the 43 igloos in Yard C and found no detectable radiological contamination above background levels (USACE 2001). The aerial radiological survey conducted at the IAAAP during October 2002 did not detect any anomalies at Yard C (JMC 2003). Yard C is currently in use by the U.S. Army.

2.1.3.2 Yard G

Yard G is located in the southern portion of the IAAAP and is approximately 259 acres (1,048,103 m^2) in size (Figure 2-1). Yard G is located in a heavily forested valley of Long Creek and consists of a looped main access road leading to individual igloos situated on small and relatively flat areas for each igloo, loading dock, and associated driveway. Within Yard G, the land rises rapidly behind each igloo and drops steeply from the edge of the access road toward Long Creek at the bottom of this area.

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. No radioactive components were reportedly stored at Yard G. The aerial radiological survey conducted at the IAAAP during October 2002 did not detect any anomalies at Yard G (JMC 2003). Yard G is currently in use by the U.S. Army.

2.1.3.3 Yard L

Yard L is located approximately 1,000 ft south of the northern boundary of the IAAAP (Figure 2-1). Yard L consists of long buildings that run in an east-to-west orientation with railroad tracks that also run along the buildings for access. In general, Yard L is flat with little change in topography. 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. A 2003 reconnaissance survey by USACE concluded that there was no indication of radiological contamination on the interior or exterior portions of the buildings (USEPA et al. 2006). Yard L is currently in use by the U.S. Army.

2.1.4 Warehouse 3-01 Description and Operational History Summary

Warehouse 3-01 is located in the central portion of the IAAAP in the north-central area of Line 3 (Figure 2-1). Warehouse 3-01 consists of a large brick building and surrounding land of approximately 0.64 acres (2,608 m^2). There is little written historical documentation concerning the operational history of Warehouse 3-01. Information obtained from the project history of Line 1 indicates that Warehouse 3-01 was used as part of AEC operations (Mason and Hanger – Silas Mason Co. Inc. 1956). Site documentation also indicated that Warehouse 3-01 was re-activated for temporary warehousing of overflow items from Building 1-11 at Line 1 (Mason and Hanger – Silas Mason Co. Inc. 1959). The aerial radiological survey conducted at the IAAAP during October 2002 did not detect any anomalies at Line 3 (JMC 2003). Warehouse 3-01 is currently in use by the U.S. Army.

2.2 ENVIRONMENTAL SETTING

The IAAAP is located near the city of Middletown, in the extreme southeast corner of Iowa (Figure 1-1), in Des Moines County. Middletown, Iowa, is located at Latitude 40°49’41”N and Longitude 91°15’37”W. Burlington, Iowa, is the county seat for Des Moines County and is located approximately 10 miles to the east of Middletown. According to the 2000 Census, the population of Des Moines County was 42,351 and the population of Burlington was 25,579 (U.S. Census Bureau 2009). The city of Middletown occupies a total area of 0.6 square miles and has a population of 535 residents or approximately one percent of the population of Des Moines County (U.S. Census Bureau 2009).

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). According to the 2000 Census, approximately 35 percent (%) of the residents of Middletown are employed in professional or office related positions, 28% are employed in production, transportation, or manufacturing industries, 14% are construction, and 23% are in service industries. Additionally, less than one percent (2 people) is employed in agriculture, forestry, fishing, and, hunting industries (U.S. Census Bureau 2009).

The IAAAP experiences climate typical of the Midwest where winters are cold and wet followed by hot and humid summers. The mean annual temperature for this area is 51.8 degrees Fahrenheit (^oF) with a minimum recorded temperature of -27^oF and a maximum recorded temperature of 111^oF. Annual average precipitation is 40.6 in and is generally well distributed throughout the year (USACE 2008a).

2.2.1 Geology and Hydrogeology

The IAAAP is located within the Southern Iowa Till Plains section of the Central Lowland Province Drift Plain Region, is gently undulating terrain due to continental glaciation, and is incised with dendritic drainage patterns. 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. There are three main creeks (Brush, Long, and Spring Creeks) along with unnamed tributaries feeding these streams. The topographic elevation of the IAAAP ranges from a high point 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 facility is underlain by a sequence of unconsolidated Pleistocene deposits including loess and thick glacial tills overlying sedimentary bedrock units. The surface soil in the area is predominantly silt loams and silty clay loams derived from the underlying loess and till deposits. The surface soil generally consists of between 95 to 100 % 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% of the fine-grained material is clay-sized.

The loess consists of fine-grained, poorly to well-sorted materials, and ranges in depth from approximately 6 to 15 ft. The Kellerville Till Member of the Glasford Formation underlies the loess and is comprised mostly of silty clay and clayey silt with thin sand seams and lenses. It extends to depths exceeding 100 ft in some areas of the northern portion of the facility. However, the till thins considerably and is locally absent to the northeast and in deeper stream valleys to the south around Mathes Lake (USACE 2001).

According to the Iowa Geologic Survey, the Kellerville Till is subdivided into superglacial and subglacial (i.e., basal) till facies, based on stratigraphic relations, sedimentological properties, and the consistency-density-consolidation properties of deposits. The basal till unit is described as silty clay, gray to yellowish-brown in color, with a trace to little sand (USACE 2001).

The underlying bedrock of the IAAAP ranges in age from Cambrian to Mississippian and is comprised of a sequence of limestones interbedded with varying thicknesses of shales and sandstones. The uppermost bedrock unit underlying the facility is associated with the Southern Iowa Mississippian Osage Series. This series is composed mostly of cherty limestones interstratified with small amounts of shale. The Osage Series is divided into the Warsaw Formation, Keokuk Limestone, and Burlington Limestone. The Warsaw Formation consists primarily of blue-gray calcareous shales, fragmented and fossiliferous dolomitic limestone, and calcarenites (TN and Associates, Inc. 2001). The site is considered to be located in an area relatively free of earthquake activity.

There are two main aquifers underlying the IAAAP: the drift aquifer (loess/till) and the underlying upper bedrock aquifer. The drift aquifer is comprised of shallow, relatively confined, sandy silt/silty sand deposits in the floodplain and adjacent till terraces of Brush Creek. The ground-water surface in the drift aquifer across the IAAAP roughly occurs within 10 ft below ground surface (bgs). Shallow ground-water flow 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 (Figure 2-1). 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). The IAAAP does not use

ground water as potable water. IAAAP purchases potable water from the Burlington Municipal Waterworks, a public utility located in and run by the City of Burlington, Iowa. IAAAP distributes water from the Burlington Municipal Waterworks to the City of Middletown, City of Danville, and the U.S. Army Reserve Center (CH2M Hill 2007).

The early Illinoian Kellerville Till is distinguished from older pre-Illinoian till by its high dolomite and illite content, which tends to harden due to the mineral matter filling the interstitial spaces. This hardened mineral matter reduces the porosity of the till. Laboratory analysis of an undisturbed sample (monitoring well JAW-51) of the till collected via Shelby tube at a depth of 19.5 to 21.5 ft bgs determined the till has a vertical hydraulic conductivity of 5.8×10^{-9} centimeters per second (cm/s). A slug test of the aquifer was performed near Line 1 (well G-14) that estimated the horizontal hydraulic conductivity to be 8.5×10^{-4} cm/s. In general, ground water in tills flows horizontally through higher hydraulically conductive zones in near-surface units with low vertical hydraulic conductivity (USACE 2001).

Most of the surface water across 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 2-1). 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.

2.2.2 Ecological Resources

Forest, agricultural land, roadside, riparian, and other habitats suitable for terrestrial and aquatic species exist throughout the IAAAP (TN and Associates, Inc. 2002). The forested habitat at IAAAP is upland forest dominated by oak (*Quercus* spp.) and hickory (*Carya* spp.) species. This type of forest is typified by gently rolling plains with steep bluffs bordering some valleys. Floodplain forests occur within the lower valleys and floodplains of Long, Brush, and Spring creeks. Hill prairies occur on dry, well-drained silt loam and clay loam soils of steep bluffs and ridge crests and appear as openings in oak-hickory forests. Grasses were once the dominant native vegetation; however, due to the favorable climate and soils, most tall grass prairie lands were cultivated, and little native vegetation remains (IAAAP 2006).

Agricultural leasing is the major commercial land use on IAAAP dating back to 1945. There are 43 agricultural row crop leases (one for hay production only) encompassing about 5,532 acres on the IAAAP (IAAAP 2006). Primary crops are corn and soybeans. Other crops include alfalfa hay and small amounts of wheat and oats. Most sites can be continually row-cropped. Rotational farming practices have been established on agriculture fields on IAAAP, and no-till farming is practiced. There are 10 leases where cattle grazing and/or haying can be conducted, which consist of about 1,575 acres of the installation. Two areas are hay-only areas due to the susceptibility of earth-covered magazines to damage by cattle. All areas are primarily in tall, smooth brome grass. Five grazing/hay areas are within ammunition storage areas; three are fenced pastures in areas not suitable for row crops; and the other is hay-only in an ammunition

storage area (IAAAP 2006). Yard C is used for agricultural haying under the IAAAP leasing program. Yard C is the only FUSRAP area on which commercial agricultural activities occur.

Aquatic habitats present at IAAAP are found within the three major streams (Long Creek, Brush Creek, and Spring Creek), and various unnamed tributaries that flow within the IAAAP (Figure 2-1). Mathes Lake and various other small ponds and surface water impoundments also support aquatic species. These impoundments and 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).

At the FUSRAP areas, the land use is considered improved or semi-improved grounds (IAAAP 2006) where routine or periodic maintenance is performed. The surrounding habitat is primarily upland forested areas or maintained grasslands surrounding buildings or storage igloos (Figure 2-1). No aquatic habitats exist within the designated FUSRAP area boundaries although these areas would drain to the major streams located at the IAAAP (Figure 2-1).

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 species observed at the IAAAP are presented in the FUSRAP RI Report.

2.3 SUMMARY AND FINDINGS OF THE REMEDIAL INVESTIGATION AND BASELINE RISK ASSESSMENT

The FUSRAP RI Work Plan (WP) (USACE 2007a) was prepared to define the necessary sampling activities to determine the nature and extent of all contamination at the FUSRAP areas. Analytical data acquired during two previous sampling rounds [identified in the FUSRAP RI WP], as well as discussions that occurred during a Technical Project Planning meeting held in Des Moines, Iowa, in June 2005, provided the basis for development of the CSM and the sampling strategies presented in the regulatory-approved RI WP. The majority of the RI sampling was conducted in 2007, a BRA was completed, and results were documented in the FUSRAP RI Report. During preparation of this FS, additional field activities were conducted to further delineate the extent of soil contamination and radiological surface contamination at a few buildings to support evaluation of remedial alternatives. The supplemental sampling investigation was performed during April 2009 to address those requirements, and the findings are documented in the Supplemental Investigation Report (Appendix A). A summary of the information used and results obtained from the RI and BRA are provided in this section to support the development of the response actions for the FUSRAP areas.

2.3.1 Soil Conceptual Site Model for the Formerly Utilized Sites Remedial Action Program Areas

The soil CSM is a graphical representation of the exposure pathways and potential receptor populations considered for the FUSRAP areas at the IAAAP. The soil CSM facilitates FS evaluations of actions needed to protect human and ecological receptors from direct and indirect contact exposures to source soil contaminants of concern (COCs). Figure 2-7 schematically presents site-specific elements of both complete and incomplete exposure pathways considered and/or evaluated for the FUSRAP areas and media of concern, except for the structure surfaces at Line 1, which are discussed in Section 2.3.2. 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. USEPA's Risk Assessment Guidance for Superfund (USEPA 1989) does not require that all plausible exposure scenarios and exposure pathways be assessed. Exposure pathways that were determined to be complete and significant were quantitatively evaluated in the BRA as part of the FUSRAP RI Report.

2.3.1.1 Potential Human Receptors and 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. Because of the uncertainty associated with the below-grade structural surfaces at the FSA, these surfaces are not represented in the CSM (Figure 2-7); however, potential contamination of these surfaces will be addressed during remediation as discussed in Sections 4.1.3 and 4.1.4 in this FS.

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. The current commercial agricultural use of Yard C is the seasonal cutting of hay. Because haying operations at Yard C are commercial, soil concentrations were compared to USEPA's (2004a) risk-based Preliminary Remediation Goals (PRGs) for direct soil contact exposures (i.e., ingestion, dermal contact, and inhalation) under industrial land use, and were found to be less than the PRGs. 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 significant contamination and 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 2-7).

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 2-7, 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, infiltration/percolation from surface soil to subsurface soil to ground water, or wind erosion and soil runoff to structural surfaces (more specifically, the FSA structural surfaces).

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.

2.3.1.2 Potential Ecological Receptors and 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* [Explanation of Significant Differences (ESD)] (Tetra Tech 2007a), 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 be inhabiting 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 2-7 presents the ingestion of insects impacted by contaminated soil as the only complete ecological exposure pathway evaluated in the BRA.

2.3.2 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 during the Supplemental Investigation (Appendix A). The interior surfaces at Line 1 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 as presented in Figure 2-7.

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 pathway 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.

2.3.3 Identification of Potential Contaminants of Concern and Remedial Investigation Screening Levels

For each FUSRAP area, a detailed review of historical usage of the area was conducted to determine the appropriate potential contaminants of concern (PCOCs). The defined PCOCs included metals, explosives, DU, and polychlorinated biphenyls (PCBs). DU is composed of three isotopes: uranium (U)-234, U-235, and U-238. The RI methods consisted of gamma walkover surveys (GWSs), radiological scans of structural surfaces, and surface and subsurface soil sampling for DU and chemical contaminants.

Initial risk-based screening levels were selected for comparison with individual sample data acquired during the RI. The screening levels were selected to ensure that any response actions are protective under current and future land use scenarios and target populations or receptors most likely to be maximally exposed as defined by the CSM. The screening levels are based on the reasonable maximum exposure setting for an industrial land use scenario using default exposure assumptions described in relevant USEPA guidance.

Screening levels for chemical PCOCs were selected as the USEPA (2004a) Region 9 PRGs for direct contact with soil in an industrial setting. The soil screening levels for the protection of ground water are presented in Table 3-2 of the RI WP. The USEPA Region 9 industrial PRGs are chemical-specific concentrations that correspond to fixed levels of risk [i.e., either a one-in-a-million (1×10^{-6}) excess carcinogenic risk (CR) or a noncarcinogenic hazard quotient (HQ) of 1 in soil, air, or water]. If a substance causes both cancer and non-cancer (systemic) effects, then the more stringent criterion was selected as the screening level. As a conservative measure, when a USEPA Region 9 industrial PRG based on non-cancer effects was utilized as the screening value, it was evaluated at one-tenth (0.1) its concentration to account for potential cumulative effects. Complete exposure pathways for USEPA Region 9 industrial PRG calculations were ingestion, inhalation of particulates, inhalation of volatiles, and dermal absorption of chemicals in soil.

The radiological screening level of 56 picocuries per gram (pCi/g) for DU in soil was selected during initial surveys of the Firing Site 12 Area based on reasonable confidence in field detectability as presented in NUREG 1507 [U.S. Nuclear Regulatory Commission (NRC) 1998]. This screening value was agreed upon during the Technical Project Planning meeting held in Des Moines, Iowa (June 22 through 24, 2005), with concurrence from the Iowa Department of Public Health. Conservative risk and dose assessment calculations were performed using the Residual Radioactive Material (RESRAD) computer code (Version 6.4) to model a site worker scenario

and a construction worker scenario assuming DU soil contamination at 56 pCi/g. The evaluation assumed DU isotopes U-238, U-235, and U-234 are present in soil at concentrations corresponding to known activity percentages (90.14%, 1.45%, and 8.40%, respectively). The same exposure assumptions input into the model during the risk and dose evaluation in the BRA were applied to the evaluation of the DU soil screening level. The resulting maximum risks for the site worker and construction worker from this evaluation are 3.0×10^{-6} and 2.0×10^{-6}, respectively. The risks estimated to both receptors are within USEPA's target CR range (1×10^{-6} to 1×10^{-4}). The resulting maximum doses for the site worker and construction worker are 2 and 3 millirem per year (mrem/yr), respectively, both of which are less than the dose limit of 25 mrem/yr.

In addition to human health screening levels established for radiological and chemical PCOCs, ecological critical concentrations (CCs) were derived during the streamlined ecological risk assessment (ERA) completed as part of the BRA for protection of the Indiana bat. Calculations of the ecological CCs for the streamlined ERA were performed using methodologies established in Appendix M of the BERA (USACE 2004) previously conducted at the IAAAP for the U.S. Army and are consistent with ecological risk-based performance criteria subsequently established in the U.S. Army ESD (Tetra Tech 2007a).

The established screening levels for total gross alpha and total gross beta activity used for the radiological survey of structural surfaces during the RI are provided in Table 2-1. These screening levels were selected from Table 1 (*"Screening Levels for Clearance"*) in American National Standards Institute/Health Physics Society N13.12-1999 [American National Standards Institute (ANSI) 1999]. The screening levels for gross alpha and beta removable activity were set at 10% of the limit for total alpha and beta activity, respectively.

Table 2-1. Selected Screening Levels for Radiological Surveys of Structures

Screening Parameter	Total Contamination (dpm/100 cm^2)	Removable Contamination (dpm/100 cm^2)	Investigation Level for Scanning
Gross alpha	600	60	NA
Gross beta	6,000	600	4,800

NA = Not applicable. Alpha scans have very limited applicability and, thus, are excluded from the surface measurements made at the FUSRAP area structures.
dpm/100 cm^2 = disintegrations per minute per 100 square centimeters.

2.3.4 Nature and Extent of Contamination

A summary of the historical operations, sources of contamination, physical characteristics of the site, and the nature and extent of contamination is presented in the FUSRAP RI Report (USACE 2008a). Table 2-2 summarizes the RI field activities conducted in each FUSRAP area.

Data generated from the RI field activities were compared to screening levels for DU and chemical PCOCs to define the nature and extent of contamination. Those locations and PCOCs where the screening levels were exceeded were retained for further evaluation as contaminants of potential concern (COPCs) for the BRA. A summary of these COPCs, by FUSRAP area, is provided in Table 2-2 and further discussed below.

2.3.4.1 Soil

Screening level exceedances were observed for soil samples collected at the FSA for metals (human health and ecological), explosives (human health and ecological), and DU (human health). Ecological screening level exceedances were also observed for metals and explosives at

both Yards C and G. No exceedances of human health or ecological screening levels were found at Firing Site 14 or at Yard L (Table 2-2). In general, the 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. Explosives contamination was detected to 2 ft bgs, while metals contamination was detected primarily in surface soil (0 to 1 ft bgs).

Table 2-2. Summary of Field Activities and Human Health and Ecological Contaminants of Potential Concern by Formerly Utilized Sites Remedial Action Program Area

FUSRAP Area	Summary of Field Activities	COPCs Evaluated in BRA[a]
Firing Sites 1 and 2	GWS Soil sampling (metals) Soil sampling (DU) Building survey (radiological)	DU in soil (56 pCi/g)
Firing Sites 3, 4, and 5	GWS Soil sampling (metals and explosives) Soil sampling (DU) Building survey (radiological)	DU in soil (56 pCi/g)
Firing Site 6 Area	GWS Soil sampling (metals and explosives) Soil sampling (DU)	TNT in soil (Region 9 industrial PRG) RDX in soil (Region 9 industrial PRG) Chromium in soil (Region 9 industrial PRG) Aluminum in soil (Region 9 industrial PRG) DU in soil (56 pCi/g)
Firing Site 12 Area	GWS Soil sampling (metals, explosives, PCBs) Soil sampling (DU) Building survey (radiological)	DU in soil (56 pCi/g) DU on the vertical vent in the Firing Site 12 Area bunker (screening level for gross beta activity)
Firing Site 14	GWS Soil sampling (metals and explosives) Soil sampling (DU)	No exceedances
FSA Ecological[b]	GWS Soil sampling (metals and explosives) Soil sampling (DU)	Antimony in soil (ecological CC) Arsenic in soil (ecological CC) Barium in soil (ecological CC) Chromium in soil (ecological CC) Cobalt in soil (ecological CC) Copper in soil (ecological CC) HMX in soil (ecological CC) Manganese in soil (ecological CC) Mercury in soil (ecological CC) Nickel in soil (ecological CC) RDX in soil (ecological CC) Selenium in soil (ecological CC) Silver in soil (ecological CC) Thallium in soil (ecological CC) TNT in soil (ecological CC)
Yard C	GWS Soil sampling (metals, explosives, PCBs) Soil sampling (DU) Building survey (radiological)	Arsenic in soil (ecological CC) Barium in soil (ecological CC) Cobalt in soil (ecological CC) HMX in soil (ecological CC)
Yard G	GWS Soil sampling (metals, explosives) Soil sampling (DU) Building survey (radiological)	HMX in soil (ecological CC) Mercury in soil (ecological CC)
Yard L	GWS Soil sampling (DU) Building survey (radiological)	No exceedances

Table 2-2. Summary of Field Activities and Human Health and Ecological Contaminants of Potential Concern by Formerly Utilized Sites Remedial Action Program Area (Continued)

FUSRAP Area	Summary of Field Activities	COPCs Evaluated in BRA[a]
Long Creek	Sediment Sampling (metals, explosives) Sediment Sampling (DU)	No exceedances
Line 1 Buildings	Building survey (radiological)	Buildings 1-11, 1-19-3, 1-63-6, and 1-65-5 (total alpha /total beta)
Warehouse 3-01	Building survey [interior] (radiological)	No exceedances

[a] Type of screening level exceeded is indicated in parentheses.
[b] Evaluation of ecological data was performed using data from the entire FSA.
HMX = octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocane

At the Firing Sites 1 and 2 Area, a DU fragment was observed at only one location and the results of soil sampling showed that the DU contamination was limited to an area of approximately 1 m^2 immediately surrounding the fragment. Additionally, at the Firing Sites 1 and 2 Area, soil samples collected for metals analysis did not exceed corresponding screening levels.

At the Firing Sites 3, 4, and 5 Area there were no PRG exceedances for explosives or metals in soil. A DU fragment was found during a GWS at an isolated area immediately adjacent to the Firing Site 5 loading dock. Soil samples collected to bound the radiological survey results did not exceed the screening level and the results of the GWS did not detect any additional elevated readings.

At the Firing Site 6 Area, DU, metals, and explosives were detected in soil samples above corresponding screening levels. The DU appears to be limited to two very small areas of the Firing Site 6 Area. The explosives contamination is limited to the soil in and around the concrete structures at Firing Site 6. The metals contamination is limited to an area near the center of the Firing Site 6 Area and the target structure at Firing Site 7. The source of metals contamination is likely remnants of the projectiles fired at the Firing Site 6 Area.

At the Firing Site 12 Area, the RI concluded that there were no PRG exceedances for explosives, metals, or PCBs in soil. Using GWSs, visual observations, and soil sampling, FUSRAP soil investigations between 2000 and 2009 identified the presence of DU fragments across the FS-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.

Under the FSA site-wide evaluation for ecological PCOCs, individual soil sample exceedances of ecological CCs were observed for the following chemicals: antimony, arsenic, barium, chromium, cobalt, copper, octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocane (HMX), manganese, mercury, nickel, RDX, selenium, silver, thallium, and TNT (USACE 2008a). Consequently, these chemicals were retained for further ecological evaluations in the BRA.

At Yard C, the results from soil sampling for metals, explosives, and PCBs showed that one of the soil samples collected exhibited concentrations that exceeded the ecological CC developed for HMX, arsenic, barium, and cobalt. The results from soil sampling at Yard C for DU had no exceedances of the human health or ecological screening levels.

At Yard G, the results from soil sampling for metals and explosives found one soil sample location exceeded the ecological CC for HMX and mercury. The results from soil sampling at Yard G for DU had no exceedances of the human health or ecological screening levels.

Additional sampling was conducted in April 2009 for HMX in Yards C and G to define extent of soil contamination. The results showed that the extent of contamination was isolated and therefore not considered major sources of soil contamination. The full evaluation of HMX detected in Yards C and G is presented in Appendix A.

Surface sediment samples (0 to 0.5 ft) 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 samples were analyzed for DU, explosives, and metals. The sediment sample results did not exceed the screening level values and indicated no surface migration or transport of DU, explosives, or metals from the FSA (USACE 2008a).

2.3.4.2 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 four buildings (Buildings 1-11, 1-63-6, 1-65-5, and 1-19-3) exhibited discrete areas of radiation that exceeded the conservative RI screening levels of 600 and 6,000 disintegrations per minute per 100 square centimeters (dpm/100 cm^2) for alpha and beta activity, respectively.

At 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 respective screening levels (600 and 6,000 dpm/100 cm^2, respectively) for all exposed interior surfaces (i.e., surfaces not covered by soil), except for the total beta counts measured at the vertical vent in the Firing Site 12 bunker basement.

During the interior building survey conducted at the Firing Site 12 bunker, sediment was observed and investigated on the floor of the bunker basement. The sedimentation resulted from the seepage of soil (i.e., facilitated by precipitation events) through open cracks in the walls of the basement. A sediment sample collected from the basement floor was submitted for analysis of uranium isotopes via alpha spectroscopy and exhibited an elevated concentration of U-238 (i.e., above the DU soil screening level of 56 pCi/g). For purposes of the FS, the sediment will be considered as a soil medium, and any remedial decisions for soil at the Firing Site 12 Area will also apply to the sediment in the bunker.

At Yard C, the evaluation of the storage igloos began with exterior surveys around each igloo drain discharge point. In addition, 18 interior surveys were performed in areas where contamination would most likely be found (i.e., igloo entrances/exits, ventilation components, floors, floor drains, and loading/offloading areas). The FUSRAP RI Report indicated that all gross alpha and beta (total) readings were below the respective screening levels.

At Yard G, the evaluation of the storage igloos began with exterior surveys around each igloo drain discharge point. In addition, seven interior surveys were performed in areas where contamination would most likely be found (i.e., igloo entrances/exits, ventilation components,

floors, floor drains, and loading/offloading areas). The FUSRAP RI Report indicated that all gross alpha and beta (total) readings were below the respective screening levels.

At Yard L, the interiors and loading docks of Buildings L-37-1, L-37-2, and L-37-3 were surveyed. The *Iowa Army Ammunition Plant Site Reconnaissance Survey for Buildings L-37-1, L-37-2, and L-37-3* (USACE 2003b) indicated the buildings were non-impacted by radiological contamination.

At Warehouse 3-01, the survey focused on the floor, horizontal surfaces most likely to accumulate contamination, and the walls around entrances. The FUSRAP RI WP (USACE 2007a) indicated that all gross alpha and beta (total) readings were below the screening levels.

2.3.4.3 Identification of Contaminants of Potential Concern for the Baseline Risk Assessment

PCOCs that were identified during the delineation of nature and extent of contamination as exceeding the screening levels in at least one sample were retained for further evaluation to determine COPCs for the BRA (Table 2-2).

For determining human health exposures to radiological contamination, DU was identified as a soil human health COPC at the FSA due to physical observations of fragments on the ground at the FSA, as well as exceedances by DU isotopes of the soil screening level (56 pCi/g) established in the FUSRAP RI WP. DU was determined to be an FSA-wide COPC because fragments were found in every firing site except for Firing Site 14.

For the human health risk assessment (HHRA), each chemical PCOC detected in at least one soil sample at a concentration exceeding the corresponding screening level was further screened as a COPC by calculating an area-based exposure point concentration (EPC) and then comparing the EPC with the same screening level. COPCs were identified as those PCOCs with EPCs exceeding corresponding screening levels and were, therefore, retained for quantitative risk calculations in the HHRA. Chemical COPCs for the HHRA were determined for each individual FUSRAP area. The Firing Site 6 Area was the only area for which chemical COPCs were identified for human health. These COPCs included metals (aluminum and chromium) and explosives (RDX and TNT).

Ecological COPCs were not determined from PCOCs in the FUSRAP RI WP but, rather, were determined from the list of chemicals identified in the BERA (USACE 2004), which was prepared for the U.S. Army, as having the greatest potential for driving ecological risks at the IAAAP. Ecological COPCs were identified as the potential risk driver chemicals from the BERA found to exceed updated CCs calculated for the Indiana bat (see Section 2.3.6) in at least one sample. For the FSA, these included metals (antimony, arsenic, barium, chromium, cobalt, copper, manganese, mercury, nickel, selenium, silver, and thallium) and explosives (HMX, RDX, and TNT). In Yard C, ecological COPCs included only HMX. In Yard G, the ecological COPCs included HMX and mercury.

Table 2-2 shows all areas for which DU and chemical COPCs (human health and ecological) were identified and evaluated in the BRA, as well as the individual COPCs evaluated for each area.

2.3.5 Contaminant Fate and Transport

COPCs that are present in environmental media in excess of protective levels represent potential threats to human health and the environment. The degree of impact is uncertain because of the capacity of some contaminants to move from one medium to another or to become degraded by

one or more biotic and abiotic processes. An analysis of contaminant fate and transport is used along with historical information, source identification, and RI sampling to assess or confirm the likely rate of migration and fate of contaminants at the IAAAP. Fate and transport analysis of COPCs determined to be risk drivers in the BRA is useful for screening potential remedial alternatives. The fate and transport of COPCs in soil varies based on the geological and hydrological characteristics of a particular site and by the chemical behavior of a particular contaminant.

The shallow aquifer at the IAAAP consists predominantly of clay-rich glacial tills that exhibit low hydraulic conductivities and yield only small quantities of ground water to wells. The water table surface in the shallow till is generally less than 10 to 15 ft bgs. The low permeability of the clay-rich till limits the lateral and vertical migration of contaminants via ground water. However, ground-water flow may be less restricted where the tills have well-developed fracture networks. Ground water in the limestone bedrock is considered to occur primarily within open bedding planes and/or joints. Therefore, the occurrence and orientation of these features may, in part, control deep ground-water flow. In areas where a fractured and weathered upper bedrock sequence is present just under the till, the basal till and the uppermost 20 ft of bedrock may comprise a single hydraulic system (Tetra Tech 2009).

Ground-water monitoring data indicate that uranium has migrated to ground water at the FSA. Uranium was detected at a maximum concentration of 345 micrograms per liter (µg/L) in shallow monitoring well JAW-32, located at the Firing Site 12 Area (Tetra Tech 2007b). Ground-water contamination at the IAAAP is considered outside the scope of FUSRAP and is being addressed pursuant to the 1990 (IAAAP/ U.S. Army) FFA. The draft final FS for the on-site ground water (OU-6), submitted in May 2010, provides an evaluation of potential remedial alternative to address ground-water contamination within the boundaries of the IAAAP.

On-site ground water is not a source of drinking water. However, domestic/agricultural wells are present in off-site areas. In November 2003, ground-water and surface-water sampling was conducted in off-site areas to address concerns about possible impacts to off-site ground 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.

The results of ground-water fate and transport calculations for RDX and TNT, which is presented in Appendix F, indicate that no significant off-site transport of these compounds has occurred, or is expected to occur, from the FSA via ground-water migration. The predicted concentrations of RDX and TNT in ground water did not exceed their action level (2 µg/L) at two downgradient locations (Tables F-1 and F-2) used in the modeling. The concentrations reaching ground water are low primarily due to the following features of the Firing Site 6 Area:

- The extent of the explosives contamination is limited. The explosives-contaminated soil present at the Firing Site 6 Area is confined to the immediate area surrounding the concrete structure at the northern end of the area (an area of approximately 0.09 acres) and is limited to a depth of 2 ft.
- The presence of relatively impermeable (clay-rich) till.
- The average depth of the water table (approximately 8 ft bgs) is below the depth of the soil contamination (approximately 2 ft).

Therefore, the potential for RDX and TNT at the Firing Site 6 Area to leach from shallow soil into ground water at levels exceeding their health-based action level is minimal. The results indicate that the projected concentrations at two downgradient locations, Long Creek and the boundary of the FSA, are below the health-based action levels. It is concluded that significant migration of TNT and RDX to ground water is not occurring and is not likely to occur in the future as a result of the presence of the limited amount of RDX- and TNT-contaminated soil at the Firing Site 6 Area.

Additionally, 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 samples were analyzed for DU, explosives, and metals. The sediment sample results did not exceed the screening level values and indicated no surface migration or transport of DU, explosives, or metals from the FSA (USACE 2008a).

In summary, the fate and transport calculations presented in Appendix F, results of off-site ground-water monitoring well sampling, and the results of sediment sampling conducted in the depositional areas of Long Creek and its tributaries indicate that off-site surface and subsurface migration of contaminants from the FSA is not occurring, and is not expected to occur.

2.3.5.1 Explosives

The explosives identified as human health and/or ecological COPCs for the BRA are TNT, RDX, and HMX.

Military-grade RDX (containing about 10% HMX by weight) has been a widely used explosive since the early years of World War II when it began to replace or supplement TNT as the primary ingredient in shells, bombs, and detonators. Although RDX has only low to moderate solubility in water [38.4 milligrams per liter (mg/L) at 20 to 25 degrees Celsius (^{o}C)], its soil sorption coefficient values are low, ranging from 63.2 to 270 (ATSDR 1995a). RDX has an estimated vapor pressure of 1.4×10^{-9} millimeters of mercury at 25°C, a low value implying that partitioning to air is unlikely. Photolysis is a potentially important process for degrading RDX in either air and/or TNT wastewater (pink water) because the compound can absorb ultraviolet light strongly at wavelengths between 240 and 250 nanometers. In addition, biodegradation of RDX is likely to occur in soil and sediment at the IAAAP because the process has been simulated under the anaerobic conditions that are typical of clay soil, assuming the presence of a number of microbial isolated and mixed cultures (ATSDR 1995a). For example, the ATSDR (1995) reports that the degradation of RDX was complete in 5 days or less in bench-top experiments where sewage sludge and mixed microbial cultures were combined and placed in a nutrient broth under anaerobic conditions.

TNT has a higher water solubility than RDX (130 mg/L at 20°C) and, consequently, may be more likely (than RDX) to remain in solution in surface-water bodies and less likely to partition to soil and sediment (Johnson and McAtee 2000). Nonetheless, large amounts of TNT have been detected in soil at this and other ammunition plants because of the large-scale production of the compound over many years. However, TNT is not expected to bioaccumulate or biomagnify in terrestrial systems (ATSDR 1995b). Biotransformation in soil is an important fate and transport mechanism for TNT because the compound is reduced by microbial action. The process appears to occur due to a reduction of the nitro groups but with conservation of the compound's aromatic ring. Microbial transformation of TNT leads to a variety of reduction products, including 2-amino- and 4-amino-dinitrotoluene and azoxydimers, although some oxidation products have been identified also. Biological transformation by bacterial and fungal species occurs in the

environment with slightly higher rates in the presence of other carbon sources (Johnson and McAtee 2000).

In a manner similar to that of RDX, photolysis is another process that can affect the fate and transport of TNT in the environment. Numerous transformation products have been identified in pink water, predominantly 1,3,5-trinitrobenzene; 4,6-dinitroanthranil; 2,4,6-trinitrobezaldehyde; and 2,4,6-trinitrobenzonitrile; in addition to several azo and azoxy derivatives formed by the coupling of nitroso and hydroxylamine products.

HMX is persistent in the environment, with little transport from water to other media (ATSDR 1997). Volatilization, sorption, and bioconcentration are not expected to be important transport mechanisms. HMX is expected to have high mobility in soil based on its soil adsorption factor. However, the extent of migration to ground water is limited by the relatively low solubility of HMX in water (6.63 mg/L). Therefore, the migration of HMX through soil is expected to be slow, resulting in low concentrations in ground water (USEPA 1988b).

The biodegradation of HMX in the environment occurs both aerobically and anaerobically. Anaerobic degradation rates are typically greater than aerobic rates and rates increase rapidly where other nutrients are present. Studies showed that the concentration of HMX decreased from 3.5 to less than 0.2 parts per million (ppm) in 3 days in cultures with 50 ppm yeast extract added (Card and Autenrieth 1998). Biodegradation rates are slower for HMX than those for RDX.

Photolysis appears to be the dominant process by which HMX is broken down in the environment. HMX has a reported first order photolytic rate constant of 0.15 $days^{-1}$ which suggests that an aqueous concentration of 0.5 mg/L HMX will have a half-life of 4 to 5 days when exposed to natural sunlight. Primary products of this process include nitrate, nitrite, and formaldehyde (USEPA 1988b).

Based on their chemical characteristics, explosives would be expected to migrate to ground water, with a limited amount of adsorption to soil. However, the concentrations reaching ground water at the IAAAP from FUSRAP source areas are expected to be minimal due to the limited extent of the explosives contamination (an area of approximately 0.09 acres at the Firing Site 6 area), the shallow depth of contamination (above 2 ft) and the presence of relatively impermeable (clay-rich) till beneath the contaminated soil. No evidence of explosive contamination migration to ground water from the FS-6 area was identified during the RI. For more information concerning the fate and transport of explosives in ground water at the Firing Site 6 Area, see Appendix F.

2.3.5.2 Metals

Metals that were identified as human health and/or ecological COPCs for the FUSRAP BRA, based on risk-based screening level exceedances, included aluminum, antimony, arsenic, barium, chromium, cobalt, copper, manganese, mercury, nickel, selenium, silver, thallium, and DU as uranium metal. Possible FSA-specific sources of some of these metals have been identified as follows (USACE 2007a):

- uranium (metal) - DU used in shells for testing of explosives,
- barium -used in baratols that were composed of up to 77% barium nitrate [$Ba(NO_3)_2$],
- mercury (related to use of the detonator), and
- chromium and silver - Photo processing chemicals (Firing Site-1 and Firing Site-5 were used to process film).

No other information is available regarding possible FSA-specific sources for the remaining metals (aluminum, antimony, arsenic, cobalt, copper, manganese, silver, and thallium), and some of the information reviewed regarding MED/AEC-related IAAAP processes had been redacted. However, all soil naturally contains trace levels of metals, and because concentrations detected in soil exceed risk-based screening levels, is not indicative of contamination. The presence of metals in soil is, therefore, not indicative of contamination. The background concentration of metals in uncontaminated soil is primarily related to the geology of the parent material from which the soil was formed. Depending on the local geology, the concentration of metals in a soil may exceed average concentration or ranges for the United States. The anthropogenic sources of metal to soil include diverse manufacturing, mining, combustion, and pesticide activities and deposition from atmospheric sources resulting from oil and coal combustion, mining and smelting, steel and iron manufacturing, waste incineration, phosphate fertilizers, cement production, and wood combustion (USEPA 1992).

Metals, unlike the organic compounds, cannot be degraded. Some metals can be transformed to other oxidation states in soil, making them less soluble and thereby reducing their mobility and toxicity (USEPA 1992). Metal speciation greatly determines the behavior and toxicity of metals in the environment. Speciation refers to the occurrence of a metal in a variety of chemical forms. These forms may include free metal ions, metal complexes dissolved in solution and sorbed on solid surfaces, and metal species that have been coprecipitated in major metal solids or that occur in their own solids (USEPA 2007b). In the soil environment, metals can exist as cations (having a positive charge), anions (having a negative charge), or neutral species (having a zero charge). Their form significantly affects their sorption, solubility, and mobility. For example, most soil is chiefly negatively charged; thus, metal cations have a higher propensity to be sorbed by soil particles than do metal anions and, therefore, would have lower mobility. Metal species may be tightly bound and difficult to dislodge from clayey soil (USEPA 1992).

Based on the RI data, in general the mobility of metals in the surficial soil at the IAAAP is low. The soil boring logs indicate shallow soil in the FUSRAP areas predominantly consists of silty clay and clayey silts. Metals are typically attenuated by clay and are not likely to leach significantly under natural conditions (i.e., undisturbed conditions and relatively neutral soil pH). Therefore, metals at the IAAAP are typically retained in shallow soil due to adsorption, ion exchange, precipitation, and/or complexation with organic matter, resulting in relatively low concentrations reaching ground water. The nature and extent of metals defined in the RI (USACE 2008A) indicate that concentrations present on the FSA are relatively low and localized. Although uranium has been detected in ground water at the Firing Site 12 Area, results of off-site ground-water and surface water sampling indicate that the uranium has not migrated off-site. Based on this fact, significant migration of metal contamination from the FSA is not occurring.

2.3.5.2.1 Aluminum

Aluminum is the most abundant metallic element in the earth's crust (about 8% by weight). It has a solubility ranging from approximately 20 to 40 µg/L in natural waters at a nearly neutral pH, but solubility is decreased by the presence of silica, which causes precipitation as a clay mineral. At high pH, aluminum may complex with hydroxides, which may increase its mobility.

2.3.5.2.2 Antimony

Antimony and its compounds are naturally present in soil and rock in very low concentrations. Antimony is a brittle metal that is not readily fabricated unless it is alloyed with lead and other metals to increase its hardness, strength, corrosion resistance, and electrochemical stability. Most

antimony metal goes into antimonial lead, which is used in lead acid storage batteries, but other uses include solder material, sheet and pipe, bearing metal, castings, ammunition, and cable sheathing. The most common end-use of antimony compounds is antimony trioxide for fire retardation. Because antimony is a fairly volatile metal, it will volatilize during combustion processes and, subsequently, condense on suspended fine particulate matter.

The binding of antimony to soil is determined by the nature of the soil and the form of antimony deposited on the soil. Some studies suggest that antimony is fairly mobile under diverse environmental conditions, while others suggest that it is strongly adsorbed to soil. Because antimony has an anionic character, it is expected to have little affinity for organic carbon. No information could be found about antimony's adsorption to clay minerals. It is not expected that cation exchange, which generally dominates adsorption to clay, would be important for anionic antimony. There is no evidence of bioconcentration of most antimony compounds (ATSDR 1992).

2.3.5.2.3 Arsenic

Arsenic is an element found in the atmosphere, soil and rocks, natural waters, and organisms. It is mobilized in the environment through a combination of natural processes such as weathering reactions, biological activity, and volcanic emissions as well as through a range of anthropogenic activities. Arsenic minerals and compounds are readily soluble but migration is greatly limited because of strong adsorption by clays, organic matter, and hydroxides (USEPA 1992). Early research demonstrated arsenic toxicity to plants decreased as clay and iron oxide contents of soil increased. The clay fraction and iron oxides have frequently been associated with arsenic-sorption in soil. Soil high in reactive iron components has been shown to absorb more arsenic than low-iron soil of similar texture (Pettry and Switzer 2001).

2.3.5.2.4 Barium

Barium is a naturally occurring component of minerals that enters the environment naturally through the weathering of rocks and minerals. Anthropogenic releases are primarily associated with industrial processes including bleach, dyes, paint, glassmaking, fireworks and tracer-bullets, and in igniter and welding materials. Barium is an ingredient of baratol (a mixture of barium nitrate and TNT) used at the IAAAP. Most barium released to the environment from industrial sources is in forms that do not become widely dispersed.

Barium is not very mobile in most soil systems due to the formation of water-insoluble salts and an inability of the barium ion to form soluble complexes with humic acids. Soil properties that influence the transportation of barium are cation exchange capacity, calcium carbonate content, and pH. In soil with a high cation exchange capacity (e.g., fine-textured mineral soil or soil with high organic matter content), barium mobility will be limited by adsorption. Barium also reacts with metal oxides and hydroxides in soil and is, subsequently, adsorbed onto soil particulates. Adsorption onto metal oxides in soil and sediment probably acts as a control over the concentration of barium in natural waters. Barium is strongly adsorbed by clay minerals and, in general, the solubility of barium compounds increases with decreasing pH (ATSDR 2007).

2.3.5.2.5 Chromium

Although chromium occurs naturally in the earth's crust, the element is present in the environment in large quantities as a result of mankind's activities. Electroplating, leather tanning, and textile industries are major sources of chromium release to the environment, mainly as the insoluble chromium (III) oxide. However, chromium (VI) has been detected in fly ash from coal-fired powered plants and from sites where chromium is manufactured or used.

Chromium occurring in the atmosphere as particulates will be deposited to surface water or soil as a result of wet or dry deposition. The majority of the chromium in soil is present as the insoluble oxide that would tend to be immobile in that matrix. However, surface runoff can transport soluble and precipitated chromium alike to surface water. The fate of chromium in soil will fluctuate depending on the oxidation-reduction (Redox) potential and the pH. Thus, the reduction of chromium (VI) to chromium (III) is facilitated by low pH and anaerobic conditions.

2.3.5.2.6 Cobalt

Cobalt occurs naturally in soil, and some low levels also occur naturally in seawater and in some surface water and ground water. The primary anthropogenic sources include fossil fuel and waste combustion, vehicular and aircraft exhausts, processing of cobalt and cobalt-containing alloys, copper and nickel smelting and refining, and the manufacture and use of cobalt chemicals and fertilizers derived from phosphate rocks. Two radioactive forms of cobalt may be released to the environment as a result of nuclear research, development, or operation of nuclear power plants (ATSDR 2007).

The mobility of cobalt in soil is inversely related to how strongly it is adsorbed by soil constituents. Soil-derived oxide materials were found to adsorb greater amounts of cobalt than other materials examined; although, substantial amounts were also adsorbed by organic materials. Clay minerals sorbed relatively smaller amounts of cobalt. In clay soil, adsorption may be due to ion exchange at the cationic sites on clay with either simple ionic cobalt or hydrolyzed ionic species such as CoOH+. Adsorption of cobalt onto iron and manganese increases with pH, and as pH increases, insoluble hydroxides or carbonates may form, which would also reduce cobalt mobility (ATSDR 2007).

2.3.5.2.7 Copper

Most copper deposited on soil from the atmosphere, from agricultural applications, and from sewage sludge amendments is strongly adsorbed to the upper few centimeters of the soil. It is especially bound to the organic matter, as well as being adsorbed by carbonate minerals and hydrous iron and manganese oxides. Copper binds more strongly than most other metals and is less influenced by pH as a result. The greatest amount of leaching of copper occurs from sandy soil [World Health Organization (WHO) 1998]. Mobility and displacement of copper is low in soil high in organic matter and clay materials (USEPA 1992).

2.3.5.2.8 Manganese

Manganese is widely distributed in nature, but elemental manganese is used in the manufacture of glass. Fumes, dust, and aerosols from metallurgical processing, mining operations, steel casting, and metal welding and cutting, mainly in the form of manganese oxide, are the principal sources of environmental pollution.

The tendency of soluble manganese compounds to adsorb to soil is dependent upon the cation exchange capacity and the organic composition of the soil. Adsorption may be highly variable and, in some cases, adsorption of manganese to soil may not be a readily reversible process. At low concentrations, manganese may be “fixed” by clays and will not be released into solution readily. At higher concentrations, manganese may be desorbed by ion exchange mechanisms with other ions in solution. For example, the discharge of waste water effluent into estuarine environments resulted in the mobilization of manganese from the bottom sediment. The metals in the effluent may have been preferentially adsorbed resulting in the release of manganese (ATSDR 2008).

2.3.5.2.9 Mercury

Mercury occurs naturally as a mineral and is distributed throughout the environment by both natural and anthropogenic processes. Mercury has many applications in industry including alkaline batteries used in hearing devices and digital watches, and mercury has also been used for pharmaceutical uses and medical equipment. Major anthropogenic sources of mercury releases to the environment include mining and smelting; industrial processes involving the use of mercury, including chlor-alkali production facilities; combustion of fossil fuels, primarily coal; production of cement; and medical and municipal waste incinerators and industrial/commercial boilers (ATSDR 1999).

In soil, the sorption process of mercury has been found to be higher with increased concentrations of organic matter content in the soil or sediment. Adsorption of mercury in soil is also decreased with increasing pH and/or chloride ion concentrations. Mercury is sorbed to soil with high iron and aluminum content up to a maximum loading capacity of 15 grams per kilogram (equivalent to 15,000 ppm). Inorganic mercury sorbed to particulate material is not readily desorbed. Thus, freshwater and marine sediment are important repositories for inorganic forms of the element, and leaching is a relatively insignificant transport process in soil. However, surface runoff is an important mechanism for moving mercury from soil to water, particularly for soil with high humic content (ATSDR 1999).

2.3.5.2.10 Nickel

Nickel and its compounds are naturally present in the earth's crust, and releases to the atmosphere occur from natural discharges such as windblown dust and volcanic eruptions, as well as from anthropogenic activities. Nickel has properties that make it very desirable for combining with other metals to form mixtures called alloys. These alloys have important uses such as in the making of metal coins, jewelry, nickel plating, stainless steel, valves, and heat exchangers. Nickel may be released to the atmosphere from the industrial facilities and end up in the soil or sediment where it is strongly attached to particles containing iron or manganese. Nickel is strongly adsorbed at mineral surfaces such as oxides and hydrous oxides of iron, manganese, and aluminum. Such adsorption plays an important role in controlling the migration of nickel in the environment. Nickel is strongly adsorbed by soil, although to a lesser degree than lead, copper, and zinc. Amorphous oxides of iron and manganese, and to a lesser extent clay minerals, are the most important adsorbents in soil. Under acidic conditions, nickel is more mobile in soil and may seep into ground water. In alkaline soil, adsorption may be irreversible, which limits nickel's availability and mobility in this soil (ATSDR 2005).

2.3.5.2.11 Selenium

Selenium is found in most rocks and soil and is released to soil primarily by leaching and weathering of the parent bedrock material, although dry and wet deposition also contribute to soil selenium levels. The principal release of selenium into the environment from anthropogenic sources is from coal and oil combustion while other sources include selenium refining factories, base metal smelting, and end-product manufacturers. Selenium and its compounds are used in some photographic devices, gun bluing (a liquid solution used to clean the metal parts of a gun), plastics, paints, anti-dandruff shampoos, vitamin and mineral supplements, fungicides, and certain types of glass. Incineration of rubber tires, paper, and municipal waste is an additional source of atmospheric selenium (ATSDR 2003).

In soil, the primary factor determining the fate of selenium in the environment is its oxidation state. Conditions such as pH, Redox, and the presence of metal oxides affect the partitioning of

the various compounds of selenium in the environment. In general, elemental selenium is essentially insoluble. Selenium has multiple oxidation states (valence states) including -2, 0, +4, and +6. The type of selenium found is a result of its oxidation state, which may vary according to ambient conditions, such as pH and microbial activity. Selenates [selenium(+6)] and selenites [selenium(+4)] are water soluble and can be found in both surface water and ground water. Sodium selenate is among the most mobile forms of selenium because of its high solubility and inability to adsorb to soil particles. Sodium and potassium selenites dominate in neutral, well-drained mineral soil, where some soluble metal selenites may be found as well. Selenite forms stable ferric oxide-selenite adsorption complexes in acid or neutral soil. When environments favor the soluble forms of selenium (alkaline and oxidizing conditions), these forms can be accumulated by plants (ATSDR 2003).

2.3.5.2.12 Silver

Silver is released to air and water through natural processes such as the weathering of rocks and the erosion of soil. Important sources of atmospheric silver from human activities include the processing of ores, steel refining, cement manufacture, fossil fuel combustion, municipal waste incineration, and cloud seeding (ATSDR 1990).

Silver tends to form complexes with inorganic chemicals and humic substances in soil. Silver as a cation will participate in adsorption and precipitation reactions. Silver is very strongly adsorbed by clay and organic matter and precipitates of silver (i.e., AgCl, Ag_2SO_4, and Ag_2CO_3) are highly insoluble. Silver is highly immobile in the soil environment. The factors governing the environmental fate of silver are not well characterized. Little information was found in the available literature on the transformation of silver in water or soil.

2.3.5.2.13 Thallium

Thallium is a heavy metallic element that exists in the environment mainly combined with other elements (primarily oxygen, sulfur, and the halogens) in inorganic compounds. Thallium is stable in the environment because it is neither transformed nor biodegraded. Thallium was primarily used as a rodenticide and insecticide until 1972. Currently, thallium compounds are used in photoelectric cells, highly reflective and low-melting glasses, electrical switches, low-range thermometers, fireworks, and in the manufacture of synthetic gems. Thallium cannot be broken down further and, as such, is highly persistent. Soil contamination occurs mainly from solid wastes from coal combustion and smelting; therefore, thallium exposure to receptors occurs via wet and/or dry deposition from these sources. Once deposited on land or water, thallium compounds are unlikely to volatilize; although, wind dispersion from soil surfaces in dry conditions is possible. Although elemental thallium is insoluble in water, thallium compounds possess a high solubility in water. Thallium adsorbs to soil containing clays, organic matter, and iron oxides and is not transformed or biodegraded [U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) 2007].

2.3.5.2.14 Uranium

DU is a byproduct of the process used to enrich uranium for use in nuclear reactors and in nuclear weapons. Natural uranium is composed of three isotopes: U-234, U-235, and U-238. The enrichment process concentrates both the U-235 and the U-234 isotopes in the product material, resulting in a byproduct depleted in both isotopes. The resulting byproduct (DU) retains a slightly greater percentage of U-238 (99.8% by mass instead of 99.3%) as compared to natural uranium. DU typically contains about 99.7990, 0.200, and 0.0010% by weight U-238, U-235, and U-234, respectively, with corresponding activity percentages of 90.14, 1.45, and 8.40,

respectively (10 *CFR* 20, Appendix B). All three isotopes are radioactive and produce decay products upon radioactive disintegration. After purification (processing) of uranium, in-growth of the decay products of all of the uranium occurs such that traces of these decay products can be detected. Because of the shorter half-life of U-234 and U-235 compared to U-238, the radioactivity associated with DU is approximately 40% less than that of natural uranium. Because of the long half-life of U-238 (4.468×10^9 years) decay is not particularly relevant to uranium fate and transport in the environment. Although the radiological properties of uranium isotopes differ considerably, their chemical behavior is essentially identical and, therefore, the effect of natural uranium in the environment is applicable to DU (USEPA 2006b).

Uranium is a naturally occurring radioactive metal in most rocks and soil. 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. During the RI, DU at the FUSRAP areas was found to be present in soil and on structural surfaces. 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. DU particles, however, are not readily observable in soil, unless made visible by a yellowish discoloration as an effect of chemical oxidation. 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. Uranium can exist in several oxidation states, with the +4 and +6 states the most common in the environment. The overall mobility of uranium in the environment is determined by its oxidation state, which is generally either hexavalent [U(VI)] or tetravalent [U(IV)]. In its hexavalent state, uranium is usually more soluble and travels with water; however, in the tetravalent state, uranium is insoluble and practically immobile. Clay soil tends to retard environmental transport. Adsorption of uranium to organic compounds in the soil also inhibits the rate of migration. In the case of metallic particles, the oxidation rate depends on fragment size, pH, humidity, soil moisture content, soil chemistry, soil oxygen content, and the presence of other metals in the soil. The soil pH and dissolved carbonate concentrations are the two most important factors influencing the adsorption behavior of uranium (USEPA 2006b).

2.3.6 Summary of Baseline Risk Assessment

Based on the complete exposure pathways identified in the CSM, findings of the nature and extent of contamination, and the potential fate and transport of the contaminants, a BRA was conducted to determine the potential for human health and ecological risks to receptors identified at the FUSRAP areas. Human health risks were determined quantitatively for exposures to soil and structures at the FUSRAP areas where screening levels were exceeded when compared to soil sampling and structural survey data presented in the FUSRAP RI Report and Supplemental Investigation Report (Appendix A). Ecological risks for the Indiana bat were determined for chemicals (metals and explosives) detected in FUSRAP soil as identified in the RI Report and Supplemental Investigation Report. Table 2-3 presents the total human health CRs summed over exposure pathways for chemicals, noncarcinogenic hazard indices (HIs) for chemicals estimated as the sums of HQs calculated for individual exposure pathways, the CR and dose estimated for DU, and the ecological risks estimated for the Indiana bat. The radiological risks summarized in Table 2-3 pertain to those FUSRAP areas that are the focus of this FS.

2.3.6.1 Summary of Human Health Risk Assessment and Radiological Risk and Dose Assessment

For the chemicals and DU evaluated in the HHRA and radiological risk and dose assessment, respectively, the process began with the identification of PCOCs from investigations conducted prior to the FUSRAP RI, as described in the RI WP and the RI Report. Once laboratory results were received from the RI sampling, they were validated to determine usability for meeting data quality objectives and combined with analytical data acquired during past investigations. The nature and extent of contamination for each FUSRAP area was determined by comparing individual detected sample results with appropriate screening levels. If a detected PCOC exceeded the corresponding screening level in at least one sample, then that PCOC was retained as a COPC for further evaluation of human health risks in the BRA.

DU was identified as a soil COPC for the FSA. Chemical COPCs in soil were identified only in the Firing Site 6 Area. All other FUSRAP areas were eliminated from evaluation in the HHRA because detected concentrations of chemicals in soil did not exceed corresponding screening levels. Based on the complete pathways defined by the CSM, an EPC was calculated for each FUSRAP area/COPC combination for surface and subsurface soil. A notable quantity of DU fragments is present at the FSA for which a qualitative risk evaluation of DU fragments was conducted.

CR and dose to both receptors (site workers and construction workers) resulting from exposures to DU in soil were computed in RESRAD (Version 6.3) by entering EPCs and the appropriate exposure parameters. The FUSRAP RI Report presented the maximum total cumulative CR (i.e., summed over all three isotopes) and maximum total dose calculated for each receptor. Exceedances of the dose limits to be considered regarding ARARs and *de minimis* CR criterion (1.0×10^{-6}) are shown in Table 2-3.

Table 2-3 shows that the maximum total CR (4.0×10^{-4}) and the maximum total radiological dose (27 mrem/yr) determined for the site worker at the FSA exceed the upper limit (1.0×10^{-4}) of USEPA's target CR range and the 25 mrem/yr dose limit, respectively. Although the upper limit of USEPA's CR range is 1×10^{-4}, USEPA (1997d) considers a CR of 3.0×10^{-4} as being "essentially equivalent to the presumptively safe level of 1×10^{-4}," which is only slightly exceeded by the CR determined for the site worker. Table 2-3 also shows that the maximum total CR (2.0×10^{-5}) and the maximum total radiological dose (36 mrem/yr) determined for the construction worker at the FSA exceed the lower limit (1.0×10^{-6}) of USEPA's target CR range and the 25-mrem/yr dose limit, respectively, though the CR is within USEPA's target CR range.

Regarding the radiological risk and dose calculated for the site and construction workers, it has been observed that the maximum total dose estimated for the construction worker (36 mrem/yr) is greater than the maximum total dose estimated for the site worker (27 mrem/yr); whereas, for CR, the opposite is true [i.e., the maximum total CR estimated for the site worker (4.0×10^{-4}) is greater than that for the construction worker (2.0×10^{-5})]. This is due to the length of time each receptor (site worker versus construction worker) is assumed to spend working on-site (i.e., the exposure duration). For the site worker, an exposure duration of 25 years is assumed; whereas, only 1 year is assumed for the construction worker. Radiological risk and dose calculations are performed over a 1,000-year evaluation period with the maximum result being reported out of the 1,000-year period. For any receptor, dose is required to be evaluated for only a single year in the 1,000-year evaluation period; however, risk is calculated as the sum of all years. Therefore, for the dose calculations, the maximum total dose in that period just happened to be for the construction worker (NOTE: the RESRAD input parameters for the site worker and construction

Table 2-3. Summary of Baseline Risk Assessment Results for Formerly Utilized Sites Remedial Action Program Investigation Areas Being Evaluated in the Feasibility Study

Area/COPC	EPC (pCi/g or mg/kg)	Potential Human Health Risks (Radiological and Chemical Exposures)										Potential Ecological Risks	
		Current and Future Site Worker[1]					Future Construction Worker[1]					Indiana Bat[2]	
		Maximum Radiological Dose (mrem/year)	Carcinogenic Risks[3]	% of Total CR	Non-Cancer HIs	% of Total HI	Maximum Radiological Dose (mrem/year)	Carcinogenic Risks[3]	% of Total CR	Non-Cancer HIs	% of Total HI	Ecological CC (mg/kg)[4]	EPC/ Ecological CC Ratio[4]
All Investigated Areas - Human Dose and Cancer Risk from Radiological Exposures													
FSA - DU[5]	U-234 = 211.23 U-235 = 5.65 U-238 = 622.58	27	4.0E-04	100%	NA	NA	36	2.0E-05	100%	NA	NA	NA	NA
Yard C - DU[5]	U-234 = 0.04 U-235 = 0.08 U-238 = 0.00	0.01	2.0E-07	100%	NA	NA	0.02	1.0E-08	100%	NA	NA	NA	NA
Yard G - DU[5]	U-234 = 0.00 U-235 = 0.03 U-238 = 0.00	0.005	7.0E-08	100%	NA	NA	0.006	4.0E-09	100%	NA	NA	NA	NA
Yard L - DU[5]	U-234 = 0.00 U-235 = 0.15 U-238 = 0.00	0.03	3.0E-07	100%	NA	NA	0.03	2.0E-08	100%	NA	NA	NA	NA
Firing Sites 6, 7, 8, and 15 Area - Human Cancer Risks and Non-Cancer HIs from Chemical Exposures													
RDX	76.9	NA	4.0E-06	23.4%	0.034	1.1%	NA	6.7E-07	24.8%	0.14	1.1%	NA	NA
2,4,6-TNT	836	NA	1.2E-05	71.6%	2.5	78.3%	NA	2.0E-06	74.0%	10	76.1%	NA	NA
Aluminum	107,000	NA	NA	NA	0.16	5.0%	NA	NA	NA	0.65	5.2%	NA	NA
Chromium	1,187	NA	8.5E-07	5.0%	0.5	15.6%	NA	3.4E-08	1.3%	2.2	17.5%	NA	NA
Total Risk/HI[6]	**NA**	NA	1.7E-05	100%	3.2	100%	NA	2.7E-06	100%	12.5	100%	NA	NA
FSA - Ecological Risk from Chemical Exposures													
TNT[7]	214.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3.55	0.2
Selenium[7]	9.028	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.61	0.61
RDX	21.32	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	25.6	0.931
Antimony	29.45	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,161	0.83
Mercury	1.146	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.86	0.62
Copper	1110	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2,445	0.454
Thallium	7.876	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	19.05	0.413
Nickel	1058	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3,097	0.34
Chromium[8]	708.9	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3,240	0.22
HMX	3.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	15.2	0.21
Silver	11.59	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	91.7	0.13
Barium	231.8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2,520	0.092
Arsenic	7.344	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	156.1	0.047
Manganese	722.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	21,987	0.033
Cobalt	9.843	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	743	0.013

Table 2-3. Summary of Baseline Risk Assessment Results for Formerly Utilized Sites Remedial Action Program Investigation Areas Being Evaluated in the Feasibility Study (Continued)

Area/COPC	EPC (pCi/g or mg/kg)	Potential Human Health Risks (Radiological and Chemical Exposures)										Potential Ecological Risks	
		Current and Future Site Worker[1]					Future Construction Worker[1]					Indiana Bat[2]	
		Maximum Radiological Dose (mrem/year)	Carcinogenic Risks[3]	% of Total CR	Non-Cancer HIs	% of Total HI	Maximum Radiological Dose (mrem/year)	Carcinogenic Risks[3]	% of Total CR	Non-Cancer HIs	% of Total HI	Ecological CC (mg/kg)[4]	EPC/ Ecological CC Ratio[4]
Yard C - Ecological Risk from Chemical Exposures													
HMX[8]	1.93	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	15.2	0.13
Barium	331.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2,520	0.13
Arsenic	9.221	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	156.1	0.059
Cobalt	11.83	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	743	0.016
Yard G - Ecological Risk from Chemical Exposures													
HMX[8]	3.96	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	15.2	0.26
Mercury	0.843	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.86	0.45

mg/kg = milligram per kilogram

CR = Carcinogenic risk.

NA = Not applicable due to no identified COPCs; lack of available toxicity values to quantify risk or dose; exposure pathway is incomplete or insignificant; or calculation of a radiological dose or carcinogenic risk or non-carcinogenic

HQ is not applicable to area.

[1]Current and future site workers and future construction workers were evaluated for exposures to COPCs in surface soil (0 to 1 ft bgs) and soil (0 to 10 ft bgs), respectively.

[2]Soil data from within the 0 to 2-ft bgs depth are applicable to Indiana bat evaluations; however, all depths (to 6 ft bgs) were used. Soil data from greater than 2 ft bgs are less than 5% of the total data set.

[3]Carcinogenic risks determined for radiological and chemical exposures are presented separately and not summed together per the reasons discussed in the RI Report (USACE 2008a).

[4]Derivations of EPCs, ecological CCs, and EPC/ecological CC ratio are described in the RI Report (USACE 2008a).

[5]Radiological cancer risk and dose were calculated for DU only based on evaluation of U-234, U-235, and U-238. Non-cancer HI calculations for DU are not applicable due to no available toxicity criteria.

[6]Total HIs were conservatively estimated for chemical COPCs at the Firing Sites 6, 7, 8, and 15 Area, regardless of target organs/critical effects.

[7]EPC/ecological CC ratios presented for TNT and selenium were estimated during the Tier 3 supplemental ecological risk evaluation presented in Appendix B.

[8]Calculations of the EPC and human health risks for chromium and the EPC and EPC/ecological CC ratio for HMX in Yards C and G were performed in Appendix A.

Underlined values exceed USEPA and NRC dose limits of 15 and 25 mrem/year, respectively; carcinogenic radiological or chemical risk exceeding 1E-06; non-carcinogenic chemical HIs exceeding 1.0; or EPC/ecological CCs exceeding 1.0. However, it should be noted that the USEPA dose limit of 15 mrem/year is not a promulgated value.

worker are very similar, with the construction worker having a greater inhalation and ingestion intake. They are assumed to be on-site for the same amount of time during 1 year). Risk, however, is additive over a 25-year period for the site worker but only for 1 year for the construction worker. This causes the cumulative risk to be higher for site worker rather than the construction worker.

The soil EPCs estimated using RI data for the DU isotopes in the FSA and that are presented in Table 2-3 (U-234 = 211.23 pCi/g; U-235 = 5.65 pCi/g; and U-238 = 622.58 pCi/g) are low relative to the total activity that is known for DU (360,000 pCi/g). Based on the qualitative risk and dose evaluations conducted for DU fragments (assuming an activity concentration of 360,000 pCi/g) in Appendix A, the CR and dose associated with exposures to soil are likely to be less than CR and dose associated with exposures to DU fragments. Both individually and combined, the CR and dose resulting from exposures to DU fragments and the adjacent soil result in exceedances of USEPA target CR and DOE target dose criteria. Therefore, the evaluation of alternatives in this FS is inclusive of both DU fragments and soil.

Based upon the radiological risk and dose results, if no further action occurs at the firing sites, then dose would exceed the 25-mrem/yr dose limit for both the site worker and construction worker scenarios, and CR would exceed the CERCLA risk range for the site worker scenario, from exposures to DU in soil.

CRs and noncarcinogenic HQs and HIs resulting from exposures to chemical COPCs by each receptor were calculated based on surface soil (0 to 1 ft bgs) EPCs for site workers and soil (0 to 10 ft bgs) EPCs for construction workers, exposure assumptions identified in Table 6-3, and the toxicity criteria presented in Tables 6-4 through 6-9 of the RI Report. The risk results were compared to USEPA's target CR of $1.0x10^{-6}$ and target HI of 1.0. Table 2-3 shows those COPCs exceeding USEPA's risk criteria as being underlined and therefore, are identified as COCs for further evaluation in this FS.

For the site worker in the Firing Site 6 Area, Table 2-3 shows that CRs exceeding the lower limit of USEPA's target range of CRs (1.0×10^{-6}) were estimated for RDX (4.0×10^{-6}) and TNT (1.2×10^{-5}), with TNT contributing 71% of the total CR (1.7×10^{-5}) for this receptor. The total CR is within USEPA's target CR range of 1×10^{-6} to 1×10^{-4}. The only noncarcinogenic COPC resulting in a HQ of greater than 1.0 for the site worker is TNT (2.5), which contributes 78% of the total HI (3.2).

For the construction worker in the Firing Site 6 Area, Table 2-3 shows that only the CR for TNT (2.0×10^{-6}) exceeds 1.0×10^{-6} and contributes 74% of the total CR (2.7×10^{-6}) for this receptor. The total CR to this receptor is within USEPA's target CR range of 1×10^{-4} to 1×10^{-6}. The noncarcinogenic COPCs resulting in individual HQs greater than USEPA's benchmark of 1.0 for the construction worker are TNT (10) and chromium (2.2). Again, TNT is the predominant contributor (76%) to the total HI (12.5).

In Table 2-3, it was observed that both radiological and chemical CRs are higher for the site worker than for the construction worker; however, the construction worker has higher non-cancer HIs (estimated only for chemical COPCs) than those estimated for the site worker. This is because the construction worker exposure is averaged over a shorter duration (365 days) than that for the site worker (9,125 days).The averaging time is the product of the exposure duration (construction worker = 1 year; site worker = 25 years) and 365 days/year and is in the denominator of the equation used to calculate HI. Therefore, larger HIs are calculated with receptors with smaller averaging times. Additionally, the higher ingestion and inhalation rates

assumed for the construction worker act as secondary contributors to the higher construction worker HIs.

However, this is not the case when evaluating CR for chemical exposures because CR is averaged over a lifetime (70 years or 25,550 days) for all receptors. For the evaluated scenarios, the exposure duration (entered into the numerator of the risk equation) determines which of the receptors has the highest risk. The longer exposure duration of 25 years for the site worker results in higher risks than the risks calculated for the construction worker that are based on the shorter exposure duration of 1 year. Unlike the calculations of non-cancer HIs, this difference is large enough such that the higher ingestion and inhalation rates of the construction worker are not enough to result in higher CRs for this receptor.

To determine if chromium concentrations are comparable to background, EPCs were calculated for chromium in background soil (surface and 0 to 10 ft bgs). By comparing site chromium EPCs with background chromium EPCs, it was determined that the EPCs used to calculate risks for the site worker and construction worker exposures to chromium in Firing Site 6 Area soil exceed the corresponding background EPCs.

Included in Table 2-3 are the risk results for the chromium that were calculated using data from both the RI and Supplemental Investigation. Although the purpose of the Supplemental Investigation was to collect additional data to facilitate more refined evaluations in the FS, a review of the supplemental data as detailed in Appendix A indicated that chromium concentrations were generally lower than those observed during the RI. Therefore, risks for chromium were re-calculated to confirm the status of chromium as a COC, as was determined during the BRA. The re-evaluation demonstrates that chromium is still retained as a COC.

The extent of contamination for structural surfaces at each FUSRAP area was determined by comparing survey results with screening levels for gross alpha and gross beta. If a measurement exceeded the screening level in at least one sample, then that structure was retained for further evaluation of human health risks. Structural surfaces that exceeded the screening level were further evaluated as part of the Supplemental Investigation Report (Appendix A).

In summary, of the total FUSRAP soil areas evaluated during this RI, potential dose and risks due to radiological exposures were determined for all of the firing sites combined, and potential carcinogenic and non-CRs due to chemical exposures were limited to the Firing Site 6 Area. Based on the evaluated risk scenarios, the following chemical and radiological COCs are identified for the FSA:

- Current and Future Site Workers (surface soil, 0 to 1 ft bgs):
  - RDX,
  - TNT,
  - Chromium, and
  - DU (U-234, U-235, and U-238).
- Future Construction Workers (soil, 0 to 10 ft bgs):
  - TNT,
  - Chromium, and
  - DU (U-234, U-235, and U-238).

2.3.6.2 Summary of the Streamlined Ecological Risk Assessment

A streamlined ERA was performed as part of the BRA to evaluate soil chemical exposures to the Indiana bat. Area EPCs were compared to CCs derived in the BERA (USACE 2004) but

re-calculated in the FUSRAP streamlined ERA for this receptor. The CC re-calculations were done in accordance with Attachment F of Appendix M of the BERA (USACE 2004) and involved modification of the bioaccumulation factors used in derivation of the CCs. The original bioaccumulation factors in the BERA (USACE 2004) assumed that Indiana bats are exposed to soil contaminants by feeding on earthworms impacted by the contaminants. Because this feeding scenario is unrealistic and overly conservative for the Indiana bat (i.e., bats do not feed on earthworms), the bioaccumulation factors were modified to reflect the more realistic scenario of bats feeding on flying insects that are potentially impacted by soil contamination from the FUSRAP areas. The comparisons with the re-calculated CCs were generally performed for detected chemicals for which CCs had been derived in the BERA (USACE 2004). Due to the prevalence of chromium detected at the firing sites, ecological CCs were derived for chromium in this streamlined ERA because they were not established in the BERA (USACE 2004).

The results of the streamlined ERA, as presented in the RI Report, identified EPC exceedances of ecological CCs for HMX in Yards C and G and for TNT and selenium at the FSA. At Yards C and G, the exceedances of the HMX ecological CC were driven by a single surface soil sample collected at each yard. Supplemental soil sampling (Appendix A) was conducted at Yards C and G in April 2009 to refine soil volume estimates in the FS; however, HMX concentrations in the supplemental samples were significantly lower than those detected in soil samples collected during the RI. Therefore, the ecological evaluations of HMX in Yards C and G soil were revised using the combined data. The EPC/CC ratios estimated during the re-evaluation and presented in Table 2-3 and Table A-9-3 show that HMX in Yards C and G soil do not pose risk to the Indiana bat.

FSA-wide EPC exceedances of the TNT and selenium ecological CCs were found to be driven predominantly by soil sample locations at the Firing Site 6 Area, and to a lesser degree, by selenium locations immediately adjacent to buildings at Firing Sites 1 and 2, Firing Site 12, and Firing Site 14. At the conclusion of the streamlined ERA in the RI Report (USACE 2008a), TNT and selenium were considered to be soil ecological COCs only at the Firing Site 6 Area.

Because some of the assumptions used during the streamlined ERA were overly conservative relative to actual site conditions at the FSA (as discussed in Section 7.3 of the RI Report), it is likely that risks determined for the Indiana bat (i.e. TNT and selenium at the Firing Site 6 Area) were overestimated. Therefore, during this FS, a three-tiered supplemental ERA was conducted using the same datasets that were used for the streamlined ERA. The supplemental ERA is presented in Appendix B and includes an analysis of uncertainties associated with the FSA-wide approach applied during the streamlined ERA. Additionally, Appendix B shows that the FSA-wide ecological CCs and EPCs originally presented in the streamlined ERA have been iteratively refined and compared using a three-tiered evaluation to reflect the following:

1) the ratio of the entire FSA to the 70-acre foraging area of the Indiana bat (Tier 1 = streamlined ERA as presented in the Final RI Report [USACE 2008a]);

2) the ratios of the sizes of the individual firing sites to the 70-acre foraging area of the Indiana bat (Tier 2); and

3) the ratios of the sizes of actual areas of contamination determined within the Firing Site 6 Area to the 70-acre foraging area of the Indiana bat (Tier 3).

The three-tiered evaluation began with the most conservative evaluation (Tier 1) which was essentially the streamlined ERA presented in the Final RI Report, and progressed toward the most site-specific evaluation (Tier 3). In short, this approach was designed to demonstrate that since the foraging area of the Indiana bat is larger than the individual firing sites (as evaluated in

Tier 2), and is even larger relative to the actual areas of contamination within the Firing Site 6 Area (as evaluated in Tier 3) that drove FSA-wide ecological risks in the Final RI Report, the probability of the Indiana bat ingesting insects that have bioaccumulated selenium and TNT from the contaminated soil areas of the Firing Site 6 Area is significantly reduced. Therefore, the actual risks to the bat are much lower than was originally determined during the streamlined ERA.

Because all ecological risks were driven by selenium and TNT in the Firing Site 6 Area, the Tier 3 evaluation focused on CCs and EPCs that reflected the separate selenium and TNT areas of contamination within the Firing Site 6 Area. Tables 2-3 and B-1 show that the Tier 3 EPC/CC ratios estimated for selenium and TNT are less than the target value of 1.0. Therefore, at the end of the Tier 3 evaluation for the supplemental ERA, it is concluded that soil contamination in the FSA, and more specifically, the Firing Site 6 Area, does not pose potential risks to the Indiana bat.

2.3.6.3 Summary of the Baseline Risk Assessment

Based on the evaluated human health (radiological and chemical) and ecological exposure and risk scenarios in the BRA, chemical COCs and DU were identified at the following FUSRAP areas (with the potentially affected receptors presented in parentheses):

- Line 1 Structures:
  - DU (site worker and construction worker).
- Firing Sites 1 and 2 (soil):
  - DU (site worker and construction worker).
- Firing Sites 3, 4, and 5 (soil):
  - DU (site worker and construction worker).
- Firing Site 6 Area (soil):
  - DU (site worker and construction worker),
  - Chromium (site worker and construction worker),
  - RDX (site worker),
  - TNT (site worker and construction worker).
- Firing Site 12 (soil and structures):
  - DU (site worker and construction worker).

Based on the evaluated human health (radiological and chemical) and ecological exposure and risk scenarios in the BRA, no risks under the industrial land use scenario were identified for the following FUSRAP areas/media, which are therefore, not being further evaluated in the FS Report:

- Firing Site 14 soil,
- FSA structures (except the Firing Site 12 Area),
- Yard C soil and structures,
- Yard G soil and structures,
- Yard L (areas surrounding Warehouses L-37-1, L-37-2, and L-37-3) soil, and
- Warehouse 3-01 structure.

The land use at all FUSRAP areas is expected to remain industrial and therefore, is not expected to become compatible with conditions allowing for unlimited used and unrestricted exposure (UUUE).

3.0 IDENTIFICATION AND SCREENING OF REMEDIAL ACTION TECHNOLOGIES

Remedial action alternatives are developed to address the potential human health risks determined for the contaminated soil and structures at FUSRAP areas of the IAAAP as presented in Section 2. Remedial action alternatives are identified through a remedy selection process based on their ability to reduce potential risks to levels identified by site-specific RAOs. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) [40 *CFR* §300.430(f)(1)(ii)(A) and (B)] states that the goal of the remedy selection process is to select remedies that are protective of human health and the environment, that maintain protection over time, and that minimize untreated waste.

In the first phase of the remedy selection process, general response actions, remedial technologies, and process options are identified and evaluated. This first phase of the remedy selection process includes several steps, which are presented in the following sections.

- Section 3.1: Identify the type of waste (principal threat wastes and/or low-level threat wastes) at the FUSRAP areas to support the evaluation of technologies.
- Section 3.2: Identify the RAOs for the source materials and contaminants identified as being associated with dose and/or carcinogenic and non-CRs exceeding benchmark criteria, as determined by the BRA, and establish human health RGs for the COCs based on a review of ARARs and/or protection of human health or the environment.
- Section 3.3: Provide an estimate of the volume of material that exceed the RGs to support the evaluation of alternatives.
- Section 3.4: Identify the general response actions, remedial technologies, and process options that could attain the RAOs and initially screen the technologies for possible use at FUSRAP areas.
- Section 3.5: Evaluate the potential remedial technologies and process options in the three broad areas of effectiveness, implementability, and cost to support the development of remedial action alternatives that will be retained for further evaluation.

3.1 DETERMINATION OF PRINCIPAL THREAT WASTES AND LOW-LEVEL THREAT WASTES

To facilitate the identification and screening of technologies, USEPA has developed guidelines to communicate the types of remedies it generally finds appropriate for different source materials and their relative threat for exposure. USEPA (1997c) defines source material as: “material that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination to ground water, to surface water, to air, or acts as a source for direct exposure.”

The focus of this FUSRAP response is limited to the removal of source materials containing DU. DU is present on the FSA and will be included in the USACE response under FUSRAP 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 MMR (see 40 *CFR* §266.200 et. seq.) to the determination of the scope of FUSRAP authority on the Firing Sites. That is, there is no requirement to respond to explosive constituents and metals contamination on an operational range associated with the range operations. However, because the DU that is present in the FSA

is a product of historic AEC operations at this site which are no longer conducted, and DU is not currently used at the FSA on the IAAAP, it may be included in the USACE response in a manner that is consistent with USACE FUSRAP authority. As part of the settlement agreement for the dispute, 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 [DU] at the Firing Site resulting from past testing operations conducted by the [AEC]. 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 FS) (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. Therefore, the main source materials present at the FUSRAP areas are surface and subsurface soil containing DU at concentrations associated with CRs that exceed USEPA's target CR of 1×10^{-6}. Other source materials present are IAAAP FUSRAP structures, which are radiologically contaminated with DU.

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 1991a). Principal threat wastes do not exist at the IAAAP FUSRAP areas, because no drummed wastes, non-aqueous-phase liquids, or highly toxic or highly mobile contaminants are present.

Low-level threat wastes are source materials that generally can be reliably contained and would pose only a low risk in the event of exposure. Low-level threat wastes are source materials that exhibit low toxicity, limited mobility in the environment, or have concentrations near health-based levels (USEPA 1991a). At the IAAAP FUSRAP areas, DU (uranium isotopes) would present the greatest risk to a maximally exposed individual (an on-site maintenance or construction worker) due to low-level radioactivity. These exposures have been estimated and result in a risk greater than 1×10^{-4} if they only occur per the conservative assumptions applied in the HHRA (e.g., 250 days for 25 years) (USACE 2008a). However, actual risks to workers are likely to be overestimated due to the conservative scenarios estimated. Risks from the metallic form of DU could not be assessed due to a lack of toxicity criteria. Therefore, the source materials are identified as low-level waste (LLW) because they are reliably contained due to low mobility and/or pose a low risk in the event of exposure.

Although the NCP [40 *CFR* §300.430(a)(1)(iii)(A) and (B)] states that USEPA expects to use treatment to address principal threat wastes and engineering controls for waste that poses a relatively low long-term threat, no mandatory classification is required; therefore, the NCP [40 *CFR* §300.430(a)(1)(iii)(A) and (B)] expectations were developed as guidelines (USEPA 1991a). Ultimately, the remedy selection decisions are based on the site-specific analysis of remedial

alternatives using the CERCLA nine evaluation criteria. The definition of source materials as principal threat wastes or low-level threat wastes helps to streamline and focus this FS on the development of cleanup options and "follow the fundamental decision as to whether any remedial action is required at the site" (USEPA 1991a).

3.2 REMEDIAL ACTION OBJECTIVES

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 RGs, that are set based on ARARs or that do not increase an individual's lifetime CR by more than 1 in 10,000 (1×10^{-4}), which is the upper bound of the CERCLA risk range. This section presents the RAOs, ARARs, and RGs that are used for the development and evaluation of the remedial action alternatives.

3.2.1 Development of the Remedial Action Objectives

LLW has been identified during the RI at several FUSRAP soil areas and structures. Below-grade structural surfaces at the FSA may exhibit elevated radiological instrument readings due to DU-contaminated soil adhered to the surface. Based upon the complete exposure routes identified in the CSM, the RAOs for the media of concern and investigated areas are as follows:

- Prevent ingestion, dust inhalation, and external gamma radiation exposures to isotopes of DU in the FSA soil that could otherwise result in cumulative CRs in exceedance of 1×10^{-4} and maximum radiological doses in exceedance of 25 mrem/yr for receptors under the current and expected future industrial land use scenario for the IAAAP.
- Prevent radiation exposures to isotopes of DU in FUSRAP structures that could otherwise result in a total effective dose equivalent (TEDE) exceeding 25 mrem/yr.

It should be noted that the RAOs do not include the remediation of ground water as this is outside the scope of FUSRAP at the IAAAP.

3.2.2 Applicable or Relevant and Appropriate Requirements

Section 121(d)(2) of CERCLA establishes a cleanup standard for remedial action with respect to any hazardous substance, pollutant, or contaminant that will remain on-site. Remedial actions must, upon completion, 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).

Identifying ARARs involves determining whether a requirement is applicable, and if it is not applicable, then whether a requirement is relevant and appropriate. Individual ARARs must be identified on a site-specific basis. Factors that assist in identifying ARARs include the physical circumstances of the site, contaminants present, and characteristics of the remedial action.

Applicable requirements are defined as "those cleanup standards, standards of control, and other substantive environmental protection 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" (40 *CFR* §300.5). A law or rule is applicable if the jurisdictional prerequisites of the law or rule are satisfied. These jurisdictional prerequisites include the following:

- Who, as specified by the statute or regulation, is subject to its authority;
- The types of substances or activities listed as falling under the authority of the statute or regulation;
- The time period for which the statute or regulation is in effect; and
- The type of activities the statute or regulation requires, limits, or prohibits.

Only those state requirements that are (1) promulgated so that they are of general applicability and legally enforceable, (2) identified by a state in a timely manner, and (3) more stringent than federal standards, may be applicable.

CERCLA Section 121(e) [42 U.S. Code (U.S.C.) 9621(d)(2)(A)] states that a relevant and appropriate requirement is a promulgated standard, requirement, criteria, or limitation under a federal environmental law or a more stringent state environmental or facility siting law that is not legally applicable to the hazardous substance or pollutant or contaminant, but that is relevant and appropriate under the circumstances of the release of the hazardous substance or pollutant or contaminant.

Determining whether a requirement is relevant and appropriate is a two-step process that involves determining whether the rule is relevant, and, if so, whether it is appropriate. A requirement is relevant if it addresses problems or situations sufficiently similar to the circumstances of the remedial action contemplated. It is appropriate if it is well-suited to the site. In determining whether a requirement is both relevant and appropriate, the following factors may be used to evaluate a requirement:

- The purpose of the requirement and the purpose of the response action;
- The medium regulated or affected by the requirement and the medium contaminated or affected at the site;
- The substances regulated by the requirement and the substances found at the site;
- The actions or activities regulated by the requirement and the remedial action contemplated at the site;
- Any variances, waivers, or exemptions of the requirement and their availability for the circumstances at the site;
- The type of place regulated and the type of place affected by the release or response action;
- The type and size of structure or facility regulated and the type and size of structure or facility affected by the release or contemplated by the response action; and
- Any consideration of use or potential use of affected resources in the requirement and the use or potential use of the affected resource at the site.

In addition, it should be considered whether another requirement is available that more fully matches the circumstances at the site.

Generally on-site activities must comply with both applicable and relevant and appropriate requirements; whereas, only applicable requirements apply to off-site activities. In addition, for on-site actions, only the substantive applicable requirements apply; whereas, both substantive and procedural applicable requirements apply off-site. A determination of relevance and appropriateness may be applied to only portions of a requirement; whereas, a determination of applicability is made for the requirement as a whole.

CERCLA Section 121(e) [42 U.S.C. 9621(e)] provides that no permit is required for the portion of any removal or remedial action conducted entirely on-site. Although no permit is required, on-site actions must comply with substantive requirements of ARARs but not with related administrative and procedural requirements. For example, remedial actions conducted on-site would not require a permit but must be conducted in a manner consistent with permitted conditions as if a permit were required.

ARARs have been classified into three types: chemical-specific requirements, location-specific requirements, and action-specific requirements. Chemical-specific requirements are media-specific and health-based limits (criteria) developed for site-specific levels of contaminants in specific media. Location-specific standards are based on particular characteristics or locations of the site. Action-specific requirements are those with which design, performance, and other aspects of implementation of specific remedial activities must comply. The following discussion summarizes the chemical-, location-, and action-specific ARARs.

3.2.2.1 Chemical-Specific Applicable or Relevant and Appropriate Requirements

Chemical-specific ARARs are promulgated values that, when applied to site-specific conditions, can be used to formulate RGs (Section 3.2.3). These values reflect potentially acceptable amounts or concentrations of a chemical that may remain in affected media or be discharged to the ambient environment. When determining the cleanup level criteria, chemical-specific ARARs are initially used to establish RGs (55 Federal Register 8715). If a chemical has more than one applicable requirement, then the most stringent requirement generally should apply. The only COC identified at the FUSRAP areas that exceeds USEPA's *de minimus* human health risk criterion is DU. The following chemical-specific ARARs have been identified for DU-contaminated soil and structures.

Title 10, *CFR* Part 20, Subpart E, Sections 20.1403(b) and 20.1403(e): These standards are generally applicable to NRC licensed facilities. The FUSRAP residuals were generated from AEC activities, which occurred prior to the establishment of NRC licensing requirements. Fabrication of DU shells at the IAAAP was later conducted under an NRC source material license (SUC-1381). Subsequently, 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 (0.25 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 [year]) 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.

The IAAAP is currently an industrialized military installation. The expected future use of the property is to continue as a military installation. Residential land use does not reflect realistic expectations for the future industrial/military uses of the site. Therefore, 10 *CFR* 20.1402 (Radiological Criteria for Unrestricted Use) was not selected as an ARAR.

3.2.2.2 Location-Specific Applicable or Relevant and Appropriate Requirements

The Endangered Species Act [16 U.S.C. §1538(a)(1), (1973)]: 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 may be found as a transient species within the FUSRAP areas of the IAAAP. Therefore, the following requirement is relevant and appropriate for remedial actions within the FUSRAP areas of the IAAAP:

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

3.2.2.3 Action-Specific Applicable or Relevant and Appropriate Requirements

Radiation Protection Programs, 10 *CFR* 20.1101(d): 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.

3.2.3 Development of Remediation Goals for DU

Human health RGs for the IAAAP FUSRAP areas are soil or structural surface concentrations developed for DU that, if allowed to remain, would not result in adverse human health or

environmental impacts under the exposure scenarios evaluated in the BRA. The DU RGs presented in this FS are risk- or ARAR-based concentrations that have been derived using computer models targeting a pre-determined risk level or dose limit derived from ARARs, and that incorporate exposure assumptions and the most updated toxicity values that were used in the BRA. Therefore, the RG for DU at the FUSRAP areas will be the lower (most conservative) of the risk- and dose-based values. All exposure assumptions and toxicity criteria used to calculate the RG are presented in the BRA conducted as part of the FUSRAP RI Report.

The purpose of the DU RGs is to allow the direct comparison of RGs to corresponding sample data acquired for each FUSRAP area to determine those individual sample locations at which RGs are exceeded. Knowing the extent of the contamination allows for the estimation of soil volumes and structural surface area to facilitate evaluations of general response actions and evaluations of remedial alternatives in this FS. Based on the results of the BRA, RGs were developed for protection of human health from exposures to DU in soil at the FSA and IAAAP structures. Below-grade structural surfaces at the FSA may exhibit elevated radiological instrument readings due to DU-contaminated soil adhered to the surface.

3.2.3.1 Risk and Dose Basis for Human Health Remediation Goals for DU

The development of human health RGs for soil and structural surfaces consider carcinogenic effects from exposures to DU. According to the NCP [40 *CFR* §300.430(e)(2)(i)(A)(2)], the acceptable human health exposure levels to known or suspected carcinogens are levels that represent an excess incremental lifetime CR (i.e., above baseline) to an individual of between 1 in 1,000,000 (1×10^{-6}) and 1 in 10,000 (1×10^{-4}). The lower limit of the range (1×10^{-6}) is considered to be USEPA's point of departure CR from which all risk management decisions begin. Risk-based RGs may be revised upward within the target CR range based on a variety of site- or remedy-specific factors such as the reliability of data, quantification or detection limits, background considerations, or other considerations consistent with the remedy selection criteria defined in the NCP [40 *CFR* §300.430(f)(1)(i)]. Therefore, RGs for DU were initially established that equate to the health-conservative end of USEPA's target CR range, or 1×10^{-6}. To facilitate site-specific risk-management decision making, RGs have also been derived and are presented for DU that target CRs of 1×10^{-5} and 1×10^{-4}. DU is the byproduct remaining after the extraction of U-235 from naturally occurring uranium. DU typically contains about 99.7990, 0.200, and 0.0010% by weight U-238, U-235, and U-234, respectively, with corresponding activity percentages of 90.14, 1.45, and 8.40. Natural uranium, by comparison, consists of about 99.284, 0.711 and 0.005 weight percent U-238, U-235, and U-234, respectively, with corresponding activity percentages of 48.6, 2.2, and 49.2 for the stated radioisotopes.

Based on ARAR analysis, 10 *CFR* 20.1403(b) and 20.1403(e) are relevant and appropriate to the derivation of remedial goals for restricted release. Because 90.14% of the activity of DU is attributable to U-238, a soil RG has been developed for U-238 in FSA soil. This approach uses U-238 as a surrogate for U-234 and facilitates comparisons with laboratory confirmation measurements.

The U-238 RG is health-protective of the cumulative effects from all three DU isotopes. This was done by targeting a TEDE of 22.5 mrem/yr (i.e., 90% of 25 mrem/y-r). The laboratory-measured U-238 concentrations (attributable to DU) for soil (pCi/g) will be compared to the corresponding RG derived for U-238 to evaluate compliance with the RG. Because the TEDE of 22.5 mrem/yr considers contributions from all three uranium isotopes in DU, the RG is protective for exposure to U-234 and U-235, as well as to U-238.

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 unit will be used to calculate the actual dose/risk associated with the residual DU.

Derivation of an RG for U-238 for Line 1 structural surfaces considers all three uranium isotopes at their activity percentages. This approach allows for direct comparisons with RG surface measurements to gross alpha and gross beta activity (in units of dpm/100 cm^2). Therefore, the structural RG is based on derived concentration guideline levels (DCGLs) derived for a cumulative dose of 25 mrem/yr.

3.2.3.2 Development of the Soil Remediation Goal for DU

In the radiological risk and dose assessment, the maximum total CR and dose calculated for the site worker at the FSA as a result of exposure to DU in site soil were $4x10^{-4}$ and 27 mrem/yr, respectively (USACE 2008a). Additionally, a maximum total CR and dose of 2×10^{-5} and 36 mrem/yr, respectively, were also calculated for the construction worker at the FSA. The risk estimated for the site worker marginally exceeds the CERCLA risk range and 10 *CFR* 20.1402 dose criteria without regard to exposures associated with structures; therefore, the site worker has been selected as the limiting receptor. Using the RESRAD Model (Version 6.4), site-specific, risk- and dose-based DCGLs for DU were developed for both receptor scenarios (site worker and construction worker) that were evaluated in the risk and dose assessment. The RESRAD output files showing the calculations and model assumptions used to derive the DCGLs for the site worker and construction worker are presented in Appendix C. The risk- and dose-based DCGLs, which are based on the known activity percentages of the uranium isotopes, are presented in Table 3-1. Additionally, DCGLs based on target CRs of 1×10^{-6}, 1×10^{-5}, and 1×10^{-4} have also been calculated for FSA soil and are presented in Table 3-1. These risk-based soil DCGLs include the contribution of U-238, U-234, and U-235.

Table 3-1. Dose- and Risk-Based Derived Concentration Guideline Levels for Consideration as Soil Remediation Goals for Depleted Uranium (Uranium-238)

Scenario	TEDE = 22.5 mrem/yr (pCi/g)	TR = 1×10^{-6} (pCi/g)	TR = 1×10^{-5} (pCi/g)	TR = 1×10^{-4} (pCi/g)
Site Worker	562	1.5	15	**150**[a]
Construction Worker	453	31	319	3,190

[a] **Bold** DCGL represents the value selected as the RG for soil in the FSA.
TR = Target risk.

Following a review of the soil DCGLs presented in Table 3-1, the risk-based DCGL derived for the site worker (150 pCi/g) corresponding to the TR of 1×10^{-4} has been selected as the RG to be applied to FSA soil. This value was selected based upon the following: the site worker has been determined to be the limiting receptor, all risk-based DCGLs determined for the site worker are less than the corresponding dose-based DCGL (562 pCi/g), the DCGL targeting 1×10^{-4} is the only risk-based DCGL for the site worker that exceeds the RI screening level for DU (56 pCi/g), the TR of 1×10^{-4} (i.e., corresponding to the selected RG) is considered to be adequately protective of human under the current and expected future land use of the IAAAP; and naturally elevated levels of radium are known to exist in soil in the state of Iowa. The reason for not selecting either of the risk-based site worker DCGLs targeting a 1×10^{-6} or 1×10^{-5} CR as the

RG is because they are less than the screening level of 56 pCi/g, which is based on a reasonable confidence in field detectability, as discussed in Section 2.3.3.

3.2.3.3 Development of the Remediation Goal for DU on Structures

An RG of 23,000 dpm/100 cm^2 was derived for U-238 for health protection of site workers currently occupying impacted buildings/structures. The RG will be used for comparisons with gross activity data obtained for structural surfaces contaminated by DU. Exceedances of this RG will indicate further actions are warranted for the respective structures.

RESRAD-BUILD code (Version 3.4) was used to derive the RG, which assumes exposure to a site worker in a room with contamination present on the four walls and floor of the room. As discussed previously, the RG accounts for cumulative effects from exposures to all three DU isotopes (U-234, U-235, and U-238). Both a dose-based DCGL (30,700 dpm/100 cm^2) targeting a cumulative dose limit of 25 mrem/yr and a risk-based DCGL (23,000 dpm/100 cm^2) targeting a cumulative CR of 1 x 10^{-4} were calculated for consideration as the RG for structural surfaces. The more restrictive of the two DCGLs [i.e., the DCGL targeting the cumulative CR of 1 x 10^{-4} (23,000 dpm/100 cm^2)] was selected as the RG for structures. A more detailed discussion of the derivation of surface DCGLs for buildings using RESRAD BUILD, along with model outputs, is presented in Appendix D of this FS.

Although structures are released to a RG (DCGL), materials and equipment are not. Materials and other equipment remaining (i.e., equipment within FS-12 including desks, chairs, etc.) are not released to a RG but rather to the applicable standards (ANSI N13.12). Equipment and materials that exceed the ANSI N13.12 standards would be decontaminated to the applicable standard to achieve UUUE, or would be disposed of as radioactive waste.

3.2.3.3.1 Structural Surface Data Comparisons with the DU Remediation Goal

During the RI, forty-one interior building surveys were conducted at Line 1, which investigated for gross alpha/beta activities. Surveys indicated that small interior surfaces of some structural components at four buildings (Buildings 1-11, 1-63-6, 1-65-5, and 1-19-3) exhibited discrete areas of radiation that exceeded the conservative RI screening levels of 600 and 6,000 dpm/100 cm^2 for alpha and beta activity, respectively. Additional surveying was conducted in 2009 using the FS proposed risk-based structural DU RG of 23,000 dpm/100 cm^2 total activity derived for industrial land use, as discussed in Appendix A. The results of this additional surveying showed that none of the building surfaces were found to be radiologically contaminated, except for two interior building components; a steel grate covering a floor sump in Building 1-11 and the air filters in an air handling unit located in Building 1-63-6. Summaries of the field activities and findings of the supplemental investigation are presented in Appendix A. The grate in Building 1-11 consists of a number of smaller grates situated over a sump that encompass a total area measuring approximately 60 ft by 15 ft. The air filter unit consists of several filters enclosed in an air-handling unit that is situated approximately 10 ft above the floor in Building 1-63-6. The radiological contamination of both units cannot be linked to soil contamination at Line 1; therefore, the exposure pathways associated with these Line 1 components are considered to be contaminant sources.

At 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 respective screening levels (600 and 6,000 dpm/100 cm^2, respectively) for all exposed interior surfaces (i.e., surfaces not covered by soil), except for the elevated total beta counts measured at the vertical vent in the Firing Site 12 bunker basement. An additional

evaluation of the survey measurements from the vertical vent was conducted using the FS proposed risk-based structural DU RG of 23,000 dpm/100 cm^2 total activity. The results of the evaluation indicate that the vertical vent meets the structural RG for DU and therefore, no buildings or structural surfaces at the FSA were above the RG-based criteria.

3.2.3.4 Summary of Remediation Goals and Health Protectiveness

Table 3-2 summarizes all soil and structures DU RGs derived for protection of human health at the FUSRAP areas. Figure 3-1 presents those individual soil sample locations that exceed human health RG.

Table 3-2. 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

It should be noted that derivation of the human health RGs ensures that the CR from exposures to DU in soil and structures does not exceed the upper end of USEPA's target CR range. Additionally, the RGs derived for DU ensure that the TEDE resulting from exposures to contaminated soil and structures does not exceed 25 mrem/yr. Table 3-3 illustrates the health protectiveness of the selected RGs by presenting the corresponding radiological doses and CRs that would result from exposures to residual concentrations of DU equivalent to the respective human health RGs. Table 3-3 also shows that the total radiological dose and CR corresponding to exposures to soil concentrations of DU equivalent to the RG are 8 mrem/yr and 1 x 10^{-4}, respectively.

Table 3-3. Human Health Protectiveness of Formerly Utilized Sites Remedial Action Program Area Remediation Goals

Human Health COC	RG	RG Basis	Corresponding Radiological Dose (mrem/yr)	Corresponding CR (unitless)
DU	150 pCi/g	CR-based DCGL for U-238 in soil	8[a]	$1.0x10^{-4}$
DU	23,000 dpm/100 cm^2	Risk-based structural DCGL for all three DU isotopes (cumulatively) converted to gross surface activity	18.7	$1.0x10^{-4}$

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

Table 3-3 also shows that the total dose and CR corresponding to exposures to gross radioactivity from a DU concentration on structural surfaces equivalent to the RG of 23,000 dpm/100 cm^2 are 18.7 mrem/yr and a CR of 1 x 10^{-4}, respectively. Therefore, the RG selected for structural surfaces meets the dose- and risk-based health protectiveness benchmarks of 25 mrem/yr and 1 x 10^{-4}, respectively.

Cumulative radiological dose and CRs from DU in both soil and structures combined, do not need to be determined because site worker exposures are likely to occur to either surface or soil contamination but not to both surface and soil contamination. Site workers who could be

exposed to structural contamination in the buildings are mainly indoor workers and are not likely to be exposed to soil while carrying out their job responsibilities.

Therefore, in summary, the soil and structural RGs determined for DU in the FUSRAP areas are both individually and cumulatively protective of the total dose limit of 25 mrem/yr and the CR of 1×10^{-4}.

3.3 ESTIMATED VOLUME OF MATERIAL EXCEEDING REMEDIATION GOALS

Site conditions, the nature and extent of contamination, and RGs were taken into consideration to estimate the volumes of each medium (soil and structures) at each affected area 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 3-4 and shown in Figure 3-2. 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 cubic yard (CY). 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 ground zero (testing pad) (Figure 3-2). The total volume calculated for the Firing Site 12 Area consists of 100% of the soil to a depth of 1 ft and 25% of the soil between 1 and 2 ft within a 100 m radius from ground zero. For distances greater than 100 m from ground zero (up to a 175-m radius), the total volume includes an estimate of 5% of the soil to a depth of 1 ft.

Table 3-4. 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	0	1
Firing Sites 3, 4, and 5	1	0	1
Firing Sites 6, 7, 8, and 15	1	0	1
Firing Site 12	13,809	3,129	16,938
Total Volume	**13,812**	**3,129**	**16,941**

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 (ft^2) of surface area may be radiologically contaminated and require cleaning.

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. The specific structures with surface radioactivity above the RG are 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 ft^2.

3.4 IDENTIFICATION AND SCREENING OF GENERAL RESPONSE ACTIONS, TECHNOLOGIES, AND PROCESS OPTIONS

General response actions are media-specific actions that satisfy the RAOs and may include land use controls, treatment, or removal. General response actions are divided into remedial technologies such as land restrictions, chemical treatment, or excavation. Remedial technologies are further divided into process options, which are specific methods used to achieve RAOs.

In accordance with USEPA guidance, remedial technologies and process options may be eliminated during the screening phase on the basis of technical implementability (USEPA 1988a). Several methods were used to screen the technologies and process options for technical implementability. The physical conditions and concentrations of DU at the FUSRAP areas were evaluated to determine which technologies could be effectively implemented. The screening process was conducted using several available technology reference guides and screening tools, including the *Remediation Technologies Screening Matrix* (FRTR 2009), the *Technology Screening Guide for Radioactively Contaminated Sites* (USEPA 1996), and *Technology Reference Guide for Radiological Contaminated Surfaces* (USEPA 2006a). Available literature on remediation technologies and process options also was researched to determine the potential innovative technologies that may be feasible for implementation at FUSRAP areas. Presumptive remedies or preferred response actions or technologies identified by USEPA for sites with similar characteristics under CERCLA were reviewed to streamline the remedy selection process. Those presumptive remedies applicable to the FUSRAP areas that have been reviewed include the *Presumptive Remedy for Metals-in-Soil Sites* (USEPA 1999c) and *Depleted Uranium Technical Brief* (USEPA 2006b). The U.S. Army ROD for soil (USACE 1998a), as part of the U.S. Army's CERCLA activities, was also reviewed for consistency and applicability. The results of the screening for general response actions, remedial technologies, and process options are summarized in Figure 3-3 and described below.

3.4.1 No Action

The NCP [40 *CFR* §300.430(e)(6)] requires that the "no action" alternative be evaluated as part of the FS process as a baseline for comparison to the other alternatives being considered. No action means that no new actions would be taken. USEPA defines baseline (and baseline risk) to be those "associated with a site in the absence of any remedial action or control" (NCP 55 Federal Register 8711). USEPA takes this position because of its mandate to be protective of public health and the environment. In that role, USEPA needs to account for maximum potential exposure at a CERCLA site so that it will not underestimate the potential risk. "Maximum potential exposure'' means exposure that could be experienced in the absence of any form of active control (institutional or otherwise). This scenario is considered by USEPA to equate with the "true" baseline situation and thus the no action alternative.

At environmental restoration sites destined to continue to be under government control after the remedial actions are completed, the baseline "maximum potential exposure," which would be compatible with UUUE (e.g., residential land use), does not reflect realistic expectations for future industrial/military uses of the site. Additionally, current response actions at the IAAAP by the U.S. Army have developed soil RGs that are protective under an industrial land use scenario (USACE 1998b). With that in mind, the maximal potential exposure was only qualitatively evaluated for the FUSRAP areas by assuming that the potential risk associated with the absence of any remedial action or control would be greater than the risk identified under government control (industrial use). Therefore, the evaluation of no action assumes that any controls currently in place at the IAAAP would not be maintained.

Under the no action alternative, the volume, toxicity, or exposure to contaminated soil and structures would not be reduced by any action. The effectiveness of the other remedial action alternatives for the future conditions is compared to site conditions as represented by the no action alternative.

3.4.2 Land Use Controls

Land use controls are classified as a limited action alternative and are non-engineering measures designed to limit exposure to hazardous substances left in place or to ensure the effectiveness of a chosen remedy. The primary goal of land use controls is to prevent access to contaminated media. Implementation of land use controls would not reduce the contaminant volume, mobility, or toxicity, but exposures to the contaminated media would be reduced. Land use controls would include administrative, procedural, and regulatory measures to control human access to and usage of the areas with contamination remaining by limiting the re-use activities associated with those portions of the installation. Current controls at the IAAAP include use restrictions and outgrants administered by the U.S. Army as part of its land management responsibilities. Additional controls may be implemented on a variety of levels including access, resource, and land use restrictions. Access restrictions could be imposed by additional fencing, signage, and/or security measures to the specific portions of the FUSRAP areas or buildings where contaminant levels remain on-site at concentrations that are not protective. Access restrictions would be maintained to prevent any site worker from accessing the area without proper protection/controls and authorization, thereby minimizing contact. Use restrictions could also include limits on disturbance of soil; restrictions or limits on the construction or renovation of new or existing facilities at the FUSRAP areas; and restrictions on the development of FUSRAP areas as residential areas, recreational areas, or training areas.

Access Restrictions: Access restrictions that limit installation personnel from entering the sites without proper authorization are currently in place at the FUSRAP areas. Maintenance activities at the site continue to be conducted, including property maintenance (e.g., grass cutting, etc.) and building maintenance on an as-needed basis. The FSA is an operational range and is currently in use as an ammunition testing facility or for other operational uses such as storage areas. Under the access restriction alternative, procedures would be developed to identify and prohibit access to contaminated areas without proper authorization and protective measures. The risk to human health would be reduced because of the reduction in the exposure to contaminated soil or structures. Access restrictions are retained for further evaluation.

Resource Restrictions: Resource restrictions could also be imposed on a facility-wide basis, although there is no current or proposed future use of the FUSRAP areas for recreational or agricultural use. Hunting and fishing are currently allowed at the IAAAP as regulated activities, although access to FUSRAP areas is restricted. Because of access restrictions to the property, exposures to recreational users are considered insignificant (USACE 2008a). The 1996 Risk Assessment (USAEC 1996) conducted for the IAAAP concluded that the few contaminants detected in surface water or sediment where on-site fishing is likely to occur do not tend to bioaccumulate in fish. Additionally, intermittent streams on-site, where contaminant runoff may be more significant, do not support an extensive edible fish population. The 1996 Risk Assessment also concluded that exposures to hunters as a result of consumption of deer foraging at the IAAAP are likely to be nominal because bioaccumulation of contaminants in deer would be low as they do not graze at ground level (USAEC 1996).

The potential for significant rancher/farmer exposures to FUSRAP area soil contaminants is unlikely. It is known that commercial agricultural activities occur within the IAAAP, but are

only allowed at Yard C of the FUSRAP areas. The current commercial agricultural use of Yard C is the cutting of hay. Because haying operations at Yard C are commercial, soil concentrations were compared to USEPA's (2004a) PRGs for direct soil contact under industrial land use, and were found to be less than the PRGs. Therefore, exposures to commercial ranchers/farmers in Yard C were determined to be insignificant. Also, because of the presence of heavy vegetation, airborne migration of contaminants to these agricultural areas is minimized and insignificant. It is also known that ground water directly beneath the IAAAP is not used for agricultural purposes. Therefore, resource restrictions would not be necessary for protection of human health (i.e., recreational user and commercial agricultural users) and the environment and are not retained.

Land Use Restrictions: Installation use restrictions of the FUSRAP areas could be implemented because the current and future land use is not expected to change. Restrictions on the installation of any ground-water wells that would be used for potable water, fire suppression, irrigation, or other non-compliance monitoring activities could also be developed. Use restrictions may also be combined with other general response actions to achieve the remediation levels for the land use designation (industrial). Land use controls for the FUSRAP areas would be implemented as part of the site-wide land use controls for the installation. The DOE is responsible for providing long-term stewardship, operation, and maintenance for FUSRAP sites, including monitoring and enforcement of land use controls.

Summary: In the NCP [40 *CFR* §300.430(a)(1)(iii)(D)], USEPA states "the use of institutional controls shall not substitute for active response measures (e.g., treatment and/or containment of source material, restoration of ground waters to their beneficial uses) as the sole remedy unless such active measures are determined not to be practicable, based on the balancing of trade-offs among alternatives that is conducted during the selection of the remedy."

For these reasons, in FUSRAP areas where active measures are not practicable, land use controls would need to be implemented to restrict use at the site. Land use controls through access controls and/or installation use restrictions are retained for further consideration as a component of the remedial alternatives for soil and structures.

3.4.3 Monitored Natural Attenuation

Natural attenuation processes include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil (USEPA 1999a). Natural attenuation processes may reduce the potential risk posed by site contaminants in three ways: (1) transformation of contaminant(s) to a less toxic form through destructive processes such as biodegradation or abiotic transformations, (2) reduction of contaminant concentrations whereby potential exposure levels may be reduced, and (3) reduction of contaminant mobility and bioavailability through sorption onto the soil or rock matrix (USEPA 1999b). Long-lived radionuclides in soil become unavailable for biological uptake due to sequestration at mineral surfaces or formation of solids. Natural attenuation by dilution may reduce dissolved contaminant concentrations to the point where RGs are met, although there has been no net reduction in contaminant mass [Sandia National Laboratories (SNL) 1999a].

It is USEPA's policy that natural attenuation does not mean "no action." Selection of this remedy must demonstrate, in advance, that natural attenuation is likely to protect public health and the environment and must show, after approval, that it is working as initially presented. Monitoring is required to ensure that natural attenuation is reducing contaminant mobility, volume, or

toxicity and results in the achievement of cleanup goals. For these reasons, the remedial technology is called monitored natural attenuation (MNA).

A key component for selection of MNA is the capacity of the natural processes to attenuate the contaminants to exceed the rate at which the contaminants are introduced into the subsurface (SNL 1997). Historical characterization data for soil (and ground water if impacted) should demonstrate a clear and meaningful trend of decreasing contaminant mass and/or concentration over time. In general, more supporting information may be required to demonstrate the efficacy of MNA at those sites with contaminants that do not readily degrade through biological processes (e.g., inorganics and radionuclides) or where monitoring has been performed for a relatively short period of time (USEPA 1999b).

A second key component in the evaluation of MNA, according to USEPA (1999b), is that the selection of MNA to achieve site-specific remediation objectives must be within a timeframe that is reasonable compared to that offered by other more active methods. Natural attenuation typically takes longer to achieve RGs than more active remediation actions. Land use concerns may result in the selection of proactive, rather than passive, remediation actions. Isolated sites with greater distances to potential receptors are, therefore, more likely candidates for natural attenuation as a remedy (SNL 1997).

DU, a radioactive metal, decays very slowly with specific half-lives of the isotopic uranium ranging between 2.455×10^5 to 4.468×10^9 years. Additionally, DU has been present at the sites since the 1960s and has shown little migration to the subsurface soil. Therefore, it is unlikely that MNA for DU would achieve the site-specific remediation objectives within a reasonable timeframe. Because concentrations of DU in the clayey soil at the FUSRAP areas are not likely to be reduced appreciably over time through natural fate and transport processes, application of MNA to DU is not likely to be fully protective of human health and the environment. For this reason, MNA has not been retained for consideration.

3.4.4 Reclamation/Recovery

Reclamation/recovery is a permanent treatment that separates metals contaminants from soil in the form of metal, metal oxide, or other useful products that have potential market value. This process is typically preceded by physical separation processes to upgrade the metal content in a specific soil volume or to recover larger metal fragments. Subsequent chemical treatment also can be performed to further leach metallic compounds from soil. DU may be recycled for manufacturing of components for scientific instruments to containers for spent fuel shipping casks. In the medical field, DU has been used for biomedical isotope shields, calorimeters, and radiographic cameras. Because of its density, DU is used as a counterweight in both commercial and military aircraft.

Reclamation and recovery is a potential technology for DU. Reclamation of DU would require additional pre-treatment to isolate the DU metal from the soil medium. For this reason, reclamation/recovery for DU would be considered as an alternative to disposal as waste along with a selection of a treatment technology that can be used to prepare the DU metal for reclamation. Reclamation/recovery is retained for further evaluation.

3.4.5 Containment

Containment is a general remedial action that is designed to provide a barrier between contaminated and uncontaminated media to prevent contaminants from migrating into ground water, surface water, air, or other media, or acting as a source for direct exposure. Containment

is often performed to prevent, or significantly reduce, the migration of contaminants in soil or ground water. Containment technologies, while designed to prevent contaminant migration and exposure, do not reduce contaminant volume or toxicity. On-site (i.e., "in place") containment generally requires land use controls and ongoing maintenance and monitoring activities as part of the containment remedy to ensure its long-term protectiveness. Containment offers quick installation times and is typically a low to moderate cost option. Unlike ex-situ actions, containment does not require excavation of soil, which can lead to increased costs from the engineering design of the equipment, possible permitting, and material handling. However, containments require periodic inspections for settlement, ponding of liquids, erosion, and naturally occurring invasion by deep-rooted vegetation. Additionally, ground-water monitoring wells associated with containments need to be periodically sampled and maintained. Even with these long-term requirements, containment is often considerably more economical than excavation and removal of the contaminants.

The NCP [40 *CFR* §300.430(a)(1)(iii)(B)] states that USEPA "expects to use engineering controls, such as containment, for wastes that pose a relatively low long-term threat or where treatment is impracticable." USEPA's presumptive remedy for soil with metals that pose a low-level threat is containment (USEPA 1999c). Containment was found to be the second most common remedy selected based upon a national FS analysis conducted on 51 sites having metals-contaminated soil (USEPA 1999c). While uranium metal was not one of the 14 metals found as contaminants at these sites, the fate and transport of uranium is characteristic of other heavy metals such as lead, iron, and nickel identified in the national FS analysis.

Containment technologies applicable for the FUSRAP areas include cover systems and horizontal barriers.

Caps/Covers: Cover systems or capping is a proven, effective technology for providing reliable long-term containment and preventing or minimizing off-site migration of constituents. Capping minimizes risk by preventing direct contact with waste and affected soil and preventing off-site migration of constituents in surface water or airborne dust. Where infiltration through waste or affected soil is a concern, a low-permeability cap design is used to minimize the potential for constituent migration into ground water by minimizing infiltration of precipitation. A cap serves as a physical barrier to prevent humans, animals, and vegetation from coming into contact with materials affected by contamination. Caps may be constructed of a variety of natural materials (i.e., clay, sand, and other soil), synthetic liners, geotextiles and other geomembranes, and other synthetic materials (e.g., asphalt or concrete). Cover systems for radionuclides would require additional design or specialized "georad" textile fabric to control gamma radiation exposure at the surface. More recently, surface-applied polymers have been introduced as part of the cap system and are used to stabilize the soil or chemically bind the contaminants. Although they are typically categorized as short- to moderate-term (<10 years) binders [Pacific Northwest National Laboratory (PNNL) 2007], they may, when used with capping systems, provide additional protectiveness. Capping is the most common form of remediation because it is generally less expensive than other technologies and effectively manages the human and ecological risks associated with a remediation site (FRTR 2009).

Although capping would reduce the potential risks by reducing exposures to soil and is implementable particularly at the Firing Site 12 Area, the use of the FSA is expected to increase as a result of actions mandated by the 2002 Base Realignment and Closure law (commonly referred to as BRAC). The Kansas Army Ammunition Plant and the Lone Star Army Ammunition Plant in Texas will be closed and some of the plant activities will be relocated to the IAAAP (USACE 2007b). Under the proposed action, the incoming missions would require

some test firing. To return the FSA to active military use, the integrity of the cap could be comprised during future firing activities and, therefore, capping as an alternative has not been retained.

Horizontal Barriers: In-situ horizontal barriers can be used to prevent vertical migration of contaminants to subsurface soil as well as to the ground water. Established technologies use grouting techniques to create a horizontal barrier beneath the contaminated soil without removing the soil, thus reducing the permeability of soil layers. Studies performed by the USACE indicate that the conventional grout technology cannot produce an impermeable horizontal barrier because it cannot ensure uniform lateral growth of the grout (USEPA 1997b). The vertical extent of DU contamination in soil is shown to be approximately 2 ft deep. The primary risk associated with the contaminated soil and structures is due to surface soil exposures. Horizontal barriers would not be effective in reducing these risks and, therefore, are not retained for further evaluation.

3.4.6 Removal by Excavation

Excavation would involve the removal of soil using construction equipment such as backhoes and front-end loaders or other digging equipment. Treatment of excavated material prior to disposal may be conducted in conjunction with applicable solid and hazardous waste requirements to reduce the toxicity, volume, or mobility of the contaminants. Excavation would require disposal of waste materials either in an on- or off-site disposal facility.

Selection of excavation equipment would be based on worker safety, production rates, and quantity of overburden. Soil excavation is not expected to be performed to a depth greater than 2 ft bgs. Radiological surveys for DU or soil analytical data would be used to determine the extent of excavation. Confirmatory sampling would be performed after excavation to assess whether the remaining soil exceeds the RG. Excavated soil materials may be characterized and sorted for appropriate follow-up treatment or disposal. Uncontaminated material may be stockpiled to be used as fill. This is a commonly used method for remediation of contaminated soil and has been shown to be effective and fully implementable. Standard engineering and administrative controls for radiation exposure and air emissions would be implemented. Radiological controls, which include limiting the amount of time an operator can work in the area, requiring personnel to wear personal protective clothing, and using distance and shielding to reduce radiation exposure, would be used as necessary to reduce radiation exposure to the operators. Air emissions would be controlled by the use of water sprays or soil fixatives to suppress dust during soil excavation and removal. Excavation is a proven, effective action for remediation of soil and is retained for further consideration.

3.4.7 Disposal

Disposal is a general response action for final disposition of excavated waste, affected soil, or waste generated by treatment processes. Landfill disposal relocates contaminants from one place to another for long-term containment. It is not a treatment to destroy or detoxify contaminants; although, treatment can be used prior to disposal to reduce the toxicity, mobility, or volume of contaminated media.

The options for disposal following excavation are an on-site constructed landfill and an off-site landfill disposal facility (including any treatment under land disposal regulations). Landfill options may include disposal in a waste disposal facility licensed for radioactive waste, placement in a solid waste landfill, or placement in a Resource Conservation and Recovery Act (RCRA) Subtitle C landfill. Selection of the disposal alternative would be made based on waste

classification. If the material were determined to be regulated, then it would require disposal in an authorized facility. Excavation of material and disposal in an on- or an off-site disposal facility could be implemented in a relatively short timeframe and would return the FUSRAP areas to the U.S. Army for active military use. Characterization data collected at the FUSRAP areas indicate that DU is primarily associated with surface soil (0 to 1 ft bgs), which can be easily removed by traditional earthmoving equipment.

On-site disposal would require new construction of an engineered landfill or the use of existing landfill units. Off-site disposal would utilize commercial or municipal landfills for disposal of waste or affected soil excavated from a contaminated area. The appropriate landfill would depend on the nature of the material for disposal. For hazardous or dangerous waste, several RCRA Subtitle C Disposal Facility landfills are available, including the landfills in Illinois, Indiana, Oklahoma, and Michigan. Low-level radioactive waste (LLRW) disposal facilities for DU-contaminated wastes are available in Utah and Idaho. For other wastes, non-hazardous landfills could be considered. Municipal landfills are allowed to accept waste that is not classified as hazardous under federal (RCRA) regulations. On- and off-site disposal options are retained for further consideration for the FUSRAP areas.

3.4.8 Treatment

Treatment is defined as a chemical, biological, or physical means to permanently or substantially eliminate or reduce the toxicity, mobility, or volume of hazardous substances by the use of in-situ or ex-situ remedial technologies. Treatment technologies are an alternative to landfill disposal of hazardous wastes without treatment (USEPA 2007a).

The selection of a remedial treatment technology depends on the physical and chemical properties of the contaminants. For example, organic compounds such as explosives are amenable to treatment by certain technologies, such as thermal desorption, because of their volatility. Chemical treatments, such as solidification/stabilization (S/S), are most often used for treatment of metals and radionuclides because they form insoluble compounds when combined with appropriate additives, such as Portland cement (USEPA 2007a).

As defined in the NCP [40 *CFR* §300.430(a)(1)(iii)], USEPA expects to use treatment to address the principal threats posed by a site whenever practicable. While no principal threats are present at the FUSRAP areas, treatment technologies are available that can reduce contaminant volume, toxicity, and/or mobility and, therefore, may achieve the RAOs identified for this OU. Although containment is USEPA's expected remediation alternative for low-level threat wastes, the NCP [40 *CFR* §300.430(e)(3)(i)] also states that the range of alternatives shall include those that remove or destroy contaminants to the maximum extent feasible (USEPA 1988a).

Several of the treatment technologies may be applied as in-situ or ex-situ treatments. In-situ (in place) treatment consists of remedial technologies that destroy COCs or reduce their toxicity or mobility without excavation or removal of the contaminated medium and are generally more cost-effective (Williams 2006). Ex-situ remediation requires excavation or removal of the contaminated media prior to treatment but is considered a more thorough remediation technique. The waste and soil can be more thoroughly mixed prior to treatment; however, the costs are generally higher due to the excavation and transportation of the soil (Williams 2006). The selection of in-situ or ex-situ treatment is dependent on site-specific conditions and the duration of the treatment for a specific contaminant.

The initial screening of treatment technologies was based, in part, on the Federal Remediation Technologies Roundtable (FRTR) Screening Matrix, Version 4.0 (FRTR 2009). The process

options that did not appear feasible or applicable were rejected, while those that were identified as "Above Average" or "Average" based on development status, overall cost, performance, and contaminant type, were retained for further evaluation. A review of innovative technologies was conducted considering USEPA's preference for innovative technologies that have comparable or superior performance to demonstrated technologies. Additionally, the soil remediation technologies identified by USEPA's *Depleted Uranium Technical Brief* include excavation followed by containment or by treatment of the waste (USEPA 2006b).

The technologies proposed for remediation of DU include physical treatment (separation) or chemical treatment (extraction) (USEPA 2006b). Innovative technologies that are showing promise for remediation of radionuclides include soil washing and biological treatments such as phytoremediation.

3.4.8.1 Physical/Chemical Treatment

Physical treatment technologies are based on the physical differences between the contaminant and the surrounding soil by taking advantage of the contaminants' physical properties. The benefit of using physical treatment is that only the contaminated fraction of the excavated soil needs to be disposed of off-site, potentially substantially reducing the volume of waste material. Technologies that use the contaminants' chemical properties to separate or chemically convert contaminants from the contaminated media are identified as chemical treatments. Chemical treatments may result in a reduction or oxidation process that chemically converts hazardous contaminants to non-hazardous or less toxic compounds that are more stable, less mobile, and/or inert. An example is S/S, which is a chemical treatment that treats contaminants by physically binding or enclosing them within a stabilized mass (solidification) or inducing chemical reactions between the stabilizing agent and contaminants to reduce their mobility (stabilization). Physical and chemical treatments may be used independently of each other but may also be combined into treatment trains.

Physical treatment technologies work successfully on heavy metals and radionuclides because they are typically associated with particular fractions of the media that can be separated based on their size and other physical attributes. In solid media (i.e., soil and sediment), most radioactive contaminants are associated with smaller particles (i.e., clays and silts). At the IAAAP, the FUSRAP radiological COC is DU, which ranges in size from fine particulates to baseball-sized fragments or larger, which may be amendable to physical separation treatments. Physical treatments have been shown to be effective in reducing contaminant volume and mobility for both radionuclides and metals.

The physical/chemical processes identified for radionuclides and heavy metals include electrokinetic separation, soil flushing, soil sorting, soil washing, and S/S (FRTR 2009). Although chemical extraction and chemical reduction/oxidation are also identified by FRTR as ex-situ physical/chemical treatment technologies, these technologies are now most often combined as part of the treatment train for soil washing (Kulpa 2001).

Electrokinetic Separation and Soil Flushing: Two in-situ processes that have been identified as potential physical treatment alternatives by FRTR (2009) are electrokinetic separation and soil flushing. Electrokinetic separation is an in-situ process that separates and extracts heavy metals, radionuclides, and organic contaminants from saturated or unsaturated soil using a low intensity direct current across electrode pairs that have been implanted in the ground on each side of the contaminated soil mass. Contaminants are desorbed from the soil surface and are transported towards respective electrodes depending on their charge. The contaminants may then be extracted to a ground-water well recovery system or deposited at the electrode and removed. The

residuals would likely require further treatment and/or disposal. Soil flushing is also an in-situ process that uses an injected fluid such as water, dilute acids or bases, complexing and chelating agents, reducing agents, solvents, or surfactants to remove contaminants from the subsurface without first having to excavate the wastes or affected soil. Water, or water containing an additive to enhance contaminant solubility, is applied to the soil or injected into the ground water to raise the water table into the contaminated soil zone. Contaminants are leached into the ground water, which is then collected at strategically placed wells, and brought to the surface for disposal, recirculation, or on-site treatment and reinjection. In both cases, these in-situ methods are designed to recover contaminants that are found at subsurface depths greater than what is encountered at the FUSRAP areas; therefore, electrokinetic separation and soil flushing are not retained for further consideration.

Soil Sorting: Soil sorting seeks to detach contaminants from their medium (i.e., the soil and/or binding material that contains them), which segregates the concentrated contaminant-bearing material from the clean soil fractions for subsequent treatment or disposal, which can substantially reduce the overall volume of waste that must be further treated or disposed (FRTR 2009). This process is most applicable to metals-contaminated soil (including DU). Physical separation of contaminated and uncontaminated soil may be accomplished using dry or wet separation techniques including magnetic separation technology, floatation, or gravimetric separation. Soil sorting can also be used to separate radioactive particles from clean soil particles using radiological detectors.

For radiologically contaminated soil, the larger fragments can be radiologically scanned to determine whether this fraction must be handled as radiological waste or can be used as backfill. Large rocks may also be crushed and placed with soil for further chemical treatment such as soil washing or additional physical treatment. Further physical treatment of radiologically contaminated soil can be accomplished by spreading the pre-screened soil to a 1/2- to 3-in thickness on a conveyor belt, which carries the soil under radiation detectors that measure and record the level of radiation in the material (Eberline 2008). Radioactive particles are tracked and mechanically diverted through automated gates that separate the soil into contaminated and clean segments. The system can be configured to detect a wide range of radionuclide contaminants and to a segregation criterion between 2.7 and 50 pCi/g based on the radionuclide (Antech 2008). The volume of radioactive material segregated can be further processed and/or disposed of, and the uncontaminated soil may be used as fill material. Soil sorting can be used as the principal means of remediation of contaminated soil if the contamination is associated with a particular soil size fraction or as a pre-treatment for other treatment alternatives. Soil sorting may be feasible as an alternative for pre-treatment or combined with other treatments to reduce the volume of material requiring disposal, particularly for the DU fragments, and the extent of soil contamination from DU and has been retained for further evaluation.

Soil Washing: Soil washing is a broad term used to describe a variety of physical and chemical separation techniques for the remediation of contaminated soil. Soil washing is an ex-situ treatment that typically incorporates both physical and chemical treatments because it removes the contaminants from soil by either dissolving or suspending contaminants in the wash solution and/or by concentrating them into a smaller volume of soil through particle size separation, gravity separation, and attrition scrubbing (FRTR 2009). Soil washing can be applied to both organic and inorganic contaminants including heavy metals and radionuclides. Soil washing has been largely developed on the principle that contaminants in soil, including metals, tend to congregate on soil surfaces and are subsequently concentrated in the smaller-size fractions of soil. Physical separation alone may not sufficiently clean the soil to meet cleanup standards, but

separating the fractions of site soil will often greatly reduce the total volume of soil requiring the follow-up chemical treatment of the soil washing process. The clean fraction from soil washing can often be returned directly to the site at very low cost [Interstate Technology and Regulatory Council (ITRC) 1997]. Soil washing is retained for further evaluation.

S/S: The third type of treatment is immobilization, which is a presumptive remedy for soil with metals that pose a principal threat (USEPA 1999c). Immobilization does not reduce the toxicity or volume of a contaminant; rather, it reduces its mobility because it physically traps the contaminants within the treated material, thus preventing their release into the environment. Over time, the level of radioactivity emitted from the immobilized product reduces itself through a process of radioactive decay. An immobilization technology typically used for metal and radioactively contaminated soil is S/S. Solidification and stabilization techniques are often used together and are closely related in that both use chemical and/or physical processes to reduce mobility. Stabilization essentially locks contaminants within their "host" medium (e.g., soil and sand) by inducing chemical reactions between the stabilizing agent and contaminants, thus reducing their mobility. Solidification encapsulates the waste in a monolithic solid of high-structural integrity. While the contaminants would not be removed and would remain radioactive, the mobility of the contaminants would be eliminated or reduced (FRTR 2009). Common stabilization compounds are phosphates, sulfates, hydroxides, and carbonates, including Portland cement, fly ash, gypsum, grout, or specific and proprietary reagents. S/S may be employed as an in-situ or ex-situ treatment technology. In-situ techniques use auger and injector head systems to apply agents to in-situ soil. Ex-situ techniques involve excavation of the contaminated soil materials and machine-mixing them with the solidifying agent instead of injecting the agent into the materials in place. Although S/S can be performed in-situ, uniform mixing of chemical reagents with the impacted soil is difficult, verification of satisfactory mixing is difficult, and soil having high clay content impedes in-situ immobilization. Therefore, in-situ S/S is not retained for further consideration.

Ex-situ S/S may facilitate the disposal of wastes in an on-site disposal facility or the transportation of wastes to an off-site disposal facility because it reduces the mobility of contaminants. Ex-situ S/S was selected as the remedial action for the IAAAP soil contaminated with metals (plus explosives) (USACE 1998a). Soil with metals contamination in excess of RGs is excavated and treated by stabilization using activated carbon along with solidification materials, such as cement and fly ash, with disposal of residuals in an on-site landfill (USACE 1998a). According to FRTR, larger particles, such as coarse gravel or cobbles (and likely fragments of DU), are undesirable for chemical extraction processes and also may not be suitable for the S/S technology (FRTR 2009). As a result, pre-treating DU for S/S (e.g., crushing) may be required to facilitate the treatment process. Ex-situ S/S has been retained as an alternative for further consideration.

3.4.8.2 Biological Treatment

Biological treatment is the use of plants and microorganisms, such as bacteria and fungi, to remediate contaminated soil, water, and other media through contaminant removal, degradation, immobilization, or containment. Biological treatment has been a major component for many years in the treatment of municipal and industrial wastewaters. More recently, it has become more widely accepted that microorganisms can transform and degrade many types of contaminants [Natural and Accelerated Bioremediation Research (NABIR) 1999; USEPA 2006d]. Applications of bioremediation have been proven effective and are now widely accepted as a remedial alternative for explosives, fuels, and other organic contaminants because it breaks

down organic substances as part of the organism's physiological processes (USEPA 2006c). More recently, microbial and phytological (plant) processes are being bench- and field-tested for the remediation of radioactive and metallic contaminants (NABIR 1999). While radioactive and metals contaminants cannot be biodegraded, biological organisms can alter the oxidation states of those contaminants, thus increasing mobility, which allows for extraction or removal. Alternatively, alteration of the oxidation state may result in greater immobilization of contaminants within a medium (NABIR 1999).

Enhanced Bioremediation: Enhanced bioremediation is a technique that can be used in-situ or ex-situ and combines two types of treatments identified as biostimulation and bioaugmentation. Biostimulation is the addition of nutrients, oxygen, or other electron donors or acceptors to increase the number or activity of naturally occurring microorganisms available for bioremediation (NABIR 1999). Bioaugmentation is a treatment that involves the addition of microbial cultures to enhance the biotreatment process and may be needed if the indigenous organisms do not degrade the specific contaminants found at a site. Bioaugmentation is almost always performed in conjunction with biostimulation (USEPA 2006c). Examples of biostimulation include land farming, bioslurry reactors, and composting.

At the FUSRAP areas, most of the human health risk is associated with the potential for radiological exposures to DU that is heterogeneously present as visible fragments or fine particulates in shallow soil (2 ft bgs or less). In-situ bioremediation treatment requires amendments to be mixed within the soil medium to promote the survival of the organisms and remediation of the contaminants. Ex-situ biological treatment would require some type of initial preparation of the soil, such as crushing and blending of the DU, to allow treatment to be effective. For this reason, biological treatment would not be feasible as a primary treatment process for FUSRAP areas where DU is present and it is not expected that a secondary treatment process would be necessary for the low level of radionuclides present in the soil. Therefore, enhanced bioremediation treatment technologies have not been retained for further screening.

Phytoremediation: Phytoremediation or phytotechnology is a process that uses plants to remove, transfer, stabilize, and destroy contaminants in soil and sediment and, in some cases, contaminated water. The remediation methods use plants to remove contaminants from soil through the uptake and transformation of organic compounds or bioaccumulation of contaminants including metals and radionuclides (NABIR 1999). In addition, recent studies have shown that several plant species have been documented as "hyperaccumulators" for a specific contaminant (AbdEl-Sabour 2007; USEPA 2001a; USEPA 2004b). Plants that have accumulated the contaminants in their biomass are subsequently harvested for disposal and treated or disposed at a waste management facility. In general, phytoremediation works best on large land areas with low levels of contamination (Ghosh and Singh 2005).

Phytoremediation is effective as a remediation alternative because it can reduce the mobility of radiological contaminants. Phytoremediation has been shown to be effective at removing radionuclides from shallow surface soil, especially when soil is amended with chelating agents such as citrate (Ebbs et al. 2001; AbdEl-Sabour 2007). Phytoremediation is primarily applied as an in-situ process but can be used ex-situ when soil is excavated and placed within an engineered unit where plants are then placed and routinely harvested. The harvested plant biomass would be analyzed for radiological concentrations and, if elevated, biomass would require disposal as LLRW. Ex-situ phytoremediation has been retained as an alternative for further consideration.

3.4.9 Structural Remediation Technologies

The hazards associated with radiological contaminants on structural surfaces include radiological exposure to humans from direct exposure to external radiation emanating from radioactive contaminants on surfaces and in equipment, radiation exposure due to inhalation of contaminants that are already airborne in the facility or are generated during the remediation activities, and radiation exposure due to ingestion of radioactive contaminants (USEPA 2006a). The technologies for remediation of structures contaminated with radionuclides include the use of surface barriers, decontamination, and demolition.

3.4.9.1 Containment Surface Barriers for Structures

The purpose of containment as a remediation technique is to limit the release of contaminants into the air to minimize the human health and environmental exposures. The containment technologies for structural surfaces of buildings and equipment involve sealing the surface with sealants to prevent direct contact with contaminants and to reduce contaminant mobility. Technologies for surface sealants include painting, applying resins or liquid plastic (foams, plastics), and the application of other impermeable materials (plastic sheeting or wooden structures) to provide a barrier.

At the FUSRAP areas, the structures that were found to be radiologically contaminated above the structural surface RG are two small, localized components, one of which can be successfully treated using containment surface barriers, especially paint sealants, and allowed for continued use of the building. Because the existing buildings at Line 1 would be used to accommodate the existing and new BRAC missions at the IAAAP, the use of these facilities, including the localized components, would be necessary. For these reasons, containment surface barriers are retained for further evaluation as a remedial action for structures.

3.4.9.2 Decontamination of Structures

Decontamination is an activity that refers to the removal or reduction of radioactive and/or other hazardous contamination from facilities, including structural and non-structural materials and equipment. Decontamination reduces the radiation risk and exposure to a level that is protective of human health and the environment. Decontamination technologies include chemical, electrochemical, and thermal processes as well as physical methods such as mechanical cleaning, washing, and other techniques. Decontamination can be a stand-alone operation conducted at a facility that is in use and will remain so after the decontamination is completed or it can be combined with demolition if a facility is undergoing a decommissioning process.

Chemical agents are widely used as decontaminants, primarily to remove fixed contamination. Chemical decontamination uses various agents to chemically transform and remove contamination. However, it is more limited because the process may destroy the surface material on which the contaminant resides and not all surfaces (e.g., porous material) are amenable to its use (USEPA 2006a).

Physical decontamination includes surface cleaning techniques (e.g., brushing, wiping, flushing, vacuuming, and strippable coatings) and surface removal (e.g., grinding, blasting, shaving, and scaling). During surface cleaning, the surface remains intact but contamination on the surface is mechanically dislodged; whereas, in surface removal, the contamination is removed by the removal of an entire layer of the surface. Risks associated with structures may also be eliminated or reduced by tearing down a portion or the entire structure, usually without the intent of re-use or replacing specific structural components. Radiological decontamination involves ensuring that

all radioactive components are removed, all surfaces are cleaned, and radioactive waste is properly packaged and sent to an appropriate disposal facility. For example, drain grates that were used to cover sediment collection basins may need to have the contamination removed or fixed in-place and be sized (cut) and packaged. Concrete that may have been in contact with radioactive soil is also characterized before or during response actions to determine whether contamination exists and be decontaminated as is appropriate and cost-effective (ITRC 2008).

LLRW, hazardous waste, and mixed waste may be generated during decontamination or replacement. Wastes would require disposal in an on- or off-site facility based on the type of waste generated.

At the FUSRAP areas, the structures that were found to be DU-contaminated above the structural surface RG are small, localized areas or structures that can be decontaminated or replaced and allow continued use of the building. Methods used for decontamination of structures using physical or chemical methods have been successfully used at many FUSRAP areas. Because the existing buildings at Line 1 would be used to accommodate the existing and new BRAC missions at the IAAAP, the restoration of these facilities would be necessary. For these reasons, decontamination by physical and/or chemical methods and/or replacement is retained for further evaluation as a remedial action for structures.

3.4.9.3 Demolition of Structures

Demolition involves the disassembly (dismantlement) and removal of any building, structure, system, or component and the long-term disposal of waste materials in compliance with applicable requirements. Demolition would reduce the exposure to contaminated building surfaces by removing the source material. Dismantlement is the removal of equipment, fixtures, fittings, etc. from a structure followed by the controlled breaking of the structure into pieces and removal of the pieces from the facility. Demolition is the controlled tearing-down of a structure, usually without the sequential breaking involved in dismantlement. Demolition would involve removal of the building structure and its shallow foundations. Demolition activities would include identification and isolation of building elements to be demolished, decontamination or abatement of all hazardous materials, demolition of the building structure, and segregation and disposal of the debris.

After all radioactive substances are removed or fixed in-place, dismantlement and demolition follow standard industry practices. Both demolition and dismantlement activities create waste that may be reduced and may have value when recycled (ITRC 2008). Some materials may be used for salvage or be sent to municipal landfills or regulated landfills if contaminated. Building materials would be characterized by taking external radiation measurements using appropriate survey instrumentation and/or swipe samples according to approved protocols. The results of these surveys would determine the eventual destinations of the materials.

After demolition, any surface depression or excavations would be backfilled with suitable clean fill material and compacted to grade in accordance with engineering requirements. The source of the fill material would be determined at the time of need, based upon local supply, and may also include uncontaminated residual rubble from the slab and foundations.

At the FUSRAP areas, the structures that were found to be radiologically contaminated above the structural surface RG are small, localized areas or structures that can be decontaminated or replaced and allow continued use of the building. Because the structures at existing storage areas, firing sites, and the buildings at Line 1 could be used to accommodate the existing and new

BRAC missions at the IAAAP, the restoration of these facilities may be necessary. For these reasons, demolition of the above-grade structures is not retained for further evaluation.

3.5 EVALUATION OF TECHNOLOGIES AND PROCESS OPTIONS

The final step of this phase is to evaluate and screen the remedial technologies and specific process options that were found to be feasible for the FUSRAP areas based on the site's physical characteristics and contaminant types (Section 3.4). The options were evaluated based on three broad evaluation criteria: effectiveness, implementability, and cost (USEPA 1988a). Each process option is rated as low, moderate, or high in each of the three criteria. Technologies and process options are screened based on these three evaluation criteria and those technologies and process options that are retained are assembled into remedial alternatives representing a broad range of technologies (Figure 3-4).

Evaluation of effectiveness considers the level of human health and environmental protection afforded by an alternative in terms of reduction of toxicity, mobility, or volume of contaminants. Process options providing significantly less effectiveness than other more promising options would be rated as low and can be eliminated from further consideration as well as those that do not provide adequate protection of human health and the environment.

Evaluation of implementability considers technical issues such as the ability to construct, reliably operate, and monitor the implementation of the remedial action, as well as administrative issues such as the ability to gain regulatory approvals and acceptance of the alternative. Process options that are technically or administratively infeasible or require equipment, specialists, or facilities that are not available within a reasonable period of time would be rated as low and may be used as a factor to exclude the technology from further consideration. .

The cost evaluation presents the estimated costs associated with capital and operating expenses. The average reported or estimated cost of a process option was rated as low [< 150 U.S. dollars ($)/CY], moderate (between $150/CY and $300/CY), or high (>$300/CY). Costs that are grossly excessive compared to the overall effectiveness of alternatives would be rated as high and may be used as a factor to exclude the technology from further consideration.

3.5.1 No Action

The no action alternative provides a baseline for comparison with other alternatives, as required under CERCLA. This alternative provides no additional protection of human health and the environment. No remedial actions would be taken to reduce, contain, or remove contaminated soil. No effort would be taken to prevent or minimize human and environmental exposure to residual contaminants on-site. Off-site migration of contaminants would not be mitigated under the no action alternative.

3.5.1.1 Effectiveness

Under the no action response, there would be no change in the current risk to site workers or construction workers because no remedial action would be implemented. Additionally, a no action alternative would also result in no additional controls that would prevent current or future exposures to DU that could result in potential human health risk under alternative land use scenarios. Under the no action alternative, there would be no reduction in the mobility, volume, or toxicity of the DU; therefore, the effectiveness would be rated as low.

3.5.1.2 Implementability

The technical implementability of no action is high because no further activities would need to be performed. However, the administrative implementability of no action is rated as low as it is likely that the regulatory agencies would require that a remedial action be taken to address the contamination.

3.5.1.3 Cost

This alternative is low cost and imposes no costs.

3.5.1.4 Summary of Evaluation

The no action alternative has been retained as a remedial action alternative for both soil and structures for use as a baseline of comparison to other alternatives being considered.

3.5.2 Land Use Controls

Land use controls would include access and installation use controls for the FUSRAP areas where contaminated soil or structures would remain above RGs. Procedures for maintaining site controls at the IAAAP used to prevent exposure to plant (site) workers, contractors, and site visitors from DU are currently in place and would remain as part of the land use controls. Digging permits, utility repairs, maintenance, or other site work required at soil areas or structures above RGs would be accomplished through internal coordination between the authorized IAAAP operator, the IAAAP, and the U.S. Army to ensure all workers are aware of and are protected from potential environmental hazards. Documented procedures and installation-based land use plans would be developed or modified to address general site controls, routine maintenance and repair activities, new construction, well construction, and emergency work (USACE 2006).

3.5.2.1 Effectiveness

Land use controls would increase human health protectiveness over baseline conditions (no action) by limiting direct access to contaminated soil areas by most military personnel and contract workers and by limiting future IAAAP uses of the FUSRAP areas. Under the land use controls alternative, there would be no reduction in the mobility, volume, or toxicity of site-related contaminants, but the potential for exposure is reduced. However, because land use controls would have to be maintained at the site to prevent UUUE, they may not be protective in the long term.

Generally, land use controls do not reduce the potential for DU to migrate from surface soil to ground water via infiltration., However, land use controls can be used to reduce or prevent exposures to contaminated ground water. Therefore, the effectiveness of land use controls for addressing soil contamination is rated as moderate.

Access controls to prevent unauthorized and/or inappropriate use of structures would limit exposure to DU-contaminated surfaces. Therefore, the effectiveness of land use controls for structures is rated as high

3.5.2.2 Implementability

The technical implementation of land use controls is not expected to entail unusual techniques, materials, or labor. Land use controls would be implemented as part of the site-wide land use controls for the installation. Some land use controls may include restrictions recorded in public

records. Additional fencing, signage, or security measures can be readily installed and managed as part of the existing security measures currently in place at the IAAAP. Land use controls would have no administrative implementability concerns, given that many of the land use controls are already in place. Therefore, both the technical and administrative implementability of land use controls are rated as high.

3.5.2.3 Cost

The costs that would be incurred for land use controls include the administrative cost of setting up the land use controls, as well as the cost of maintaining and monitoring the controls. The costs also may include material costs if additional signage or fencing is installed. The relative costs of additional land use controls are low.

3.5.2.4 Summary of Evaluation

Land use controls at the FUSRAP areas have been retained for further evaluation. The effectiveness of land use controls is rated moderate, the implementability is high, and the cost is low.

3.5.3 Reclamation/Recovery

Reclamation of DU would require additional pre-treatment to isolate the DU metal from the soil medium. For this reason, reclamation/recovery for DU would be considered as an alternative to disposal as waste along with a selection of a treatment technology that can be used to prepare the DU metal for reclamation.

3.5.3.1 Effectiveness

Reclamation/recovery is a permanent treatment that separates metal contaminants from soil, establishes the metal products as a commodity instead of a waste, and is used as an alternative to disposal of the materials as waste. The process of reclamation is highly dependent upon the soil type and the available methods to separate and concentrate the metals into a re-usable fraction, while the remaining larger fractions of soil would be returned as uncontaminated fill material. The process of reclamation and recovery is considered highly effective at reducing the toxicity, mobility, and volume of contaminated material because the DU would be removed from the media.

3.5.3.2 Implementability

Economic viability of the recovered materials and vendor availability are key components in determining whether reclamation and recovery can be implemented as a remedial alternative. DU is currently used for industrial radiographic shields, medical isotope transportation shields, counterweights, and various items for energy and physics research [Manufacturing Sciences Corporation (MSC) 2009]. A study of the potential uses for DU oxide by DOE included the potential conversion of DU oxide to DU metal for reclamation and re-use. The DOE study concluded that the quantity of DU in demand for beneficial use is currently a small fraction of the available inventory. Additionally, DOE determined that the conversion of DU oxide to DU metal would be performed only when uses for the converted material are identified (DOE 1999).

Reclamation/recovery is expected to have some technical implementation problems. Currently, only one DU rolling mill is licensed for commercial use in the United States. Since 1985, MSC in Tennessee has converted over 6 million lbs of DU into more than 70,000 safe, useful products under a radioactive material operating license issued by the state of Tennessee under NRC

guidelines (MSC 2009). The acceptance of DU material by this manufacturer is at a cost to USACE. Although the vendor is currently accepting clean DU material, the lack of more vendors, the marketability of the metal, and the pre-treatment requirement to separate the metal would make implementation of this alternative difficult. Therefore, the technical implementability for reclamation/recovery is rated as moderate. Issues affecting the administrative implementability, such as the ability to obtain regulatory approval for the technology, are not expected to be significant. Therefore, the administrative implementability is rated as high.

3.5.3.3 Cost

Reclamation/recovery is not practicable for metals that lack economic viability. If the revenues generated by the re-sale/re-use of the recovered materials outweigh the costs of implementing the technology, or are comparable with other protective alternatives, then reclamation/recovery should still be considered (USEPA 1999c).

To reclaim the DU metal, the contaminated soil must undergo a sorting process to separate the DU metal from the soil portion at an additional cost. Furthermore, DU reclamation is not currently economically viable. In an email from Mr. Brian Woods of MSC, dated May 18, 2009, the price for acceptance of DU metal is $3.00 to $9.00 per lb (Woods 2009). Because of the density of the DU material, the expected weight of a 55-gallon drum weighing approximately 700 lb and using $6.00 per lb as an average cost would total $4,200/drum ($15,555/CY). The cost of reclamation/recovery of DU metal is high as compared to other technologies.

3.5.3.4 Summary of Evaluation

Reclamation/recovery was evaluated as a remedial alternative for soil contaminated with DU. The effectiveness of using reclamation as a remedial alternative was rated as high because the volume, toxicity, and mobility would be reduced as a result of separating DU from soil. The technical implementability was rated as moderate because, although only one vendor currently exists for DU reclamation, the vendor is currently accepting clean DU material. The re-sale of DU currently does not generate revenue that is typically associated with metals reclamation, and the cost has been rated as high in comparison to other available technologies. Because effectiveness and technical implementability are rated as high and moderate, respectively, reclamation/recovery has been retained for remediation of soil contaminated with DU.

3.5.4 Removal

Conventional excavation and removal of contaminated soil can be used for DU found at the FUSRAP areas.

3.5.4.1 Effectiveness

Soil removal is protective of human health and the environment because potential risks would be reduced, such that soil that exceeds the RG would be removed. Compliance with ARARs would also be achieved. During implementation, there would be possible short-term risk from fugitive dust emissions, which would be readily managed by means of implementation of a health and safety plan and an environmental protection plan. Although air quality could be adversely affected by the release of particulates, mitigation measures, such as dust suppression methods and use of proper safety procedures and equipment, would be implemented to minimize any increased risk to site workers during implementation. Short-term risks, including occupational injuries, and a risk of fatalities would increase as the volume of soil being handled increases.

Excavation can be more effective when used with characterization activities to identify excavation boundaries, which can limit both under- and over-excavation of soil. Removal of contaminated soil by excavation would reduce the mobility and toxicity of contaminants to humans; therefore, the effectiveness is rated as high.

3.5.4.2 Implementability

Soil excavation uses readily available resources and conventional earthmoving equipment. Some ancillary construction of temporary roads, a staging area for loading and unloading, soil erosion control, and additional clearing and grubbing may be necessary. Transportation and disposal of wastes are technologies that are generally combined with excavation. The technical implementability of soil removal is rated as high.

At the FSA, there are significant administrative implementability issues related to its use as an operational range. Most of the individual firing sites within the FSA are currently in use for ammunition testing or for other operational uses such as storage areas. Current use of the FSA by the DoD/U.S. Army limits accessibility to the Firing Site 6 Area to approximately 5 consecutive days per year. To be granted access to the area over a longer period than currently allowed, extensive negotiations and planning would be required, and some operational activities at the FSA would have to be postponed or cancelled. Therefore, the administrative implementability of excavation at the FSA is rated as low.

3.5.4.3 Cost

Costs related to soil excavation are estimated at $20 to $70/CY. Costs for removal include equipment, staging, labor, and stockpiling soil. The cost is rated as low. Additional costs associated with treatment and/or disposal are discussed in following sections.

3.5.4.4 Summary of Evaluation

Excavation using conventional earthmoving equipment is typically used as a remedial alternative for radiologically contaminated soil. The effectiveness and technical implementability of removal by excavation is rated as high and the costs are comparatively low. Removal of contaminated soil by excavation is retained for further evaluation.

3.5.5 Disposal – On-Site Landfill Containment

On-site disposal involves removal of the contaminated soil and developing a landfill facility designed to guidelines developed by NRC and USEPA for commercial, mixed, LLRW. The on-site landfill would also be used to dispose of any DU-contaminated structures that may result from remediation of structures at the FUSRAP areas if the need exists. Disposal facilities of this type typically include two or more composite liners (e.g., geomembrane and compacted soil layer) and a leachate collection system located above and between the liners. The facility design minimizes water contact with the encapsulated waste, as required by NRC, by installing a liner or other impermeable material in the excavated area. Radioactive waste and/or residuals requiring disposal are then transported and backfilled into the lined, excavated area, and an appropriate cover or cap is installed. Landfills are generally used as a final disposal method and, thus, can be applied to a wide variety of chemical and low-level radioactive contaminants.

3.5.5.1 Effectiveness

A disposal facility is designed to be a long-term solution to waste disposal. However, without some treatment prior to disposal, it does not reduce the volume or concentration of the

contaminants. To mitigate this, engineering design features of the disposal facility, such as liner integrity, monitoring, and mitigation procedures, are necessary to ensure effectiveness. Given the long period of time that LLRW will be a hazard, the disposal facility must pay particular attention to the degradational characteristics of construction materials for hazardous waste disposal sites. Disposal facilities are designed to be reliable for 100 to 1,000 years with the appropriate maintenance activities and, therefore, are rated as high for effectiveness.

Environmental and human health risks are of principal concern when radioactive materials are being excavated and handled. Potential health impacts to site workers also include exposure to fugitive dust emissions and fugitive gases. Appropriate mitigative measures should be implemented during excavation to reduce worker exposures, airborne emissions, and surface-water runoff.

Because the use of an engineered disposal facility would reduce the exposure and mobility of contaminants, the effectiveness of on-site disposal is rated as high.

3.5.5.2 Implementability

The materials and equipment necessary to construct a disposal facility are readily available. In addition, construction of the landfill would involve commonly used construction procedures and would not require specialized workers. However, safety and siting considerations may affect construction of a new on-site landfill for radioactive materials. Site characteristics such as topography, seasonal variations in temperature and precipitation, and seismic activity may affect the facility's integrity and must be considered. Therefore, the technical implementability for construction of an on-site landfill is rated as moderate.

Delays caused by the need to conduct siting studies and facility design could make implementation untimely by postponing operations beyond the time for remedial activities to begin. In addition, there would likely be difficulties obtaining the approval of Iowa Department of Natural Resources to dispose of radioactive waste in a new on-site landfill. For these reasons, the administrative implementability for a LLRW landfill on-site is rated as low.

3.5.5.3 Cost

The quantity of material for disposal most influences the cost. For large volumes of material, it may be desirable to reduce the volume through other treatments prior to disposal. Costs also depend on the distance the waste must be transported to a disposal facility, although on-site disposal would be less costly than off-site disposal.

Disposal of wastes in an on-site disposal facility is a containment technology designed to be a long-term solution to waste disposal; however, it does not reduce the toxicity or volume of waste. The costs for constructing a LLRW landfill on-site are rated as high.

3.5.5.4 Summary of Evaluation

The effectiveness and the technical implementability of disposal of contaminants in a landfill are rated as high and moderate, respectively. However, the administrative implementability and costs associated with siting studies and the design and construction of an on-site disposal facility are rated low and high, respectively. Therefore, construction of a new landfill at the IAAAP is not retained for further evaluation.

3.5.6 Disposal – Off-Site Landfill Containment

Contaminated soil and any structural materials that would result from response actions at the FUSRAP areas could be disposed of in an off-site landfill. DU-contaminated soil exceeding waste acceptance criteria (WAC) of Subtitle C facilities would require disposal as LLRW (Class A).

3.5.6.1 Effectiveness

Disposal of wastes in an off-site disposal facility is a containment technology designed to be a long-term solution to waste disposal. However, without some treatment prior to disposal, it does not reduce the volume or concentration of the contaminants. To mitigate this, engineering design features of the disposal facility, such as liner integrity, monitoring, and mitigation procedures, are necessary to ensure effectiveness. The liner and the cap/cover would be designed to provide isolation of the contaminated material from the environment. Regular inspections and monitoring would be necessary to ensure effectiveness. Disposal facilities are designed to be reliable for 100 to 1,000 years with the appropriate maintenance activities and are considered to be highly effective.

Environmental and human health risks are of principal concern radioactive materials are being excavated and handled. Potential health impacts to site workers also include exposure to fugitive dust emissions and fugitive gases. Appropriate mitigative measures should be implemented during excavation to reduce worker exposures, airborne emissions, and surface- water runoff.

Because the use of an engineering disposal facility would reduce the exposure and mobility of DU, the effectiveness of off-site disposal is rated as high.

3.5.6.2 Implementability

Off-site disposal of contaminated soil and debris from contaminated structures is a relatively simple process with proven procedures and widespread use. Therefore, the technical implementability for disposal in an off-site landfill is rated as high.

Several factors affect the administrative implementability of this technology, including the limited number of permitted facilities accepting radioactive waste and concerns over the risks associated with the possible excavation, handling, and transportation of radioactive waste. Transportation and disposal of contaminated soil and debris would use specially lined dump trucks, rail cars, or inter-model containers, which can be transported by truck or rail. If soil were moved out of state, then coordination would need to be provided ahead of time to allow the waste to cross state lines. Because not all rail lines and highways can be used to transport waste material, a shipping route would need to be carefully laid out, and an emergency response procedure would need to be developed. Barge access is not available unless truck transport is also used. The administrative feasibility of an out-of-state shipment would require coordination with the appropriate state and federal agencies. Increased coordination between agencies and use of special procedures and equipment to ensure public and worker safety during transport and disposal activities limit the negative effects on the administrative implementability.

Twenty-one commercial hazardous waste landfills exist in the United States that currently engage in commercial disposal of RCRA Subtitle C hazardous waste. Disposal facilities in the Midwestern region exist in Illinois, Indiana, and Oklahoma.

Currently, there are four NRC-licensed commercial LLRW disposal facilities: Hanford, Washington; Barnwell, South Carolina; Clive, Utah and Grand View, Idaho. The two

commercial disposal facilities licensed for LLRW and currently available for use for disposal by FUSRAP are in Clive, Utah and Grand View, Idaho. These facilities are authorized to receive Atomic Energy Act, Section 11(e)(2) byproduct material, Class A LLRW, and mixed LLRW. The Hanford, Washington, facility currently accepts only waste from the 11 states in the Northwest and Rocky Mountain compacts, and the Barnwell, South Carolina, facility is restricted to accepting wastes only from the 3 states of the Atlantic compact (American Nuclear Society 2009). One other LLRW facility in Texas has been permitted for acceptance of DU waste, but it is currently not accepting waste. It should be noted, however, that this facility may be available when remediation activities commence.

Although there are only two LLRW facilities currently accepting LLRW, the volume of DU-contaminated soil that requires disposal is not prohibitive for acceptance at these facilities. Therefore, the administrative implementability of off-site disposal is rated as high.

3.5.6.3 Cost

The quantity of material for disposal most influences the cost. For large volumes of material, it may be desirable to reduce the volume through other treatments prior to disposal. Costs also depend on the distance the waste must be transported to the disposal facility.

Cost estimates for off-site disposal is $650/CY for LLRW. These estimates do not include transportation to an LLRW facility. Additional costs may include soil characterization and treatment to meet land ban requirements. Overall, the costs associated with off-site disposal are rated as high.

3.5.6.4 Summary of Evaluation

Disposal of soil or structural materials at off-site licensed or permitted facilities is retained because its effectiveness and technical and administrative implementability are high. Although the costs associated with off-site disposal are rated as high, other alternatives are also rated as relatively costly for radioactive materials. There is potential for reduction of the volume of wastes that would require off-site disposal through treatment, which would potentially reduce disposal costs.

3.5.7 Physical Treatment – Soil Sorting

Soil sorting is a treatment technology that is appropriate for use for volume reduction of DU-contaminated soil. Once treatment has been completed, soil that meets the RG would be re-used as backfill and any soil that does not meet the RG would be disposed of in an approved landfill.

3.5.7.1 Effectiveness

Soil sorting (separation) can substantially reduce the volume of radionuclide-contaminated materials at some sites. For example, a 99% volume reduction of radioactively contaminated material was demonstrated at the Savannah River Site. Cesium-137 levels in clean soil fractions were reduced by 99% to less than the level of detection at 4 pCi/g (USEPA 1996).

Soil sorting would be most effective when separating contaminants that are not bound to the fine soil fractions. Most of the DU is located as chunks or fine particles on the surface of the ground with some oxidation of DU to surrounding soil.

The soil sorting method that would be used at the IAAAP would include a radionuclide detecting system capable of analyzing and separating soil based on specific radionuclide criteria and would allow for more effective volume reduction. Because all excavated soil would be screened and

segregated by its radioactivity level, clean soil can be returned to the site. Volume reductions of radionuclide-contaminated soil greater than 90% ensure that most of the soil can be safely re-used. However, the fraction of radioactive residual materials that is separated from the uncontaminated soil would require disposal.

The effectiveness of soil sorting is influenced by the types of soil to be treated. The soil types encountered at the FUSRAP areas at the IAAAP are loams that are chiefly composed of fine-grained particles (i.e., silt- and clay-sized particles). At the Firing Site 12 Area, where the greatest volume of DU-contaminated soil would be excavated, the soil types include Clinton silt loam and Clinton silty clay loam consisting of between 95 to 100% fine-grained particles (NRCS 2009a). The clay-sized fraction ranges from 16 to 42% within the upper 2 ft of soil (NRCS 2009a). Soil sorting tends to lend itself much more readily to segregation of sandy, coarse-grained soil as opposed to these types of fine-grained soil. This is partially the result of agglomeration of finer particles such that it tends to adversely affect the sorting ability of automated equipment. As an example, agglomeration adversely affects segregation based on the size of the materials involved and tends to absorb radiation, thus adversely affecting the detectability of radiologically contaminated soil.

Size screening or sieving-type soil sorting systems can lend themselves to the sorting of DU metal especially when metal pieces are present in sandy soil. Given a specific activity of DU of 360,000 pCi/g (10 *CFR* 20, Appendix B), such systems allow the removal of much of the higher activity source term present. Such systems have limited application because the materials segregated are directly dependent on the size of the sieve or screen being used, the moisture content of the soil, and the particle sizes of the soil itself. Materials smaller than the associated mesh pass through the system irrespective of activity, thus increasing the average DU concentration of the residual soil present.

Volume reductions of greater than 90% have been achieved using the radiological soil sorting method in sandy soil. However, the soil found at the Firing Site 12 Area of the IAAAP is silty clay loam, which generally consists of a high percentage (over 95%) of fine-grained material. Studies using the soil sorting methods for fine-grained soil show markedly smaller volume reductions than those achieved for coarser-grained soil. A 1997 study at Pantex Plant Firing Site 5 involving the use of a segmented gate system (SGS) reported an overall volume reduction of just 38.5% (SNL 1999b). The type of soil treated during the Pantex study was the Pullman Clay Loam, which consists of between 70 and 90% fine-grained (silt- and clay-sized) material (NRCS 2009b). Another study of a SGS was conducted in 1999 at the Auxiliary Reactor Area-23 at the Idaho National Engineering and Environmental Laboratory (INEEL). The treated soil consisted of fine-grained aeolian soil deposits with some fluvial gravel and gravelly sand (INEEL 1999). The INEEL study achieved an overall volume reduction of 2.7%. Based on the results of the Sandia National Laboratories and INEEL studies, use of the SGS to physically sort fine-grained soil similar to the soil types found at the Firing Site 12 Area is expected to achieve between a 3 and 38.5% volume reduction (or an average of approximately 20%). The effectiveness of soil sorting has been rated as moderate.

3.5.7.2 Implementability

The technology can be implemented without significant difficulties; however, the soil must first be excavated and broken up to allow for screening/sorting. Separated contaminated soil portions would require further treatment and/or disposal. Portable sorting equipment is commercially available as well; therefore, the technical implementability of soil sorting is rated as high. Soil sorting is a commonly used technology and no problems related to obtaining approvals from

other agencies are expected. Therefore, use of soil sorting for DU-contaminated soil is also rated as high for administrative implementability.

3.5.7.3 Cost

Costs of using this technology would be attributed to leasing capital equipment, operating large capacity systems, or operating the systems for long periods of time, excavation, and disposal of residual radioactive waste. Dry soil separation is economical because it allows large volumes of clean material to be returned to a site without further processing or disposal. The estimated cost for soil sorting is low at approximately $40/CY (FRTR 2009), excluding equipment mobilization and demobilization costs.

3.5.7.4 Summary of Evaluation

The soil sorting option is retained as a treatment option for DU-contaminated soil due to its moderate effectiveness, high implementability, and low cost.

3.5.8 Chemical Treatment – Soil Washing

Soil washing involves the use of water, chemical surfactants, or co-solvents to strip or dissolve contaminants and then remove them from soil. Soil washing is feasible for the treatment of a wide range of contaminants including heavy metals, radionuclides, cyanides, polynuclear aromatic hydrocarbons, pesticides, and PCBs (ITRC 1997). It is, therefore, potentially suitable for treating DU identified at the FUSRAP areas.

Soil washing can achieve volume reduction of the soil in two ways: (1) by dissolving or suspending the contaminants in the wash solution, or (2) by concentrating the contaminants into a smaller volume through particle size separation. Soil washing systems that incorporate both of these processes achieve the greatest success. While soil washing reduces the volume of the contaminated soil, it does not reduce the toxicity or mobility of the original contaminants. A limitation of the soil washing process is that after treatment, there is a volume of contaminated solid media and washwater that must be further treated or disposed.

3.5.8.1 Effectiveness

Several parameters affect the effectiveness of soil washing, including soil grain size distribution, clay content, soil cation exchange capacity, organic content, and contaminant type. Several parameters have been identified that could negatively affect the effectiveness of the soil washing treatment process at the IAAAP.

The soil at the IAAAP does not have the optimal grain size distribution and clay content for soil washing. The predominant soil types at the IAAAP are loams that consist of greater than 50% clay- and silt-sized particles (NRCS 2009a). Soil washing is most appropriate for soil that contains at least 50% sand and gravel (USEPA 1991c). Soil types rich in clay and silt, such as those found at the IAAAP, are typically not effectively treated by conventional soil washing systems because contaminants are often bound more tightly to fine soil particles (i.e., clay and silt) than to the coarser-grained particles (i.e., sand and gravel). In addition, when soil washing is used to remediate contaminated soil with significant amounts of clay and silt, very large amounts of additives may be required to achieve the RGs (USEPA 1997c) and after treatment, there is a volume of contaminated solid media and washwater that must be further treated or disposed of.

Soil washing was not retained as a process option for the IAAAP soil under the U.S. Army's soil OU FS because the process was considered "not appropriate for the high clay content soil at the

IAAAP nor for the contaminants due to low mass transfer rates to water" (USACE 1998b). Contaminated silt, clay, and wash water may require further treatment and may result in the generation of large amounts of hazardous wastes.

Other soil parameters (e.g., the soil cation exchange capacity and organic content) that may influence the effectiveness of the option are not expected to be significant factors at the IAAAP. The soil at the IAAAP does not generally contain high amounts of organic material (NRCS 2009a); therefore, this parameter is not expected to reduce the effectiveness of the treatment. The soil at the IAAAP has relatively low cation exchange capacity values (less than 50 millequivalents per kilogram) (NRCS 2009a) and, therefore, would be expected to respond better to soil washing than soil with high cation exchange capacity values (greater than 100 millequivalents per kilogram) (USEPA 1991c).

Because the effectiveness of soil washing is limited in clay-rich soil, the effectiveness is rated as low.

3.5.8.2 Implementability

Qualified vendors and equipment are readily available to perform ex-situ soil washing treatment. There are a number of companies offering a wide range of soil washing systems. Much of the equipment used for soil washing (e.g., mixers, washers, screens, and conveyors) is in common use for mining and ore processing. Therefore, the technical implementability of soil washing is rated as high. No problems related to obtaining approvals from other agencies are expected for this option. Therefore, use of soil washing for DU-contaminated soil is also rated as high for administrative implementability.

3.5.8.3 Cost

Treatment costs vary widely for soil washing technologies. Typically, on-site treatment of soil using soil washing is not cost effective unless a site contains at least 5,000 tons of contaminated soil (ITRC 1997). Based on the estimated volume of soil exceeding the RG at the IAAAP (Table 3-4), there is a sufficient volume of contaminated soil to meet this criterion. The costs related to soil washing are generally moderate if the treatment is conducted on-site, the soil consists predominantly of sand-sized material, and the cleaned soil from the treatment operation can be directly placed back onto the site as backfill.

The major factor influencing cost for soil washing at the IAAAP is the fines (silt/clay) content of the soil. Soil washing would generally not be cost effective for soil with a silt/clay content in excess of 30 to 50% (ITRC 1997). The high clay content of the IAAAP soil would prevent the DU RG from being achieved using physical treatment only. Soil washing using both physical and chemical separation methods would be required. Costs in the range of $150 to $300/CY can be expected when treatment involves both physical and chemical separation (ITRC 1997).

Because the costs of implementing a soil washing system generally are at the higher end of the cost range for sites with clay-rich soil and soil with multiple types of contaminants, the costs are rated as moderate to high for the IAAAP soil. The Ashtabula project in Ohio utilized physical and chemical soil washing processes to remove radionuclides from soil with over 75% fines content (ITRC 1997). However, the results of an audit of the Ashtabula soil-washing project indicate that the treatment was not cost effective for the site soil, in large part due to technical problems resulting from the high clay content (DOE 2002). Additionally, costs for the soil washing process would need to include treatment or disposal of a volume of contaminated solid media and washwater that results after treatment of soil.

Costs for soil washing at the IAAAP are rated as moderate due to the potential need for complex treatment trains to address multiple contaminants in clay-rich soil.

3.5.8.4 Summary of Evaluation

Soil washing has not been retained based on its limited effectiveness in clay-rich soil, its uncertainty in meeting the RG, and the potential for excessive costs due to complex treatment trains that may be needed to address multiple contaminants in clay-rich soil. Other treatment options provide greater demonstrated effectiveness.

3.5.9 Physical/Chemical Treatment – Solidification/Stabilization

S/S is a technology that physically binds or encloses contaminants within a stabilized mass (solidification) and/or induces chemical reactions between a stabilizing agent and contaminants to reduce their mobility (stabilization). S/S is feasible for the treatment of a wide range of contaminants including heavy metals and radionuclides (ITRC 1997). It is potentially suitable for treating DU identified at the FUSRAP areas. For the FUSRAP areas, S/S would be implemented as an ex-situ treatment after soil removal and prior to disposal.

3.5.9.1 Effectiveness

Although this technology does not reduce the toxicity or volume of contaminants, it has been proven to greatly reduce the mobility, thus protecting human health and the environment by reducing the risk of exposure. In-situ processes have demonstrated the capability to reduce the mobility of contaminated waste by greater than 95% (FRTR 2009).

Because the S/S process may not provide adequate shielding from all types of radiation, additional containment typically is required. Ex-situ S/S would facilitate the transportation of wastes to an off-site disposal facility because it reduces the mobility of contaminants. The main advantage of ex-situ S/S is that the mixing process and, therefore, the final characteristics of the structure, are much better controlled than if the treatment takes place in-situ. The S/S treatment, however, can significantly increase the total volume of contaminated material (up to double the original volume) that would require disposal because of the addition of stabilizing agents such as Portland cement or fly ash (USEPA 2007c).

For S/S to be effective, the soil would need to be removed and a pre-treatment process would be needed to separate the DU fragments. Although S/S could be used to solidify the oxidized particles of DU the volume of soil requiring disposal would be increased. For these reasons, the effectiveness is rated as low.

3.5.9.2 Implementability

Cement S/S is well demonstrated and easy to implement. Additionally, cement S/S is best suited to highly porous, coarse-grained, LLRW in permeable matrices (USEPA 1996). Most reagents and additives are generally widely available and relatively inexpensive industrial commodities. However, detailed characterization of the site and the waste matrix is required to determine the suitability of in-situ processes. The in-situ method also may not be suitable if mass is thin, discontinuous, and at or near the surface. Special concerns may be posed by other types of hazardous waste (e.g., organic chemicals) that may interfere with solidifying the radioactive waste. Some factors include inorganic acids that will decrease the durability for Portland Type I cement and chlorinated organics that may increase the set time and decrease the durability of cement if the concentration is too high (USEPA 1996). However, the U.S. Army has indicated

that the soil at the IAAAP has no characteristics that may make it unsuitable for S/S (USAEC 1997).

Certain soil is incompatible with variations of the S/S process, and treatability studies are generally required. The soil characteristics that influence whether the technology will contain the waste effectively include void volume, which determines how much grout can be injected into the site; soil pore size, which determines the size of the cement particles that can be injected; and the permeability of the surrounding soil, which determines whether water will flow preferentially around the solidified mass.

According to FRTR, larger particles, such as coarse gravel or cobbles (and likely fragments of DU), are undesirable for chemical extraction processes and may not be suitable for the S/S technology (FRTR 2009). However, qualified vendors and equipment are readily available to perform S/S treatment. Therefore, the technical implementability of S/S is rated as moderate. No problems related to obtaining approvals from other agencies are expected for this option. Therefore, use of S/S is rated as high for administrative implementability.

3.5.9.3 Cost

Costs can vary based on specific soil conditions, contaminants, and availability of solidification agents. In addition, ex-situ costs for transportation and off-site disposal of the solidified material play a role in the overall cost. Low costs may reflect in-situ mixing techniques and high costs may reflect in-drum mixing techniques.

For ex-situ S/S processes, overall costs for operation and maintenance (O&M) are approximately $230/CY. However, S/S would require additional costs associated with excavation of soil and pre-treatment of DU fragments prior to implementation of the technology. Disposal of the solidified DU-contaminated soil after treatment can substantially increase the cost, as it requires disposal at a regulated facility. The cost has been rated as high.

3.5.9.4 Summary of Evaluation

S/S technologies are well demonstrated and can be applied to most common sites and waste types, require conventional materials handling equipment, and are available competitively from a number of vendors.

S/S technologies have not been retained based on their low effectiveness and their high cost compared to other treatment options.

3.5.10 Biological Treatment – Phytoremediation

Phytoremediation involves the use of vegetation to remove contaminants from soil and/or ground water and incorporates those contaminants into the plant tissue. Currently, phytoremediation is considered to be an emerging, rather than established, technology for remediation. It has been shown to be effective for the treatment of several types of organic, inorganic, and radiological contaminants in shallow soil; therefore, the possibility exists for its use at the IAAAP.

Phytoremediation is not an appropriate technology for the large DU fragments but may be effective for soil that is radiologically contaminated from oxidation of the DU fragments. Phytoremediation could be implemented using ex-situ methods in which soil would be excavated and relocated to a location on the IAAAP where the treatment could be implemented. After treatment, the soil could be re-used as backfill on-site, while the plant material would require disposal as a waste.

3.5.10.1 Effectiveness

As a general rule, inorganics in soil that are bioavailable for plant uptake include arsenic, cadmium, copper, nickel, selenium, and zinc; whereas, chromium, lead, and uranium are not very bioavailable (ITRC 2009). To enhance the phytoextraction capabilities of some metals, several strategies have been attempted, including adding soil amendments to increase the bioavailability and using hyperaccumulating plants, which absorb unusually large amounts of metals in comparison to other plants. For soil contaminated with uranium, researchers have found that adding the organic anion citrate, an inexpensive soil amendment, greatly increases both the solubility of uranium and its bioavailability for plant uptake and translocation. Citrate does this by binding to insoluble uranium in the soil. With the citrate treatment, shoots of test plants increased their uranium uptake by 100 times (Becker 2000). Phytoremediation of uranium using sunflowers (genus *Helianthus)* has been demonstrated with uranium waste at Ashtabula, Ohio, and at a small pond contaminated with uranium near the Chernobyl nuclear power plant site in Pripyat, Ukraine (USEPA 2006b). Removal efficiencies of 75 to 90% were achieved for the biological treatment of uranium from contaminated soil at the Ashtabula plant using sodium bicarbonate as a soil amendment (AbdEl-Sabour 2007).

Chelators like ethylene diamine tetraacetic acid (EDTA) and citric acid assist in mobilization and subsequent accumulation of soil contaminants such as lead, cadmium, chromium, copper, nickel, and zinc by *Brassica juncea* (Indian mustard) and *Helianthus anuus* (sunflower) (Blaylock et al. 1997 and Turgut et al. 2004). Munn et. al. (2008) determined that increasing EDTA doses increased metal bioavailability. However, for most experiments the higher metal concentration was toxic to the plants as shown by diminished biomass and metal uptake. Although the use of EDTA did increase the amount of metal that could be extracted, care should be taken during in-situ field applications. Chelators can also increase the amount of metals that are leached past the root zone (Munn et. al 2008).

Bioremediation of metals and radionuclides holds a number of possibilities for use, but most applications to date have been at the bench or pilot scale (NABIR 1999). Phytoremediation is most appropriate for large areas of relatively thin surface layers of contaminated soil within the root depth of the selected plant. High contaminant concentrations or small soil volumes might be more effectively treated using conventional technologies (USEPA 2001a). High initial contaminant concentrations can be phytotoxic and prevent plant growth; therefore, treatability studies are likely to be necessary to screen candidate plants (USEPA 2001a). As a result, hot spots of contaminated soil may have to be removed prior to application of phytoremediation.

Winter can slow or halt phytoremediation, and competition from native plants may eliminate the plant chosen for phytoremediation (Medina 1997). A longer time period (10 to 20 years) for phytoremediation is likely to be required than for other treatment technologies because this technology is dependent on plant growth rates for establishment of an extensive root system or significant above ground biomass (USEPA 2001a). More recently, research has focused on the use of hyperaccumulating plants and multiple harvesting periods per season to reduce remediation efforts to 1 year (USEPA 2001a). Phytoremediation also provides a natural barrier, resistance to erosion and leaching, and can be further used to minimize surface runoff if soil is impacted.

For phytoremediation to be effective, the soil would need to be removed and a pre-treatment process would be needed to separate the DU fragments. Although studies indicate that use of soil amendments and specific plant species do effectively reduce the toxicity, mobility, and volume of contaminated soil, the technology would require a pilot demonstration on-site and would

require a long remediation time relative to other potential treatment technologies. For these reasons, the effectiveness of phytoremediation is rated as low.

3.5.10.2 Implementability

Growing plants at the site would likely be easy with a minimal amount of maintenance (i.e., irrigation and fertilizing). The planting and harvesting of plants may be repeated as necessary to bring soil contaminant levels down to allowable limits. Maintenance of the phytoremediation system may include adding fertilizer agents to bind metals to the soil or chelates to assure plant uptake of the contaminants. Replanting may be required due to drought, disease, insects, or animals killing off plants (ITRC 1999).

Qualified vendors and equipment are available to perform this treatment option, and the land needed to construct a phytoremediation treatment plot on-site is available. Phytoremediation is also likely to be more acceptable to the local community than other treatment options because it has been perceived to be more environmentally friendly and as a low-technology alternative (USEPA 2001a). The technical implementability is rated as high.

It is not anticipated that regulatory agencies would have technical or administrative concerns with this alternative when applied to the DU-contaminated soil. Therefore, the administrative implementability of phytoremediation is rated as high for the treatment of soil that is radiologically contaminated from oxidation of the DU fragments.

3.5.10.3 Cost

Because many phytoremediation technologies are still in the field-demonstration stage, cost data for full-scale implementation of phytoremediation are sparse (USEPA 2001a). Costs are available from pilot-scale or experimental studies, but they may not accurately reflect full-scale remediation costs. Phytoremediation costs would include: preliminary treatability studies to select the proper plant and to assess its effectiveness; soil preparation; planting; maintenance such as irrigation and fertilization; monitoring, which may include plant nutrient status, plant contaminant concentrations, as well as soil concentrations; and disposal of contaminated biomass.

Generally, the O&M costs are expected to be relatively low because the technology involves minimal maintenance once the plants are established. However, phytoremediation would require additional costs associated with excavation of soil and pre-treatment of DU-contaminated fragments prior to implementation of the technology. Disposal of radiologically or chemically contaminated biomass after harvesting can substantially increase the cost if it requires incineration or disposal at a regulated facility. Otherwise, the potential risks associated with the remaining plant matter would require analysis.

Based on available cost data for implementing phytoremediation at sites of varying size and complexity, the costs range from $112 to $1,775/CY of soil (FRTR 2009). Costs have been rated as high.

3.5.10.4 Summary of Evaluation

Phytoremediation was not retained based on its low effectiveness and high cost compared to other treatment options that provide greater demonstrated effectiveness and lower cost.

3.5.11 Containment Using Surface Barriers

Contaminant technologies for structures include sealing the structural surfaces to prevent direct contact with contaminants and to prevent migration of contaminants. Technologies such as

paints, sealing resins, plastic, or other impermeable sheeting may be used as a barrier. The structures that have exceeded the RG include a grate covering a sump at Line 1 Building 1-11 and the air filter in an air-handling unit at Line 1 Building 1-63-6.

3.5.11.1 Effectiveness

Surface barrier is a remediation technology in which shielding materials are applied to structural surfaces to reduce emissions and direct contact exposure and control the mobility and spread of contamination. As long as the sealing material is maintained at design and operating conditions, the RAOs and ARARs would be met. Although sealing surfaces would reduce exposure to contaminants, it would not be effective for external gamma radiation and contamination would remain intact. Because the surface barrier would degrade over time, and additional maintenance and/or future reapplications would be necessary, the effectiveness of this technology is considered to be short term for protection of human health and the environment.

Applying the sealants inside the buildings creates no risk to the community. Mitigative measures to site employees during the response action would include temporarily relocating site employees and using proper safety protocols to minimize any risk to site workers.

The effectiveness of using sealants for containment of radiologically contaminated surface materials is rated as moderate because of the comparatively short-term nature of the technology.

3.5.11.2 Implementability

Surface sealants such as paint, resin, and plastic as well as physical barriers such as plastic sheeting, are easily applied and are used extensively in the construction industry, but generally on new or well-prepared surfaces. Poor condition of surfaces would involve surface preparation that, in most cases, would likely remove the contamination found. Coordination with the application or installation of the surface barrier would be required to minimize disruption of plant activities. The availability of products is extensive and, therefore, the technical implementability is rated high. No issues affecting the administrative implementability have been identified. Therefore, the administrative implementability of containment using surface barriers is high.

3.5.11.3 Cost

Using paint as a surface barrier is extremely cost-effective (<$1.00/ft^2). This alternative would have low costs compared to other alternatives.

3.5.11.4 Summary of Evaluation

Containment using surface barriers was retained based on its high technical and administrative implementability, moderate effectiveness, and low cost.

3.5.12 Decontamination

Decontamination is a conventional method of remediating radiologically contaminated structures. Decontamination can be conducted using physical or chemical methods; although, physical decontamination methods are proposed for the IAAAP Line 1 areas because of the successful use of these techniques at other FUSRAP sites.

The structures that have exceeded the surface RG include a steel grate covering a sump at Line 1 Building 1-11 and an air filter in an air-handling unit at the Line 1 Building 1-63-6.

Decontamination methods previously used at other FUSRAP sites have included high-pressure water, high-pressure water with detergent cleansers, grit blasting, carbon dioxide blasting, scabbling, and other similar forms of scaling. Simple flushing with water (high pressure) is the most basic approach to radiological surface decontamination. Soluble contaminants are dissolved and unbound particulates are dislodged and carried away. Increased pressures and flow rates enhance the mechanical effects of the water stream, which allows more strongly bonded particulates or those trapped in surface occlusions to be removed and allows other surface material such as paint layers and other debris to be stripped. In all cases, the wastewater is collected and filtered, with the filtered water either being further treated for soluble material or recycled prior to final treatment to reduce both water consumption and the total waste volumes.

After decontamination, surfaces would be radiologically surveyed to determine the potential surface radioactivity. If the surface radioactivity were below the RG, then the structures would be released for further use. If the surface radioactivity exceeds the RG, then additional methods of decontamination would be employed including high-pressure water with detergent cleansers, grit blasting, or scaling.

3.5.12.1 Effectiveness

The USEPA Office of Radiation and Indoor Air has determined that surface decontamination technologies can effectively remove radiological contaminants from building, structure, and equipment surfaces (USEPA 2006a). This alternative would protect human health and the environment, comply with ARARs, and achieve RAOs for the structures. Restoration of surfaces after decontamination is sometimes required and may include repainting, resurfacing, or replacement of some structural components. Although the contaminant source would be removed from most surfaces, decontamination may not be completely effective on some surfaces where access is limited. Consequently, some surfaces having limited access for decontamination equipment would be re-evaluated for risk, and further decontamination or replacement solutions may be implemented.

Under this alternative, no long-term maintenance would be required because the contaminant sources would be removed from the structures. Potential short-term risk to site workers would be mitigated by adhering to the health and safety plan. The effectiveness of decontamination is rated high because the removal of contaminated material or residuals from the structure reduces or eliminates radiation exposure, enables the re-use of structures or equipment, and reduces the amount of material (e.g., equipment, construction, and related debris) requiring further treatment or disposal.

3.5.12.2 Implementability

Physical and chemical decontamination methods are implementable. Physical decontamination can work on almost all surfaces. Although it is fairly easy to remove a plaster or grout surface, it becomes more difficult and expensive to remove a steel surface. Surface preparation is usually not an issue with physical decontamination techniques because the entire surface may be removed as part of the decontamination efforts. Waste management tends to be simpler because the removed surface material can be collected directly and routed to waste disposal rather than requiring secondary treatments that would be required when using chemical decontaminants. The decontamination of buildings and structures requires specialized equipment and trained personnel, which are all commercially available. Monitoring would be conducted during implementation to ensure protection of remedial workers. Issues affecting the administrative implementability are not expected to be significant for decontamination. The technical and administrative implementability of decontamination is rated as high.

3.5.12.3 Cost

High-pressure water cleaning systems are a primary technology for decontamination and cost approximately $3.63/ft^2 (USEPA 2006a). In comparison, the approximate cost of using a piston scabbler is $6.00/ft^2 and grit blasting is $12.95/ft^2 (USEPA 2006a). According to USEPA (2006a), the costs per square foot were determined for these physical decontamination technologies based on large surface areas (high pressure water cleaning – 1,150 ft^2; piston scabbler – 620 ft^2; and grit blasting – 180 ft^2). The aforementioned costs for high pressure water cleaning and grit blasting include the cost of waste disposal. However, for piston scabbling, the presence of a vacuum filtration system significantly reduces the issue of dust contamination, and, because the system operates without a liquid stream, waste streams created are minimal. However, additional contributors to the piston scabbler waste stream include personal protective equipment, plastic wrapping and sleeving for vacuum hoses, and the concrete dust collected by a vacuum if one is used. Decontamination and any potential restoration costs are low compared to similar alternatives.

For some components, such as the contaminated air filters at Line 1 Building 1-63-6, decontamination is not cost effective and, therefore, the filters will be removed and replaced. The filters would be disposed of consistent with the actions defined for DU-contaminated soil at the FUSRAP areas.

3.5.12.4 Summary of Evaluation

Decontamination of structures has been retained for further consideration. After decontamination has been completed, the level of residual radioactivity on structures would comply with ARARs. Therefore, this alternative is potentially effective, easily implemented, and would meet RAOs after implementation. The option of replacing components that are not cost-effective to decontaminate has significant advantages over decontamination because all new surfaces would be below guidelines for residual radioactive contamination.

3.6 SUMMARY

The results of the technology screening are summarized in Figure 3-4. For contaminated soil at the FUSRAP areas, the following technologies have been retained:

- No action,
- Land use controls,
- Removal by excavation,
- Off-site disposal,
- Treatment by soil sorting, and
- Reclamation/Recovery.

For contaminated structures at the FUSRAP areas, the following technologies have been retained:

- No action,
- Land use controls,
- Surface barriers, and
- Decontamination/replacement.

These technologies were considered in the development of remedial alternatives as presented in Section 4.

4.0 DEVELOPMENT OF REMEDIAL ALTERNATIVES

This section presents the development and detailed descriptions of the remedial action alternatives. The alternatives were developed by assembling combinations of technologies retained after the screening (discussed in Section 3) into alternatives that addressed each media (i.e. soils and structures) at the FUSRAP areas. Emphasis was placed on identifying alternatives that (1) ensured adequate protection of human health and the environment from exposures to DU, (2) achieved ARARs, (3) permanently and significantly reduced the volume, toxicity, or mobility of DU and (4) were implementable.

A total of four remedial alternatives for soil contamination were developed along with three remedial alternatives for structural contamination. The alternatives range from no action to complete removal and treatment of the contaminated materials. The alternatives developed and evaluated for soil and structures are summarized in Table 4-1.

There is one common feature of all alternatives, with the exception of the no action alternatives. Based on the results of the evaluations conducted during the RI and BRA that assumed industrial land use scenarios, there were no exceedances of DU screening criteria for soil or structures and therefore, no potential risks or dose that exceed the *de minimus* USEPA target risk criterion of 1×10^{-6} or the dose-based ARAR [10 CFR 20, Subpart E, 20.1403(b)] of 25 mrem/yr for the following FUSRAP areas:

- Firing Site 14,
- FSA structures (except the Firing Site 12 Area),
- Yard C soil and structures,
- Yard G soil and structures,
- Yard L (areas surrounding Warehouses L-37-1, L-37-2, and L-37-3), and
- Warehouse 3-01 structure.

All remedial alternatives proposed in this FS (except for the no action alternatives) were developed based on the current and expected future industrial land use of the IAAAP. Initial development of alternatives to address soil contamination resulted in formulation of four alternatives (Alternatives 1, 2, 3 and 4), which are presented and discussed in greater detail in Section 4.1.

4.1 REMEDIAL ALTERNATIVES FOR SOIL

4.1.1 Alternative 1, No Action for Soil

Under Alternative 1, no remedial actions would be implemented at the IAAAP FUSRAP areas. The NCP [40 *CFR* §300.430(e)(6)] requires a no action alternative be evaluated as a baseline for comparison to other remedial alternatives. 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.

Cost: There are no costs for Alternative 1.

Table 4-1. Summary of Remedial Alternatives Development

General Response Action	Technology	Process Option	Remedial Alternatives for Soil				Remedial Alternatives for Structures		
			1	2	3	4	S1	S2	S3
No Action	Not applicable	No actions to limit current or future use of soil or structural surfaces	X				X		
Land Use Controls (Institutional and Engineering Controls)	Engineering controls	Physical barriers, and/or signs		Xa				Xa	
	Installation use restrictions	Administration of structure or land use limitations and outgrants		Xa	X	X		Xa	X
Removal (Soil)	Excavation	Conventional, selective excavation of DU-contaminated soil			X	X			
Disposal	Landfill	Off-site			X	X			X
Treatment (Soil)	Physical/Chemical	Soil sorting (physical sorting and radionuclide detection) for DU-contaminated soil				X			
Decontamination (Structural Surfaces)	Decontamination	Physical and/or chemical decontamination or removal of DU-contaminated structural surfaces							X

[a] Alternatives 2 and S2 involve the implementation of additional land use controls for soil and structures, respectively. The remaining action alternatives include continuation of existing industrial/military land use at the IAAAP.

4.1.2 Alternative 2, Land Use Controls for Soil

Major Components of Alternative 2
• Implement additional land use controls at areas where soil exceeds the industrial RG: Firing Sites 1 and 2; Firing Sites 3, 4, and 5; Firing Site 6 Area; and Firing Site 12 Area.
• No additional land use controls would be implemented at Yards C, G, and L and Firing Site 14.
• 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 FUSRAP areas exceeding UUUE.

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 allow comparison of a complete range of alternatives in the FS.

Alternative 2 consists of the following components.

Land Use Controls: Additional land use controls would be required and implemented under this alternative 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. Land use controls may also include restrictions that would be identified in public records. 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 FUSRAP areas where contaminants are left above levels acceptable for UUUE. Industrial land use will be verified during each five-year review.

Cost: The estimated cost of Alternative 2 is $2,332,013.

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

Major Components of Alternative 3
• 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.
• Dispose of materials exceeding the DU RG at properly permitted off-site facility.
• 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.
• Five-year reviews for all areas exceeding UUUE, which would verify industrial land use.

Alternative 3 includes excavation of soil exceeding the DU RG and off-site disposal. None of the excavated material would be treated after excavation. Alternative 3 consists of the following 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. 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.

No excavation activities would be required at Yards C, G, and L and Firing Site 14.

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.

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 an LLRW disposal site.

There is no evidence from the RI sampling that suggests 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 75-1-2, *UXO Support During HTRW and Construction Activities*. All waste transport for off-site disposal will be compliant with existing DOT regulations.

Site Restoration: Backfilling of excavated areas with clean soil, grading, re-vegetation, and temporary storage are included.

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.

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.

Cost: The estimated cost of Alternative 3 is $50,401,517.

Additional information on the excavation and disposal procedures for this remedial alternative is provided in Appendix E.

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

Major Components of Alternative 4
• 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.
• 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.
• 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).

Major Components of Alternative 4 (Continued)
• 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.
• Five-year reviews for all areas exceeding UUUE, which would verify industrial land use.

Alternative 4 includes excavation of soil exceeding the DU RG, physical treatment, and off-site disposal for DU-contaminated soil. Alternative 4 consists of the following 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. 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.

No excavation activities would be required at Yards C, G, and L and Firing Site 14.

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 at the IAAAP) consist of a high percentage (>95%) of fine-grained particles, of which between 16 to 42% is clay-sized material (NRCS 2009a). The estimated average volume reduction expected for this type of soil and for this FS is 20% based on the results of studies on similar fine-grained soil (INEEL 1999; SNL 1999b). 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.

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.

There is no evidence from the RI sampling that suggests 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 75-1-2. All waste transport for disposal will be off-site compliant with existing DOT regulations.

Site Restoration: Backfilling of excavated areas with clean soil, grading, re-vegetation, and temporary storage are included.

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.

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.

Cost: The estimated cost of Alternative 4 is $45,172,033.

Additional information on the excavation and disposal procedures for this remedial alternative is provided in Appendix E.

4.2 REMEDIAL ALTERNATIVES FOR STRUCTURES

4.2.1 Alternative S1, No Action for Structures

Under Alternative S1, no remedial actions would be implemented for IAAAP structural surfaces at the FUSRAP areas. DU-contaminated structural surfaces would be left in place, the existing land use controls would not be maintained by FUSRAP, and no additional measures would be implemented to control exposures to the contaminated structural surfaces.

Cost: There are no costs for Alternative S1.

4.2.2 Alternative S2, Land Use Controls for Structures

Major Components of Alternative S2
• Implement and maintain additional land use controls for structures (e.g., Building 1-11 floor grate and Building 1-63-6 air filters).
• Continued industrial land use supported by use restrictions and outgrants administered by the U.S. Army as part of its land management responsibilities.
• Include structures in five-year reviews if they exceed levels appropriate for UUUE.

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.

Alternative S2 consists of the following 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.

Cost: The estimated cost of Alternative S2 is $285,772.

4.2.3 Alternative S3: Decontamination/Replacement of Structures

Major Components of Alternative S3
• 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.
• Continued industrial land use supported by use restrictions and outgrants administered by the U.S. Army as part of its land management responsibilities. No additional land use controls are implemented.
• Include structures in five-year reviews if they exceed levels appropriate for UUUE, which would verify industrial land use.

The specific components of Alternative S3 include physical decontamination of DU-contaminated structural surfaces and/or replacement of the structural components. Refer to the technical discussions in Appendix E for additional information on this remedial alternative.

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: Decontamination of DU-contaminated components such as air filters is not feasible and, for some components, is not cost effective. 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 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.

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.

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.

Cost: The estimated cost of Alternative S3 is $102,961.

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5.0 DETAILED ANALYSIS OF ALTERNATIVES

5.1 OVERVIEW OF CERCLA CRITERIA

This section presents the detailed analysis of alternatives using CERCLA criteria, the goal of which is to establish a basis for the identification of one preferred alternative for soil and one preferred alternative for structures. The detailed and comparative analysis of the remedial alternatives includes evaluations of overall protection; compliance with ARARs; long- and short-term effectiveness; reduction in contaminant toxicity, mobility, or volume through treatment; implementability; and cost. The preferred alternatives will be presented in the PP. The definitions of the CERCLA criteria (threshold, balancing, and modifying) are provided below and were obtained from the *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (USEPA 1988a).

5.1.1 Comprehensive Environmental Response, Compensation, and Liability Act Threshold Criteria

Assessments against two of the criteria relate directly to statutory findings that must ultimately be made in the ROD. Therefore, these are categorized as threshold criteria in that each alternative must meet them. These two criteria are Overall Protection of Human Health and the Environment and Compliance with ARARs.

Overall protection of human health and the environment: The assessment against this criterion describes how the alternative, as a whole, achieves and maintains protection of human health and the environment.

Compliance with ARARs: The assessment against this criterion describes how the alternative complies with ARARs, or if a waiver is required and how it is justified. The assessment also addresses other information from advisories, criteria, and guidances that the lead and support agencies have agreed is "to be considered."

5.1.2 Comprehensive Environmental Response, Compensation, and Liability Act Primary Balancing Criteria

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: The evaluation of alternatives under this criterion addresses the results of a remedial action in terms of the risk remaining at the site after response objectives have been met. The primary focus of this evaluation is the extent and effectiveness of the controls that may be required to manage the risk posed by treatment residuals and/or untreated wastes. The following components of the criterion should be addressed for each alternative: (1) magnitude of residual risk and (2) adequacy and reliability of controls.

Reduction of toxicity, mobility, or volume through treatment: This evaluation criterion addresses the statutory preference for selecting remedial actions that employ treatment technologies that permanently and significantly reduce toxicity, mobility, or volume of the hazardous substances as their principal element. This preference is satisfied when treatment is used to reduce the principal threats at a site through destruction of toxic contaminants, reduction of the total mass of

toxic contaminants, irreversible reduction in contaminant mobility, or reduction of total volume of contaminated media.

Short-term effectiveness: This evaluation criterion addresses the effects of the alternative during the construction and implementation phase until remedial response objectives are met. Under this criterion, alternatives should be evaluated with respect to their effects on human health and the environment during implementation of the remedial action. The following factors should be addressed as appropriate for each alternative: (1) protection of the community during remedial actions, (2) protection of workers during remedial actions, (3) environmental impacts, and (4) time until remedial response actions are achieved.

Implementability: The implementability criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation. This criterion involves analysis of the following factors: (1) technical feasibility (construction and operation, reliability of technology, ease of undertaking additional remedial action, and monitoring considerations), (2) administrative feasibility (activities needed to coordinate with other offices and agencies), and (3) availability of services and materials.

Cost: This assessment evaluates the capital and O&M costs of each alternative.

A budgetary cost estimate has been determined for each alternative and is included in Appendix E. This appendix also includes a detailed description of the cost components for each alternative and calculated estimates of excavation volumes. Present worth costs are provided as the total of capital and O&M costs. Capital costs include expenditures required to initiate and perform a remedial action, including activities such as soil excavation, staging, soil disposal, sampling, and soil treatment, if applicable. The O&M costs consist of five-year review activities for these alternatives. Although all alternatives, except the no action alternatives, will require five-year reviews for an indefinite time period, an O&M period of 30 years was used for cost estimation purposes, as a simplifying assumption. These cost estimates are for guidance in project evaluation and implementation and are believed to be accurate within a range between -30% and +50% of actual costs in accordance with the USEPA guidance (USEPA 2000a). The individual costs items are presented in the detailed estimates for each alternative in Appendix E.

5.1.3 Comprehensive Environmental Response, Compensation, and Liability Act Modifying Criteria

The two modifying criteria described below will be evaluated as part of the ROD after the public has had the opportunity to comment.

State acceptance: This criterion considers comments received by the state of Iowa on RI/FS documents. The decision-making process for remediation of the IAAAP has been developed in coordination with USEPA and the state of Iowa. Because final comments will not be received until after the RI/FS has been issued, this criterion will be addressed in the responsiveness summary of the ROD. The State's comments are requested on the PP in accordance with Section 117 of CERCLA.

Community acceptance: This criterion addresses the comments made by the community on the alternatives being considered. Because public comments will not be received until after the alternatives have been evaluated in this FS and the preferred alternative has been presented in the PP, this criterion will be addressed in the responsiveness summary and the ROD.

5.2 INDIVIDUAL ANALYSIS OF ALTERNATIVES

This section presents a detailed analysis of the alternatives. Each alternative is described and evaluated against the criteria outlined in Section 5.1.

5.2.1 Alternative 1, No Action for Soil

This alternative assumes that no remedial actions would be implemented at the FUSRAP areas for soil. The no action alternative is required by the NCP [40 *CFR* §300.430(e)(6)] and CERCLA guidance to provide a baseline to which all other remedial alternatives are compared. It is assumed that the controls currently in place (e.g., use restrictions and outgrants administered by the U.S. Army as part of its land management responsibilities) would not be maintained.

5.2.1.1 Overall Protection of Human Health and the Environment

Alternative 1 is not protective of human health or the environment. Results of the HHRA indicate that potential cumulative CRs exceed the CERCLA target CR range at the FSA. 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.

5.2.1.2 Compliance with Applicable or Relevant and Appropriate Requirements

Alternative 1 does not comply with chemical-specific ARARs. Alternative 1 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. There are no location- or action-specific ARARs considered under Alternative 1 because no remedial action would take place.

5.2.1.3 Long-Term Effectiveness and Permanence

Alternative 1 includes no long-term measures to prevent exposures or spread of DU-contamination. All potential future risks remain at levels that exceed the CERCLA target CR range because none of the DU would be removed. Although existing site security could provide limited control over exposure to site contaminants, this alternative assumes that controls do not remain in place and provides no additional controls to prevent exposure to contaminants. This alternative would allow the contamination to remain on-site and relies upon the long-term processes of radioactive decay for contaminant mass reduction. Under the current and expected future land use scenarios, there are potential risks to human health and the environment if the contaminated soil remains in place.

5.2.1.4 Reduction of Contaminant Toxicity, Mobility, or Volume Through Treatment

No reduction in contaminant toxicity, mobility, or volume through treatment is achieved because no treatment process is proposed under Alternative 1.

5.2.1.5 Short-Term Effectiveness

There are no short-term risks associated with Alternative 1 beyond baseline conditions. There would be no additional short-term health risks to the community because no remedial actions would be implemented. Site workers would not be subject to any additional health risks.

5.2.1.6 Implementability

No actions are required for this alternative.

5.2.1.7 Cost

Under this alternative, there are no costs.

5.2.2 Alternative 2, Land Use Controls for Soil

Alternative 2 consists of land use controls for the FUSRAP areas. Land use controls are used to prevent inadvertent intrusion into soil with residual concentrations of DU. The existing land use controls for the IAAAP (e.g., use restrictions and outgrants administered by the U.S. Army as part of its land management responsibilities) would be maintained. Additional land use restrictions, such as additional fencing, signage, and/or security measures to specific portions of the FUSRAP areas, would be imposed. Use restrictions would be imposed to limit activities that could disturb soil in the FUSRAP areas. This would provide additional protection by limiting direct exposure to contaminated soil and ground water. Alternative 2 also includes five-year reviews.

5.2.2.1 Overall Protection of Human Health and the Environment

Land use controls increase human health protectiveness by limiting direct access to DU-contaminated soil. The overall protection of human health is maintained as long as land use controls are in place. Land use controls are maintained to prevent unrestricted use of the site. Potential future soil and ground-water exposure pathways are limited through the use of soil excavation restrictions.

5.2.2.2 Compliance with Applicable or Relevant and Appropriate Requirements

Alternative 2 does 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.

Inability to meet the threshold criteria of compliance with ARARs is a significant problem with this alternative. Section 121(d) of CERCLA and NCP [40 *CFR* §300.430(f)(l)(ii)(B)] require that remedial actions at CERCLA sites attain ARARs unless such ARARs are waived under CERCLA Section 121(d)(4).

5.2.2.3 Long-Term Effectiveness and Permanence

Alternative 2 may not be protective in the long term. It would rely on land use controls to eliminate or reduce exposures to site contaminants. The land use controls would include the existing use restrictions and outgrants administered by the U.S. Army as part of its land management responsibilities at the IAAAP and would also include additional restrictions to limit activities that could disturb soil. It is reasonably expected that land use controls can be implemented and would be effective in protecting human health, but they would not result in a permanent reduction in site risks. 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. Five-year reviews would be conducted to ensure that land use controls continue to be protective.

Alternative 2 is less permanent than other alternatives because the land use controls could be lost. Land use controls could be compromised through the degradation of physical barriers (i.e., fencing) through natural causes and/or vandalism. Until the gap in the barrier is noticed and fixed

the controls would be limited and/or lost. The risks under Alternative 2 could exceed the CERCLA target CR range, and doses could exceed 100 mrem/yr if controls are lost. 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.

5.2.2.4 Reduction of Contaminant Toxicity, Mobility, or Volume Through Treatment

No reduction of toxicity, mobility, or volume of contaminants through treatment would be obtained under Alternative 2.

5.2.2.5 Short-Term Effectiveness

There would be no additional short-term risks to the community, site workers, or the environment under this alternative. Because Alternative 2 would make use of land use controls rather than active remediation to minimize exposures, it avoids adverse short-term impacts due to potential construction or transportation accidents associated with active remedial technologies.

5.2.2.6 Implementability

Alternative 2 would be easy to implement. No technical or administrative problems are anticipated that would limit the implementability of land use controls at the site as long as the IAAAP continues to be a ammunition plant maintained by the U.S. Army.

5.2.2.7 Cost

The estimated total cost for Alternative 2 over the 30-year period is $2,332,013. The cost would include implementation and maintenance of land use controls and the performance of five-year reviews for soil.

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

The principal components of Alternative 3 are removal of DU-contaminated soil by excavation, and off-site disposal. Soil would be excavated to an approximate depth of 2 ft to achieve the DU RG at the firing sites identified for remediation. The estimated total volume of DU-contaminated soil requiring excavation is 16,941 in-situ CY. Soil exceeding the RG would be disposed of in a properly permitted off-site disposal facility.

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. Because contamination may remain on-site at concentrations above levels that would allow UUUE, Alternative 3 also includes five-year reviews during which industrial land use will be verified.

5.2.3.1 Overall Protection of Human Health and the Environment

Alternative 3 is protective of human health and is also protective of the environment. Alternative 3 includes removal of DU-contaminated soil to limit risks to within the CERCLA target CR range and achieve the ARAR-based limits. 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.

5.2.3.2 Compliance with Applicable or Relevant and Appropriate Requirements

Location-, action-, and chemical-specific ARARs would be achieved at all FUSRAP areas. Alternative 3 complies with these ARARs:

Title 10, CFR §20.1403 (b) and (e): This alternative meets the provisions of 10 CFR §20.1403(e), which requires 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. It also complies with the requirement that the remedy achieve doses that are ALARA.

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 relevant and appropriate for remedial actions within the FUSRAP areas.

Radiation Protection Programs, 10 CFR §20.1101(d): 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.

5.2.3.3 Long-Term Effectiveness and Permanence

Alternative 3 would achieve both long-term effectiveness and permanence. Long-term effectiveness would be high because DU-contaminated soil would be removed from the FUSRAP areas. Because soil would remain at the site above UUUE, industrial land use would continue to prevent unauthorized and/or inappropriate use of the site. Industrial land use would be verified through the five-year review process.

5.2.3.4 Reduction of Contaminant Volume, Toxicity, or Mobility Through Treatment

Treatment is not proposed under Alternative 3. Therefore, no reduction in contaminant toxicity, mobility, or volume through treatment is achieved under this alternative.

5.2.3.5 Short-Term Effectiveness

Short-term risks to site workers and surrounding community associated with excavation, transport, and disposal of soil could occur during excavation of contaminated soil. Air quality could be affected by release of particulates during soil excavation. During excavation activities, dust suppression measures would be required to mitigate fugitive dust emissions.

5.2.3.6 Implementability

Alternative 3 has high technical implementability. Excavation activities are common and proven methods for site remediation and would be easily implemented. Alternatives 3 is rated low in administrative implementability because it involves 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.

5.2.3.7 Cost

The estimated total cost for Alternative 3 over the 30-year period is $50,401,517. The cost includes site clearing; GWSs; excavation, staging, transport, and disposal of contaminated soil; confirmation sampling; site restoration; preparation of a construction completion report; and the performance of five-year reviews for soil.

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

The principal components of Alternative 4 are removal of DU-contaminated soil by excavation, treatment using physical treatment technologies (e.g., soil sorting and radiological scanning), and off-site disposal. Soil would be excavated to an approximate depth of 2 ft to achieve the DU RG at the firing sites identified for remediation. The estimated total volume of DU-contaminated soil requiring excavation is 16,941 in-situ CY.

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. Confirmation 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.

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. Because contamination may remain on-site at concentrations above levels that would allow UUUE, Alternative 4 also includes five-year reviews during which industrial land use will be verified.

5.2.4.1 Overall Protection of Human Health and the Environment

Alternative 4 is protective of human health and is also protective of the environment. Alternative 4 includes removal of DU-contaminated soil to limit risks to within the CERCLA target CR range and achieve the ARAR-based limits. 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.

5.2.4.2 Compliance with Applicable or Relevant and Appropriate Requirements

Location-, action-, and chemical-specific ARARs would be achieved at all FUSRAP areas. Alternative 4 complies with all ARARs as identified for Alternative 3 (Section 5.2.3.2).

5.2.4.3 Long-Term Effectiveness and Permanence

Alternative 4 would achieve both long-term effectiveness and permanence. Long-term effectiveness would be high because DU-contaminated soil would be removed from the FUSRAP areas. Industrial land use would continue to prevent unauthorized and/or inappropriate use of the site. Industrial land use would be verified through the five-year review process.

5.2.4.4 Reduction of Contaminant Volume, Toxicity, or Mobility Through Treatment

Alternative 4 would not reduce toxicity or mobility through treatment, but physical treatment (e.g., soil sorting and radiological scanning) could reduce the overall volume of soil (by approximately 20%) 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.

5.2.4.5 Short-Term Effectiveness

Short-term risks to site workers and surrounding community associated with excavation, treatment, transport, and disposal of soil could occur during excavation of contaminated soil. Air quality could be affected by release of particulates during soil excavation. During excavation activities, dust suppression measures would be required to mitigate fugitive dust emissions.

5.2.4.6 Implementability

Alternative 4 has high technical implementability. Excavation and soil sorting activities are common and proven methods for site remediation and would be easily implemented. A pilot study would be conducted to refine the design of the system, then USACE may implement a full-scale treatment system. The services and materials to be utilized to implement physical treatment are readily available and no special construction techniques would be required to construct the treatment facility.

Alternative 4 is rated low in administrative implementability because it involves 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.

5.2.4.7 Cost

The estimated total cost for Alternative 4 over the 30-year period is $45,172,033. This alternative includes the same cost components as Alternative 3. It also includes costs for treatment (i.e., mobilization/demobilization, performance of physical treatment, and treatment confirmation sampling). The total cost of Alternative 4 is lower than the cost of Alternative 3 due to reduced transportation and disposal costs resulting from the treatment of DU-contaminated soil. It was assumed that, after treatment, 20% of the DU-contaminated soil would be used as backfill.

5.2.5 Alternative S1, No Action for Structures

This alternative assumes that no remedial actions would be implemented at the impacted IAAAP structures in FUSRAP areas. The no action alternative is required by the NCP [40 *CFR* §300.430(e)(6)] and CERCLA guidance to provide a baseline to which all other remedial alternatives are compared. It is assumed that land use controls currently in place (e.g., use restrictions and outgrants administered by the U.S. Army as part of its land management responsibilities) would not be maintained.

5.2.5.1 Overall Protection of Human Health and the Environment

Alternative S1 is not protective of human health or the environment. 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.

5.2.5.2 Compliance with Applicable or Relevant and Appropriate Requirements

Alternative S1 does not comply with chemical-specific ARARs. Alternative S1 would not meet the restricted release provisions of 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 considered under Alternative S1 because no remedial action would take place.

5.2.5.3 Long-Term Effectiveness and Permanence

Alternative S1 includes no long-term measures to prevent exposures or spread of contamination. All potential future risks remain at levels that exceed the CERCLA target CR range because none of the DU would be removed. 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 do not remain in place and provides no additional controls to prevent exposure to contaminants. This alternative would allow the contamination to remain on-site and would rely upon the long-term processes of radioactive decay for contaminant mass reduction. Under the current and expected future land use scenarios, there are potential risks to human health and the environment if the contaminated structures remains in place.

5.2.5.4 Reduction of Contaminant Toxicity, Mobility, or Volume Through Treatment

No reduction in contaminant toxicity, mobility, or volume through treatment is achieved because no treatment process is proposed under Alternative S1.

5.2.5.5 Short-Term Effectiveness

There are no short-term risks associated with the Alternative S1 beyond baseline conditions. There would be no additional short-term health risks to the community or site workers because no remedial actions would be implemented.

5.2.5.6 Implementability

No actions are required for this alternative.

5.2.5.7 Cost

Under this alternative, there are no costs.

5.2.6 Alternative S2, Land Use Controls for Structures

Alternative S2 consists of land use controls for structures. The existing land use controls for the IAAAP (e.g., use restrictions and outgrants administered by the U.S. Army as part of its land management responsibilities) would be continued. Additional land use controls, such as access restrictions for structures (e.g., via site security, fencing, and signage) or use restrictions for structures, would be imposed to limit exposure to the DU-contaminated structural surfaces. Alternative S2 also includes five-year reviews.

5.2.6.1 Overall Protection of Human Health and the Environment

Land use controls increase human health protectiveness by limiting direct access to DU-contaminated structural surfaces. The overall protection of human health would be maintained as long as land use controls are in place. Potential exposures to DU-contaminated structural surfaces would be limited by restricting the use of structures or establishing no-entry zones. Overall protection of the environment would also be maintained since only interior structures exceed the DU RG.

5.2.6.2 Compliance with Applicable or Relevant and Appropriate Requirements

Alternative S2 does 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.

Inability to meet the threshold criteria of compliance with ARARs is a significant problem with this alternative. Section 121(d) of CERCLA and NCP [40 *CFR* §300.430(f)(l)(ii)(B)] require that remedial actions at CERCLA sites attain ARARs unless such ARARs are waived under CERCLA Section 121(d)(4).

5.2.6.3 Long-Term Effectiveness and Permanence

Alternative S2 may not be protective in the long term. It would rely on land use controls to eliminate or reduce exposures to site contaminants on structures. It is reasonably expected that land use controls can be implemented and would be effective in protecting human health, but they would not result in a permanent reduction in site risks. The land use controls would have to be maintained for a considerable period of time to prevent unauthorized and/or inappropriate use of structures. Five-year reviews would be conducted to ensure that land use controls continue to be protective.

Alternative S2 is less permanent than other remedial alternatives for structures because the land use controls could be lost. The risks under Alternative S2 could exceed the CERCLA target CR range, and doses could exceed 100 mrem/yr if controls are lost. To avoid loss of controls, Alternative S2 includes requirements to verify the continued protectiveness of the land use controls through the CERCLA five-year review process.

5.2.6.4 Reduction of Contaminant Toxicity, Mobility, or Volume Through Treatment

No reduction of toxicity, mobility, or volume of contaminants through treatment would be obtained under Alternative S2.

5.2.6.5 Short-Term Effectiveness

There would be no additional short-term risks to the community, site workers, or the environment under this alternative. Because Alternative S2 would make use of land use controls rather than active remediation to minimize exposures, it would avoid adverse short-term impacts due to potential construction or transportation accidents associated with active remedial technologies.

5.2.6.6 Implementability

Alternative S2 would be easy to implement. No technical or administrative problems are anticipated that would limit the implementability of land use controls at the site.

5.2.6.7 Cost

The estimated total cost for Alternative S2 over the 30-year period is $285,772. The cost would include implementation and maintenance of land use controls for structures and the performance of five-year reviews for structures.

5.2.7 Alternative S3, Decontamination/Replacement of Structures

The specific components of Alternative S3 include physical decontamination of DU-contaminated structural surfaces and/or replacement of the structural components.

5.2.7.1 Overall Protection of Human Health and the Environment

This alternative would protect human health and the environment by removing DU-contamination from structural surfaces. The long-term risk of potential exposure to DU-contamination from site structures is reduced or eliminated. Industrial land use would continue to prevent unauthorized and/or inappropriate use of the site. In addition, structures would need to be included in the five-year reviews if they exceed levels appropriate for UUUE. The five-year reviews would include verification of industrial land use.

5.2.7.2 Compliance with Applicable or Relevant and Appropriate Requirements

Under Alternative S3, ARARs would be achieved.

5.2.7.3 Long-Term Effectiveness and Permanence

The effectiveness of decontamination is rated high because it would permanently reduce the levels of residual radioactivity on structural surfaces. It also reduces the amount of material (e.g., equipment, construction, and related debris) requiring further treatment or disposal.

5.2.7.4 Reduction of Contaminant Volume, Toxicity, or Mobility Through Treatment

Treatment is not proposed under this alternative. Therefore, no reduction in contaminant volume, toxicity, or mobility through treatment is achieved under Alternative S3.

5.2.7.5 Short-Term Effectiveness

There would be short-term risks due to potential exposures to remediation workers during the decontamination activities. All worker exposures and injuries would be mitigated through implementation of the health and safety program, including good safety practices and personal protective equipment.

5.2.7.6 Implementability

Decontamination is a conventional method of remediating DU-contaminated structures and would be easily implemented. Decontamination equipment and trained personnel are readily available. For those structural components for which decontamination is not cost effective, such as the DU-contaminated air filters at Line 1 Building 1-63-6, removal and replacement would be performed. Replacement materials are readily available.

5.2.7.7 Cost

The estimated total cost for Alternative S3 is $102,961. Costs include the physical decontamination of DU-contaminated structures and replacement of the contaminated air filters at Line 1 Building 1-63-6.

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6.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

Alternatives developed for the FUSRAP areas are examined by comparative analysis for the purpose of identifying relative advantages and disadvantages of each alternative on the basis of the previous detailed analysis (Section 5). The comparative analysis provides a means by which remedial alternatives can be directly compared to one another with respect to common criteria. Overall protection and compliance with ARARs are threshold criteria that must be met by an alternative for it to be eligible for selection. The other five criteria, consisting of short- and long-term effectiveness; reduction of contaminant volume, toxicity, and mobility through treatment; ease of implementation; and cost are the primary balancing criteria used to select a preferred remedy among alternatives satisfying threshold criteria. The community and state acceptance criteria have been considered but will be fully addressed after the public comment period. This comparative analysis provides the basis for the selection of a preferred alternative.

6.1 COMPARISON OF THE ALTERNATIVES USING THE COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT THRESHOLD AND BALANCING CRITERIA

Table 6-1 summarizes the results of the comparative analysis of the seven criteria for the four remedial action alternatives for soil. Table 6-2 summarizes the results of the comparative analysis for the three remedial action alternatives for structures.

6.1.1 Overall Protection of Human Health and the Environment

Each of the soil alternatives, except Alternative 1, is protective of human health. The degree of protection and permanence of the protectiveness is a function of whether, and to what extent, an alternative uses excavation, excavation with treatment, or land use control strategies. Alternatives 1 and 2 result in the highest levels of contamination remaining on-site. Alternative 1 does not prevent potential exposures to contaminated soil. Under Alternative 1, current and future risk to human health and the environment would neither be eliminated nor reduced. Alternative 2 is effective by reducing exposures to humans by restricting access to contaminated soil through land use controls.

Alternatives 3 and 4 rely on soil removal to provide an effective and permanent remedy for the FUSRAP areas. Excavation of DU-contaminated soil at the FUSRAP areas would achieve a lower potential dose by reducing the overall EPC. For these alternatives, human health is protected as long as land use remains industrial. Even if control of the site were lost in the future, the dose would be less than 100 mrem/yr to the maximally exposed individual as required by 10 *CFR* 20.1403(e).

Each of the remedial alternatives for structures, except Alternative S1, is protective of human health. Alternative S1 does not prevent potential exposures to DU-contaminated structures. 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 S3 (which involves decontamination of structural surfaces and/or replacement of structural components) provides the greatest overall protection to human health and the environment because potential current and future exposures to DU contamination on structures would be eliminated.

Table 6-1. 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 for those areas where contamination remains in place above RGs.	Protective. Removal of DU-contaminated soil provides protectiveness.	Protective. Removal of DU-contaminated soil provides protectiveness.
Environment	Protective. Soil contamination in the FSA does not pose potential risks to the Indiana bat.	Protective. Soil contamination in the FSA does not pose potential risks to the Indiana bat.	Protective. Soil contamination in the FSA does not pose potential risks to the Indiana bat.	Protective. Soil contamination in the FSA does not pose potential risks to the Indiana bat.
Compliance With ARARs				
Chemical-Specific	Not compliant.	Not compliant. Does not achieve the restricted release conditions given in 10 CFR 20.1403, which require that the annual dose to an average member of the critical group not exceed 100 mrem/yr if land use controls are lost.	Compliant.	Compliant.
Action-Specific	NA	NA	Compliant.	Compliant.
Location-Specific	NA	NA	Compliant.	Compliant.

Table 6-1. 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
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 controlled by continuation of industrial land use.	Low. Remaining risks at the FUSRAP areas controlled by continuation of industrial land use.
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 restrictions, 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.
Reduction of Contaminant (Overall)				
Toxicity, Mobility, or Volume by Treatment	None.	None.	None.	Volume of soil requiring disposal would be reduced by soil sorting.

Table 6-1. 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
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 and transportation activities could be reduced by mitigative measures. Potential for added risk to workers due to materials handling during treatment operations 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.	Short-term impacts to ecosystem. Long-term benefit.	Short-term impacts to ecosystem. Long-term benefit.
Geology and Soil	No impacts to soil.	No impacts to soil.	Short-term soil disturbance during excavation.	Short-term soil disturbance during excavation.
Implementability				
Technical Feasibility	Feasible.	Feasible.	Feasible.	Feasible.
Administrative Feasibility	Feasible.	Feasible.	Feasible.	Feasible.
Cost (Present Worth)				
Total Cost Over 30-Year Period	$0	$2,332,013	$50,401,517	$45,172,033

NA = Not applicable.

Table 6-2. 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 for those areas where contamination remains in place above levels that would allow UUUE.	Protective. Decontamination or removal and replacement of structural components as necessary will reduce or eliminate potential exposures to radiological contamination.
Environment	Protective. DU contamination on structures does not pose potential risks to the Indiana bat. No significant impacts to ground water expected.	Protective. DU contamination on structures does not pose potential risks to the Indiana bat. No significant impacts to ground water expected.	Protective. DU contamination on structures does not pose potential risks to the Indiana bat. No significant impacts to ground water expected.
Compliance With ARARs			
Chemical-Specific	Not compliant.	Not compliant. Does not achieve the restricted release conditions given in 10 *CFR* 20.1403, which require that the annual dose to an average member of the critical group not exceed 100 mrem/yr if land use controls are lost.	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.

Table 6-2. 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
Reduction of Contaminant (Overall)			
Toxicity, Mobility, or Volume by Treatment	None.	None.	None.
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.
Geology and Soil	NA	NA	No expected impacts to soil.
Implementability			
Technical Feasibility	Feasible.	Feasible.	Feasible.
Administrative Feasibility	Feasible.	Feasible.	Feasible.
Cost (Present Worth)			
Total Cost Over 30-Year Period	$0	$285,772	$102,961

NA = Not applicable.

6.1.2 Compliance with Applicable or Relevant and Appropriate Requirements

A summary of the ARARs is presented in Tables 6-3 and 6-4. 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). However, Alternatives 1 and 2 do not comply with chemical-specific ARARs.

Two of the remedial alternatives for structures, S1 (no action) and S2 (land use controls), do not comply with chemical-specific ARARs. Alternative S3 (decontamination/replacement of structures) complies with the ARAR by reducing potential future doses below the 25-mrem/yr level and achieving doses that are ALARA.

6.1.3 Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence refers to the ability of a remedy to maintain reliable protection of human health and the environment. 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 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.

6.1.4 Reduction in Contaminant Toxicity, Mobility, or Volume through Treatment

Alternative 4 provides a reduction in contaminant volume and mobility through treatment. The remaining alternatives do not use treatment to reduce the toxicity, mobility, or volume of contaminants at the site.

6.1.5 Short-Term Effectiveness

Alternatives 1 and 2 rate higher than Alternatives 3 and 4 with respect to short-term effectiveness because no remedial activities will be conducted that have the potential to impact the health and safety of site workers or the surrounding communities. Alternatives 3 and 4 include the excavation and disposal of DU-contaminated soil off-site. They have increased short-term risks to the site workers conducting the excavation, transport, and disposal activities. There would be additional short-term risks due to potential exposures to equipment operators and other remediation workers during treatment activities under Alternative 4. 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 residing at the excavated locations and potentially destroys existing features of the environment that provide habitat or food to plants and animals. Although the implementation of Alternatives 3 and 4 may temporarily create non-point source surface-water discharges, all of these impacts would

Table 6-3. Documentation of Applicable or Relevant and Appropriate Requirements for the Remedial 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
Chemical-Specific ARAR				
NRC Radiological Criteria for License Termination: 10 *CFR* Part 20 Subpart E, 20.1403 (b) and 20.1403(e)	Will not comply.	Will not comply.	Will comply.	Will comply.
Action-Specific ARAR				
Radiation Protection Programs: 10 *CFR* Part 20, Subpart B, 20.1101(d)	Not ARAR.	Not ARAR.	Will comply.	Will comply.
Location-Specific ARAR				
The Endangered Species Act: 16 U.S.C §1538(a)(1)	Not ARAR. [a]	Not ARAR. [a]	Will comply.	Will comply.

[a] This criterion is not an ARAR for this Alternative.

Table 6-4. Documentation of Applicable or Relevant and Appropriate Requirements for the Remedial Alternatives for Structures

Criteria	Alternative S1: No Action for Structures	Alternative S2: Land Use Controls for Structures	Alternative S3: Decontamination/ Replacement of Structures
Chemical-Specific ARAR			
NRC Radiological Criteria for License Termination: 10 *CFR* Part 20 Subpart E 20.1403 (b) and 20.1403(e)	Will not comply.	Will not comply.	Will comply.
Location-Specific ARAR			
The Endangered Species Act: 16 U.S.C §1538(a)(1)	Not ARAR. [a]	Not ARAR. [a]	Will comply.

[a] This criterion is not an ARAR for this Alternative.

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 not expected to impact 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 at critical periods of roosting.

Alternatives S1 and S2 would not involve any remedial actions; therefore, there would be no short-term impacts to site 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. Off-site migration of airborne contaminants is unlikely due to the indoor locations of the structures, but any ancillary actions would be outdoors and could be minimized by using dust suppression controls and monitoring. Decontamination activities at outdoor locations may temporarily create non-point source surface-water discharges; all of these impacts will 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 this alternative.

6.1.6 Implementability

Alternative 1 is the easiest alternative to implement from a technical standpoint. Alternative 2 is rated higher than the remaining soil alternatives in technical implementability because no active remediation is 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.

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. Alternative 2 involves the implementation of land use controls and so is administratively more complex than the other soil alternatives. However, no significant difficulties are anticipated in implementing and obtaining approvals for the land use controls, so it has been rated as high in administrative implementability. 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. Use of the FSA is expected to increase in the future as a result of actions mandated by BRAC (USACE 2007b). There could be administrative challenges in scheduling and coordinating remediation activities to avoid causing significant delays or cancelation of essential operational range activities.

All three remedial alternatives for structures are implementable. Alternatives S1 and S2 are the easiest to implement from a technical standpoint 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. The administrative implementability of S1 (no action) is rated as lower than the other two remedial alternatives for structures as it is likely that the regulatory agencies would require that a remedial action be taken to address the contamination.

6.1.7 Cost

Costs for each alternative, itemization of individual components, and the sensitivity analysis for each alternative may be found in Appendix E. The estimated total 30-year costs for the alternatives are listed in Table 6-5.

Table 6-5. Comparison of Costs for Remedial Alternatives for the Formerly Utilized Sites Remedial Action Program Areas

Alternatives for Soil	
Alternative	**Estimated Cost**
1	$0
2	$2,332,013
3	$50,401,517
4	$45,172,033
Alternatives for Structures	
S1	$0
S2	$285,772
S3	$102,961

6.1.8 State and Community Acceptance

The modifying criteria of state and community acceptance, will be completed after the receipt of comments on the PP through various community relations activities. USACE, USEPA, the state of Iowa, and IAAAP will hold a public meeting to present the findings of the FUSRAP RI/FS and PP. The comments, concerns, and written statements from the public meeting will be published in the responsiveness summary included in the ROD.

A copy of the Administrative Record File for actions at the FUSRAP areas has been maintained by USACE. The Administrative Record File and the documents describing the results of the FUSRAP RI/FS have been made available to the public for review and comment at the:

Burlington Public Library
210 Court Street
Burlington, Iowa 52601

6.2 PROPOSED PLAN AND RECORD OF DECISION

6.2.1 Proposed Plan

As part of this FS process, a PP is being prepared to solicit public input on the alternatives presented in the FS and the proposed alternative for remediating the FUSRAP areas of the IAAAP. Both the FS and PP were prepared by USACE as the lead agency with support from USEPA, the state of Iowa, and the IAAAP. The PP presents all of the alternatives evaluated in the FS together with the preferred alternative. The PP reviews the FS results, presents the preferred alternative, and identifies the plan for remediating the FUSRAP areas. A draft PP was submitted to the USEPA, the state of Iowa, and the IAAAP for their review prior to the issuance of the PP for public review and comment. Public comments received on the PP will be used to evaluate the CERCLA criteria of “community acceptance.”

6.2.2 Record of Decision

The ROD will select the remedy for the IAAAP FUSRAP areas. Comments received from both the regulators and the public on the PP will be considered in drafting the ROD. The ROD will describe the CERCLA selection process and will provide a brief summary of the history, characteristics, risks, and alternatives for site remediation. The ROD will also include a responsiveness summary to address public comments received through the community relations activities for the FUSRAP.

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FIGURES

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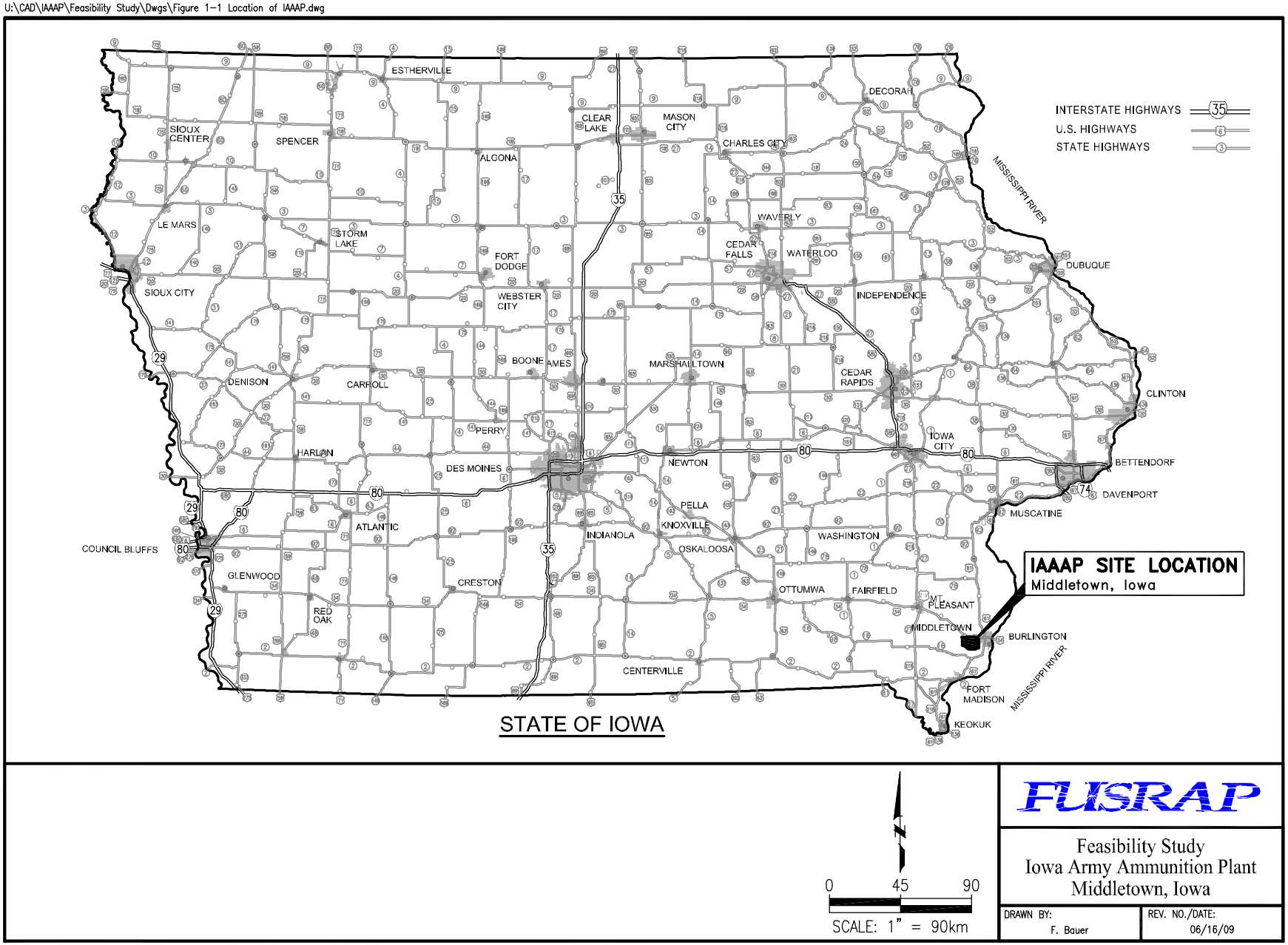


Figure 1-1. Location of IAAAP

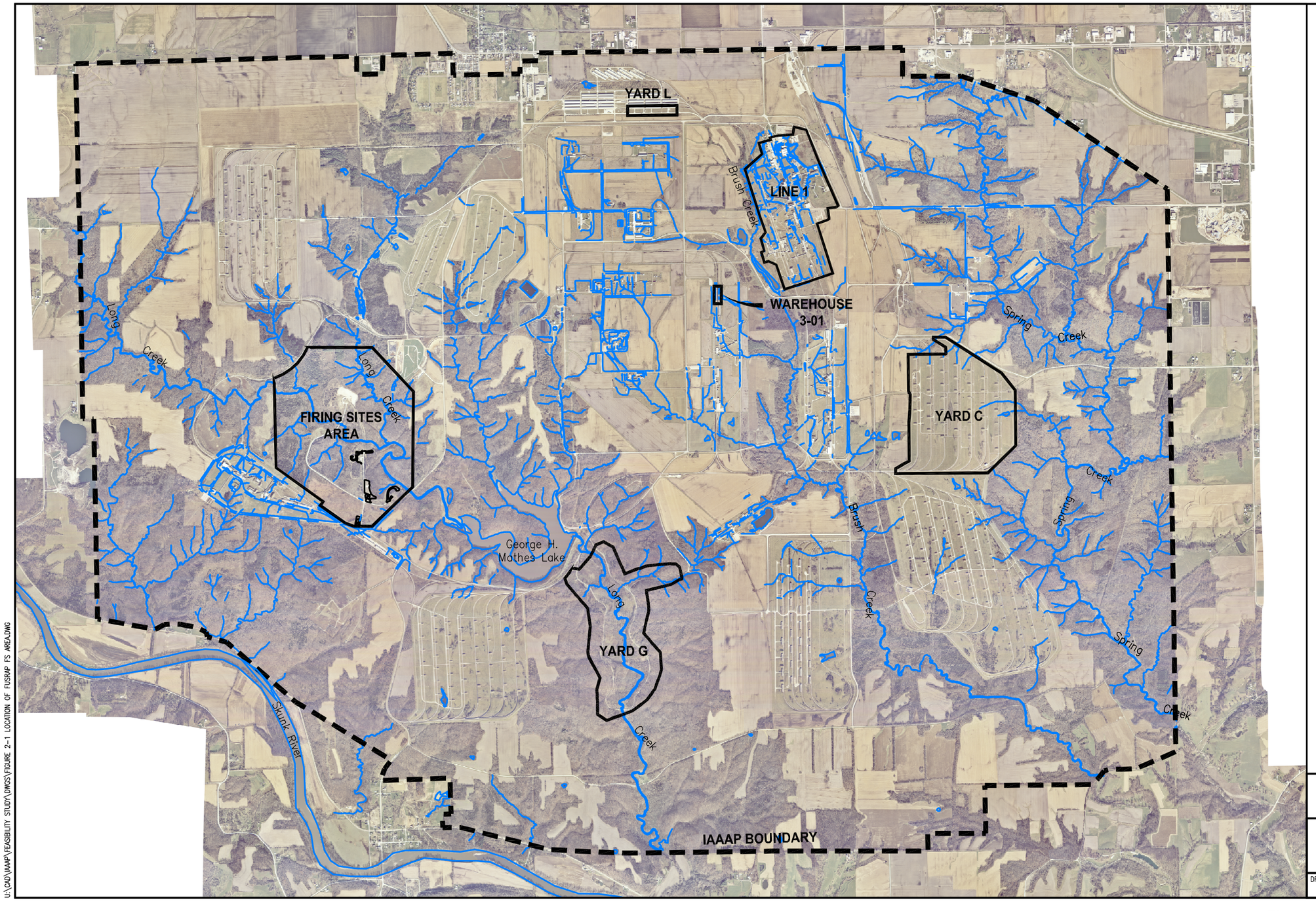
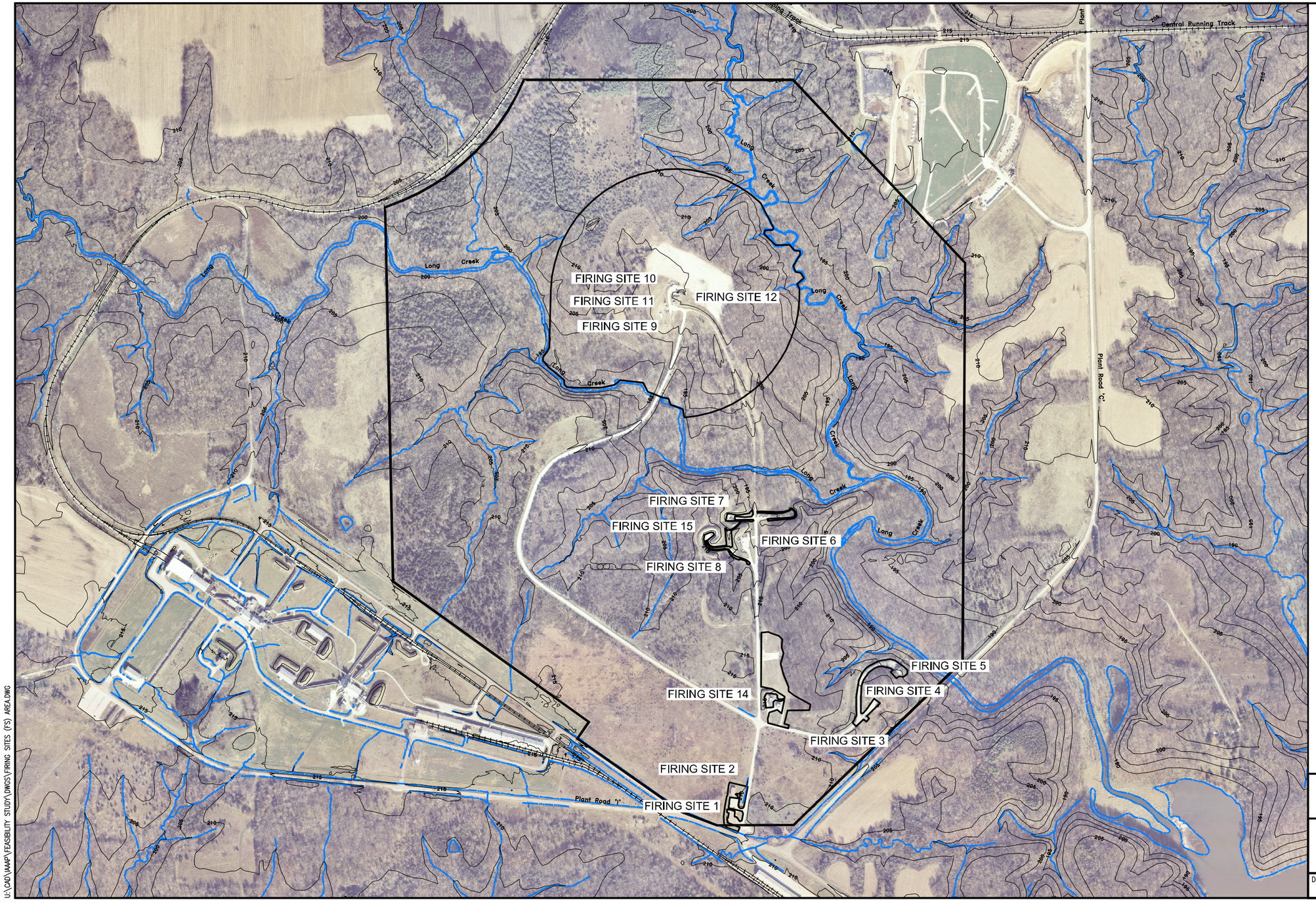


Figure 2-1. Location of FUSRAP Areas



LEGEND:

- RAILROAD
- STREAM
- 200 TOPOGRAPHIC CONTOURS
- AREA WITHIN THE SCOPE OF FS

N

0 120 240

SCALE: 1" = 240 meters

FUSRAP

Feasibility Study
Iowa Army Ammunition Plant
Middletown, Iowa

DRAWN BY:	REV. NO./DATE:
F. Bauer	12/07/10

U:\CAD\IAAP\FEASIBILITY STUDY\DWGS\FIRING SITES (FS) AREA.DWG

Figure 2-2. FUSRAP Firing Sites Area



LEGEND:

- Stream
- Surface Feature
- Topographic Contours

N
W E
S

Iowa-South State Plane
(NAD 83, Meters)

0 7 14 Meters

Feasibility Study
Iowa Army Ammunition Plant
Middletown, Iowa

FUSRAP

DRAWN BY:	REV:	DATE:
DLL	0	03/21/2011

U:\GPS\IAAAP\Feasibility Study\Projects\New\February 2011\Figure 2-3 Firing Sites 1 and 2 Area.mxd

Figure 2-3. Firing Sites 1 and 2 Area



Figure 2-4. 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

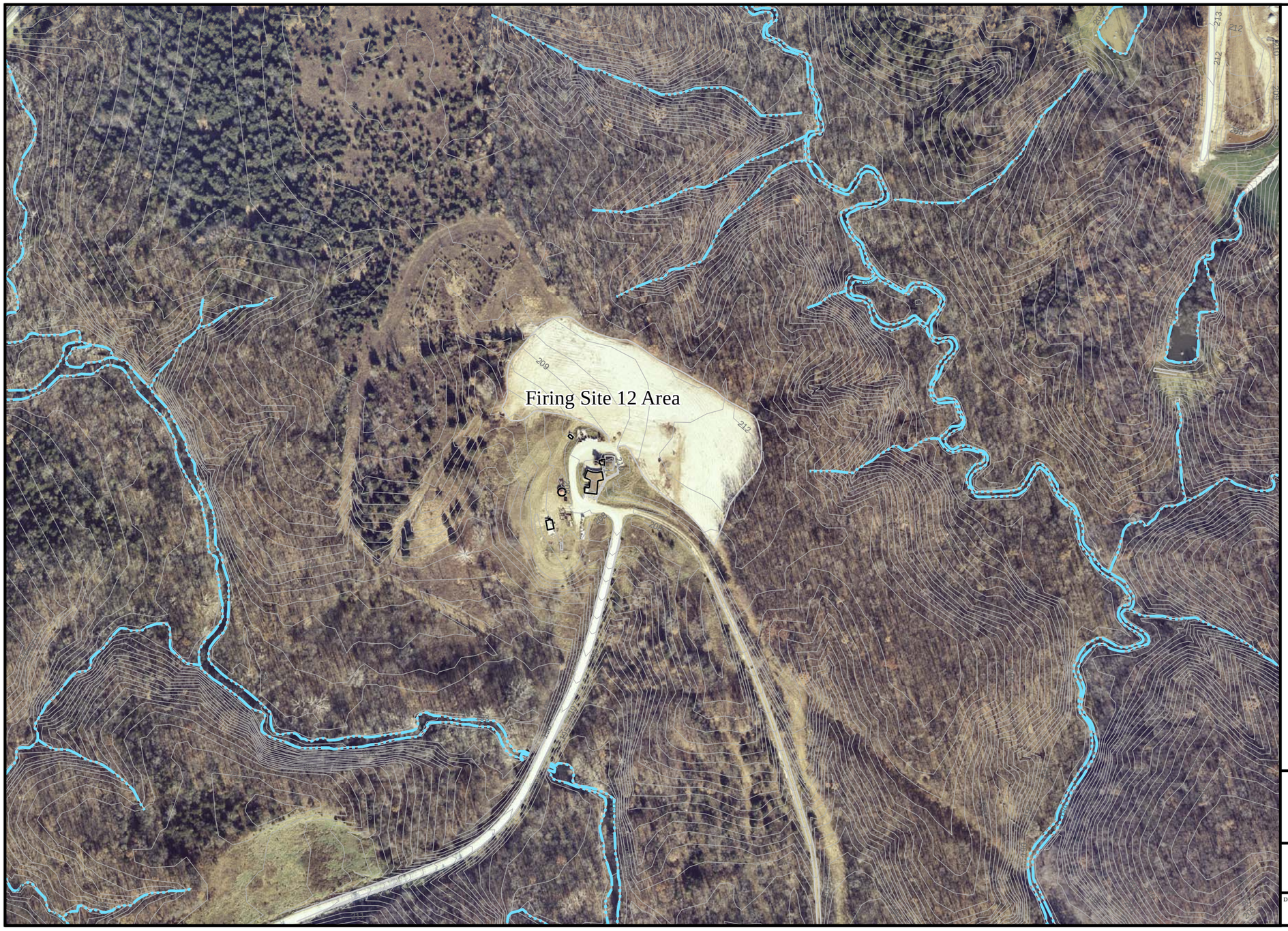
Feasibility Study
Iowa Army Ammunition Plant
Middletown, Iowa

FUSRAP

DRAWN BY:	REV:	DATE:
DLL	0	03/21/2011

U:\GPS\IAAAP\Feasibility Study\Projects\New\February 2011\Figure 2-5 Firing Site 6 Area.mxd

Figure 2-5. Firing Site 6 Area



U:\GPS\IAAAP\Feasibility Study\Projects\New\February 2011\Figure 2-6 Firing Site 12 Area.mxd

Figure 2-6. Firing Site 12 Area

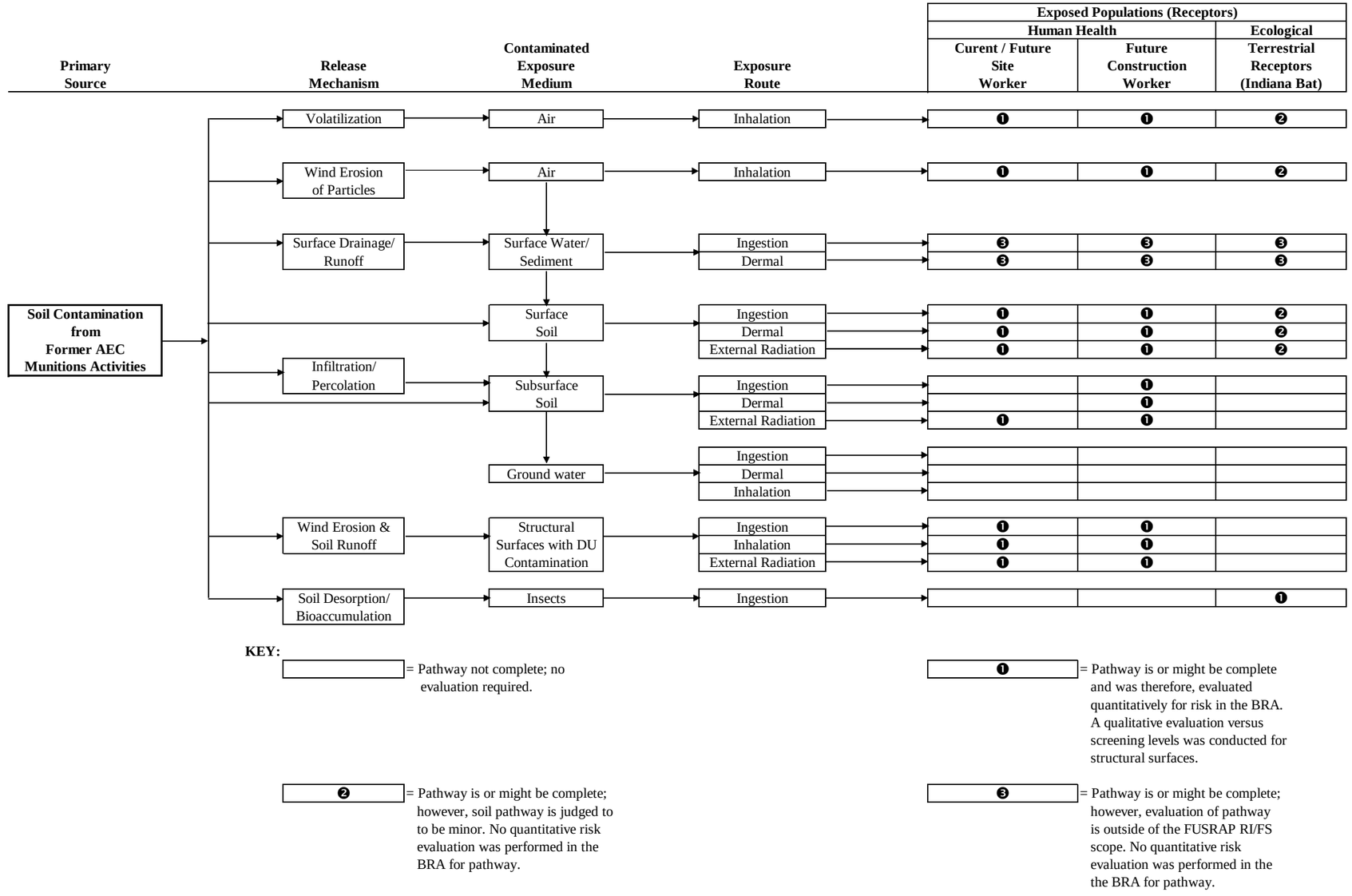


Figure 2-7. Conceptual Site Model for the FUSRAP Feasibility Study at the IAAAP - Soil Pathways

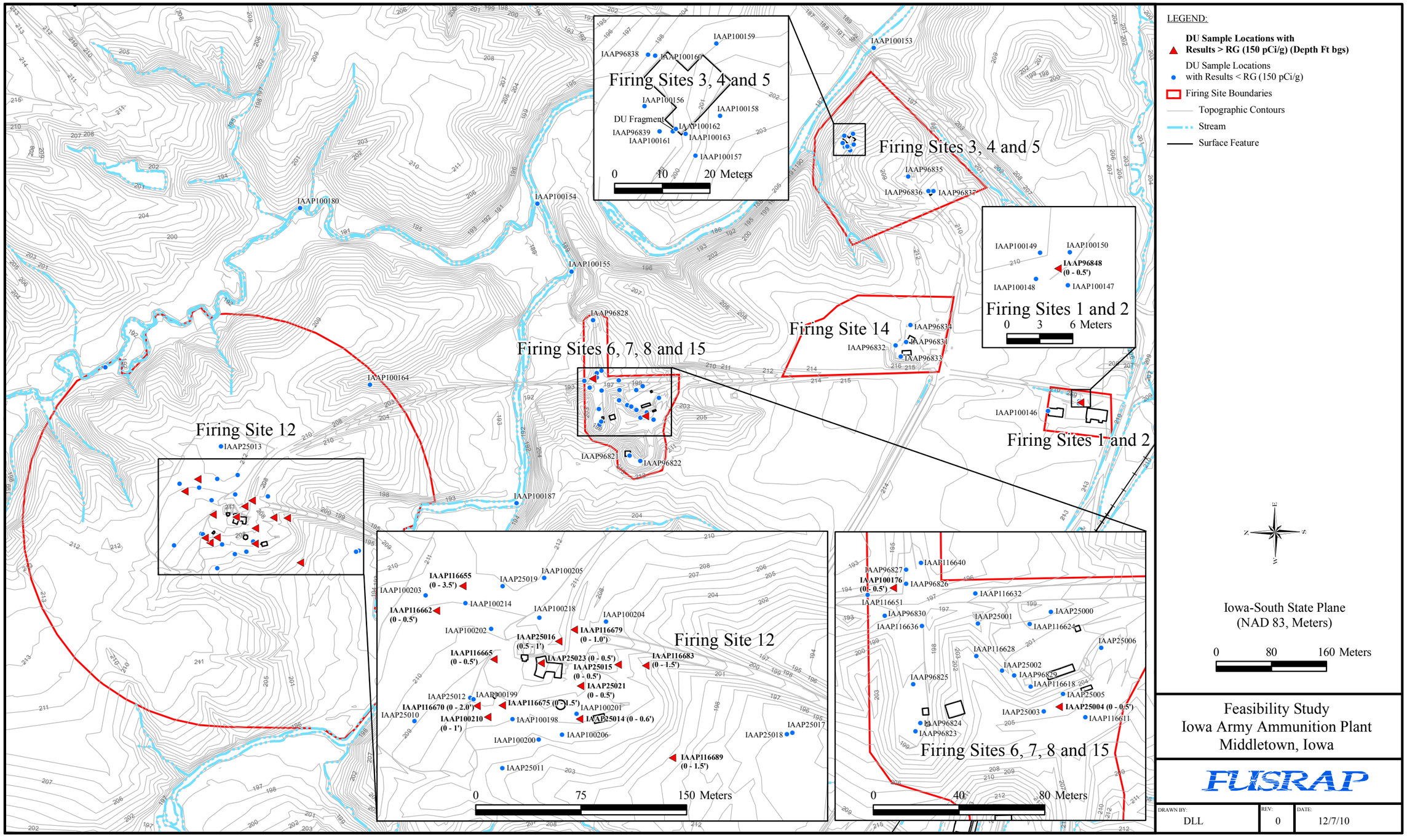


Figure 3-1.
Exceedances of the Human Health RG
for DU (150 pCi/g) in FSA Soil

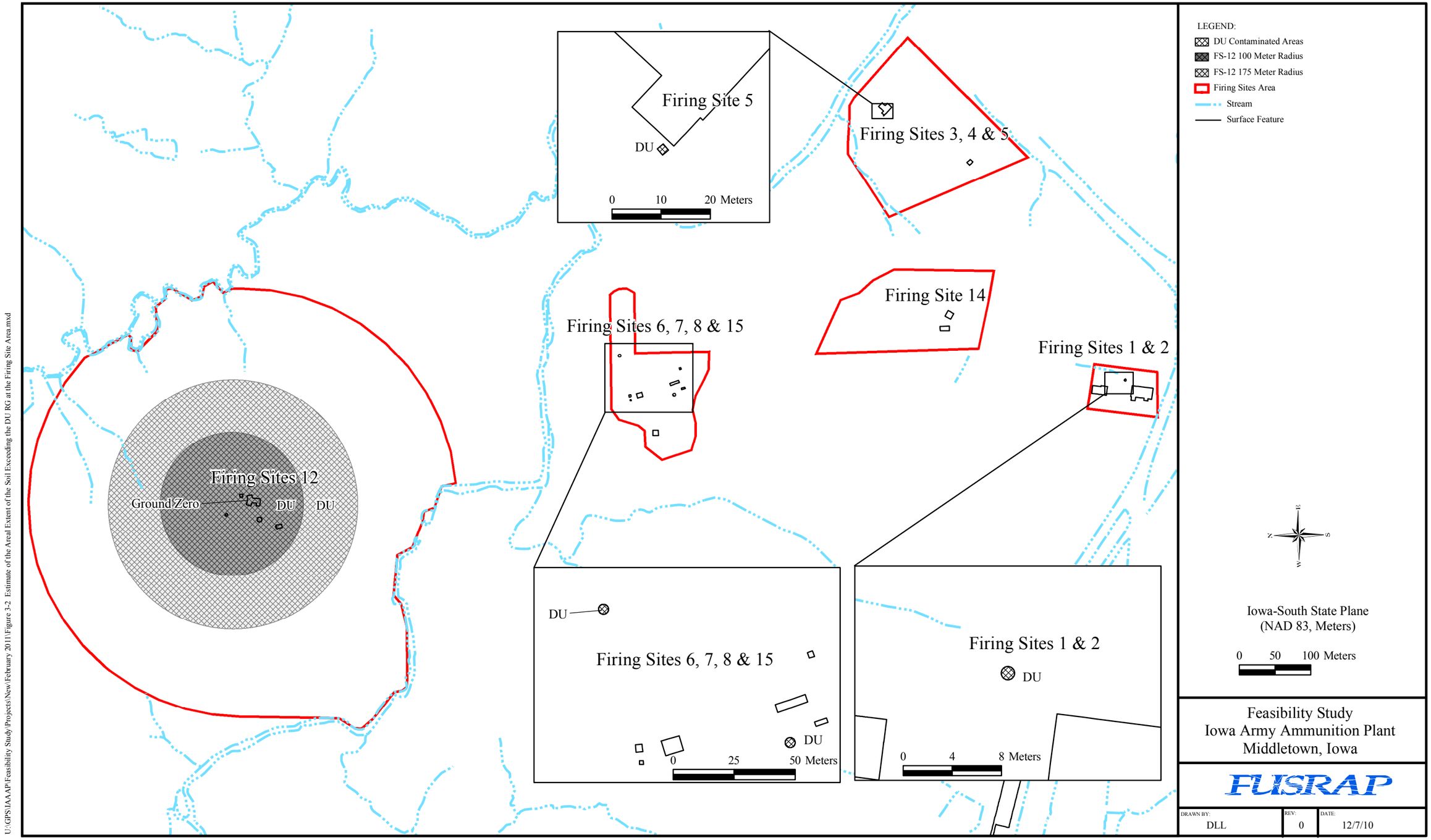


Figure 3-2. Estimate of the Areal Extent of Soil Exceeding the DU RG at the Firing Site Area

MEDIUM	GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGIES	PROCESS OPTIONS	DESCRIPTIONS	TECHNICAL FEASIBILITY SCREENING COMMENTS
Soil and DU Fragments	No Action	None	Not Applicable	No further action	Required for consideration by NCP to establish baseline conditions.
	Land Use Controls	Access Restrictions	Entry Control	Restricted access to contaminated areas in order to reduce potential exposures.	Ongoing restricted access to FUSRAP areas.
		Resource Restrictions	Hunting and Fishing Restrictions	Facility–wide restrictions to reduce exposure to biouptake.	Not retained because not necessary for protection of human health and environment.
		Land Use Restrictions	Installation Use Restrictions	Would include restrictions for land use such as limits on construction and drilling activities.	Potentially applicable.
	Natural Attenuation	Monitored Natural Attenuation	Biodegradation	Explosives are known to biodegrade under natural conditions.	Not retained because it would not achieve the RG in a reasonable timeframe.
	Reclamation/ Recovery	Reclamation/ Recovery	Physical/Chemical Separation	Separation of metals contaminants from soil in the form of metal, metal oxide, or other useful products.	Potentially applicable as a pretreatment method for recovery of DU. Not feasible for remediation of other metals due to insignificant recovery volume.
	Containment	Cap	Engineered Cover System	Clay, asphalt, textile fabrics, or surface applied polymers are used to form an impermeable cover over contaminated soil areas.	Not implementable. Areas must be returned for active military use.
		Barrier Systems	Horizontal Barrier	Use of grouting techniques to create a horizontal barrier beneath the contaminated soil thus reducing the permeability of soil layers.	Studies indicate that conventional grout technology cannot produce an impermeable horizontal barrier.
	Removal	Excavation	Conventional	Excavation of contaminated soil with conventional earthmoving equipment.	Potentially applicable.
	Disposal	Landfill	On–Site Disposal	Contaminated media exceeding remediation criteria but would be excavated and disposed on a newly constructed landfill.	Potentially applicable.
			Off–Site Disposal	Contaminated media exceeding remediation criteria would be excavated and disposed in a newly constructed or existing landfill that meets regulatory guidelines.	Potentially applicable.
	Treatment	Physical/Chemical	Electro kinetic Separation	In–situ treatment utilizing direct current to draw contaminants towards electrode. Also considered a chemical treatment as solutions are used to augment the movement of contaminants.	Not appropriate for shallow surface contamination present at FUSRAP sites.
			Soil Flushing	In–situ treatment; injection of water solutions to mobilize contaminants towards ground–water wells for removal.	Not appropriate for shallow surface contamination present at FUSRAP sites.
			Soil Sorting	Ex–situ treatment; separation of radionuclides and heavy metals. Sorting can be accomplished by size separation, magnetic, or radiological scanning (radiological contamination).	Potentially applicable.
			Soil Washing	Ex–situ treatment; contaminants are removed from soil using washing fluid with appropriate surfactants.	Potentially applicable.
			Solidification/ Stabilization	Ex–situ treatment; soil is mixed with stabilizing agents to immobilize contaminants within soil matrix.	Potentially applicable.
		Biological	Enhanced Bioremediation	In–situ treatment; Degradation of compounds utilizing biological organisms along with soil amendments to optimize soil conditions.	Not appropriate for DU chunks.
			Phytoremediation	Ex–situ treatment; Uptake of inorganic soil contaminants by plants along with possible soil amendments to optimize soil conditions.	Potentially applicable.
Structures	No Action	None	Not Applicable	No further action.	Required for consideration by NCP to establish baseline conditions. At some FUSRAP areas, the concentrations are below RGs and, therefore, do not require a response action.
	Land Use Controls	Access Restrictions	Structure–specific restrictions	Security fencing, signage. Restricted use of structures for the long term.	Potentially applicable.
	Containment	Surface Barriers	Sealants/ Impermeable Sheeting	Spray on chemicals or applied sheeting that provides a surface barrier to reduce exposure to contaminated surfaces.	Potentially applicable.
	Decontamination	Decontamination	Physical or Chemical Decontamination	Removal of radiological contamination by removal of soil particles adhered to surfaces by physical scrubbing, scouring, high pressure water, or with chemical agents.	Potentially applicable.
	Demolition	Removal and Disposal	On–Site Disposal	Dismantlement of contaminated surfaces structures and disposal of the debris to an on–site disposal landfill.	Not implementable. Areas must be returned for active military use.
			Off–Site Disposal	Dismantlement of contaminated surfaces structures and disposal of the debris to an off–site disposal landfill.	Not implementable. Areas must be returned for active military use.

Potentially Applicable Technology

Eliminated from Further Consideration

Figure 3-3

Initial Screening of Technologies and Process Options

FUSRAP Feasibility Study

Iowa Army Ammunition Plant

Middletown, Iowa

MEDIUM	GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGIES	PROCESS OPTIONS	EVALUATION CRITERIA: EFFECTIVENESS	IMPLEMENTABILITY: Administrative	IMPLEMENTABILITY: Technical	COST	RETAINED?
Soil and DU Fragments	No Action	None	No Action	L	L	H	L	YES
	Land Use Controls	Access Restrictions	Entry Control	M	H	H	L	YES
		Land Use Restrictions	Installation Use Restrictions	M	H	H	L	YES
	Reclamation/ Recovery	Reclamation/ Recovery	Physical/Chemical Separation	H	H	M	H	YES
	Removal	Excavation	Conventional	H	L[a]	H	L	YES
	Disposal	Landfill	On-Site Disposal	H	L	M	H	NO High Cost Low Administrative Implementability
			Off-Site Disposal	H	H	H	H	YES
	Treatment	Physical/Chemical	Soil Sorting	M	H	H	L	YES
			Soil Washing	L	H	H	M	NO Low Effectiveness
			Solidification/ Stabilization	L	H	M	H	NO Low Effectiveness
		Biological	Phytoremediation	L	H	H	H	NO Low Effectiveness
Structures	No Action	None	No Action	L	L	H	L	YES
	Land Use Controls	Access Restrictions	Structure-specific restrictions	H	H	H	L	YES
	Containment	Surface Barriers	Sealants/ Impermeable Sheeting	M	H	H	L	YES
	Decontamination	Decomtamination and Reuse	Physical or Chemical Decontamination or Replacement	H	H	H	L	YES

NOTE:

EVALUATION CRITERIA ARE RATED AS H (HIGH), M (MODERATE) OR L (LOW). AN EFFECTIVENESS RATING OF H (HIGH) INDICATES THAT THE TECHNOLOGY IS PROTECTIVE OF HUMAN HEALTH AND THE ENVIRONMENT BY REDUCING THE TOXICITY, MOBILITY, OR VOLUME OF CONTAMINANTS. A RATING OF H (HIGH) FOR IMPLEMENTABILITY SIGNIFIES THAT THE TECHNOLOGY CAN RELIABLY BE INITIATED AND PERFORMED AT THE SPECIFIC LOCATION. A RATING OF L (LOW) FOR COST SUGGESTS THAT THE ESTIMATED AVERAGE COSTS ASSOCIATED WITH CAPITAL AND OPERATING COSTS ARE LESS THAN $150 PER CUBIC YARD AND REASONABLE AS COMPARED TO OTHER TECHNOLOGIES EVALUATED. THE COST WAS RATED AS MODERATE IF IT WAS BETWEEN $150 AND $300 PER CUBIC YARD, OR HIGH IF IT WAS GREATER THAN $300 PER CUBIC YARD.

Retained

Ellminated due to Low Effectiveness, Low Implementability or High Cost

[a] Low administrative implementability at the FSA due to access limitations related to its use as an operational range.

Figure 3-4

Evaluation of Technologies and Process Options

FUSRAP Feasibility Study

Iowa Army Ammunition Plant

Middletown, Iowa

APPENDIX A

SUPPLEMENTAL INVESTIGATION REPORT

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Attachment A-2* Yard G HMX Analytical Data
Attachment A-3* Firing Site 6 Area Chromium Data
Attachment A-4* Firing Site 6 Area DU Data
Attachment A-5* Firing Site 12 Area DU Data
Attachment A-6* Building 1-11 DU (Sediment and Water) Data
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Attachment A-8* HHRA Addendum: Evaluation of Chromium Risks in Firing Site 6 Area Soil Using Supplemental Investigation Data
Attachment A-9* Supplemental Streamlined ERA: Evaluation of HMX in Yards C and G Soil

BACK COVER

*CD-ROM Attachments A-1, A-2, A-3, A-4, A-5, A-6, A-7, A-8, A-9

A-1.0 INTRODUCTION

This Supplemental Investigation Report was developed as part of the FUSRAP to address AEC-related "releases or threats of releases of hazardous substances, pollutants or contaminants except for groundwater contamination" at selected areas of the IAAAP, near Middletown, Iowa (USEPA et al. 2006).

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 2008a) presented the characterization data and the BRA for soil and structures located at the FUSRAP areas. The RI Report described several soil areas that were determined to exhibit human health risk or ecological risk at levels that require additional evaluation. Those soil areas included the FSA, Yard C, and Yard G. Additionally, results of surface radiological surveys exceeded initial screening levels at Line 1 buildings. Limited additional investigations were, therefore, conducted in these areas. This Supplemental Investigation Report, included as an appendix to this FUSRAP FS Report, describes the additional fieldwork, findings, and associated evaluations related to the supplemental investigations. A supplemental sampling plan was submitted to USEPA Region VII for review in May 2009. The supplemental sampling plan utilized the methodologies presented in the *Remedial Investigation Work Plan for Line 1, Firing Sites Area, Yards C, G, and L, Warehouse 3-01 and the West Burn Pads Area South of the Road* (USACE 2007a), which contains the HHRA WP, Quality Assurance Project Plan, Data Management Program Plan, and Health and Safety Plan.

The supplemental investigations associated with the May 2009 sampling plan were conducted in April 2009. Results of these investigations, as well as pertinent results from previous investigations, are summarized in this report.

A-1.1 PURPOSE

This Supplemental Investigation Report incorporates and evaluates the results from the supplemental investigations conducted at Yard C, Yard G, FSA, and Line 1 buildings in April 2009. The results, when combined with previously obtained data, comprise a refined data set for risk analysis as well as evaluation of contaminant distribution. The specific purposes of the supplemental investigations in the selected areas are as follows:

Yard C: RI sampling showed that, although there were no exceedances of human health screening levels, one sample location (IAAP96889) exhibited an HMX concentration that had the effect of driving the Yard C ecological EPC to exceed the ecological CC for HMX. To better estimate the ecological risk to Indiana bats in Yard C, additional soil samples were obtained to accurately represent the presence of HMX in the area of IAAP96889.

Yard G: RI sampling showed that, although there were no exceedances of human health screening levels, one sample location (IAAP96872) exhibited an HMX concentration that had the effect of driving the Yard G ecological EPC to exceed the ecological CC for HMX. To better estimate the ecological risk to Indiana bats in Yard G, additional soil samples were obtained to accurately represent the presence of HMX in the area of IAAP96872.

Firing Site 6 Area: RI sampling showed that soil within portions of the Firing Site 6 Area contains chromium at levels that present a potential risk to a hypothetical site worker and construction worker. Additional grid-based soil samples were obtained to refine chromium-contaminated soil extent. In addition, RI sampling revealed two isolated locations where DU was located in the Firing Site 6 Area soil. Therefore, additional grid-based and biased soil samples were obtained to refine DU-contaminated soil extent.

Firing Site 12 Area: Supplemental investigation activities were conducted to gather additional data related to DU fragments present in soil at the Firing Site 12 Area. Specifically, several individual DU fragments and the adjacent soil were analyzed to determine the specific ratio of uranium isotopes contained within the fragment for potential use during risk and dose evaluations. In addition, the soil in the immediate area of each DU fragment was investigated and sampled to determine the extent to which oxidation of DU impacts the surrounding soil.

Line 1 Buildings: Radiological surveys conducted during the RI indicated that radiological activity exceeding RI screening levels was present in four buildings: 1-11, 1-63-6, 1-65-5, and 1-19-3. Initial RI data showed that an isolated area within Building 1-19-3 (638 dpm/100 cm^2) slightly exceeded the RI screening level of 600 dpm/100 cm^2. Subsequent development of a risk-based structural RG (23,000 dpm/100 cm^2), as presented in Section 3.2.3.1.2 of the FS, made additional investigation within Building 1-19-3 unnecessary. Surveys were conducted within the applicable buildings to gather additional data regarding volume of impacted structural material.

A-1.2 REPORT ORGANIZATION

Section A-1.0 describes the purpose and organization of this Supplemental Investigation Report.

Section A-2.0 summarizes the field activities conducted as part of the supplemental investigation.

Section A-3.0 presents an expanded discussion of the supplemental investigations and associated results for each of the FUSRAP areas investigated.

Section A-4.0 presents summaries of the supplemental human health and ecological risk evaluations associated with the data obtained during the supplemental investigation.

Attachment 1 presents the compiled data set for HMX at Yard C.

Attachment 2 presents the compiled data set for HMX at Yard G.

Attachment 3 presents the compiled data set for chromium at the Firing Site 6 Area.

Attachment 4 presents the compiled data set for DU at the Firing Site 6 Area.

Attachment 5 presents the compiled data set for DU at the Firing Site 12 Area.

Attachment 6 presents sediment and water data from the Line 1 Building 1-11 sump.

Attachment 7 presents radiological survey data for Line 1 buildings.

Attachment 8 presents an additional evaluation of human health risks from chromium at the Firing Site 6 Area.

Attachment 9 presents an additional evaluation of ecological risks from HMX in Yards C and G.

A-2.0 SUPPLEMENTAL INVESTIGATION ACTIVITIES

As previously stated, this Supplemental Investigation Report incorporates and evaluates the results from additional investigations at Yard C, Yard G, FSA, and Line 1 buildings completed in April 2009. The results, when combined with previously obtained data, comprise a refined data set for use in risk analysis as well as evaluation of contaminant distribution.

A-2.1 SUPPLEMENTAL INVESTIGATION FIELD ACTIVITIES SUMMARY

The following activities were conducted at the IAAAP during the supplemental sampling in April 2009:

- Collected and analyzed 11 surface and subsurface soil samples for HMX at Yard C.
- Collected and analyzed 11 surface and subsurface soil samples for HMX at Yard G.
- Collected and analyzed 42 surface and subsurface soil samples for chromium at the Firing Site 6 Area.
- Collected and analyzed 40 surface and subsurface soil samples for DU at the Firing Site 6 Area.
- Collected and analyzed 40 surface and subsurface soil samples for DU at the Firing Site 12 Area.
- Obtained fixed-point radiological readings in Buildings 1-11, 1-63-6, and 1-65-5 at Line 1.
- Collected and analyzed one water and one sediment sample for DU in the buildings at Line 1. (For the purposes of this Supplemental Investigation Report, sediment was considered to be soil-like material that is present in the sump area of Line 1 Building 1-11.)

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A-3.0 SUPPLEMENTAL INVESTIGATION ACTIVITIES AND RESULTS

This section presents the descriptions and results of supplemental investigation activities and where appropriate, provides initial comparisons of supplemental data against screening levels from the RI Report and/or RGs established in Section 3.2.3 of the FS.

A-3.1 YARD C

A-3.1.1 Summary of Field Activities

Previous RI sampling showed that one surface sample location (IAAP96889) exhibited an HMX concentration (94 mg/kg) that had the effect of elevating the Yard C ecological EPC above the HMX ecological CC (15.2 mg/kg). To better estimate the ecological risk to Indiana bats in Yard C due to HMX, as well to delineate horizontal and vertical extent of HMX around location IAAP96889, three additional soil locations, located in a triangular pattern approximately 30 ft from IAAP96889, were sampled at 0.5-ft intervals from the surface to a depth of 1.5 ft bgs. In addition, two subsurface soil samples were obtained at IAAP96889 at depths of 0.5 to 1.0 ft and 1.0 to 1.5 ft, respectively. Sample locations are shown on Figure A-1. In total, 11 additional soil samples were obtained from the area of IAAP96889.

A-3.1.2 Summary of Supplemental Sampling Results

Results of supplemental HMX sampling in the area of IAAP96889 are shown in Table A-1. None of the supplemental soil samples exhibited HMX results that exceed the ecological CC for HMX (15.2 mg/kg). A supplemental evaluation of the resulting ecological risk for Yard C is presented in Section A-4.2 of this Supplemental Investigation Report.

Table A-1. Yard C HMX Soil Sample Results from the Formerly Utilized Sites Remedial Action Program 2009 Supplemental Sampling

Sample Name	Sample Type	Depth (ft bgs)	HMX (mg/kg)
IAAP116572	Biased	0.5-1.0	0.73
IAAP116573	Biased	1.0-1.5	0.37
IAAP116574	Biased	0.0-0.5	0.34
IAAP116575	Biased	0.5-1.0	0.32
IAAP116576	Biased	1.0-1.5	0.31
IAAP116577	Biased	0.0-0.5	0.32
IAAP116577-1	Duplicate	0.0-0.5	0.32
IAAP116578	Biased	0.5-1.0	0.32
IAAP116579	Biased	1.0-1.5	0.32
IAAP116580	Biased	0.0-0.5	0.37
IAAP116581	Biased	0.5-1.0	0.33
IAAP116582	Biased	1.0-1.5	0.32

HMX ecological critical concentration = 15.2 mg/kg.

A-3.2 YARD G

A-3.2.1 Summary of Field Activities

Previous RI sampling showed that one surface sample location (IAAP96872) exhibited an HMX concentration (51 mg/kg) that had the effect of elevating the Yard G ecological EPC above the HMX ecological CC (15.2 mg/kg). To better estimate the ecological risk to Indiana bats in Yard G due to HMX, as well to delineate horizontal and vertical extent of HMX around location IAAP96872, three additional soil locations, located in a triangular pattern approximately 30 ft from IAAP96872, were sampled at 0.5-ft intervals from the surface to a depth of 1.5 ft bgs. In addition, two soil samples were obtained at IAAP96872 at depths of 0.5 to 1.0 ft and 1.0 to 1.5 ft, respectively. Sample locations are shown on Figure A-2. In total, 11 additional soil samples were obtained from the area of IAAP96872.

A-3.2.2 Summary of Supplemental Sampling Results

Results of supplemental HMX sampling in the area of IAAP96872 are shown in Table A-2. None of the supplemental soil samples exhibited HMX results that exceed the ecological CC for HMX (15.2 mg/kg). A supplemental evaluation of the resulting ecological risk for Yard G is presented in Section A-4.2 of this Supplemental Investigation Report.

Table A-2. Yard G HMX Soil Sample Results from the Formerly Utilized Sites Remedial Action Program 2009 Supplemental Sampling

Sample Name	Sample Type	Depth (ft bgs)	HMX (mg/kg)
IAAP116583	Biased	0.5-1.0	0.29
IAAP116584	Biased	1.0-1.5	0.3
IAAP116585	Biased	0.0-0.5	0.32
IAAP116586	Biased	0.5-1.0	0.29
IAAP116587	Biased	1.0-1.5	0.29
IAAP116588	Biased	0.0-0.5	0.27
IAAP116589	Biased	0.5-1.0	0.27
IAAP116590	Biased	1.0-1.5	0.28
IAAP116590-1	Duplicate	1.0-1.5	0.29
IAAP116591	Biased	0.0-0.5	0.36
IAAP116592	Biased	0.5-1.0	0.3
IAAP116593	Biased	1.0-1.5	0.3

HMX ecological critical concentration = 15.2 mg/kg.

A-3.3 FIRING SITE 6 AREA

A-3.3.1 Summary of Field Activities

A-3.3.1.1 Chromium Investigation

Previous RI sampling and risk analysis showed that soil within portions of the Firing Site 6 Area contains chromium at levels that present a risk to a hypothetical site worker and construction worker. Forty-four additional grid-based and biased soil samples were obtained to refine chromium-contaminated soil extent estimates. Sample locations are shown on Figure A-3.

A-3.3.1.2 Depleted Uranium Investigation

Previous RI sampling revealed two isolated locations (IAAP25004 and IAAP100176) where DU was located in the Firing Site 6 Area soil at concentrations greater than the DU RG of 150 pCi/g. Additional grid-based and biased surface and subsurface soil samples were obtained to refine estimates of DU-contaminated soil extent. A total of 40 samples were collected from 8 locations during the supplemental investigation. All RI and supplemental sample locations are shown on Figure A-3.

A-3.3.2 Summary of Sampling Results

A-3.3.2.1 Chromium Results

The results of the soil samples analyzed for chromium are summarized in Table A-3. A supplemental human health risk evaluation that incorporates the supplemental chromium data is presented in Section A-4.3 of this Supplemental Investigation Report.

Table A-3. Firing Site 6 Area Chromium Soil Sample Results from the Formerly Utilized Sites Remedial Action Program 2009 Supplemental Sampling

Sample Name	Sample Type	Depth (ft bgs)	Chromium (mg/kg)
IAAP116507	Systematic	0.0-0.5	1,220
IAAP116508	Systematic	0.5-1.0	16.6
IAAP116509	Systematic	1.0-1.5	16.2
IAAP116510	Systematic	0.0-0.5	1,700
IAAP116511	Systematic	0.5-1.0	35.6
IAAP116512	Systematic	1.0-1.5	27.1
IAAP116513	Systematic	0.0-0.5	798
IAAP116514	Systematic	0.5-1.0	18.5
IAAP116515	Systematic	1.0-1.5	12.3
IAAP116516	Systematic	0.0-0.5	23.3
IAAP116517	Systematic	0.5-1.0	13.9
IAAP116518	Systematic	1.0-1.5	16.5
IAAP116519	Systematic	0.0-0.5	3,760
IAAP116520	Systematic	0.5-1.0	324
IAAP116521	Systematic	1.0-1.5	118
IAAP116522	Systematic	0.0-0.5	382
IAAP116523	Systematic	0.5-1.0	19.1
IAAP116524	Systematic	1.0-1.5	5.6
IAAP116525	Systematic	0.0-0.5	51.6
IAAP116526	Systematic	0.5-1.0	45.3
IAAP116527	Systematic	1.0-1.5	21.6
IAAP116528	Systematic	0.0-0.5	59.8
IAAP116529	Systematic	0.5-1.0	47.9
IAAP116530	Systematic	1.0-1.5	22.3
IAAP116531	Systematic	0.0-0.5	44.4

Table A-3. Firing Site 6 Area Chromium Soil Sample Results from the Formerly Utilized Sites Remedial Action Program 2009 Supplemental Sampling (Continued)

Sample Name	Sample Type	Depth (ft bgs)	Chromium (mg/kg)
IAAP116532	Systematic	0.5-1.0	673
IAAP116533	Systematic	1.0-1.5	23
IAAP116533-1	Duplicate	1.0-1.5	12.8
IAAP116534	Systematic	0.0-0.5	2,850
IAAP116535	Systematic	0.5-1.0	8.8
IAAP116536	Systematic	1.0-1.5	12.2
IAAP116537	Systematic	0.0-0.5	337
IAAP116538	Systematic	0.5-1.0	24.3
IAAP116539	Systematic	1.0-1.5	5.3
IAAP116540	Systematic	0.0-0.5	8.1
IAAP116541	Systematic	0.5-1.0	17.7
IAAP116542	Systematic	1.0-1.5	17.8
IAAP116542-1	Duplicate	1.0-1.5	20
IAAP116543	Biased	0.0-0.5	85.8
IAAP116544	Biased	0.5-1.0	27.9
IAAP116545	Biased	1.0-1.5	19.6
IAAP116546	Biased	0.0-0.5	86.3
IAAP116547	Biased	0.5-1.0	7.3
IAAP116548	Biased	1.0-1.5	14.6

Chromium remediation goal = 465 mg/kg.

A-3.3.2.2 Depleted Uranium Results

The analytical results of supplemental soil samples collected from this area are summarized in Table A-4. IAAP116615 through IAAP116617 and IAAP116648 through IAAP116650 were collected beneath samples IAAP25004 and IAAP100176, respectively. The remaining samples were collected on a grid pattern to further define the lateral and vertical extent of DU at the Firing Site 6 Area as shown on Figure A-4. None of the supplemental samples collected for DU at the Firing Site 6 Area exhibited DU concentrations above the RI screening level of 56 pCi/g. Figure A-3 shows the comparisons of all RI and supplemental soil sampling results with the DU soil RG (150 pCi/g) derived in the FS Report. Figure A-3 shows that exceedances of the DU RG occur at two RI locations (IAAP100176 and IAAP25004).

Table A-4. Firing Site 6 Area Depleted Uranium Soil Sample Results from the Formerly Utilized Sites Remedial Action Program 2009 Supplemental Sampling

Sample ID	Sample Type	Depth (ft bgs)	Uranium-234 (pCi/g)	Uranium-235 (pCi/g)	Uranium-238 (pCi/g)
IAAP116611	Systematic	0.0-0.5	0.46	0.00	0.65
IAAP116612	Systematic	0.5-1.0	0.50	0.00	0.95
IAAP116613	Systematic	1.0-1.5	0.60	0.00	0.77
IAAP116614	Systematic	1.5-2.0	0.67	0.07	1.03
IAAP116615	Biased	0.5-1.0	0.76	0.00	0.63

Table A-4. Firing Site 6 Area Depleted Uranium Soil Sample Results from the Formerly Utilized Sites Remedial Action Program 2009 Supplemental Sampling (Continued)

Sample ID	Sample Type	Depth (ft bgs)	Uranium-234 (pCi/g)	Uranium-235 (pCi/g)	Uranium-238 (pCi/g)
IAAP116616	Biased	1.0-1.5	0.78	0.00	0.84
IAAP116617	Biased	1.5-2.0	0.88	0.05	0.88
IAAP116618	Systematic	0.0-0.5	0.19	0.00	0.41
IAAP116619	Systematic	0.5-1.0	0.28	0.00	0.99
IAAP116620	Systematic	1.0-1.5	0.58	0.16	4.34
IAAP116621	Systematic	1.5-2.0	5.54	0.64	41.86
IAAP116622	Systematic	2.0-2.5	1.74	0.15	11.15
IAAP116623	Systematic	2.5-3.0	1.65	0.08	7.45
IAAP116624	Systematic	0.0-0.5	0.67	0.06	0.52
IAAP116624-1	Duplicate	0.0-0.5	1.51	0.10	1.04
IAAP116625	Systematic	0.5-1.0	0.54	0.15	0.71
IAAP116626	Systematic	1.0-1.5	0.75	0.00	0.68
IAAP116627	Systematic	1.5-2.0	0.38	0.05	1.06
IAAP116628	Systematic	0.0-0.5	1.04	0.07	1.09
IAAP116629	Systematic	0.5-1.0	0.62	0.23	1.05
IAAP116630	Systematic	1.0-1.5	1.09	0.24	1.19
IAAP116631	Systematic	1.5-2.0	0.95	-0.02	1.42
IAAP116632	Systematic	0.0-0.5	0.45	0.00	1.06
IAAP116633	Systematic	0.5-1.0	0.92	0.07	1.31
IAAP116634	Systematic	1.0-1.5	1.03	0.08	1.57
IAAP116634-1	Duplicate	1.0-1.5	1.01	0.13	1.12
IAAP116635	Systematic	1.5-2.0	1.13	0.07	1.47
IAAP116636	Systematic	0.0-0.5	0.54	0.06	0.62
IAAP116637	Systematic	0.5-1.0	0.77	0.00	0.93
IAAP116638	Systematic	1.0-1.5	0.96	-0.02	0.70
IAAP116639	Systematic	1.5-2.0	0.80	0.00	1.18
IAAP116640	Systematic	0.0-0.5	0.62	0.00	1.18
IAAP116641	Systematic	0.5-1.0	0.92	0.00	1.20
IAAP116642	Systematic	1.0-1.5	0.83	-0.01	0.96
IAAP116647	Systematic	1.5-2.0	0.91	0.00	0.92
IAAP116648	Biased	0.5-1.0	0.92	0.12	1.07
IAAP116649	Biased	1.0-1.5	1.29	0.00	1.06
IAAP116650	Biased	1.5-2.0	1.40	0.09	0.91
IAAP116651	Systematic	0.0-0.5	0.49	0.00	1.21
IAAP116652	Systematic	0.5-1.0	1.53	0.07	1.25
IAAP116653	Systematic	1.0-1.5	0.82	0.12	0.82
IAAP116654	Systematic	1.5-2.0	0.86	0.00	0.84

DU soil remediation goal = 150 pCi/g.

A-3.4 FIRING SITE 12 AREA

A-3.4.1 Summary of Field Activities

In accordance with the supplemental sampling plan, selected DU fragments and soil at the Firing Site 12 Area were evaluated to provide additional data for use in risk evaluation and estimation of DU extent. Previously conducted GWS data obtained during the RI were used to identify probable locations of DU fragments based on discrete areas of elevated radioactivity. DU fragments were then field-located utilizing geographic information from the GWS as well as gamma radiation detecting field instruments. DU fragments and soil below each fragment were investigated at eight locations across the Firing Site 12 Area. At each location, the DU fragment was visually located and set aside for possible subsequent analysis. The soil immediately around and beneath the former location of the fragment was sampled in 0.5-ft intervals and scanned for radioactivity using a Ludlum 44-9 meter. Collection of soil samples continued in 0.5-ft intervals until radiation readings indicated that sample radioactivity was approaching background levels. A total of 35 soil samples were obtained from the 8 locations. Depths of soil samples ranged from surface (0.0 to 0.5 ft) to subsurface (as deep as 3.5 ft). At locations where the DU fragments were small enough to fit within a standard soil sampling container (five locations), the actual DU fragment was also collected for laboratory analysis. All RI and supplemental investigation sampling locations are shown on Figure A-5.

A-3.4.2 Summary of Sampling Results

The analytical results of the supplemental Firing Site 12 Area DU fragment investigation are shown in Table A-5. Most supplemental samples collected for DU at the Firing Site 12 Area exhibited DU concentrations above the RI screening level of 56 pCi/g, with a majority of those sample results also exceeding the DU RG of 150 pCi/g. Figure A-3 shows the comparisons of all RI and supplemental soil sampling results with the DU soil RG (150 pCi/g) derived in the FS Report. Results of the RI and supplemental investigations show that DU fragments at Firing Site 12 vary widely in size; the largest fragment identified in this investigation was approximately 2 by 4 by 8 inches. In addition, soil sampling beneath DU fragments indicates that DU fragment oxidation does not appear to have radiologically impacted soil beyond approximately 2.0 ft beneath the DU fragment.

Table A-5. Firing Site 12 Area Depleted Uranium Soil Sample Results from the Formerly Utilized Sites Remedial Action Program 2009 Supplemental Sampling

Sample ID	Sample Type	Depth (ft bgs)	Uranium-234 (pCi/g)	Uranium-235 (pCi/g)	Uranium-238 (pCi/g)
IAAP116655	Biased	0.0-0.5	[b]	555	22,290
IAAP116656	Biased	0.5-1.0	[b]	37.6	2,645
IAAP116657	Biased	1.0-1.5	[b]	6.79	451
IAAP116658	Biased	1.5-2.0	[b]	9.41	627
IAAP116659	Biased	2.0-2.5	17.5	2.4	99.9
IAAP116660	Biased	2.5-3.0	10	1.31	52.8
IAAP116661	Biased	3.0-3.5	22.3	1.95	152
IAAP116662[a]	Biased	--	[b]	735	34,120
IAAP116663	Biased	0.0-0.5	[b]	9.44	711
IAAP116664	Biased	0.5-1.0	1.32	0	1.24

Table A-5. Firing Site 12 Area Depleted Uranium Soil Sample Results from the Formerly Utilized Sites Remedial Action Program 2009 Supplemental Sampling (Continued)

Sample ID	Sample Type	Depth (ft bgs)	Uranium-234 (pCi/g)	Uranium-235 (pCi/g)	Uranium-238 (pCi/g)
IAAP116665[a]	Biased	--	[b]	57.7	3,162
IAAP116666	Biased	0.0-0.5	[b]	185	8,828
IAAP116667	Biased	0.5-1.0	9.48	1.6	59.7
IAAP116668	Biased	1.0-1.5	12.5	1.71	88.8
IAAP116669	Biased	1.5-2.0	8	0.905	50.2
IAAP116670	Biased	0.0-0.5	[b]	354	14,160
IAAP116671	Biased	0.5-1.0	[b]	91.7	5,252
IAAP116672	Biased	1.0-1.5	[b]	25.6	1,814
IAAP116673	Biased	1.5-2.0	[b]	8.72	584
IAAP116674	Biased	2.0-2.5	4.23	0.589	27.6
IAAP116675	Biased	0.0-0.5	[b]	282	12,460
IAAP116676	Biased	0.5-1.0	[b]	86.3	4,818
IAAP116677	Biased	1.0-1.5	[b]	8.53	589
IAAP116678	Biased	1.5-2.0	15.1	1.53	93
IAAP116679[a]	Biased	--	[b]	54.2	3,210
IAAP116680	Biased	0.0-0.5	[b]	234	11,860
IAAP116681	Biased	0.5-1.0	[b]	3.71	246
IAAP116682	Biased	1.0-1.5	8.37	0.875	53.7
IAAP116683[a]	Biased	--	[b]	74	3,680
IAAP116684	Biased	0.0-0.5	[b]	208	11,030
IAAP116685	Biased	0.5-1.0	[b]	67.6	3,986
IAAP116686	Biased	1.0-1.5	25	2.94	146
IAAP116687	Biased	1.5-2.0	9.88	0.932	59.8
IAAP116688	Biased	2.0-2.5	3.67	0.138	23.3
IAAP116689[a]	Biased	--	[b]	50.5	3,844
IAAP116690	Biased	0.0-0.5	[b]	407	21,860
IAAP116691	Biased	0.5-1.0	[b]	9.3	778
IAAP116692	Biased	1.0-1.5	27.7	3.55	266
IAAP116693	Biased	1.5-2.0	15.7	2.83	142
IAAP116694	Biased	2.0-2.5	4.65	0.473	35.4

[a] DU fragment found at or near surface of soil.
[b] Not analyzed for.
RI soil screening level for DU = 56 pCi/g.
DU soil remediation goal = 150 pCi/g.

A-3.5 LINE 1 BUILDINGS

A-3.5.1 Summary of Field Activities

During the RI, radiological (DU) building surveys were conducted within 41 Line 1 buildings. Surveys indicated that small portions of four of those buildings (1-11, 1-63-6, 1-65-5, and 1-19-3) exhibited discrete areas of radiation that exceeded the conservative RI screening levels of 600 and 6,000 dpm/100 cm^2 for alpha and beta activity, respectively. It should be noted that

portions of three other surveyed buildings (1-65-6, 1-100-2, and 1-65-4) also exhibited discrete measurements that exceeded RI screening levels; however, the elevated measurements in these three buildings were directly attributable to current U.S. Army usage or storage of radioactive materials and, therefore, additional FUSRAP investigation in these areas is not warranted. Subsequent development of a risk-based structural DU RG, as presented in Section 3.2.3.3 of the FS, resulted in an RG of 23,000 dpm/100 cm^2 total activity.

In April 2009, additional radiological surveys were conducted within Buildings 1-11, 1-63-6, and 1-65-5 to further investigate the previously found elevated activity. In Building 1-11, additional surveys were mainly performed on and around the metal grate that covers the sump in the northwest portion of the building. Previous surveys had indicated the presence of elevated radiological activity on the grate. In Building 1-63-6, additional investigation included supplemental surveys of the air filters in the cell area that exhibited elevated radiological activity during original RI survey efforts.

In addition, a water sample and a sediment sample were obtained from the contents of the sump beneath the metal grate in the northwest portion of Building 1-11. These samples were analyzed for isotopic uranium.

A-3.5.2 Summary of Sampling Results

Table A-6 summarizes the results of supplemental radiological measurements within the surveyed Line 1 buildings. Additional survey information is presented in Attachments A-7-1 and A-7-2. Discrete areas within Buildings 1-11 and 1-63-6 exhibited radiological activity at levels that exceed the structural RG for DU of 23,000 dpm/100 cm^2.

Table A-6. Line 1 Building Survey Results from the Formerly Utilized Sites Remedial Action Program Remedial Investigation and Remedial Investigation Supplemental Sampling

Sample Location	Survey Number	Survey Point	Total Alpha and Beta[a] (dpm/100 cm^2)
1-65-5 drain near double doors	1-25-2	1	1,637
1-65-5 single door on floor	1-25-2	2	442
1-65-5 right floor middle by drain	1-25-2	3	448
1-65-5 floor 2.5 ft from drain	1-25-2	4	13,954
1-65-5 floor 8 ft from drain	CC04272009-01	1	43
1-65-5 floor 4 ft from drain	CC04272009-01	2	53
1-65-5 floor 6 ft from drain	CC04272009-01	3	9
1-65-5 floor 9 ft from drain	CC04272009-01	4	9
1-65-5 floor 12 ft from drain	CC04272009-01	5	0
1-65-5 floor 10 ft from drain	CC04272009-01	6	43
1-65-5 floor 6 ft from drain	CC04272009-01	7	167
1-65-5 floor 3 ft from drain	CC04272009-01	8	9
1-65-5 floor 2 ft from drain	CC04272009-01	9	35
1-65-5 floor 1ft from drain	CC04272009-01	10	0
1-63-6 air vent filter in large circular room	6-06-02	1	12,393
1-63-6 concrete floor in large circular room where old equipment would have been	6-06-02	2	1,284

Table A-6. Line 1 Building Survey Results from the Formerly Utilized Sites Remedial Action Program Remedial Investigation and Remedial Investigation Supplemental Sampling (Continued)

Sample Location	Survey Number	Survey Point	Total Alpha and Beta[a] (dpm/100 cm^2)
1-63-6 on floor at entrance to circular room	6-06-02	3	796
1-63-6 floor of storage area	6-06-02	4	937
1-63-6 floor of entrance way	6-06-02	5	1,481
1-63-6 floor in manway	CC04272009-01	1	369
1-63-6 floor in room C	CC04272009-01	2	102
1-63-6 floor grate	CC04272009-01	3	0
1-63-6 Sump lid	CC04272009-01	4	0
1-63-6 floor in round room	CC04272009-01	5	123
1-63-6 floor mechanical room	CC04272009-01	6	198
1-63-6 north side of air filter	CC04272009-01	NA	25,566
1-63-6 west side of air filter	CC04272009-01	NA	11,920
1-63-6 east side of air filter	CC04272009-01	NA	18,743
1-63-6 south side of air filter	CC04272009-01	NA	11,920
1-11 on steel grate above pit	6-06-03	1	76,037
1-11 on concrete floor below sample number1	6-06-03	2	3,681
1-11 on steel grate	6-06-03	3	53,798
1-11 on floor (ORISE fixed point 2 location)	6-06-03	4	1,782
On seam 3 ft from wall	6-06-03	5	8,992
1-11 grate	CC04272009-02	1	4,653
1-11 grate	CC04272009-02	2	7,718
1-11 grate	CC04272009-02	3	16,532
1-11 grate	CC04272009-02	4	6,941
1-11 grate	CC04272009-02	5	6,687
1-11 grate	CC04272009-02	6	17,685
1-11 grate	CC04272009-02	7	3,466
1-11 grate	CC04272009-02	8	31,882
1-11 grate	CC04272009-02	9	2,363
1-11 grate	CC04272009-02	10	1,801
1-11 grate	CC04272009-02	11	337
1-11 grate	CC04272009-02	12	68
1-11 grate	CC04272009-02	13	1,591
1-11 grate	CC04272009-02	14	846
1-11 grate	CC04272009-02	15	3,487
1-11 grate	CC04272009-02	16	396
1-11 grate	CC04272009-02	17	0
1-11 grate	CC04272009-02	18	2,721
1-11 grate	CC04272009-02	19	9

Table A-6. Line 1 Building Survey Results from the Formerly Utilized Sites Remedial Action Program Remedial Investigation and Remedial Investigation Supplemental Sampling (Continued)

Sample Location	Survey Number	Survey Point	Total Alpha and Beta[a] (dpm/100 cm^2)
1-11 grate	CC04272009-02	20	20
1-11 grate	CC04272009-02	21	3
1-11 grate	CC04272009-02	22	3
1-11 grate	CC04272009-02	23	11
1-11 grate	CC04272009-02	24	11
1-11 grate	CC04272009-02	25	0
1-11 grate	CC04272009-02	26	3
1-11 grate	CC04272009-02	27	159
1-11 grate	CC04272009-02	28	11
1-11 grate	CC04272009-02	29	3
1-11 grate	CC04272009-02	30	20
1-11 grate	CC04272009-02	31	11
1-11 grate	CC04272009-02	32	0
1-11 grate	CC04272009-02	33	0
1-11 grate	CC04272009-02	34	11
1-11 grate	CC04272009-02	35	3
1-11 grate	CC04272009-02	36	0
1-11 grate	CC04272009-02	37	37
1-11 grate	CC04272009-02	38	20
1-11 grate	CC04272009-02	39	11
1-11 concrete next to grate	CC04272009-02	40	1,433
1-11 concrete next to grate	CC04272009-02	41	3,626
1-11 2.5 ft from grate in crack	CC04272009-02	42	7,470
1-11 12 ft from grate in crack	CC04272009-02	43	16,731
11-1 2.5 ft from grate	CC04272009-02	44	700
11-1 4 ft from grate	CC04272009-02	45	606
11-1 12 ft from grate	CC04272009-02	46	878
11-1 floor outside grate room	CC04272009-02	47	408
11-1 floor outside grate room	CC04272009-02	48	285
1-11 next to interior center building	CC04272009-02	49	307
1-11 off the corner of interior center building	CC04272009-02	50	350
1-11 next to exterior door	CC04272009-02	51	194
11-1 off corner of interior building	CC04272009-02	52	489
11-1 in front of interior building	CC04272009-02	53	226
11-1 off front corner of interior building	CC04272009-02	54	239
11-1 between interior building and loading docks	CC04272009-02	55	141
1-11 inside interior building	CC04272009-02	56	137

Table A-6. Line 1 Building Survey Results from the Formerly Utilized Sites Remedial Action Program Remedial Investigation and Remedial Investigation Supplemental Sampling (Continued)

Sample Location	Survey Number	Survey Point	Total Alpha and Beta[a] (dpm/100 cm^2)
11-1 next to loading dock	CC04272009-02	57	3,452
11-1 next to loading dock	CC04272009-02	58	639
11-1 next to loading dock	CC04272009-02	59	298
11-1 next to loading dock	CC04272009-02	60	76
11-1 next to loading dock	CC04272009-02	61	355
1-11 south raised dock floor	10/26-1	1	97
1-11 north end railroad track	10/26-1	2	187

[a] Surface remediation goal for total gross alpha and gross beta = 23,000 dpm/100 cm^2.

In Building 1-11, a limited portion of the metal grate that covers the sump in the northwest portion of the building exhibited survey readings as high as 75,895 dpm/100 cm^2. Radiological readings in exceedance of the structural DU RG were isolated to one section of the metal grate.

DU sample results for the sediment sample obtained from the contents of the sump in the northwest portion of Building 1-11 are presented in Table A-7. Sample results show that DU does not exceed the soil RG of 150 pCi/g in the sump sediment.

Table A-7. Line 1 Building 1-11 Sump Sediment Sample

Sample ID	Uranium-234 (pCi/g)	Uranium-235 (pCi/g)	Uranium-238 (pCi/g)
IAAP117014	2.36	0.24	10.66

DU sample results for the water sample obtained from the contents of the sump in the northwest portion of Building 1-11 are presented in Table A-8. Sample results show that DU concentrations are not elevated in the sump water.

Table A-8. Line 1 Building 1-11 Sump Water Sample

Sample ID	Uranium-234 (pCi/L)	Uranium-235 (pCi/L)	Uranium-238 (pCi/L)
IAAP117015	1.36	0.19	2.26

In Building 1-63-6, radiological readings exceeding the structural DU RG were observed on air filter material within the cell area. Specifically, readings on air filter material on the north side of the air handling unit averaged approximately 26,000 dpm/100 cm^2. Surveys of other portions of Building 1-63-6 did not identify areas of significantly elevated radioactivity.

A-3.6 SUMMARY OF SUPPLEMENTAL INVESTIGATION

- **Yard C:** Additional HMX samples were obtained from soil in the area of sample location IAAP96889 to delineate the HMX extent to better estimate the ecological HMX risk to Indiana bats that may visit Yard C. The associated risk evaluation that incorporates these additional sample results is presented in Section A-4.2 of this Supplemental Investigation Report.

- **Yard G:** Additional HMX samples were obtained from soil in the area of sample location IAAP96872 to delineate the HMX extent to better estimate the ecological HMX risk to Indiana bats that may visit Yard G. The associated risk evaluation that incorporates these additional sample results is presented in Section A-4.2 of this Supplemental Investigation Report.
- **Firing Site 6 Area:** Additional chromium samples were obtained to refine delineation of chromium-contaminated soil. Also, additional DU samples were collected to refine DU-contaminated soil estimates. Analysis of soil samples for DU collected during the supplemental investigation showed that none of the grid-based or biased sampling locations exhibit concentrations of DU above the RI screening level or RG at the Firing Site 6 Area.
- **Firing Site 12 Area:** Fragments of DU and the surrounding soil were investigated at eight locations across Firing Site 12. Information generated during this investigation was used during the FS to assist with remedial volume estimation and remedial technology selection. Analysis of soil samples associated with the DU fragments indicates that oxidation of DU does not appear to impact soil beneath the fragments to depths greater than approximately 2 ft beneath the fragment.
- **Line 1 Buildings:** Supplemental radiological surveys were performed within buildings where previous surveys indicated the presence of radioactivity near or above the radiological RG for structures. The surveys indicated that discrete portions of Buildings 1-11 and 1-63-6 exceed the structural DU RG.

A-4.0 SUPPLEMENTAL RISK EVALUATIONS

Upon review of the supplemental data for chromium and HMX, which were identified as human health and ecological COCs, respectively, in the BRA (USACE 2008a), it was observed that the concentrations were lower than those that were reported during the RI. Therefore, human health risks that could result from site worker and construction worker exposures to chromium in the Firing Sites 6 Area soil, as well as ecological risks that could result from the Indiana bat ingesting insects that are assumed to be impacted by HMX from Yards C and G soil, have been re-evaluated in this Supplemental Investigation Report. The re-evaluations have been conducted using both the RI and supplemental data combined. The purpose of these re-evaluations of risk is to confirm the human health COC status of chromium in the Firing Site 6 Area soil and the ecological COC status of HMX in Yards C and G soil in light of the lower concentrations detected during the Supplemental Investigation.

It should be noted that the results of the Radiological Risk and Dose Assessment of the FSA that was conducted during the RI have not been quantitatively re-evaluated using the Supplemental Investigation data for DU because the results were sufficiently elevated such that the risk and dose outcomes are not expected to change. Additional evaluations of DU will be conducted during a Final Status Survey of the FSA.

A-4.1 QUALITATIVE RISK AND DOSE EVALUATION OF DEPLETED URANIUM FRAGMENTS

Radiological risk and dose calculations for DU isotopes in soil are presented in the RI Report in accordance with the RI Work Plan. The maximum soil EPCs of DU isotopes at the FSA (i.e., U-238 = 622.58 pCi/g, U-234 = 211.23 pCi/g, and U-235 = 5.65 pCi/g) exceeded USEPA dose and risk criteria, as presented in Table 2-3. The soil exposure pathways evaluated for both receptors included incidental ingestion, inhalation of dusts, and external radiation.

A notable quantity of DU fragments is present at the FSA for which a quantitative risk and dose evaluation of DU fragments had not been conducted previously. This primarily was not conducted because of the large number of technical/statistical assumptions that would be needed for defining the DU fragments as either a single source or multiple sources, as well as for determining worker exposures. To provide some assessment of the potential risks associated with the DU fragments, a qualitative evaluation was conducted.

For evaluations of DU fragments scattered throughout the FSA, conservative estimates of the EPC would likely assume that receptors are exposed to fragments conceptualized as one collective area source rather than as numerous individual sources (fragments). Additionally, the EPC would incorporate assumptions regarding the known activity concentration of DU (the widely accepted approximation is 360,000 pCi/g), the mass of DU at the FSA (approximately 4,000 kg), and the area and depth of the contaminated zone. The only potentially complete pathway for the evaluation of DU fragments would be external radiation, as ingestion and inhalation of DU present as a single area source would not be applicable.

Based on a qualitative analysis of risk from DU fragments at the FSA

- It is possible that when considering external radiation as the only complete pathway for DU fragments (versus the three complete pathways for soil), the risk and dose associated with DU fragments may potentially be higher than the risk and dose already calculated for DU isotopes in soil, which exceed USEPA and DOE target criteria.

- Residual soil concentrations that would remain after removal of the DU fragments and the underlying/surrounding soil will not exceed the RG calculated for DU isotopes in soil.

Whether or not the risk and/or dose that would be quantitatively estimated for DU fragments exceed USEPA and DOE target criteria (per the first bullet), the FS evaluation of remedial alternatives already assumes that DU fragments must be removed from FUSRAP area soil for protection of human health and the environment.

A-4.2 SUPPLEMENTAL ECOLOGICAL RISK EVALUATIONS OF HMX IN YARDS C AND G

The Streamlined ERA that was conducted as part of the FUSRAP RI (USACE 2008a) determined that the potential for risk exists for the Indiana bat at Yards C and G due to the presence of HMX concentrations in soil that exceed the ecological CC (15.2 mg/kg).

The exceedances of the HMX ecological CC (15.2 mg/kg) observed in Yards C and G were each driven by a single surface soil sample. In Yard C, the single sample exceedance of the HMX CC occurred at location IAAP96889 (0 – 0.5 ft depth) (Figure A-1). In Yard G, the single sample exceedance of the HMX CC occurred at location IAAP96872 (0 – 0.5 ft depth) (Figure A-2). To delineate these elevated HMX concentrations, eleven samples were collected from four locations around and beneath each elevated location in Yard C and Yard G during the Supplemental Investigation. The analytical results of these additional samples show that the four supplemental investigation locations surrounding each of the RI locations have successfully delineated the lateral and vertical extent of HMX in those areas. To conduct the supplemental ecological risk evaluations of HMX in Yards C and G, the mean concentration for each elevated location was determined by averaging the RI and Supplemental Investigation data for those locations. The resulting mean HMX concentration for each Yard was then used to determine revised HMX EPCs for Yards C and G. Table A-9 shows that incorporation of the Supplemental Investigation data for HMX results in reduced EPCs for Yards C and G that are now less than the HMX CC.

Table A-9. Summary of Ecological Evaluation Results for HMX in Yards C and G

Site	Eco CC (mg/kg)	Streamlined ERA[a]		Supplemental Streamlined ERA[b]	
		EPC (mg/kg)	EPC/CC Ratio	EPC (mg/kg)	EPC/CC Ratio
Yard C HMX	15.2	42.99	**2.83**	1.93	0.127
Yard G HMX	15.2	46.55	**3.06**	3.96	0.261

[a] EPCs were calculated using only the RI data for HMX and were presented in the BRA (USACE 2008a).
[b] EPCs were calculated using the combined RI and Supplemental Investigation data for HMX.
Bold ratios indicate that the EPC is greater than the CC.

Therefore, based on this re-evaluation of HMX, Yards C and G do not pose potential risks to the Indiana bat and HMX is no longer retained as an ecological COC for those areas. The spreadsheets showing EPC and EPC/CC ratio calculations for HMX in Yards C and G, using both the RI and Supplemental Investigation data, are presented in Attachment 9 to this appendix.

A-4.3 SUPPLEMENTAL HUMAN HEALTH RISK EVALUATIONS OF CHROMIUM AT THE FIRING SITES 6 AREA

During the HHRA conducted as part of the FUSRAP RI (USACE 2008a), chromium was identified as a COPC and was quantitatively evaluated for carcinogenic and non-carcinogenic risk to the site worker and construction worker that could result for soil exposures in the Firing Site 6 Area. Table A-10 shows that an EPC of 3,106 mg/kg calculated using the RI data resulted in cancer risks of 2.2×10^{-6} and 8.9×10^{-8} to the site worker and construction worker, respectively, in the HHRA (USACE 2008a). The cancer risk for the site worker exceeded the lower limit of USEPA's target risk range (1.0×10^{-6}). Additionally, the EPC of 3,106 mg/kg also resulted in non-carcinogenic HQs of 1.4 and 5.8 to the site worker and construction worker, respectively, in the HHRA (USACE 2008a). Both HQs exceeded USEPA's benchmark value of 1.0. Based on these risk results, chromium was retained as a soil COC for the Firing Site 6 Area.

Table A-10. Human Health Risk Summary for Chromium in Firing Site 6 Area Soil

Chromium	EPC (mg/kg)	Current and Future Site Worker		Future Construction Worker	
		Carcinogenic Risk	Non-carcinogenic HQ	Carcinogenic Risk	Non-carcinogenic HQ
HHRA[a]	3,106	**2.2×10^{-6}**	1.4	8.9×10^{-8}	**5.8**
Supplemental HHRA[b]	1,187	8.5×10^{-7}	0.5	3.4×10^{-8}	**2.2**

[a] EPC, carcinogenic risks, and non-carcinogenic HQs were calculated using only the RI data for chromium and were presented in the BRA (USACE 2008a).

[b] EPC, carcinogenic risks, and non-carcinogenic HQs were calculated using the combined RI and Supplemental Investigation data for chromium.

Bold indicates carcinogenic risk or non-carcinogenic HQ exceeds USEPA target criteria of 1.0E-06 or 1.0.

Table A-10 also shows that a reduced soil EPC of 1,187 mg/kg has been calculated for chromium in the Firing Site 6 Area using both the RI and Supplemental Investigation data. This EPC resulted in only the HQ for the construction worker (2.2) exceeding USEPA's benchmark value (1.0). The cancer risks for both the site worker and construction worker are less than the lower limit of USEPA's target risk range. The spreadsheets showing the supplemental EPC and risk calculations for chromium are presented in Attachment 8 to this appendix.

Although a slightly elevated HQ (i.e., above USEPA's target value of 1.0) has been estimated for construction worker exposures to chromium in the Firing Site 6 Area, no soil RG has been calculated for this metal. This is because the FSA (including the Firing Site 6 Area) is an operational range and metals contamination within the operational area is not included in the scope of the scope of the FUSRAP FS, which is consistent with the 2006 Dispute Resolution Agreement between the U.S. Army and USEPA (U.S. Army 2006), as previously discussed in the FS Report.

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APPENDIX A

FIGURES

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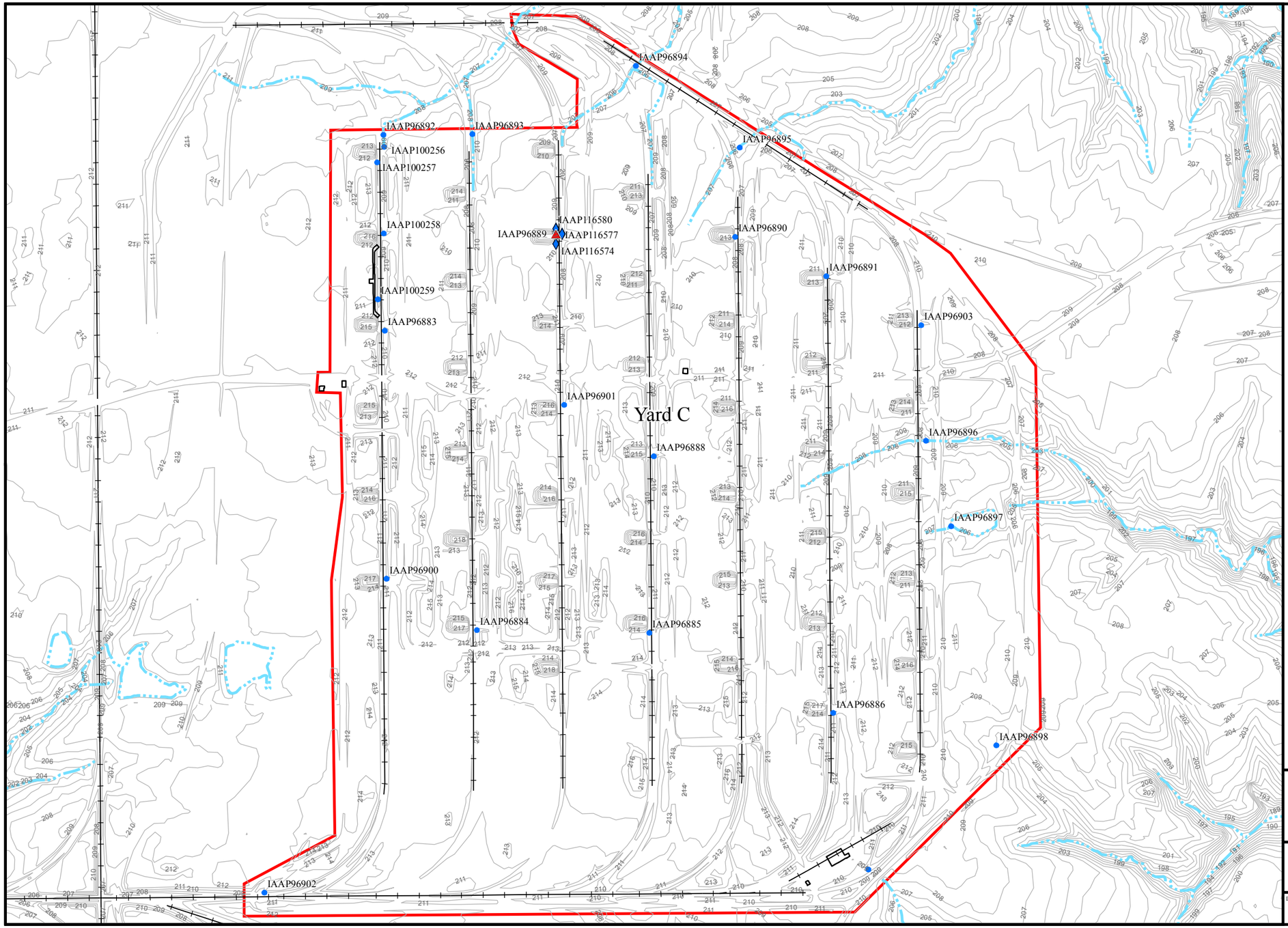


LEGEND:

- HMX Sample Locations with Results > 15.2 mg/kg
- Supplemental Sample Location HMX Sample Locations with Results < 15.2 mg/kg
- HMX Sample Locations with Results < 15.2 mg/kg
- Yard C Survey Boundary
- Topographic Contours
- Stream
- Surface Feature
- Railroad

N
W E
S

Iowa-South State Plane
(NAD 83, Meters)

0 90 180 Meters

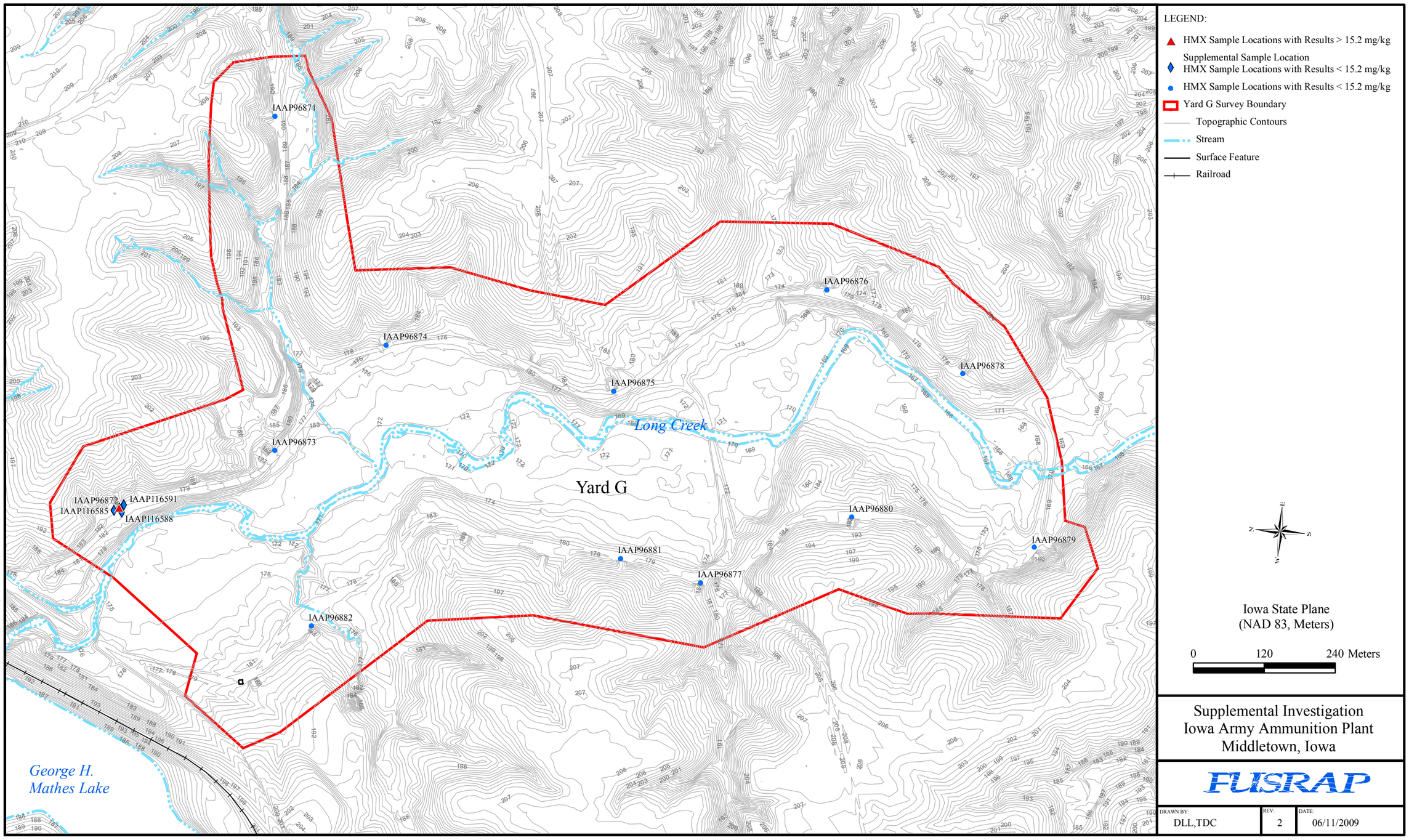
Supplemental Investigation
Iowa Army Ammunition Plant
Middletown, Iowa

FUSRAP

DRAWN BY:	REV:	DATE:
DLL,TDC	2	06/11/2009

U:\GPS\IAAAP\Feasibility Study\Projects\Figure A-1 Yard C HMX Samples.mxd

Figure A-1. Yard C
Comparison of HMX Sample Results
with Ecological CC (15.2 mg/kg)



U:\GPS\IAAAPFeasibility Study\Projects\Figure A-2 Yard G HMX Samples.mxd

LEGEND:

- HMX Sample Locations with Results > 15.2 mg/kg
- Supplemental Sample Location
  HMX Sample Locations with Results < 15.2 mg/kg
- HMX Sample Locations with Results < 15.2 mg/kg
- Yard G Survey Boundary
- Topographic Contours
- Stream
- Surface Feature
- Railroad

N E S W

Iowa State Plane
(NAD 83, Meters)

0 120 240 Meters

Supplemental Investigation
Iowa Army Ammunition Plant
Middletown, Iowa

FUSRAP

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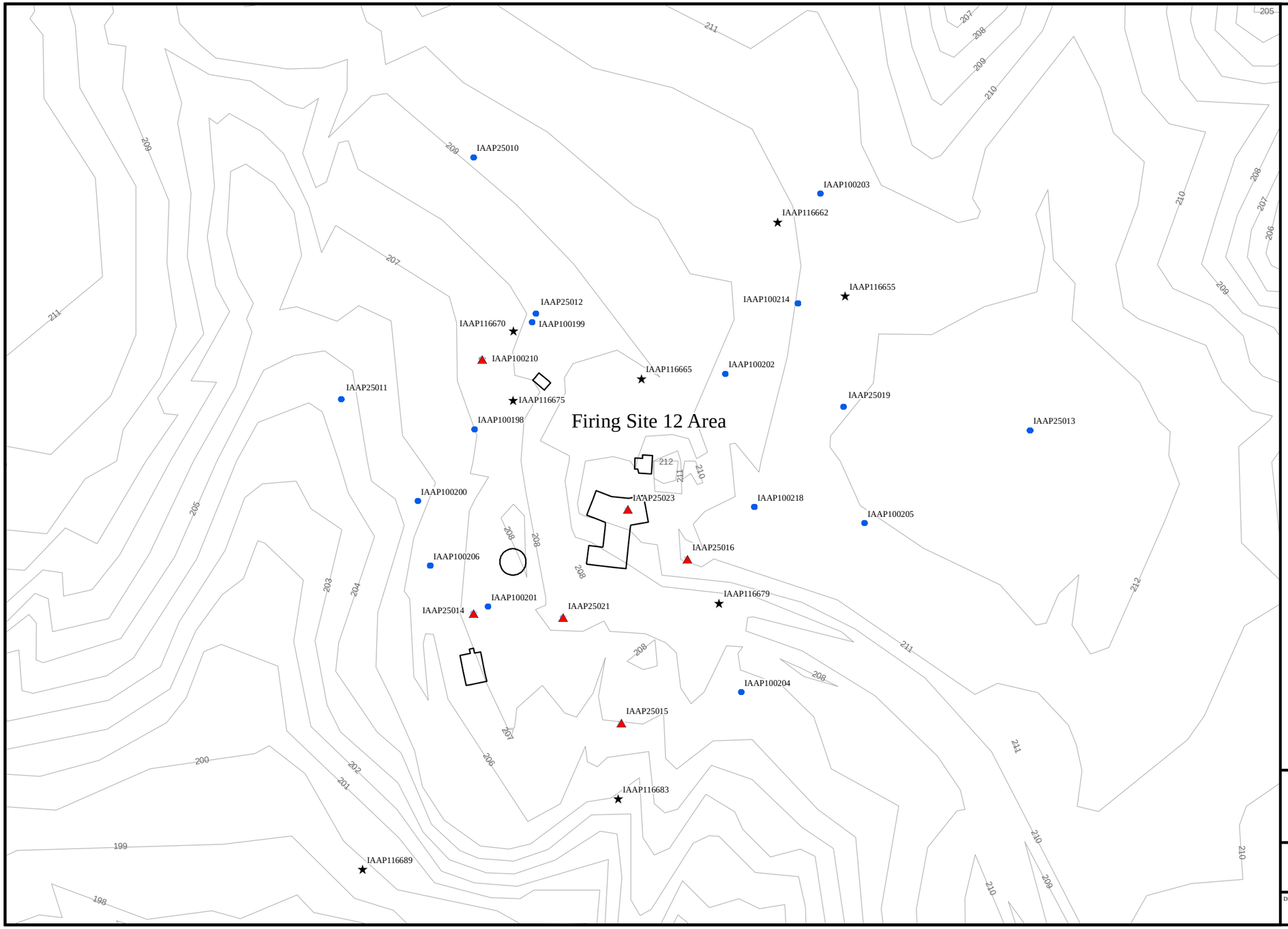
Figure A-2. Yard G
Comparison of HMX Sample Results
with Ecological CC (15.2 mg/kg)



Figure A-3. Firing Site 6 Area
Comparison of DU Sample Results
with Human Health RG (150 pCi/g)



U:\GPS\IAAP\Feasibility Study\Projects\Figure A-5 Firing Site 12 DU Samples.mxd

LEGEND:

- Sample Locations with DU results > 150 pCi/g
- Sample Locations with DU results < 150 pCi/g
- DU Fragment Investigation Locations
- Topographic Contours
- Surface Feature

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Iowa-South State Plane
(NAD 83, Meters)

0 10 20 Meters

Supplemental Investigation
Iowa Army Ammunition Plant
Middletown, Iowa

FUSRAP

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DLL	0	06/11/2009

Figure A-4. Firing Site 12 Area
Comparison of DU Sample Results
with Human Health RG (150 pCi/g)

ATTACHMENT A-1

Yard C HMX Data

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Table A-1-1. Yard C HMX

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier	Site Name	Area	EU
SAIC	IAAP96883	IAAP96883	693200	90942	0.0	0.5	10/23/2006	SW846 8330	HMX	300		300	ug/Kg	U	Yard C	Yard C	NA
SAIC	IAAP96884	IAAP96884	693340	90486	0.0	0.5	10/23/2006	SW846 8330	HMX	340		340	ug/Kg	U	Yard C	Yard C	NA
SAIC	IAAP96885	IAAP96885	693603	90482	0.0	0.5	10/23/2006	SW846 8330	HMX	340		340	ug/Kg	U	Yard C	Yard C	NA
SAIC	IAAP96886	IAAP96886	693883	90360	0.0	0.5	10/23/2006	SW846 8330	HMX	340		340	ug/Kg	U	Yard C	Yard C	NA
SAIC	IAAP96888	IAAP96888	693610	90751	0.0	0.5	10/23/2006	SW846 8330	HMX	170		340	ug/Kg	=	Yard C	Yard C	NA
SAIC	IAAP96889	IAAP96889	693461	91088	0.0	0.5	10/23/2006	SW846 8330	HMX	94000		280	ug/Kg	=	Yard C	Yard C	NA
SAIC	IAAP116572	IAAP96889	693461	91088	0.5	1.0	4/9/2009	SW846 8330	HMX	730		320	ug/Kg	=	Yard C	Yard C	NA
SAIC	IAAP116573	IAAP96889	693461	91088	1.0	1.5	4/9/2009	SW846 8330	HMX	370		310	ug/Kg	=	Yard C	Yard C	NA
SAIC	IAAP96890	IAAP96890	693734	91084	0.0	0.5	10/23/2006	SW846 8330	HMX	280		280	ug/Kg	U	Yard C	Yard C	NA
SAIC	IAAP96891	IAAP96891	693872	91025	0.0	0.5	10/23/2006	SW846 8330	HMX	320		320	ug/Kg	U	Yard C	Yard C	NA
SAIC	IAAP96892	IAAP96892	693198	91240	0.0	0.5	10/23/2006	SW846 8330	HMX	480		320	ug/Kg	=	Yard C	Yard C	NA
SAIC	IAAP96893	IAAP96893	693334	91241	0.0	0.5	10/23/2006	SW846 8330	HMX	420		420	ug/Kg	U	Yard C	Yard C	NA
SAIC	IAAP96894	IAAP96894	693583	91345	0.0	0.5	10/23/2006	SW846 8330	HMX	340		340	ug/Kg	U	Yard C	Yard C	NA
SAIC	IAAP96895	IAAP96895	693741	91221	0.0	0.5	10/23/2006	SW846 8330	HMX	320		320	ug/Kg	U	Yard C	Yard C	NA
SAIC	IAAP96896	IAAP96896	694024	90774	0.0	0.5	10/23/2006	SW846 8330	HMX	340		340	ug/Kg	U	Yard C	Yard C	NA
SAIC	IAAP96897	IAAP96897	694062	90644	0.0	0.5	10/23/2006	SW846 8330	HMX	350		350	ug/Kg	U	Yard C	Yard C	NA
SAIC	IAAP96898	IAAP96898	694131	90311	0.0	0.5	10/23/2006	SW846 8330	HMX	330		330	ug/Kg	U	Yard C	Yard C	NA
SAIC	IAAP96899	IAAP96899	693936	90122	0.0	0.5	10/23/2006	SW846 8330	HMX	340		340	ug/Kg	U	Yard C	Yard C	NA
SAIC	IAAP96900	IAAP96900	693203	90565	0.0	0.5	10/23/2006	SW846 8330	HMX	330		330	ug/Kg	U	Yard C	Yard C	NA
SAIC	IAAP96900-1	IAAP96900	693203	90565	0.0	0.5	10/23/2006	SW846 8330	HMX	330		330	ug/Kg	U	Yard C	Yard C	NA
SAIC	IAAP96901	IAAP96901	693474	90829	0.0	0.5	10/23/2006	SW846 8330	HMX	330		330	ug/Kg	U	Yard C	Yard C	NA
SAIC	IAAP96902	IAAP96902	693018	90087	0.0	0.5	10/23/2006	SW846 8330	HMX	320		320	ug/Kg	U	Yard C	Yard C	NA
SAIC	IAAP96903	IAAP96903	694017	90950	0.0	0.5	10/23/2006	SW846 8330	HMX	330		330	ug/Kg	U	Yard C	Yard C	NA
SAIC	IAAP100256	IAAP100256	693200	91222	0.0	0.5	3/26/2007	SW846 8330	HMX	460		460	ug/Kg	U	Yard C	Yard C	NA
SAIC	IAAP100257	IAAP100257	693189	91198	0.0	0.5	3/26/2007	SW846 8330	HMX	410		410	ug/Kg	U	Yard C	Yard C	NA
SAIC	IAAP100258	IAAP100258	693199	91090	0.0	0.5	3/26/2007	SW846 8330	HMX	450		450	ug/Kg	U	Yard C	Yard C	NA
SAIC	IAAP100259	IAAP100259	693190	90989	0.0	0.5	3/26/2007	SW846 8330	HMX	350		350	ug/Kg	U	Yard C	Yard C	NA
SAIC	IAAP100259-1	IAAP100259	693190	90989	0.0	0.5	3/26/2007	SW846 8330	HMX	350		350	ug/Kg	U	Yard C	Yard C	NA
SAIC	IAAP116574	IAAP116574	693461	91074	0.0	0.5	4/9/2009	SW846 8330	HMX	340		340	ug/Kg	U	Yard C	Yard C	NA
SAIC	IAAP116575	IAAP116574	693461	91074	0.5	1.0	4/9/2009	SW846 8330	HMX	320		320	ug/Kg	U	Yard C	Yard C	NA
SAIC	IAAP116576	IAAP116574	693461	91074	1.0	1.5	4/9/2009	SW846 8330	HMX	310		310	ug/Kg	U	Yard C	Yard C	NA
SAIC	IAAP116577	IAAP116577	693470	91089	0.0	0.5	4/9/2009	SW846 8330	HMX	320		320	ug/Kg	U	Yard C	Yard C	NA
SAIC	IAAP116577-1	IAAP116577	693470	91089	0.0	0.5	4/9/2009	SW846 8330	HMX	320		320	ug/Kg	U	Yard C	Yard C	NA
SAIC	IAAP116578	IAAP116577	693470	91089	0.5	1.0	4/9/2009	SW846 8330	HMX	320		320	ug/Kg	U	Yard C	Yard C	NA
SAIC	IAAP116579	IAAP116577	693470	91089	1.0	1.5	4/9/2009	SW846 8330	HMX	320		320	ug/Kg	U	Yard C	Yard C	NA
SAIC	IAAP116580	IAAP116580	693461	91097	0.0	0.5	4/9/2009	SW846 8330	HMX	370		370	ug/Kg	U	Yard C	Yard C	NA
SAIC	IAAP116581	IAAP116580	693461	91097	0.5	1.0	4/9/2009	SW846 8330	HMX	330		330	ug/Kg	U	Yard C	Yard C	NA
SAIC	IAAP116582	IAAP116580	693461	91097	1.0	1.5	4/9/2009	SW846 8330	HMX	320		320	ug/Kg	U	Yard C	Yard C	NA

*Coordinates in NAD Iowa South State Plane (meters).

EU - Exposure unit.

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ATTACHMENT A-2

Yard G HMX Data

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Table A-2-1. Yard G HMX

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier	Site Name	Area	EU
SAIC	IAAP96871	IAAP96871	690731	89031	0.0	0.5	10/24/2006	SW846 8330	HMX	280		280	ug/Kg	UJ	Yard G	Yard G	NA
SAIC	IAAP96872	IAAP96872	690047	89238	0.0	0.5	10/24/2006	SW846 8330	HMX	51000		320	ug/Kg	J	Yard G	Yard G	NA
SAIC	IAAP116583	IAAP96872	690047	89238	0.5	1.0	4/9/2009	SW846 8330	HMX	290		290	ug/Kg	U	Yard G	Yard G	NA
SAIC	IAAP116584	IAAP96872	690047	89238	1.0	1.5	4/9/2009	SW846 8330	HMX	300		300	ug/Kg	U	Yard G	Yard G	NA
SAIC	IAAP96873	IAAP96873	690166	88984	0.0	0.5	10/24/2006	SW846 8330	HMX	330		330	ug/Kg	UJ	Yard G	Yard G	NA
SAIC	IAAP96874	IAAP96874	690360	88811	0.0	0.5	10/24/2006	SW846 8330	HMX	33		300	ug/Kg	UJ	Yard G	Yard G	NA
SAIC	IAAP96875	IAAP96875	690314	88420	0.0	0.5	10/24/2006	SW846 8330	HMX	340		340	ug/Kg	UJ	Yard G	Yard G	NA
SAIC	IAAP96876	IAAP96876	690516	88074	0.0	0.5	10/24/2006	SW846 8330	HMX	320		320	ug/Kg	UJ	Yard G	Yard G	NA
SAIC	IAAP96876-1	IAAP96876	690516	88074	0.0	0.5	10/24/2006	SW846 8330	HMX	320		320	ug/Kg	UJ	Yard G	Yard G	NA
SAIC	IAAP96877	IAAP96877	690003	88246	0.0	0.5	10/24/2006	SW846 8330	HMX	320		320	ug/Kg	UJ	Yard G	Yard G	NA
SAIC	IAAP96878	IAAP96878	690394	87833	0.0	0.5	10/24/2006	SW846 8330	HMX	300		300	ug/Kg	UJ	Yard G	Yard G	NA
SAIC	IAAP96879	IAAP96879	690110	87687	0.0	0.5	10/24/2006	SW846 8330	HMX	330		330	ug/Kg	UJ	Yard G	Yard G	NA
SAIC	IAAP96880	IAAP96880	690136	88000	0.0	0.5	10/24/2006	SW846 8330	HMX	330		330	ug/Kg	UJ	Yard G	Yard G	NA
SAIC	IAAP96881	IAAP96881	690032	88384	0.0	0.5	10/24/2006	SW846 8330	HMX	140		340	ug/Kg	UJ	Yard G	Yard G	NA
SAIC	IAAP96882	IAAP96882	689875	88897	0.0	0.5	10/24/2006	SW846 8330	HMX	340		340	ug/Kg	UJ	Yard G	Yard G	NA
SAIC	IAAP116585	IAAP116585	690042	89247	0.0	0.5	4/9/2009	SW846 8330	HMX	320		320	ug/Kg	U	Yard G	Yard G	NA
SAIC	IAAP116586	IAAP116585	690042	89247	0.5	1.0	4/9/2009	SW846 8330	HMX	290		290	ug/Kg	U	Yard G	Yard G	NA
SAIC	IAAP116587	IAAP116585	690042	89247	1.0	1.5	4/9/2009	SW846 8330	HMX	290		290	ug/Kg	U	Yard G	Yard G	NA
SAIC	IAAP116588	IAAP116588	690040	89234	0.0	0.5	4/9/2009	SW846 8330	HMX	270		270	ug/Kg	U	Yard G	Yard G	NA
SAIC	IAAP116589	IAAP116588	690040	89234	0.5	1.0	4/9/2009	SW846 8330	HMX	270		270	ug/Kg	U	Yard G	Yard G	NA
SAIC	IAAP116590	IAAP116588	690040	89234	1.0	1.5	4/9/2009	SW846 8330	HMX	280		280	ug/Kg	U	Yard G	Yard G	NA
SAIC	IAAP116590-1	IAAP116588	690040	89234	1.0	1.5	4/9/2009	SW846 8330	HMX	290		290	ug/Kg	U	Yard G	Yard G	NA
SAIC	IAAP116591	IAAP116591	690053	89231	0.0	0.5	4/9/2009	SW846 8330	HMX	360		360	ug/Kg	U	Yard G	Yard G	NA
SAIC	IAAP116592	IAAP116591	690053	89231	0.5	1.0	4/9/2009	SW846 8330	HMX	300		300	ug/Kg	U	Yard G	Yard G	NA
SAIC	IAAP116593	IAAP116591	690053	89231	1.0	1.5	4/9/2009	SW846 8330	HMX	300		300	ug/Kg	U	Yard G	Yard G	NA

*Coordinates in NAD Iowa South State Plane (meters).

EU - Exposure unit.

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ATTACHMENT A-3

Firing Site 6 Area Chromium Data

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Table A-3-1. Firing Site 6 Area Chromium

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier	Site Name	Area	EU
SAIC	IAAP96821	IAAP96821	687523	90220	0.0	0.5	10/25/2006	SW846 6010B	Chromium	20.00		0.38	mg/Kg	J	Firing Sites	FS 6	NA
SAIC	IAAP96822	IAAP96822	687514	90204	0.0	0.5	10/25/2006	SW846 6010B	Chromium	14.30		0.43	mg/Kg	J	Firing Sites	FS 6	NA
SAIC	IAAP96823	IAAP96823	687569	90263	0.0	0.5	10/25/2006	SW846 6010B	Chromium	798.00		0.47	mg/Kg	J	Firing Sites	FS 6	NA
SAIC	IAAP96824	IAAP96824	687572	90260	0.0	0.5	10/25/2006	SW846 6010B	Chromium	56.60		0.37	mg/Kg	J	Firing Sites	FS 6	NA
SAIC	IAAP96825	IAAP96825	687590	90263	0.0	0.5	10/25/2006	SW846 6010B	Chromium	11.00		4.00	mg/Kg	J	Firing Sites	FS 6	NA
SAIC	IAAP96826	IAAP96826	687637	90266	0.0	0.5	10/25/2006	SW846 6010B	Chromium	17.00		0.38	mg/Kg	J	Firing Sites	FS 6	NA
SAIC	IAAP96827	IAAP96827	687643	90266	0.0	0.5	10/25/2006	SW846 6010B	Chromium	14.00		0.37	mg/Kg	J	Firing Sites	FS 6	NA
SAIC	IAAP96828	IAAP96828	687720	90270	0.0	0.5	10/25/2006	SW846 6010B	Chromium	5.80		0.39	mg/Kg	J	Firing Sites	FS 6	NA
SAIC	IAAP96829	IAAP96829	687594	90216	0.0	0.5	10/25/2006	SW846 6010B	Chromium	6620.00		0.37	mg/Kg	J	Firing Sites	FS 6	NA
SAIC	IAAP100174	IAAP96829	687594	90216	0.5	1.0	4/13/2007	SW846 6010B	Chromium	32.40		0.41	mg/Kg	=	Firing Sites	FS 6	NA
SAIC	IAAP96830	IAAP96830	687622	90276	0.0	0.5	10/25/2006	SW846 6010B	Chromium	13.70		0.44	mg/Kg	J	Firing Sites	FS 6	NA
SAIC	IAAP96830-1	IAAP96830	687622	90276	0.0	0.5	10/25/2006	SW846 6010B	Chromium	14.20		0.45	mg/Kg	J	Firing Sites	FS 6	NA
SAIC	IAAP100153	IAAP100153	688109	89856	0.0	0.5	4/15/2007	SW846 6010B	Chromium	2.80		0.48	mg/Kg	=	Firing Sites	FS Area	NA
SAIC	IAAP100154	IAAP100154	687890	90348	0.0	0.5	4/15/2007	SW846 6010B	Chromium	8.20		0.50	mg/Kg	=	Firing Sites	FS Area	NA
SAIC	IAAP100155	IAAP100155	687791	90300	0.0	0.5	4/15/2007	SW846 6010B	Chromium	6.20		0.53	mg/Kg	=	Firing Sites	FS Area	NA
SAIC	IAAP100164	IAAP100164	687631	90595	0.0	0.5	4/15/2007	SW846 6010B	Chromium	8.90		0.47	mg/Kg	=	Firing Sites	FS Area	NA
SAIC	IAAP100165	IAAP100165	687631	90595	0.0	0.5	4/15/2007	SW846 6010B	Chromium	3.20		0.42	mg/Kg	=	Firing Sites	FS Area	NA
SAIC	IAAP100166	IAAP100166	687591	90218	0.0	0.5	4/13/2007	SW846 6010B	Chromium	595.00		0.38	mg/Kg	=	Firing Sites	FS 6	NA
SAIC	IAAP100167	IAAP100166	687591	90218	0.5	1.0	4/13/2007	SW846 6010B	Chromium	464.00		1.90	mg/Kg	=	Firing Sites	FS 6	NA
SAIC	IAAP100168	IAAP100168	687600	90223	0.0	0.5	4/13/2007	SW846 6010B	Chromium	1070.00		0.50	mg/Kg	=	Firing Sites	FS 6	NA
SAIC	IAAP100169	IAAP100168	687600	90223	0.5	1.0	4/13/2007	SW846 6010B	Chromium	26.50		0.44	mg/Kg	=	Firing Sites	FS 6	NA
SAIC	IAAP100170	IAAP100170	687598	90216	0.0	0.5	4/13/2007	SW846 6010B	Chromium	1010.00		1.90	mg/Kg	=	Firing Sites	FS 6	NA
SAIC	IAAP100171	IAAP100170	687598	90216	0.5	1.0	4/13/2007	SW846 6010B	Chromium	397.00		1.90	mg/Kg	=	Firing Sites	FS 6	NA
SAIC	IAAP100172	IAAP100172	687599	90210	0.0	0.5	4/13/2007	SW846 6010B	Chromium	1990.00		1.90	mg/Kg	=	Firing Sites	FS 6	NA
SAIC	IAAP100173	IAAP100173	687588	90214	0.0	0.5	4/14/2007	SW846 6010B	Chromium	1630.00		1.90	mg/Kg	=	Firing Sites	FS 6	NA
SAIC	IAAP100175	IAAP100175	687568	90268	0.0	0.5	4/13/2007	SW846 6010B	Chromium	559.00		2.00	mg/Kg	=	Firing Sites	FS 6	NA
SAIC	IAAP100177	IAAP100177	687573	90267	0.0	0.5	4/13/2007	SW846 6010B	Chromium	81.10		1.90	mg/Kg	=	Firing Sites	FS 6	NA
SAIC	IAAP100178	IAAP100178	687662	90979	0.0	0.5	4/15/2007	SW846 6010B	Chromium	3.50		0.44	mg/Kg	=	Firing Sites	FS Area	NA
SAIC	IAAP100179	IAAP100179	687566	90260	0.0	0.5	4/13/2007	SW846 6010B	Chromium	113.00		2.00	mg/Kg	=	Firing Sites	FS 6	NA
SAIC	IAAP100180	IAAP100180	687889	90693	0.0	0.5	4/15/2007	SW846 6010B	Chromium	16.10		0.41	mg/Kg	=	Firing Sites	FS Area	NA
SAIC	IAAP100181	IAAP100181	687563	90262	0.0	0.5	4/13/2007	SW846 6010B	Chromium	64.50		2.10	mg/Kg	=	Firing Sites	FS 6	NA
SAIC	IAAP100182	IAAP100181	687563	90262	0.5	1.0	4/13/2007	SW846 6010B	Chromium	14.40		0.42	mg/Kg	=	Firing Sites	FS 6	NA
SAIC	IAAP100182-1	IAAP100181	687563	90262	0.5	1.0	4/13/2007	SW846 6010B	Chromium	16.50		0.42	mg/Kg	=	Firing Sites	FS 6	NA
SAIC	IAAP100183	IAAP100183	687568	90263	0.5	1.0	4/13/2007	SW846 6010B	Chromium	19.60		0.45	mg/Kg	=	Firing Sites	FS 6	NA
SAIC	IAAP100187	IAAP100187	687456	90385	0.0	0.5	4/15/2007	SW846 6010B	Chromium	6.50		0.39	mg/Kg	=	Firing Sites	FS Area	NA
SAIC	IAAP116507	IAAP116507	687581	90215	0.0	0.5	4/9/2009	SW846 6010B	Chromium	1220.00		0.72	mg/Kg	J	Firing Sites	FS 7	NA
SAIC	IAAP116508	IAAP116507	687581	90215	0.5	1.0	4/9/2009	SW846 6010B	Chromium	16.60		0.36	mg/Kg	J	Firing Sites	FS 8	NA
SAIC	IAAP116509	IAAP116507	687581	90215	1.0	1.5	4/9/2009	SW846 6010B	Chromium	16.20		0.35	mg/Kg	J	Firing Sites	FS 9	NA
SAIC	IAAP116510	IAAP116510	687588	90219	0.0	0.5	4/9/2009	SW846 6010B	Chromium	1700.00		0.74	mg/Kg	J	Firing Sites	FS 10	NA
SAIC	IAAP116511	IAAP116510	687588	90219	0.5	1.0	4/9/2009	SW846 6010B	Chromium	35.60		0.36	mg/Kg	J	Firing Sites	FS 11	NA
SAIC	IAAP116512	IAAP116510	687588	90219	1.0	1.5	4/9/2009	SW846 6010B	Chromium	27.10		0.36	mg/Kg	J	Firing Sites	FS 12	NA
SAIC	IAAP116513	IAAP116513	687595	90223	0.0	0.5	4/9/2009	SW846 6010B	Chromium	798.00		0.75	mg/Kg	J	Firing Sites	FS 13	NA
SAIC	IAAP116514	IAAP116513	687595	90223	0.5	1.0	4/9/2009	SW846 6010B	Chromium	18.50		0.36	mg/Kg	J	Firing Sites	FS 14	NA
SAIC	IAAP116515	IAAP116513	687595	90223	1.0	1.5	4/9/2009	SW846 6010B	Chromium	12.30		0.73	mg/Kg	J	Firing Sites	FS 15	NA
SAIC	IAAP116516	IAAP116516	687602	90228	0.0	0.5	4/9/2009	SW846 6010B	Chromium	23.30		0.37	mg/Kg	J	Firing Sites	FS 16	NA
SAIC	IAAP116517	IAAP116516	687602	90228	0.5	1.0	4/9/2009	SW846 6010B	Chromium	13.90		0.36	mg/Kg	J	Firing Sites	FS 17	NA
SAIC	IAAP116518	IAAP116516	687602	90228	1.0	1.5	4/9/2009	SW846 6010B	Chromium	16.50		0.37	mg/Kg	J	Firing Sites	FS 18	NA
SAIC	IAAP116519	IAAP116519	687586	90207	0.0	0.5	4/9/2009	SW846 6010B	Chromium	3760.00		1.80	mg/Kg	J	Firing Sites	FS 19	NA
SAIC	IAAP116520	IAAP116519	687586	90207	0.5	1.0	4/9/2009	SW846 6010B	Chromium	324.00		0.69	mg/Kg	J	Firing Sites	FS 20	NA
SAIC	IAAP116521	IAAP116519	687586	90207	1.0	1.5	4/9/2009	SW846 6010B	Chromium	118.00		0.70	mg/Kg	J	Firing Sites	FS 21	NA
SAIC	IAAP116522	IAAP116522	687593	90212	0.0	0.5	4/9/2009	SW846 6010B	Chromium	382.00		0.32	mg/Kg	J	Firing Sites	FS 22	NA
SAIC	IAAP116523	IAAP116522	687593	90212	0.5	1.0	4/9/2009	SW846 6010B	Chromium	19.10		0.32	mg/Kg	J	Firing Sites	FS 23	NA
SAIC	IAAP116524	IAAP116522	687593	90212	1.0	1.5	4/9/2009	SW846 6010B	Chromium	5.60		0.33	mg/Kg	J	Firing Sites	FS 24	NA
SAIC	IAAP116525	IAAP116525	687600	90216	0.0	0.5	4/9/2009	SW846 6010B	Chromium	51.60		0.32	mg/Kg	J	Firing Sites	FS 25	NA
SAIC	IAAP116526	IAAP116525	687600	90216	0.5	1.0	4/9/2009	SW846 6010B	Chromium	45.30		0.32	mg/Kg	J	Firing Sites	FS 26	NA

Table A-3-1. Firing Site 6 Area Chromium

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier	Site Name	Area	EU
SAIC	IAAP116527	IAAP116525	687600	90216	1.0	1.5	4/9/2009	SW846 6010B	Chromium	21.60		0.33	mg/Kg	=	Firing Sites	FS 27	NA
SAIC	IAAP116528	IAAP116528	687606	90220	0.0	0.5	4/9/2009	SW846 6010B	Chromium	59.80		0.33	mg/Kg	=	Firing Sites	FS 28	NA
SAIC	IAAP116529	IAAP116528	687606	90220	0.5	1.0	4/9/2009	SW846 6010B	Chromium	47.90		0.36	mg/Kg	=	Firing Sites	FS 29	NA
SAIC	IAAP116530	IAAP116528	687606	90220	1.0	1.5	4/9/2009	SW846 6010B	Chromium	22.30		0.35	mg/Kg	=	Firing Sites	FS 30	NA
SAIC	IAAP116531	IAAP116531	687591	90200	0.0	0.5	4/10/2009	SW846 6010B	Chromium	44.40		0.38	mg/Kg	=	Firing Sites	FS 31	NA
SAIC	IAAP116532	IAAP116531	687591	90200	0.5	1.0	4/10/2009	SW846 6010B	Chromium	673.00		0.74	mg/Kg	=	Firing Sites	FS 32	NA
SAIC	IAAP116533	IAAP116531	687591	90200	1.0	1.5	4/10/2009	SW846 6010B	Chromium	23.00		0.36	mg/Kg	=	Firing Sites	FS 33	NA
SAIC	IAAP116533-1	IAAP116531	687591	90200	1.0	1.5	4/10/2009	SW846 6010B	Chromium	12.80		0.36	mg/Kg	=	Firing Sites	FS 34	NA
SAIC	IAAP116534	IAAP116534	687597	90204	0.0	0.5	4/10/2009	SW846 6010B	Chromium	2850.00		1.70	mg/Kg	=	Firing Sites	FS 35	NA
SAIC	IAAP116535	IAAP116534	687597	90204	0.5	1.0	4/10/2009	SW846 6010B	Chromium	8.80		0.33	mg/Kg	=	Firing Sites	FS 36	NA
SAIC	IAAP116536	IAAP116534	687597	90204	1.0	1.5	4/10/2009	SW846 6010B	Chromium	12.20		0.35	mg/Kg	=	Firing Sites	FS 37	NA
SAIC	IAAP116537	IAAP116537	687604	90208	0.0	0.5	4/10/2009	SW846 6010B	Chromium	337.00		0.32	mg/Kg	=	Firing Sites	FS 38	NA
SAIC	IAAP116538	IAAP116537	687604	90208	0.5	1.0	4/10/2009	SW846 6010B	Chromium	24.30		0.32	mg/Kg	=	Firing Sites	FS 39	NA
SAIC	IAAP116539	IAAP116537	687604	90208	1.0	1.5	4/10/2009	SW846 6010B	Chromium	5.30		0.34	mg/Kg	=	Firing Sites	FS 40	NA
SAIC	IAAP116540	IAAP116540	687611	90212	0.0	0.5	4/10/2009	SW846 6010B	Chromium	8.10		0.32	mg/Kg	=	Firing Sites	FS 41	NA
SAIC	IAAP116541	IAAP116540	687611	90212	0.5	1.0	4/10/2009	SW846 6010B	Chromium	17.70		0.32	mg/Kg	=	Firing Sites	FS 42	NA
SAIC	IAAP116542	IAAP116540	687611	90212	1.0	1.5	4/10/2009	SW846 6010B	Chromium	17.80		0.36	mg/Kg	=	Firing Sites	FS 43	NA
SAIC	IAAP116542-1	IAAP116540	687611	90212	1.0	1.5	4/10/2009	SW846 6010B	Chromium	20.00		0.36	mg/Kg	=	Firing Sites	FS 44	NA
SAIC	IAAP116543	IAAP116543	687569	90272	0.0	0.5	4/10/2009	SW846 6010B	Chromium	85.80		0.76	mg/Kg	=	Firing Sites	FS 45	NA
SAIC	IAAP116544	IAAP116543	687569	90272	0.5	1.0	4/10/2009	SW846 6010B	Chromium	27.90		0.80	mg/Kg	=	Firing Sites	FS 46	NA
SAIC	IAAP116545	IAAP116543	687569	90272	1.0	1.5	4/10/2009	SW846 6010B	Chromium	19.60		0.79	mg/Kg	=	Firing Sites	FS 47	NA
SAIC	IAAP116546	IAAP116546	687562	90271	0.0	0.5	4/10/2009	SW846 6010B	Chromium	86.30		0.38	mg/Kg	=	Firing Sites	FS 48	NA
SAIC	IAAP116547	IAAP116546	687562	90271	0.5	1.0	4/10/2009	SW846 6010B	Chromium	7.30		0.36	mg/Kg	=	Firing Sites	FS 49	NA
SAIC	IAAP116548	IAAP116546	687562	90271	1.0	1.5	4/10/2009	SW846 6010B	Chromium	14.60		0.82	mg/Kg	=	Firing Sites	FS 50	NA
TNA	TFS06003	FS06016	687660	90256	0.0	1.0	1/18/2002	SW6010	Chromium	12.00		1.20	mg/Kg		Firing Sites	FS 6	NA
TNA	TFS15002	FS15051	687560	90209	0.0	1.0	1/18/2002	SW6010	Chromium	18.00		1.20	mg/Kg		Firing Sites	FS 6	NA

Coordinates in NAD Iowa South State Plane (meters).

Results, error, and detection limit are rounded to 2 decimal places regardless of significant digits.

EU - Exposure unit.

ATTACHMENT A-4

Firing Site 6 Area DU Data

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Table A-4-1. Firing Site 6 Area DU

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier
SAIC	IAAP100153	IAAP100153	688109	89856	0.0	0.5	4/15/2007	ML-003	Actinium-227	0.02	0.05	0.08	pCi/g	UJ
SAIC	IAAP100153	IAAP100153	688109	89856	0.0	0.5	4/15/2007	ML-003	Americium-241	0.01	0.01	0.02	pCi/g	UJ
SAIC	IAAP100153	IAAP100153	688109	89856	0.0	0.5	4/15/2007	ML-003	Cesium-137	0.01	0.01	0.01	pCi/g	UJ
SAIC	IAAP100153	IAAP100153	688109	89856	0.0	0.5	4/15/2007	ML-003	Potassium-40	6.75	0.46	0.06	pCi/g	=
SAIC	IAAP100153	IAAP100153	688109	89856	0.0	0.5	4/15/2007	ML-003	Protactinium-231	-0.02	0.16	0.23	pCi/g	UJ
SAIC	IAAP100153	IAAP100153	688109	89856	0.0	0.5	4/15/2007	ML-003	Radium-226	0.20	0.06	0.02	pCi/g	J
SAIC	IAAP100153	IAAP100153	688109	89856	0.0	0.5	4/15/2007	ML-003	Radium-228	0.16	0.02	0.03	pCi/g	J
SAIC	IAAP100153	IAAP100153	688109	89856	0.0	0.5	4/15/2007	ML-003	Thorium-228	0.16	0.02	0.03	pCi/g	J
SAIC	IAAP100153	IAAP100153	688109	89856	0.0	0.5	4/15/2007	ML-003	Thorium-230	0.33	1.20	1.90	pCi/g	UJ
SAIC	IAAP100153	IAAP100153	688109	89856	0.0	0.5	4/15/2007	ML-003	Thorium-232	0.16	0.02	0.03	pCi/g	J
SAIC	IAAP100153	IAAP100153	688109	89856	0.0	0.5	4/15/2007	ML-003	Uranium-235	0.02	0.07	0.11	pCi/g	UJ
SAIC	IAAP100153	IAAP100153	688109	89856	0.0	0.5	4/15/2007	ML-003	Uranium-238	0.50	0.19	0.18	pCi/g	=
SAIC	IAAP100154	IAAP100154	687890	90348	0.0	0.5	4/15/2007	ML-003	Actinium-227	0.00	0.08	0.13	pCi/g	UJ
SAIC	IAAP100154	IAAP100154	687890	90348	0.0	0.5	4/15/2007	ML-003	Americium-241	0.00	0.02	0.03	pCi/g	UJ
SAIC	IAAP100154	IAAP100154	687890	90348	0.0	0.5	4/15/2007	ML-003	Cesium-137	0.03	0.01	0.01	pCi/g	=
SAIC	IAAP100154	IAAP100154	687890	90348	0.0	0.5	4/15/2007	ML-003	Potassium-40	9.30	0.62	0.09	pCi/g	=
SAIC	IAAP100154	IAAP100154	687890	90348	0.0	0.5	4/15/2007	ML-003	Protactinium-231	0.15	0.25	0.36	pCi/g	UJ
SAIC	IAAP100154	IAAP100154	687890	90348	0.0	0.5	4/15/2007	ML-003	Radium-226	0.51	0.14	0.03	pCi/g	J
SAIC	IAAP100154	IAAP100154	687890	90348	0.0	0.5	4/15/2007	ML-003	Radium-228	0.50	0.04	0.04	pCi/g	=
SAIC	IAAP100154	IAAP100154	687890	90348	0.0	0.5	4/15/2007	ML-003	Thorium-228	0.50	0.04	0.04	pCi/g	=
SAIC	IAAP100154	IAAP100154	687890	90348	0.0	0.5	4/15/2007	ML-003	Thorium-230	-0.09	1.93	3.02	pCi/g	UJ
SAIC	IAAP100154	IAAP100154	687890	90348	0.0	0.5	4/15/2007	ML-003	Thorium-232	0.50	0.04	0.04	pCi/g	=
SAIC	IAAP100154	IAAP100154	687890	90348	0.0	0.5	4/15/2007	ML-003	Uranium-235	-0.09	0.11	0.17	pCi/g	UJ
SAIC	IAAP100154	IAAP100154	687890	90348	0.0	0.5	4/15/2007	ML-003	Uranium-238	0.49	0.29	0.31	pCi/g	J
SAIC	IAAP100155	IAAP100155	687791	90300	0.0	0.5	4/15/2007	ML-003	Actinium-227	0.05	0.08	0.13	pCi/g	UJ
SAIC	IAAP100155	IAAP100155	687791	90300	0.0	0.5	4/15/2007	ML-003	Americium-241	0.01	0.02	0.03	pCi/g	UJ
SAIC	IAAP100155	IAAP100155	687791	90300	0.0	0.5	4/15/2007	ML-003	Cesium-137	0.02	0.01	0.01	pCi/g	=
SAIC	IAAP100155	IAAP100155	687791	90300	0.0	0.5	4/15/2007	ML-003	Potassium-40	9.20	0.61	0.09	pCi/g	=
SAIC	IAAP100155	IAAP100155	687791	90300	0.0	0.5	4/15/2007	ML-003	Protactinium-231	0.05	0.24	0.35	pCi/g	UJ
SAIC	IAAP100155	IAAP100155	687791	90300	0.0	0.5	4/15/2007	ML-003	Radium-226	0.55	0.15	0.03	pCi/g	=
SAIC	IAAP100155	IAAP100155	687791	90300	0.0	0.5	4/15/2007	ML-003	Radium-228	0.44	0.03	0.04	pCi/g	=
SAIC	IAAP100155	IAAP100155	687791	90300	0.0	0.5	4/15/2007	ML-003	Thorium-228	0.44	0.03	0.04	pCi/g	=
SAIC	IAAP100155	IAAP100155	687791	90300	0.0	0.5	4/15/2007	ML-003	Thorium-230	1.21	1.81	2.90	pCi/g	UJ
SAIC	IAAP100155	IAAP100155	687791	90300	0.0	0.5	4/15/2007	ML-003	Thorium-232	0.44	0.03	0.04	pCi/g	=
SAIC	IAAP100155	IAAP100155	687791	90300	0.0	0.5	4/15/2007	ML-003	Uranium-235	0.04	0.10	0.17	pCi/g	UJ
SAIC	IAAP100155	IAAP100155	687791	90300	0.0	0.5	4/15/2007	ML-003	Uranium-238	0.37	0.28	0.27	pCi/g	J
SAIC	IAAP100164	IAAP100164	687631	90595	0.0	0.5	4/15/2007	ML-003	Actinium-227	-0.04	0.10	0.16	pCi/g	UJ
SAIC	IAAP100164	IAAP100164	687631	90595	0.0	0.5	4/15/2007	ML-003	Americium-241	0.02	0.03	0.04	pCi/g	UJ
SAIC	IAAP100164	IAAP100164	687631	90595	0.0	0.5	4/15/2007	ML-003	Cesium-137	0.24	0.03	0.01	pCi/g	=
SAIC	IAAP100164	IAAP100164	687631	90595	0.0	0.5	4/15/2007	ML-003	Potassium-40	10.50	0.70	0.13	pCi/g	=
SAIC	IAAP100164	IAAP100164	687631	90595	0.0	0.5	4/15/2007	ML-003	Protactinium-231	0.45	0.30	0.47	pCi/g	U
SAIC	IAAP100164	IAAP100164	687631	90595	0.0	0.5	4/15/2007	ML-003	Radium-226	0.79	0.21	0.04	pCi/g	=
SAIC	IAAP100164	IAAP100164	687631	90595	0.0	0.5	4/15/2007	ML-003	Radium-228	0.71	0.05	0.04	pCi/g	=
SAIC	IAAP100164	IAAP100164	687631	90595	0.0	0.5	4/15/2007	ML-003	Thorium-228	0.71	0.05	0.04	pCi/g	=
SAIC	IAAP100164	IAAP100164	687631	90595	0.0	0.5	4/15/2007	ML-003	Thorium-230	-1.30	2.39	3.66	pCi/g	UJ
SAIC	IAAP100164	IAAP100164	687631	90595	0.0	0.5	4/15/2007	ML-003	Thorium-232	0.71	0.05	0.04	pCi/g	=
SAIC	IAAP100164	IAAP100164	687631	90595	0.0	0.5	4/15/2007	ML-003	Uranium-235	0.02	0.13	0.22	pCi/g	UJ
SAIC	IAAP100164	IAAP100164	687631	90595	0.0	0.5	4/15/2007	ML-003	Uranium-238	0.87	0.30	0.36	pCi/g	=
SAIC	IAAP100165	IAAP100165	687631	90595	0.0	0.5	4/15/2007	ML-003	Actinium-227	-0.03	0.06	0.09	pCi/g	UJ
SAIC	IAAP100165	IAAP100165	687631	90595	0.0	0.5	4/15/2007	ML-003	Americium-241	0.00	0.01	0.02	pCi/g	UJ
SAIC	IAAP100165	IAAP100165	687631	90595	0.0	0.5	4/15/2007	ML-003	Cesium-137	0.01	0.01	0.01	pCi/g	UJ
SAIC	IAAP100165	IAAP100165	687631	90595	0.0	0.5	4/15/2007	ML-003	Potassium-40	6.73	0.46	0.06	pCi/g	=
SAIC	IAAP100165	IAAP100165	687631	90595	0.0	0.5	4/15/2007	ML-003	Protactinium-231	0.18	0.17	0.26	pCi/g	U
SAIC	IAAP100165	IAAP100165	687631	90595	0.0	0.5	4/15/2007	ML-003	Radium-226	0.28	0.08	0.02	pCi/g	J
SAIC	IAAP100165	IAAP100165	687631	90595	0.0	0.5	4/15/2007	ML-003	Radium-228	0.24	0.02	0.03	pCi/g	J
SAIC	IAAP100165	IAAP100165	687631	90595	0.0	0.5	4/15/2007	ML-003	Thorium-228	0.24	0.02	0.03	pCi/g	J
SAIC	IAAP100165	IAAP100165	687631	90595	0.0	0.5	4/15/2007	ML-003	Thorium-230	1.90	1.69	1.96	pCi/g	U

Table A-4-1. Firing Site 6 Area DU

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier
SAIC	IAAP100165	IAAP100165	687631	90595	0.0	0.5	4/15/2007	ML-003	Thorium-232	0.24	0.02	0.03	pCi/g	J
SAIC	IAAP100165	IAAP100165	687631	90595	0.0	0.5	4/15/2007	ML-003	Uranium-235	-0.01	0.08	0.13	pCi/g	UJ
SAIC	IAAP100165	IAAP100165	687631	90595	0.0	0.5	4/15/2007	ML-003	Uranium-238	0.29	0.20	0.20	pCi/g	J
SAIC	IAAP100176	IAAP100176	687635	90272	0.0	0.5	4/14/2007	ML-003	Actinium-227	1.20	0.79	1.14	pCi/g	UJ
SAIC	IAAP100176	IAAP100176	687635	90272	0.0	0.5	4/14/2007	ML-003	Americium-241	4.30	0.67	0.50	pCi/g	J
SAIC	IAAP100176	IAAP100176	687635	90272	0.0	0.5	4/14/2007	ML-003	Cesium-137	-0.04	0.05	0.08	pCi/g	UJ
SAIC	IAAP100176	IAAP100176	687635	90272	0.0	0.5	4/14/2007	ML-003	Potassium-40	4.09	0.46	0.29	pCi/g	=
SAIC	IAAP100176	IAAP100176	687635	90272	0.0	0.5	4/14/2007	ML-003	Protactinium-231	-0.39	1.80	2.86	pCi/g	UJ
SAIC	IAAP100176	IAAP100176	687635	90272	0.0	0.5	4/14/2007	ML-003	Radium-226	0.72	0.28	0.26	pCi/g	J
SAIC	IAAP100176	IAAP100176	687635	90272	0.0	0.5	4/14/2007	ML-003	Radium-228	0.23	0.13	0.19	pCi/g	UJ
SAIC	IAAP100176	IAAP100176	687635	90272	0.0	0.5	4/14/2007	ML-003	Thorium-228	0.23	0.13	0.19	pCi/g	UJ
SAIC	IAAP100176	IAAP100176	687635	90272	0.0	0.5	4/14/2007	ML-003	Thorium-230	165.00	32.70	45.80	pCi/g	U
SAIC	IAAP100176	IAAP100176	687635	90272	0.0	0.5	4/14/2007	ML-003	Thorium-232	0.23	0.13	0.19	pCi/g	UJ
SAIC	IAAP100176	IAAP100176	687635	90272	0.0	0.5	4/14/2007	ML-003	Uranium-235	29.00	2.11	1.81	pCi/g	=
SAIC	IAAP100176	IAAP100176	687635	90272	0.0	0.5	4/14/2007	ML-003	Uranium-238	2274.00	77.00	4.53	pCi/g	=
SAIC	IAAP116648	IAAP100176	687635	90272	0.5	1.0	4/14/2009	ML-015	Uranium-234	0.92	0.46	0.24	pCi/g	J
SAIC	IAAP116648	IAAP100176	687635	90272	0.5	1.0	4/14/2009	ML-015	Uranium-235	0.12	0.17	0.16	pCi/g	UJ
SAIC	IAAP116648	IAAP100176	687635	90272	0.5	1.0	4/14/2009	ML-015	Uranium-238	1.07	0.50	0.13	pCi/g	=
SAIC	IAAP116648	IAAP100176	687635	90272	0.5	1.0	4/14/2009	ML-003	Actinium-227	0.00	0.09	0.15	pCi/g	UJ
SAIC	IAAP116648	IAAP100176	687635	90272	0.5	1.0	4/14/2009	ML-003	Americium-241	0.00	0.02	0.03	pCi/g	UJ
SAIC	IAAP116648	IAAP100176	687635	90272	0.5	1.0	4/14/2009	ML-003	Cesium-137	0.03	0.02	0.01	pCi/g	J
SAIC	IAAP116648	IAAP100176	687635	90272	0.5	1.0	4/14/2009	ML-003	Potassium-40	11.40	0.66	0.12	pCi/g	=
SAIC	IAAP116648	IAAP100176	687635	90272	0.5	1.0	4/14/2009	ML-003	Protactinium-231	0.06	0.24	0.38	pCi/g	UJ
SAIC	IAAP116648	IAAP100176	687635	90272	0.5	1.0	4/14/2009	ML-003	Radium-226	0.87	0.22	0.04	pCi/g	=
SAIC	IAAP116648	IAAP100176	687635	90272	0.5	1.0	4/14/2009	ML-003	Radium-228	0.75	0.05	0.05	pCi/g	=
SAIC	IAAP116648	IAAP100176	687635	90272	0.5	1.0	4/14/2009	ML-003	Thorium-228	0.75	0.05	0.05	pCi/g	=
SAIC	IAAP116648	IAAP100176	687635	90272	0.5	1.0	4/14/2009	ML-003	Thorium-230	2.40	2.39	2.98	pCi/g	U
SAIC	IAAP116648	IAAP100176	687635	90272	0.5	1.0	4/14/2009	ML-003	Thorium-232	0.75	0.05	0.05	pCi/g	=
SAIC	IAAP116649	IAAP100176	687635	90272	1.0	1.5	4/14/2009	ML-015	Uranium-234	1.29	0.63	0.30	pCi/g	=
SAIC	IAAP116649	IAAP100176	687635	90272	1.0	1.5	4/14/2009	ML-015	Uranium-235	0.00	0.00	0.20	pCi/g	U
SAIC	IAAP116649	IAAP100176	687635	90272	1.0	1.5	4/14/2009	ML-015	Uranium-238	1.06	0.56	0.16	pCi/g	J
SAIC	IAAP116649	IAAP100176	687635	90272	1.0	1.5	4/14/2009	ML-003	Actinium-227	-0.01	0.09	0.15	pCi/g	UJ
SAIC	IAAP116649	IAAP100176	687635	90272	1.0	1.5	4/14/2009	ML-003	Americium-241	0.01	0.02	0.03	pCi/g	UJ
SAIC	IAAP116649	IAAP100176	687635	90272	1.0	1.5	4/14/2009	ML-003	Cesium-137	0.01	0.01	0.01	pCi/g	J
SAIC	IAAP116649	IAAP100176	687635	90272	1.0	1.5	4/14/2009	ML-003	Potassium-40	11.90	0.67	0.13	pCi/g	=
SAIC	IAAP116649	IAAP100176	687635	90272	1.0	1.5	4/14/2009	ML-003	Protactinium-231	-0.07	0.26	0.39	pCi/g	UJ
SAIC	IAAP116649	IAAP100176	687635	90272	1.0	1.5	4/14/2009	ML-003	Radium-226	0.95	0.24	0.04	pCi/g	=
SAIC	IAAP116649	IAAP100176	687635	90272	1.0	1.5	4/14/2009	ML-003	Radium-228	0.81	0.05	0.05	pCi/g	=
SAIC	IAAP116649	IAAP100176	687635	90272	1.0	1.5	4/14/2009	ML-003	Thorium-228	0.81	0.05	0.05	pCi/g	=
SAIC	IAAP116649	IAAP100176	687635	90272	1.0	1.5	4/14/2009	ML-003	Thorium-230	1.71	1.81	3.20	pCi/g	UJ
SAIC	IAAP116649	IAAP100176	687635	90272	1.0	1.5	4/14/2009	ML-003	Thorium-232	0.81	0.05	0.05	pCi/g	=
SAIC	IAAP116650	IAAP100176	687635	90272	1.5	2.0	4/14/2009	ML-015	Uranium-234	1.40	0.72	0.19	pCi/g	J
SAIC	IAAP116650	IAAP100176	687635	90272	1.5	2.0	4/14/2009	ML-015	Uranium-235	0.09	0.17	0.23	pCi/g	UJ
SAIC	IAAP116650	IAAP100176	687635	90272	1.5	2.0	4/14/2009	ML-015	Uranium-238	0.91	0.55	0.19	pCi/g	J
SAIC	IAAP116650	IAAP100176	687635	90272	1.5	2.0	4/14/2009	ML-003	Actinium-227	0.03	0.09	0.15	pCi/g	UJ
SAIC	IAAP116650	IAAP100176	687635	90272	1.5	2.0	4/14/2009	ML-003	Americium-241	0.00	0.02	0.03	pCi/g	UJ
SAIC	IAAP116650	IAAP100176	687635	90272	1.5	2.0	4/14/2009	ML-003	Cesium-137	0.01	0.01	0.01	pCi/g	UJ
SAIC	IAAP116650	IAAP100176	687635	90272	1.5	2.0	4/14/2009	ML-003	Potassium-40	11.80	0.68	0.13	pCi/g	=
SAIC	IAAP116650	IAAP100176	687635	90272	1.5	2.0	4/14/2009	ML-003	Protactinium-231	-0.02	0.24	0.37	pCi/g	UJ
SAIC	IAAP116650	IAAP100176	687635	90272	1.5	2.0	4/14/2009	ML-003	Radium-226	1.04	0.26	0.04	pCi/g	=
SAIC	IAAP116650	IAAP100176	687635	90272	1.5	2.0	4/14/2009	ML-003	Radium-228	0.77	0.05	0.04	pCi/g	=
SAIC	IAAP116650	IAAP100176	687635	90272	1.5	2.0	4/14/2009	ML-003	Thorium-228	0.77	0.05	0.04	pCi/g	=
SAIC	IAAP116650	IAAP100176	687635	90272	1.5	2.0	4/14/2009	ML-003	Thorium-230	3.05	2.70	2.92	pCi/g	J
SAIC	IAAP116650	IAAP100176	687635	90272	1.5	2.0	4/14/2009	ML-003	Thorium-232	0.77	0.05	0.04	pCi/g	=
SAIC	IAAP100178	IAAP100178	687662	90979	0.0	0.5	4/15/2007	ML-003	Actinium-227	0.00	0.05	0.09	pCi/g	UJ
SAIC	IAAP100178	IAAP100178	687662	90979	0.0	0.5	4/15/2007	ML-003	Americium-241	-0.01	0.01	0.02	pCi/g	UJ
SAIC	IAAP100178	IAAP100178	687662	90979	0.0	0.5	4/15/2007	ML-003	Cesium-137	0.00	0.01	0.01	pCi/g	UJ

Table A-4-1. Firing Site 6 Area DU

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier
SAIC	IAAP100178	IAAP100178	687662	90979	0.0	0.5	4/15/2007	ML-003	Potassium-40	6.58	0.45	0.07	pCi/g	=
SAIC	IAAP100178	IAAP100178	687662	90979	0.0	0.5	4/15/2007	ML-003	Protactinium-231	0.20	0.16	0.25	pCi/g	U
SAIC	IAAP100178	IAAP100178	687662	90979	0.0	0.5	4/15/2007	ML-003	Radium-226	0.27	0.08	0.02	pCi/g	J
SAIC	IAAP100178	IAAP100178	687662	90979	0.0	0.5	4/15/2007	ML-003	Radium-228	0.22	0.02	0.03	pCi/g	J
SAIC	IAAP100178	IAAP100178	687662	90979	0.0	0.5	4/15/2007	ML-003	Thorium-228	0.22	0.02	0.03	pCi/g	J
SAIC	IAAP100178	IAAP100178	687662	90979	0.0	0.5	4/15/2007	ML-003	Thorium-230	-0.34	1.27	1.97	pCi/g	UJ
SAIC	IAAP100178	IAAP100178	687662	90979	0.0	0.5	4/15/2007	ML-003	Thorium-232	0.22	0.02	0.03	pCi/g	J
SAIC	IAAP100178	IAAP100178	687662	90979	0.0	0.5	4/15/2007	ML-003	Uranium-235	-0.04	0.07	0.11	pCi/g	UJ
SAIC	IAAP100178	IAAP100178	687662	90979	0.0	0.5	4/15/2007	ML-003	Uranium-238	0.11	0.14	0.23	pCi/g	UJ
SAIC	IAAP100180	IAAP100180	687889	90693	0.0	0.5	4/15/2007	ML-003	Actinium-227	0.02	0.08	0.11	pCi/g	UJ
SAIC	IAAP100180	IAAP100180	687889	90693	0.0	0.5	4/15/2007	ML-003	Americium-241	0.02	0.02	0.03	pCi/g	U
SAIC	IAAP100180	IAAP100180	687889	90693	0.0	0.5	4/15/2007	ML-003	Cesium-137	0.01	0.01	0.01	pCi/g	UJ
SAIC	IAAP100180	IAAP100180	687889	90693	0.0	0.5	4/15/2007	ML-003	Potassium-40	6.85	0.46	0.07	pCi/g	=
SAIC	IAAP100180	IAAP100180	687889	90693	0.0	0.5	4/15/2007	ML-003	Protactinium-231	-0.06	0.21	0.29	pCi/g	UJ
SAIC	IAAP100180	IAAP100180	687889	90693	0.0	0.5	4/15/2007	ML-003	Radium-226	0.53	0.14	0.03	pCi/g	=
SAIC	IAAP100180	IAAP100180	687889	90693	0.0	0.5	4/15/2007	ML-003	Radium-228	0.44	0.03	0.03	pCi/g	=
SAIC	IAAP100180	IAAP100180	687889	90693	0.0	0.5	4/15/2007	ML-003	Thorium-228	0.44	0.03	0.03	pCi/g	=
SAIC	IAAP100180	IAAP100180	687889	90693	0.0	0.5	4/15/2007	ML-003	Thorium-230	0.15	1.81	2.61	pCi/g	UJ
SAIC	IAAP100180	IAAP100180	687889	90693	0.0	0.5	4/15/2007	ML-003	Thorium-232	0.44	0.03	0.03	pCi/g	=
SAIC	IAAP100180	IAAP100180	687889	90693	0.0	0.5	4/15/2007	ML-003	Uranium-235	0.06	0.09	0.16	pCi/g	UJ
SAIC	IAAP100180	IAAP100180	687889	90693	0.0	0.5	4/15/2007	ML-003	Uranium-238	0.41	0.30	0.26	pCi/g	J
SAIC	IAAP100187	IAAP100187	687456	90385	0.0	0.5	4/15/2007	ML-003	Actinium-227	0.00	0.07	0.11	pCi/g	UJ
SAIC	IAAP100187	IAAP100187	687456	90385	0.0	0.5	4/15/2007	ML-003	Americium-241	0.00	0.02	0.03	pCi/g	UJ
SAIC	IAAP100187	IAAP100187	687456	90385	0.0	0.5	4/15/2007	ML-003	Cesium-137	0.01	0.01	0.01	pCi/g	J
SAIC	IAAP100187	IAAP100187	687456	90385	0.0	0.5	4/15/2007	ML-003	Potassium-40	7.93	0.52	0.08	pCi/g	=
SAIC	IAAP100187	IAAP100187	687456	90385	0.0	0.5	4/15/2007	ML-003	Protactinium-231	0.00	0.20	0.29	pCi/g	UJ
SAIC	IAAP100187	IAAP100187	687456	90385	0.0	0.5	4/15/2007	ML-003	Radium-226	0.52	0.14	0.03	pCi/g	=
SAIC	IAAP100187	IAAP100187	687456	90385	0.0	0.5	4/15/2007	ML-003	Radium-228	0.30	0.03	0.03	pCi/g	=
SAIC	IAAP100187	IAAP100187	687456	90385	0.0	0.5	4/15/2007	ML-003	Thorium-228	0.30	0.03	0.03	pCi/g	=
SAIC	IAAP100187	IAAP100187	687456	90385	0.0	0.5	4/15/2007	ML-003	Thorium-230	-0.55	1.66	2.35	pCi/g	UJ
SAIC	IAAP100187	IAAP100187	687456	90385	0.0	0.5	4/15/2007	ML-003	Thorium-232	0.30	0.03	0.03	pCi/g	=
SAIC	IAAP100187	IAAP100187	687456	90385	0.0	0.5	4/15/2007	ML-003	Uranium-235	-0.04	0.08	0.14	pCi/g	UJ
SAIC	IAAP100187	IAAP100187	687456	90385	0.0	0.5	4/15/2007	ML-003	Uranium-238	0.30	0.26	0.23	pCi/g	J
SAIC	IAAP116611	IAAP116611	687574	90184	0.0	0.5	4/13/2009	ML-015	Uranium-234	0.46	0.32	0.14	pCi/g	J
SAIC	IAAP116611	IAAP116611	687574	90184	0.0	0.5	4/13/2009	ML-015	Uranium-235	0.00	0.00	0.17	pCi/g	U
SAIC	IAAP116611	IAAP116611	687574	90184	0.0	0.5	4/13/2009	ML-015	Uranium-238	0.65	0.40	0.26	pCi/g	J
SAIC	IAAP116611	IAAP116611	687574	90184	0.0	0.5	4/13/2009	ML-003	Actinium-227	0.00	0.11	0.18	pCi/g	UJ
SAIC	IAAP116611	IAAP116611	687574	90184	0.0	0.5	4/13/2009	ML-003	Americium-241	-0.02	0.03	0.04	pCi/g	UJ
SAIC	IAAP116611	IAAP116611	687574	90184	0.0	0.5	4/13/2009	ML-003	Cesium-137	0.02	0.02	0.02	pCi/g	J
SAIC	IAAP116611	IAAP116611	687574	90184	0.0	0.5	4/13/2009	ML-003	Potassium-40	13.70	0.85	0.13	pCi/g	=
SAIC	IAAP116611	IAAP116611	687574	90184	0.0	0.5	4/13/2009	ML-003	Protactinium-231	0.01	0.32	0.48	pCi/g	UJ
SAIC	IAAP116611	IAAP116611	687574	90184	0.0	0.5	4/13/2009	ML-003	Radium-226	0.83	0.22	0.04	pCi/g	=
SAIC	IAAP116611	IAAP116611	687574	90184	0.0	0.5	4/13/2009	ML-003	Radium-228	0.82	0.06	0.06	pCi/g	=
SAIC	IAAP116611	IAAP116611	687574	90184	0.0	0.5	4/13/2009	ML-003	Thorium-228	0.82	0.06	0.06	pCi/g	=
SAIC	IAAP116611	IAAP116611	687574	90184	0.0	0.5	4/13/2009	ML-003	Thorium-230	0.92	2.29	3.79	pCi/g	UJ
SAIC	IAAP116611	IAAP116611	687574	90184	0.0	0.5	4/13/2009	ML-003	Thorium-232	0.82	0.06	0.06	pCi/g	=
SAIC	IAAP116611	IAAP116611	687574	90184	0.0	0.5	4/13/2009	ML-003	Uranium-235	-0.03	0.15	0.23	pCi/g	UJ
SAIC	IAAP116611	IAAP116611	687574	90184	0.0	0.5	4/13/2009	ML-003	Uranium-238	0.64	0.42	0.38	pCi/g	J
SAIC	IAAP116612	IAAP116611	687574	90184	0.5	1.0	4/13/2009	ML-015	Uranium-234	0.50	0.36	0.15	pCi/g	J
SAIC	IAAP116612	IAAP116611	687574	90184	0.5	1.0	4/13/2009	ML-015	Uranium-235	0.00	0.00	0.19	pCi/g	U
SAIC	IAAP116612	IAAP116611	687574	90184	0.5	1.0	4/13/2009	ML-015	Uranium-238	0.95	0.51	0.15	pCi/g	J
SAIC	IAAP116612	IAAP116611	687574	90184	0.5	1.0	4/13/2009	ML-003	Actinium-227	0.04	0.10	0.17	pCi/g	UJ
SAIC	IAAP116612	IAAP116611	687574	90184	0.5	1.0	4/13/2009	ML-003	Americium-241	0.00	0.02	0.04	pCi/g	UJ
SAIC	IAAP116612	IAAP116611	687574	90184	0.5	1.0	4/13/2009	ML-003	Cesium-137	0.02	0.01	0.02	pCi/g	U
SAIC	IAAP116612	IAAP116611	687574	90184	0.5	1.0	4/13/2009	ML-003	Potassium-40	12.20	0.76	0.12	pCi/g	=
SAIC	IAAP116612	IAAP116611	687574	90184	0.5	1.0	4/13/2009	ML-003	Protactinium-231	0.06	0.30	0.46	pCi/g	UJ
SAIC	IAAP116612	IAAP116611	687574	90184	0.5	1.0	4/13/2009	ML-003	Radium-226	0.74	0.20	0.04	pCi/g	=

Table A-4-1. Firing Site 6 Area DU

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier
SAIC	IAAP116612	IAAP116611	687574	90184	0.5	1.0	4/13/2009	ML-003	Radium-228	0.77	0.05	0.05	pCi/g	=
SAIC	IAAP116612	IAAP116611	687574	90184	0.5	1.0	4/13/2009	ML-003	Thorium-228	0.77	0.05	0.05	pCi/g	=
SAIC	IAAP116612	IAAP116611	687574	90184	0.5	1.0	4/13/2009	ML-003	Thorium-230	1.92	2.26	3.53	pCi/g	UJ
SAIC	IAAP116612	IAAP116611	687574	90184	0.5	1.0	4/13/2009	ML-003	Thorium-232	0.77	0.05	0.05	pCi/g	=
SAIC	IAAP116612	IAAP116611	687574	90184	0.5	1.0	4/13/2009	ML-003	Uranium-235	-0.10	0.14	0.20	pCi/g	UJ
SAIC	IAAP116612	IAAP116611	687574	90184	0.5	1.0	4/13/2009	ML-003	Uranium-238	0.94	0.45	0.35	pCi/g	=
SAIC	IAAP116613	IAAP116611	687574	90184	1.0	1.5	4/13/2009	ML-015	Uranium-234	0.60	0.34	0.12	pCi/g	J
SAIC	IAAP116613	IAAP116611	687574	90184	1.0	1.5	4/13/2009	ML-015	Uranium-235	0.00	0.00	0.14	pCi/g	U
SAIC	IAAP116613	IAAP116611	687574	90184	1.0	1.5	4/13/2009	ML-015	Uranium-238	0.77	0.40	0.12	pCi/g	J
SAIC	IAAP116613	IAAP116611	687574	90184	1.0	1.5	4/13/2009	ML-003	Actinium-227	-0.03	0.09	0.14	pCi/g	UJ
SAIC	IAAP116613	IAAP116611	687574	90184	1.0	1.5	4/13/2009	ML-003	Americium-241	0.01	0.02	0.03	pCi/g	UJ
SAIC	IAAP116613	IAAP116611	687574	90184	1.0	1.5	4/13/2009	ML-003	Cesium-137	0.04	0.01	0.01	pCi/g	=
SAIC	IAAP116613	IAAP116611	687574	90184	1.0	1.5	4/13/2009	ML-003	Potassium-40	10.60	0.68	0.12	pCi/g	=
SAIC	IAAP116613	IAAP116611	687574	90184	1.0	1.5	4/13/2009	ML-003	Protactinium-231	0.01	0.27	0.41	pCi/g	UJ
SAIC	IAAP116613	IAAP116611	687574	90184	1.0	1.5	4/13/2009	ML-003	Radium-226	0.75	0.20	0.04	pCi/g	=
SAIC	IAAP116613	IAAP116611	687574	90184	1.0	1.5	4/13/2009	ML-003	Radium-228	0.64	0.05	0.05	pCi/g	=
SAIC	IAAP116613	IAAP116611	687574	90184	1.0	1.5	4/13/2009	ML-003	Thorium-228	0.64	0.05	0.05	pCi/g	=
SAIC	IAAP116613	IAAP116611	687574	90184	1.0	1.5	4/13/2009	ML-003	Thorium-230	-0.11	1.90	3.11	pCi/g	UJ
SAIC	IAAP116613	IAAP116611	687574	90184	1.0	1.5	4/13/2009	ML-003	Thorium-232	0.64	0.05	0.05	pCi/g	=
SAIC	IAAP116613	IAAP116611	687574	90184	1.0	1.5	4/13/2009	ML-003	Uranium-235	0.04	0.12	0.20	pCi/g	UJ
SAIC	IAAP116613	IAAP116611	687574	90184	1.0	1.5	4/13/2009	ML-003	Uranium-238	0.37	0.32	0.33	pCi/g	J
SAIC	IAAP116614	IAAP116611	687574	90184	1.5	2.0	4/13/2009	ML-015	Uranium-234	0.68	0.41	0.27	pCi/g	J
SAIC	IAAP116614	IAAP116611	687574	90184	1.5	2.0	4/13/2009	ML-015	Uranium-235	0.07	0.13	0.18	pCi/g	UJ
SAIC	IAAP116614	IAAP116611	687574	90184	1.5	2.0	4/13/2009	ML-015	Uranium-238	1.03	0.53	0.32	pCi/g	J
SAIC	IAAP116614	IAAP116611	687574	90184	1.5	2.0	4/13/2009	ML-003	Actinium-227	0.04	0.09	0.15	pCi/g	UJ
SAIC	IAAP116614	IAAP116611	687574	90184	1.5	2.0	4/13/2009	ML-003	Americium-241	0.00	0.02	0.03	pCi/g	UJ
SAIC	IAAP116614	IAAP116611	687574	90184	1.5	2.0	4/13/2009	ML-003	Cesium-137	0.02	0.01	0.01	pCi/g	J
SAIC	IAAP116614	IAAP116611	687574	90184	1.5	2.0	4/13/2009	ML-003	Potassium-40	10.90	0.70	0.15	pCi/g	=
SAIC	IAAP116614	IAAP116611	687574	90184	1.5	2.0	4/13/2009	ML-003	Protactinium-231	0.02	0.30	0.42	pCi/g	UJ
SAIC	IAAP116614	IAAP116611	687574	90184	1.5	2.0	4/13/2009	ML-003	Radium-226	0.75	0.20	0.04	pCi/g	=
SAIC	IAAP116614	IAAP116611	687574	90184	1.5	2.0	4/13/2009	ML-003	Radium-228	0.65	0.05	0.05	pCi/g	=
SAIC	IAAP116614	IAAP116611	687574	90184	1.5	2.0	4/13/2009	ML-003	Thorium-228	0.65	0.05	0.05	pCi/g	=
SAIC	IAAP116614	IAAP116611	687574	90184	1.5	2.0	4/13/2009	ML-003	Thorium-230	1.15	2.17	3.35	pCi/g	UJ
SAIC	IAAP116614	IAAP116611	687574	90184	1.5	2.0	4/13/2009	ML-003	Thorium-232	0.65	0.05	0.05	pCi/g	=
SAIC	IAAP116614	IAAP116611	687574	90184	1.5	2.0	4/13/2009	ML-003	Uranium-235	0.06	0.13	0.21	pCi/g	UJ
SAIC	IAAP116614	IAAP116611	687574	90184	1.5	2.0	4/13/2009	ML-003	Uranium-238	0.97	0.43	0.32	pCi/g	=
SAIC	IAAP116618	IAAP116618	687588	90209	0.0	0.5	4/13/2009	ML-015	Uranium-234	0.19	0.21	0.26	pCi/g	UJ
SAIC	IAAP116618	IAAP116618	687588	90209	0.0	0.5	4/13/2009	ML-015	Uranium-235	0.00	0.00	0.17	pCi/g	U
SAIC	IAAP116618	IAAP116618	687588	90209	0.0	0.5	4/13/2009	ML-015	Uranium-238	0.41	0.31	0.14	pCi/g	J
SAIC	IAAP116618	IAAP116618	687588	90209	0.0	0.5	4/13/2009	ML-003	Actinium-227	-0.01	0.06	0.09	pCi/g	UJ
SAIC	IAAP116618	IAAP116618	687588	90209	0.0	0.5	4/13/2009	ML-003	Americium-241	-0.01	0.02	0.04	pCi/g	UJ
SAIC	IAAP116618	IAAP116618	687588	90209	0.0	0.5	4/13/2009	ML-003	Cesium-137	0.00	0.01	0.01	pCi/g	UJ
SAIC	IAAP116618	IAAP116618	687588	90209	0.0	0.5	4/13/2009	ML-003	Potassium-40	1.13	0.22	0.06	pCi/g	J
SAIC	IAAP116618	IAAP116618	687588	90209	0.0	0.5	4/13/2009	ML-003	Protactinium-231	-0.13	0.16	0.24	pCi/g	UJ
SAIC	IAAP116618	IAAP116618	687588	90209	0.0	0.5	4/13/2009	ML-003	Radium-226	0.26	0.08	0.02	pCi/g	J
SAIC	IAAP116618	IAAP116618	687588	90209	0.0	0.5	4/13/2009	ML-003	Radium-228	0.08	0.02	0.03	pCi/g	J
SAIC	IAAP116618	IAAP116618	687588	90209	0.0	0.5	4/13/2009	ML-003	Thorium-228	0.08	0.02	0.03	pCi/g	J
SAIC	IAAP116618	IAAP116618	687588	90209	0.0	0.5	4/13/2009	ML-003	Thorium-230	-0.04	1.56	2.62	pCi/g	UJ
SAIC	IAAP116618	IAAP116618	687588	90209	0.0	0.5	4/13/2009	ML-003	Thorium-232	0.08	0.02	0.03	pCi/g	J
SAIC	IAAP116618	IAAP116618	687588	90209	0.0	0.5	4/13/2009	ML-003	Uranium-235	-0.01	0.08	0.12	pCi/g	UJ
SAIC	IAAP116618	IAAP116618	687588	90209	0.0	0.5	4/13/2009	ML-003	Uranium-238	0.01	0.21	0.36	pCi/g	UJ
SAIC	IAAP116619	IAAP116618	687588	90209	0.5	1.0	4/13/2009	ML-015	Uranium-234	0.29	0.26	0.15	pCi/g	J
SAIC	IAAP116619	IAAP116618	687588	90209	0.5	1.0	4/13/2009	ML-015	Uranium-235	0.00	0.00	0.19	pCi/g	U
SAIC	IAAP116619	IAAP116618	687588	90209	0.5	1.0	4/13/2009	ML-015	Uranium-238	0.99	0.54	0.34	pCi/g	J
SAIC	IAAP116619	IAAP116618	687588	90209	0.5	1.0	4/13/2009	ML-003	Actinium-227	-0.04	0.08	0.13	pCi/g	UJ
SAIC	IAAP116619	IAAP116618	687588	90209	0.5	1.0	4/13/2009	ML-003	Americium-241	-0.04	0.04	0.05	pCi/g	UJ
SAIC	IAAP116619	IAAP116618	687588	90209	0.5	1.0	4/13/2009	ML-003	Cesium-137	0.00	0.01	0.01	pCi/g	UJ

Table A-4-1. Firing Site 6 Area DU

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier
SAIC	IAAP116619	IAAP116618	687588	90209	0.5	1.0	4/13/2009	ML-003	Potassium-40	3.68	0.42	0.12	pCi/g	=
SAIC	IAAP116619	IAAP116618	687588	90209	0.5	1.0	4/13/2009	ML-003	Protactinium-231	-0.01	0.24	0.37	pCi/g	UJ
SAIC	IAAP116619	IAAP116618	687588	90209	0.5	1.0	4/13/2009	ML-003	Radium-226	0.47	0.14	0.03	pCi/g	J
SAIC	IAAP116619	IAAP116618	687588	90209	0.5	1.0	4/13/2009	ML-003	Radium-228	0.21	0.03	0.04	pCi/g	J
SAIC	IAAP116619	IAAP116618	687588	90209	0.5	1.0	4/13/2009	ML-003	Thorium-228	0.21	0.03	0.04	pCi/g	J
SAIC	IAAP116619	IAAP116618	687588	90209	0.5	1.0	4/13/2009	ML-003	Thorium-230	1.56	2.54	4.41	pCi/g	UJ
SAIC	IAAP116619	IAAP116618	687588	90209	0.5	1.0	4/13/2009	ML-003	Thorium-232	0.21	0.03	0.04	pCi/g	J
SAIC	IAAP116619	IAAP116618	687588	90209	0.5	1.0	4/13/2009	ML-003	Uranium-235	0.07	0.10	0.17	pCi/g	UJ
SAIC	IAAP116619	IAAP116618	687588	90209	0.5	1.0	4/13/2009	ML-003	Uranium-238	1.09	0.50	0.46	pCi/g	=
SAIC	IAAP116620	IAAP116618	687588	90209	1.0	1.5	4/13/2009	ML-015	Uranium-234	0.58	0.34	0.12	pCi/g	J
SAIC	IAAP116620	IAAP116618	687588	90209	1.0	1.5	4/13/2009	ML-015	Uranium-235	0.17	0.19	0.15	pCi/g	J
SAIC	IAAP116620	IAAP116618	687588	90209	1.0	1.5	4/13/2009	ML-015	Uranium-238	4.34	1.27	0.12	pCi/g	=
SAIC	IAAP116620	IAAP116618	687588	90209	1.0	1.5	4/13/2009	ML-003	Actinium-227	-0.01	0.13	0.18	pCi/g	UJ
SAIC	IAAP116620	IAAP116618	687588	90209	1.0	1.5	4/13/2009	ML-003	Americium-241	0.03	0.06	0.10	pCi/g	UJ
SAIC	IAAP116620	IAAP116618	687588	90209	1.0	1.5	4/13/2009	ML-003	Cesium-137	0.01	0.01	0.02	pCi/g	UJ
SAIC	IAAP116620	IAAP116618	687588	90209	1.0	1.5	4/13/2009	ML-003	Potassium-40	6.87	0.63	0.12	pCi/g	=
SAIC	IAAP116620	IAAP116618	687588	90209	1.0	1.5	4/13/2009	ML-003	Protactinium-231	0.02	0.32	0.50	pCi/g	UJ
SAIC	IAAP116620	IAAP116618	687588	90209	1.0	1.5	4/13/2009	ML-003	Radium-226	0.50	0.15	0.05	pCi/g	J
SAIC	IAAP116620	IAAP116618	687588	90209	1.0	1.5	4/13/2009	ML-003	Radium-228	0.34	0.05	0.06	pCi/g	=
SAIC	IAAP116620	IAAP116618	687588	90209	1.0	1.5	4/13/2009	ML-003	Thorium-228	0.34	0.05	0.06	pCi/g	=
SAIC	IAAP116620	IAAP116618	687588	90209	1.0	1.5	4/13/2009	ML-003	Thorium-230	-1.19	4.62	7.70	pCi/g	UJ
SAIC	IAAP116620	IAAP116618	687588	90209	1.0	1.5	4/13/2009	ML-003	Thorium-232	0.34	0.05	0.06	pCi/g	=
SAIC	IAAP116620	IAAP116618	687588	90209	1.0	1.5	4/13/2009	ML-003	Uranium-235	0.31	0.17	0.25	pCi/g	J
SAIC	IAAP116620	IAAP116618	687588	90209	1.0	1.5	4/13/2009	ML-003	Uranium-238	14.80	1.50	0.85	pCi/g	=
SAIC	IAAP116621	IAAP116618	687588	90209	1.5	2.0	4/13/2009	ML-015	Uranium-234	5.54	1.63	0.13	pCi/g	=
SAIC	IAAP116621	IAAP116618	687588	90209	1.5	2.0	4/13/2009	ML-015	Uranium-235	0.64	0.41	0.16	pCi/g	J
SAIC	IAAP116621	IAAP116618	687588	90209	1.5	2.0	4/13/2009	ML-015	Uranium-238	41.90	9.94	0.13	pCi/g	=
SAIC	IAAP116621	IAAP116618	687588	90209	1.5	2.0	4/13/2009	ML-003	Actinium-227	0.03	0.19	0.27	pCi/g	UJ
SAIC	IAAP116621	IAAP116618	687588	90209	1.5	2.0	4/13/2009	ML-003	Americium-241	0.06	0.11	0.17	pCi/g	UJ
SAIC	IAAP116621	IAAP116618	687588	90209	1.5	2.0	4/13/2009	ML-003	Cesium-137	0.04	0.02	0.02	pCi/g	J
SAIC	IAAP116621	IAAP116618	687588	90209	1.5	2.0	4/13/2009	ML-003	Potassium-40	6.66	0.58	0.12	pCi/g	=
SAIC	IAAP116621	IAAP116618	687588	90209	1.5	2.0	4/13/2009	ML-003	Protactinium-231	0.04	0.46	0.71	pCi/g	UJ
SAIC	IAAP116621	IAAP116618	687588	90209	1.5	2.0	4/13/2009	ML-003	Radium-226	0.60	0.18	0.06	pCi/g	J
SAIC	IAAP116621	IAAP116618	687588	90209	1.5	2.0	4/13/2009	ML-003	Radium-228	0.42	0.05	0.06	pCi/g	=
SAIC	IAAP116621	IAAP116618	687588	90209	1.5	2.0	4/13/2009	ML-003	Thorium-228	0.42	0.05	0.06	pCi/g	=
SAIC	IAAP116621	IAAP116618	687588	90209	1.5	2.0	4/13/2009	ML-003	Thorium-230	-7.31	7.55	12.50	pCi/g	UJ
SAIC	IAAP116621	IAAP116618	687588	90209	1.5	2.0	4/13/2009	ML-003	Thorium-232	0.42	0.05	0.06	pCi/g	=
SAIC	IAAP116621	IAAP116618	687588	90209	1.5	2.0	4/13/2009	ML-003	Uranium-235	0.83	0.28	0.38	pCi/g	=
SAIC	IAAP116621	IAAP116618	687588	90209	1.5	2.0	4/13/2009	ML-003	Uranium-238	43.30	2.65	1.38	pCi/g	=
SAIC	IAAP116622	IAAP116618	687588	90209	2.0	2.5	4/13/2009	ML-015	Uranium-234	1.74	0.65	0.11	pCi/g	=
SAIC	IAAP116622	IAAP116618	687588	90209	2.0	2.5	4/13/2009	ML-015	Uranium-235	0.15	0.17	0.13	pCi/g	J
SAIC	IAAP116622	IAAP116618	687588	90209	2.0	2.5	4/13/2009	ML-015	Uranium-238	11.20	2.80	0.11	pCi/g	=
SAIC	IAAP116622	IAAP116618	687588	90209	2.0	2.5	4/13/2009	ML-003	Actinium-227	-0.01	0.12	0.17	pCi/g	UJ
SAIC	IAAP116622	IAAP116618	687588	90209	2.0	2.5	4/13/2009	ML-003	Americium-241	-0.02	0.08	0.12	pCi/g	UJ
SAIC	IAAP116622	IAAP116618	687588	90209	2.0	2.5	4/13/2009	ML-003	Cesium-137	0.02	0.02	0.02	pCi/g	J
SAIC	IAAP116622	IAAP116618	687588	90209	2.0	2.5	4/13/2009	ML-003	Potassium-40	7.99	0.69	0.12	pCi/g	=
SAIC	IAAP116622	IAAP116618	687588	90209	2.0	2.5	4/13/2009	ML-003	Protactinium-231	-0.11	0.34	0.51	pCi/g	UJ
SAIC	IAAP116622	IAAP116618	687588	90209	2.0	2.5	4/13/2009	ML-003	Radium-226	0.63	0.18	0.05	pCi/g	J
SAIC	IAAP116622	IAAP116618	687588	90209	2.0	2.5	4/13/2009	ML-003	Radium-228	0.53	0.05	0.06	pCi/g	=
SAIC	IAAP116622	IAAP116618	687588	90209	2.0	2.5	4/13/2009	ML-003	Thorium-228	0.53	0.05	0.06	pCi/g	=
SAIC	IAAP116622	IAAP116618	687588	90209	2.0	2.5	4/13/2009	ML-003	Thorium-230	0.66	5.14	8.67	pCi/g	UJ
SAIC	IAAP116622	IAAP116618	687588	90209	2.0	2.5	4/13/2009	ML-003	Thorium-232	0.53	0.05	0.06	pCi/g	=
SAIC	IAAP116622	IAAP116618	687588	90209	2.0	2.5	4/13/2009	ML-003	Uranium-235	0.35	0.19	0.25	pCi/g	J
SAIC	IAAP116622	IAAP116618	687588	90209	2.0	2.5	4/13/2009	ML-003	Uranium-238	19.70	1.69	0.95	pCi/g	=
SAIC	IAAP116623	IAAP116618	687588	90209	2.5	3.0	4/13/2009	ML-015	Uranium-234	1.65	0.75	0.17	pCi/g	=
SAIC	IAAP116623	IAAP116618	687588	90209	2.5	3.0	4/13/2009	ML-015	Uranium-235	0.08	0.15	0.20	pCi/g	UJ
SAIC	IAAP116623	IAAP116618	687588	90209	2.5	3.0	4/13/2009	ML-015	Uranium-238	7.45	2.26	0.31	pCi/g	=

Table A-4-1. Firing Site 6 Area DU

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier
SAIC	IAAP116623	IAAP116618	687588	90209	2.5	3.0	4/13/2009	ML-003	Actinium-227	0.06	0.12	0.18	pCi/g	UJ
SAIC	IAAP116623	IAAP116618	687588	90209	2.5	3.0	4/13/2009	ML-003	Americium-241	0.00	0.06	0.09	pCi/g	UJ
SAIC	IAAP116623	IAAP116618	687588	90209	2.5	3.0	4/13/2009	ML-003	Cesium-137	0.01	0.01	0.02	pCi/g	UJ
SAIC	IAAP116623	IAAP116618	687588	90209	2.5	3.0	4/13/2009	ML-003	Potassium-40	9.57	0.79	0.18	pCi/g	=
SAIC	IAAP116623	IAAP116618	687588	90209	2.5	3.0	4/13/2009	ML-003	Protactinium-231	0.07	0.31	0.48	pCi/g	UJ
SAIC	IAAP116623	IAAP116618	687588	90209	2.5	3.0	4/13/2009	ML-003	Radium-226	0.79	0.22	0.05	pCi/g	=
SAIC	IAAP116623	IAAP116618	687588	90209	2.5	3.0	4/13/2009	ML-003	Radium-228	0.63	0.06	0.06	pCi/g	=
SAIC	IAAP116623	IAAP116618	687588	90209	2.5	3.0	4/13/2009	ML-003	Thorium-228	0.63	0.06	0.06	pCi/g	=
SAIC	IAAP116623	IAAP116618	687588	90209	2.5	3.0	4/13/2009	ML-003	Thorium-230	0.44	3.94	6.66	pCi/g	UJ
SAIC	IAAP116623	IAAP116618	687588	90209	2.5	3.0	4/13/2009	ML-003	Thorium-232	0.63	0.06	0.06	pCi/g	=
SAIC	IAAP116623	IAAP116618	687588	90209	2.5	3.0	4/13/2009	ML-003	Uranium-235	0.19	0.19	0.26	pCi/g	U
SAIC	IAAP116623	IAAP116618	687588	90209	2.5	3.0	4/13/2009	ML-003	Uranium-238	6.12	0.93	0.74	pCi/g	=
SAIC	IAAP116624	IAAP116624	687617	90209	0.0	0.5	4/13/2009	ML-015	Uranium-234	0.67	0.41	0.26	pCi/g	J
SAIC	IAAP116624-1	IAAP116624	687617	90209	0.0	0.5	4/13/2009	ML-015	Uranium-234	1.51	0.81	0.41	pCi/g	J
SAIC	IAAP116624	IAAP116624	687617	90209	0.0	0.5	4/13/2009	ML-015	Uranium-235	0.06	0.13	0.18	pCi/g	UJ
SAIC	IAAP116624-1	IAAP116624	687617	90209	0.0	0.5	4/13/2009	ML-015	Uranium-235	0.10	0.20	0.27	pCi/g	UJ
SAIC	IAAP116624	IAAP116624	687617	90209	0.0	0.5	4/13/2009	ML-015	Uranium-238	0.52	0.35	0.14	pCi/g	J
SAIC	IAAP116624-1	IAAP116624	687617	90209	0.0	0.5	4/13/2009	ML-015	Uranium-238	1.04	0.64	0.22	pCi/g	J
SAIC	IAAP116624	IAAP116624	687617	90209	0.0	0.5	4/13/2009	ML-003	Actinium-227	-0.04	0.14	0.21	pCi/g	UJ
SAIC	IAAP116624-1	IAAP116624	687617	90209	0.0	0.5	4/13/2009	ML-003	Actinium-227	-0.12	0.14	0.20	pCi/g	UJ
SAIC	IAAP116624	IAAP116624	687617	90209	0.0	0.5	4/13/2009	ML-003	Americium-241	-0.02	0.05	0.09	pCi/g	UJ
SAIC	IAAP116624-1	IAAP116624	687617	90209	0.0	0.5	4/13/2009	ML-003	Americium-241	0.00	0.05	0.08	pCi/g	UJ
SAIC	IAAP116624	IAAP116624	687617	90209	0.0	0.5	4/13/2009	ML-003	Cesium-137	0.00	0.01	0.02	pCi/g	UJ
SAIC	IAAP116624-1	IAAP116624	687617	90209	0.0	0.5	4/13/2009	ML-003	Cesium-137	0.01	0.01	0.02	pCi/g	UJ
SAIC	IAAP116624	IAAP116624	687617	90209	0.0	0.5	4/13/2009	ML-003	Potassium-40	9.73	0.95	0.20	pCi/g	=
SAIC	IAAP116624-1	IAAP116624	687617	90209	0.0	0.5	4/13/2009	ML-003	Potassium-40	9.47	0.86	0.17	pCi/g	=
SAIC	IAAP116624	IAAP116624	687617	90209	0.0	0.5	4/13/2009	ML-003	Protactinium-231	0.20	0.44	0.70	pCi/g	UJ
SAIC	IAAP116624-1	IAAP116624	687617	90209	0.0	0.5	4/13/2009	ML-003	Protactinium-231	0.09	0.38	0.60	pCi/g	UJ
SAIC	IAAP116624	IAAP116624	687617	90209	0.0	0.5	4/13/2009	ML-003	Radium-226	0.77	0.22	0.06	pCi/g	=
SAIC	IAAP116624-1	IAAP116624	687617	90209	0.0	0.5	4/13/2009	ML-003	Radium-226	0.77	0.23	0.06	pCi/g	=
SAIC	IAAP116624	IAAP116624	687617	90209	0.0	0.5	4/13/2009	ML-003	Radium-228	0.56	0.07	0.07	pCi/g	=
SAIC	IAAP116624-1	IAAP116624	687617	90209	0.0	0.5	4/13/2009	ML-003	Radium-228	0.63	0.06	0.06	pCi/g	=
SAIC	IAAP116624	IAAP116624	687617	90209	0.0	0.5	4/13/2009	ML-003	Thorium-228	0.56	0.07	0.07	pCi/g	=
SAIC	IAAP116624-1	IAAP116624	687617	90209	0.0	0.5	4/13/2009	ML-003	Thorium-228	0.63	0.06	0.06	pCi/g	=
SAIC	IAAP116624	IAAP116624	687617	90209	0.0	0.5	4/13/2009	ML-003	Thorium-230	8.27	7.01	7.08	pCi/g	J
SAIC	IAAP116624-1	IAAP116624	687617	90209	0.0	0.5	4/13/2009	ML-003	Thorium-230	-2.34	4.22	6.92	pCi/g	UJ
SAIC	IAAP116624	IAAP116624	687617	90209	0.0	0.5	4/13/2009	ML-003	Thorium-232	0.56	0.07	0.07	pCi/g	=
SAIC	IAAP116624-1	IAAP116624	687617	90209	0.0	0.5	4/13/2009	ML-003	Thorium-232	0.63	0.06	0.06	pCi/g	=
SAIC	IAAP116625	IAAP116624	687617	90209	0.5	1.0	4/13/2009	ML-015	Uranium-234	0.54	0.38	0.16	pCi/g	J
SAIC	IAAP116625	IAAP116624	687617	90209	0.5	1.0	4/13/2009	ML-015	Uranium-235	0.15	0.21	0.20	pCi/g	UJ
SAIC	IAAP116625	IAAP116624	687617	90209	0.5	1.0	4/13/2009	ML-015	Uranium-238	0.71	0.45	0.16	pCi/g	J
SAIC	IAAP116625	IAAP116624	687617	90209	0.5	1.0	4/13/2009	ML-003	Actinium-227	0.01	0.11	0.17	pCi/g	UJ
SAIC	IAAP116625	IAAP116624	687617	90209	0.5	1.0	4/13/2009	ML-003	Americium-241	-0.01	0.04	0.07	pCi/g	UJ
SAIC	IAAP116625	IAAP116624	687617	90209	0.5	1.0	4/13/2009	ML-003	Cesium-137	0.01	0.01	0.02	pCi/g	UJ
SAIC	IAAP116625	IAAP116624	687617	90209	0.5	1.0	4/13/2009	ML-003	Potassium-40	8.39	0.69	0.14	pCi/g	=
SAIC	IAAP116625	IAAP116624	687617	90209	0.5	1.0	4/13/2009	ML-003	Protactinium-231	-0.08	0.30	0.45	pCi/g	UJ
SAIC	IAAP116625	IAAP116624	687617	90209	0.5	1.0	4/13/2009	ML-003	Radium-226	0.69	0.19	0.04	pCi/g	=
SAIC	IAAP116625	IAAP116624	687617	90209	0.5	1.0	4/13/2009	ML-003	Radium-228	0.53	0.05	0.06	pCi/g	=
SAIC	IAAP116625	IAAP116624	687617	90209	0.5	1.0	4/13/2009	ML-003	Thorium-228	0.53	0.05	0.06	pCi/g	=
SAIC	IAAP116625	IAAP116624	687617	90209	0.5	1.0	4/13/2009	ML-003	Thorium-230	0.41	3.26	5.52	pCi/g	UJ
SAIC	IAAP116625	IAAP116624	687617	90209	0.5	1.0	4/13/2009	ML-003	Thorium-232	0.53	0.05	0.06	pCi/g	=
SAIC	IAAP116626	IAAP116624	687617	90209	1.0	1.5	4/13/2009	ML-015	Uranium-234	0.75	0.47	0.17	pCi/g	J
SAIC	IAAP116626	IAAP116624	687617	90209	1.0	1.5	4/13/2009	ML-015	Uranium-235	0.00	0.00	0.21	pCi/g	U
SAIC	IAAP116626	IAAP116624	687617	90209	1.0	1.5	4/13/2009	ML-015	Uranium-238	0.68	0.44	0.17	pCi/g	J
SAIC	IAAP116626	IAAP116624	687617	90209	1.0	1.5	4/13/2009	ML-003	Actinium-227	0.09	0.11	0.18	pCi/g	UJ
SAIC	IAAP116626	IAAP116624	687617	90209	1.0	1.5	4/13/2009	ML-003	Americium-241	0.01	0.04	0.07	pCi/g	UJ
SAIC	IAAP116626	IAAP116624	687617	90209	1.0	1.5	4/13/2009	ML-003	Cesium-137	0.03	0.02	0.02	pCi/g	J

Table A-4-1. Firing Site 6 Area DU

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier
SAIC	IAAP116626	IAAP116624	687617	90209	1.0	1.5	4/13/2009	ML-003	Potassium-40	7.49	0.64	0.12	pCi/g	=
SAIC	IAAP116626	IAAP116624	687617	90209	1.0	1.5	4/13/2009	ML-003	Protactinium-231	0.10	0.29	0.47	pCi/g	UJ
SAIC	IAAP116626	IAAP116624	687617	90209	1.0	1.5	4/13/2009	ML-003	Radium-226	0.84	0.23	0.04	pCi/g	=
SAIC	IAAP116626	IAAP116624	687617	90209	1.0	1.5	4/13/2009	ML-003	Radium-228	0.52	0.05	0.04	pCi/g	=
SAIC	IAAP116626	IAAP116624	687617	90209	1.0	1.5	4/13/2009	ML-003	Thorium-228	0.52	0.05	0.04	pCi/g	=
SAIC	IAAP116626	IAAP116624	687617	90209	1.0	1.5	4/13/2009	ML-003	Thorium-230	-0.40	3.30	5.52	pCi/g	UJ
SAIC	IAAP116626	IAAP116624	687617	90209	1.0	1.5	4/13/2009	ML-003	Thorium-232	0.52	0.05	0.04	pCi/g	=
SAIC	IAAP116627	IAAP116624	687617	90209	1.5	2.0	4/13/2009	ML-015	Uranium-234	0.38	0.30	0.15	pCi/g	J
SAIC	IAAP116627	IAAP116624	687617	90209	1.5	2.0	4/13/2009	ML-015	Uranium-235	0.05	0.14	0.34	pCi/g	UJ
SAIC	IAAP116627	IAAP116624	687617	90209	1.5	2.0	4/13/2009	ML-015	Uranium-238	1.06	0.54	0.27	pCi/g	J
SAIC	IAAP116627	IAAP116624	687617	90209	1.5	2.0	4/13/2009	ML-003	Actinium-227	-0.07	0.15	0.23	pCi/g	UJ
SAIC	IAAP116627	IAAP116624	687617	90209	1.5	2.0	4/13/2009	ML-003	Americium-241	0.09	0.11	0.10	pCi/g	UJ
SAIC	IAAP116627	IAAP116624	687617	90209	1.5	2.0	4/13/2009	ML-003	Cesium-137	0.05	0.04	0.02	pCi/g	J
SAIC	IAAP116627	IAAP116624	687617	90209	1.5	2.0	4/13/2009	ML-003	Potassium-40	10.90	0.96	0.15	pCi/g	=
SAIC	IAAP116627	IAAP116624	687617	90209	1.5	2.0	4/13/2009	ML-003	Protactinium-231	0.10	0.39	0.69	pCi/g	UJ
SAIC	IAAP116627	IAAP116624	687617	90209	1.5	2.0	4/13/2009	ML-003	Radium-226	0.98	0.27	0.06	pCi/g	=
SAIC	IAAP116627	IAAP116624	687617	90209	1.5	2.0	4/13/2009	ML-003	Radium-228	0.87	0.08	0.08	pCi/g	=
SAIC	IAAP116627	IAAP116624	687617	90209	1.5	2.0	4/13/2009	ML-003	Thorium-228	0.87	0.08	0.08	pCi/g	=
SAIC	IAAP116627	IAAP116624	687617	90209	1.5	2.0	4/13/2009	ML-003	Thorium-230	0.31	4.62	7.80	pCi/g	UJ
SAIC	IAAP116627	IAAP116624	687617	90209	1.5	2.0	4/13/2009	ML-003	Thorium-232	0.87	0.08	0.08	pCi/g	=
SAIC	IAAP116628	IAAP116628	687603	90234	0.0	0.5	4/13/2009	ML-015	Uranium-234	1.04	0.55	0.16	pCi/g	J
SAIC	IAAP116628	IAAP116628	687603	90234	0.0	0.5	4/13/2009	ML-015	Uranium-235	0.07	0.14	0.19	pCi/g	UJ
SAIC	IAAP116628	IAAP116628	687603	90234	0.0	0.5	4/13/2009	ML-015	Uranium-238	1.09	0.56	0.16	pCi/g	J
SAIC	IAAP116628	IAAP116628	687603	90234	0.0	0.5	4/13/2009	ML-003	Actinium-227	-0.02	0.15	0.23	pCi/g	UJ
SAIC	IAAP116628	IAAP116628	687603	90234	0.0	0.5	4/13/2009	ML-003	Americium-241	0.03	0.06	0.10	pCi/g	UJ
SAIC	IAAP116628	IAAP116628	687603	90234	0.0	0.5	4/13/2009	ML-003	Cesium-137	0.06	0.04	0.03	pCi/g	J
SAIC	IAAP116628	IAAP116628	687603	90234	0.0	0.5	4/13/2009	ML-003	Potassium-40	12.10	1.00	0.23	pCi/g	=
SAIC	IAAP116628	IAAP116628	687603	90234	0.0	0.5	4/13/2009	ML-003	Protactinium-231	0.40	0.42	0.70	pCi/g	UJ
SAIC	IAAP116628	IAAP116628	687603	90234	0.0	0.5	4/13/2009	ML-003	Radium-226	0.79	0.23	0.06	pCi/g	=
SAIC	IAAP116628	IAAP116628	687603	90234	0.0	0.5	4/13/2009	ML-003	Radium-228	0.77	0.07	0.08	pCi/g	=
SAIC	IAAP116628	IAAP116628	687603	90234	0.0	0.5	4/13/2009	ML-003	Thorium-228	0.77	0.07	0.08	pCi/g	=
SAIC	IAAP116628	IAAP116628	687603	90234	0.0	0.5	4/13/2009	ML-003	Thorium-230	-0.37	4.24	7.12	pCi/g	UJ
SAIC	IAAP116628	IAAP116628	687603	90234	0.0	0.5	4/13/2009	ML-003	Thorium-232	0.77	0.07	0.08	pCi/g	=
SAIC	IAAP116629	IAAP116628	687603	90234	0.5	1.0	4/13/2009	ML-015	Uranium-234	0.62	0.42	0.17	pCi/g	J
SAIC	IAAP116629	IAAP116628	687603	90234	0.5	1.0	4/13/2009	ML-015	Uranium-235	0.23	0.27	0.21	pCi/g	J
SAIC	IAAP116629	IAAP116628	687603	90234	0.5	1.0	4/13/2009	ML-015	Uranium-238	1.05	0.57	0.17	pCi/g	J
SAIC	IAAP116629	IAAP116628	687603	90234	0.5	1.0	4/13/2009	ML-003	Actinium-227	-0.06	0.15	0.23	pCi/g	UJ
SAIC	IAAP116629	IAAP116628	687603	90234	0.5	1.0	4/13/2009	ML-003	Americium-241	0.01	0.06	0.10	pCi/g	UJ
SAIC	IAAP116629	IAAP116628	687603	90234	0.5	1.0	4/13/2009	ML-003	Cesium-137	0.02	0.02	0.03	pCi/g	U
SAIC	IAAP116629	IAAP116628	687603	90234	0.5	1.0	4/13/2009	ML-003	Potassium-40	12.80	1.01	0.13	pCi/g	=
SAIC	IAAP116629	IAAP116628	687603	90234	0.5	1.0	4/13/2009	ML-003	Protactinium-231	-0.08	0.39	0.60	pCi/g	UJ
SAIC	IAAP116629	IAAP116628	687603	90234	0.5	1.0	4/13/2009	ML-003	Radium-226	1.00	0.27	0.06	pCi/g	=
SAIC	IAAP116629	IAAP116628	687603	90234	0.5	1.0	4/13/2009	ML-003	Radium-228	0.89	0.08	0.08	pCi/g	=
SAIC	IAAP116629	IAAP116628	687603	90234	0.5	1.0	4/13/2009	ML-003	Thorium-228	0.89	0.08	0.08	pCi/g	=
SAIC	IAAP116629	IAAP116628	687603	90234	0.5	1.0	4/13/2009	ML-003	Thorium-230	2.82	4.69	8.07	pCi/g	UJ
SAIC	IAAP116629	IAAP116628	687603	90234	0.5	1.0	4/13/2009	ML-003	Thorium-232	0.89	0.08	0.08	pCi/g	=
SAIC	IAAP116630	IAAP116628	687603	90234	1.0	1.5	4/13/2009	ML-015	Uranium-234	1.09	0.60	0.33	pCi/g	J
SAIC	IAAP116630	IAAP116628	687603	90234	1.0	1.5	4/13/2009	ML-015	Uranium-235	0.24	0.28	0.22	pCi/g	J
SAIC	IAAP116630	IAAP116628	687603	90234	1.0	1.5	4/13/2009	ML-015	Uranium-238	1.19	0.64	0.39	pCi/g	J
SAIC	IAAP116630	IAAP116628	687603	90234	1.0	1.5	4/13/2009	ML-003	Actinium-227	-0.01	0.14	0.21	pCi/g	UJ
SAIC	IAAP116630	IAAP116628	687603	90234	1.0	1.5	4/13/2009	ML-003	Americium-241	-0.03	0.05	0.08	pCi/g	UJ
SAIC	IAAP116630	IAAP116628	687603	90234	1.0	1.5	4/13/2009	ML-003	Cesium-137	0.05	0.02	0.02	pCi/g	=
SAIC	IAAP116630	IAAP116628	687603	90234	1.0	1.5	4/13/2009	ML-003	Potassium-40	10.20	0.88	0.14	pCi/g	=
SAIC	IAAP116630	IAAP116628	687603	90234	1.0	1.5	4/13/2009	ML-003	Protactinium-231	0.17	0.35	0.57	pCi/g	UJ
SAIC	IAAP116630	IAAP116628	687603	90234	1.0	1.5	4/13/2009	ML-003	Radium-226	0.90	0.25	0.05	pCi/g	=
SAIC	IAAP116630	IAAP116628	687603	90234	1.0	1.5	4/13/2009	ML-003	Radium-228	0.73	0.07	0.07	pCi/g	=
SAIC	IAAP116630	IAAP116628	687603	90234	1.0	1.5	4/13/2009	ML-003	Thorium-228	0.73	0.07	0.07	pCi/g	=

Table A-4-1. Firing Site 6 Area DU

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier
SAIC	IAAP116630	IAAP116628	687603	90234	1.0	1.5	4/13/2009	ML-003	Thorium-230	-0.37	4.30	7.21	pCi/g	UJ
SAIC	IAAP116630	IAAP116628	687603	90234	1.0	1.5	4/13/2009	ML-003	Thorium-232	0.73	0.07	0.07	pCi/g	=
SAIC	IAAP116631	IAAP116628	687603	90234	1.5	2.0	4/13/2009	ML-015	Uranium-234	0.95	0.53	0.16	pCi/g	J
SAIC	IAAP116631	IAAP116628	687603	90234	1.5	2.0	4/13/2009	ML-015	Uranium-235	-0.02	0.04	0.37	pCi/g	UJ
SAIC	IAAP116631	IAAP116628	687603	90234	1.5	2.0	4/13/2009	ML-015	Uranium-238	1.42	0.67	0.16	pCi/g	=
SAIC	IAAP116631	IAAP116628	687603	90234	1.5	2.0	4/13/2009	ML-003	Actinium-227	0.13	0.14	0.24	pCi/g	UJ
SAIC	IAAP116631	IAAP116628	687603	90234	1.5	2.0	4/13/2009	ML-003	Americium-241	-0.01	0.06	0.10	pCi/g	UJ
SAIC	IAAP116631	IAAP116628	687603	90234	1.5	2.0	4/13/2009	ML-003	Cesium-137	0.01	0.02	0.03	pCi/g	UJ
SAIC	IAAP116631	IAAP116628	687603	90234	1.5	2.0	4/13/2009	ML-003	Potassium-40	12.20	0.99	0.13	pCi/g	=
SAIC	IAAP116631	IAAP116628	687603	90234	1.5	2.0	4/13/2009	ML-003	Protactinium-231	0.03	0.41	0.63	pCi/g	UJ
SAIC	IAAP116631	IAAP116628	687603	90234	1.5	2.0	4/13/2009	ML-003	Radium-226	0.95	0.27	0.06	pCi/g	=
SAIC	IAAP116631	IAAP116628	687603	90234	1.5	2.0	4/13/2009	ML-003	Radium-228	0.85	0.08	0.07	pCi/g	=
SAIC	IAAP116631	IAAP116628	687603	90234	1.5	2.0	4/13/2009	ML-003	Thorium-228	0.85	0.08	0.07	pCi/g	=
SAIC	IAAP116631	IAAP116628	687603	90234	1.5	2.0	4/13/2009	ML-003	Thorium-230	6.83	7.12	7.77	pCi/g	UJ
SAIC	IAAP116631	IAAP116628	687603	90234	1.5	2.0	4/13/2009	ML-003	Thorium-232	0.85	0.08	0.07	pCi/g	=
SAIC	IAAP116632	IAAP116632	687632	90234	0.0	0.5	4/14/2009	ML-015	Uranium-234	0.45	0.34	0.15	pCi/g	J
SAIC	IAAP116632	IAAP116632	687632	90234	0.0	0.5	4/14/2009	ML-015	Uranium-235	0.00	0.00	0.19	pCi/g	U
SAIC	IAAP116632	IAAP116632	687632	90234	0.0	0.5	4/14/2009	ML-015	Uranium-238	1.06	0.55	0.28	pCi/g	J
SAIC	IAAP116632	IAAP116632	687632	90234	0.0	0.5	4/14/2009	ML-003	Actinium-227	0.00	0.11	0.18	pCi/g	UJ
SAIC	IAAP116632	IAAP116632	687632	90234	0.0	0.5	4/14/2009	ML-003	Americium-241	-0.01	0.04	0.07	pCi/g	UJ
SAIC	IAAP116632	IAAP116632	687632	90234	0.0	0.5	4/14/2009	ML-003	Cesium-137	0.36	0.04	0.02	pCi/g	=
SAIC	IAAP116632	IAAP116632	687632	90234	0.0	0.5	4/14/2009	ML-003	Potassium-40	7.48	0.72	0.16	pCi/g	=
SAIC	IAAP116632	IAAP116632	687632	90234	0.0	0.5	4/14/2009	ML-003	Protactinium-231	0.00	0.30	0.46	pCi/g	UJ
SAIC	IAAP116632	IAAP116632	687632	90234	0.0	0.5	4/14/2009	ML-003	Radium-226	0.56	0.16	0.05	pCi/g	J
SAIC	IAAP116632	IAAP116632	687632	90234	0.0	0.5	4/14/2009	ML-003	Radium-228	0.30	0.05	0.05	pCi/g	J
SAIC	IAAP116632	IAAP116632	687632	90234	0.0	0.5	4/14/2009	ML-003	Thorium-228	0.30	0.05	0.05	pCi/g	J
SAIC	IAAP116632	IAAP116632	687632	90234	0.0	0.5	4/14/2009	ML-003	Thorium-230	-0.85	3.14	5.21	pCi/g	UJ
SAIC	IAAP116632	IAAP116632	687632	90234	0.0	0.5	4/14/2009	ML-003	Thorium-232	0.30	0.05	0.05	pCi/g	J
SAIC	IAAP116633	IAAP116632	687632	90234	0.5	1.0	4/14/2009	ML-015	Uranium-234	0.92	0.51	0.16	pCi/g	J
SAIC	IAAP116633	IAAP116632	687632	90234	0.5	1.0	4/14/2009	ML-015	Uranium-235	0.07	0.14	0.19	pCi/g	UJ
SAIC	IAAP116633	IAAP116632	687632	90234	0.5	1.0	4/14/2009	ML-015	Uranium-238	1.31	0.63	0.15	pCi/g	=
SAIC	IAAP116633	IAAP116632	687632	90234	0.5	1.0	4/14/2009	ML-003	Actinium-227	0.06	0.13	0.21	pCi/g	UJ
SAIC	IAAP116633	IAAP116632	687632	90234	0.5	1.0	4/14/2009	ML-003	Americium-241	0.02	0.05	0.08	pCi/g	UJ
SAIC	IAAP116633	IAAP116632	687632	90234	0.5	1.0	4/14/2009	ML-003	Cesium-137	0.22	0.04	0.02	pCi/g	=
SAIC	IAAP116633	IAAP116632	687632	90234	0.5	1.0	4/14/2009	ML-003	Potassium-40	9.47	0.80	0.14	pCi/g	=
SAIC	IAAP116633	IAAP116632	687632	90234	0.5	1.0	4/14/2009	ML-003	Protactinium-231	-0.10	0.35	0.53	pCi/g	UJ
SAIC	IAAP116633	IAAP116632	687632	90234	0.5	1.0	4/14/2009	ML-003	Radium-226	1.00	0.27	0.06	pCi/g	=
SAIC	IAAP116633	IAAP116632	687632	90234	0.5	1.0	4/14/2009	ML-003	Radium-228	0.59	0.06	0.06	pCi/g	=
SAIC	IAAP116633	IAAP116632	687632	90234	0.5	1.0	4/14/2009	ML-003	Thorium-228	0.59	0.06	0.06	pCi/g	=
SAIC	IAAP116633	IAAP116632	687632	90234	0.5	1.0	4/14/2009	ML-003	Thorium-230	0.76	3.88	6.58	pCi/g	UJ
SAIC	IAAP116633	IAAP116632	687632	90234	0.5	1.0	4/14/2009	ML-003	Thorium-232	0.59	0.06	0.06	pCi/g	=
SAIC	IAAP116634	IAAP116632	687632	90234	1.0	1.5	4/14/2009	ML-015	Uranium-234	1.03	0.59	0.19	pCi/g	J
SAIC	IAAP116634-1	IAAP116632	687632	90234	1.0	1.5	4/14/2009	ML-015	Uranium-234	1.01	0.54	0.16	pCi/g	J
SAIC	IAAP116634	IAAP116632	687632	90234	1.0	1.5	4/14/2009	ML-015	Uranium-235	0.08	0.17	0.23	pCi/g	UJ
SAIC	IAAP116634-1	IAAP116632	687632	90234	1.0	1.5	4/14/2009	ML-015	Uranium-235	0.13	0.21	0.37	pCi/g	UJ
SAIC	IAAP116634	IAAP116632	687632	90234	1.0	1.5	4/14/2009	ML-015	Uranium-238	1.57	0.77	0.19	pCi/g	=
SAIC	IAAP116634-1	IAAP116632	687632	90234	1.0	1.5	4/14/2009	ML-015	Uranium-238	1.12	0.58	0.16	pCi/g	J
SAIC	IAAP116634	IAAP116632	687632	90234	1.0	1.5	4/14/2009	ML-003	Actinium-227	-0.14	0.36	0.54	pCi/g	UJ
SAIC	IAAP116634-1	IAAP116632	687632	90234	1.0	1.5	4/14/2009	ML-003	Actinium-227	-0.13	0.39	0.58	pCi/g	UJ
SAIC	IAAP116634	IAAP116632	687632	90234	1.0	1.5	4/14/2009	ML-003	Americium-241	0.08	0.14	0.25	pCi/g	UJ
SAIC	IAAP116634-1	IAAP116632	687632	90234	1.0	1.5	4/14/2009	ML-003	Americium-241	0.02	0.14	0.24	pCi/g	UJ
SAIC	IAAP116634	IAAP116632	687632	90234	1.0	1.5	4/14/2009	ML-003	Cesium-137	0.20	0.08	0.04	pCi/g	=
SAIC	IAAP116634-1	IAAP116632	687632	90234	1.0	1.5	4/14/2009	ML-003	Cesium-137	0.08	0.06	0.07	pCi/g	J
SAIC	IAAP116634	IAAP116632	687632	90234	1.0	1.5	4/14/2009	ML-003	Potassium-40	14.30	1.88	0.26	pCi/g	=
SAIC	IAAP116634-1	IAAP116632	687632	90234	1.0	1.5	4/14/2009	ML-003	Potassium-40	15.90	1.97	0.58	pCi/g	=
SAIC	IAAP116634	IAAP116632	687632	90234	1.0	1.5	4/14/2009	ML-003	Protactinium-231	-0.12	0.99	1.51	pCi/g	UJ
SAIC	IAAP116634-1	IAAP116632	687632	90234	1.0	1.5	4/14/2009	ML-003	Protactinium-231	-0.53	1.17	1.70	pCi/g	UJ

Table A-4-1. Firing Site 6 Area DU

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier
SAIC	IAAP116634	IAAP116632	687632	90234	1.0	1.5	4/14/2009	ML-003	Radium-226	1.35	0.43	0.16	pCi/g	=
SAIC	IAAP116634-1	IAAP116632	687632	90234	1.0	1.5	4/14/2009	ML-003	Radium-226	1.32	0.43	0.17	pCi/g	=
SAIC	IAAP116634	IAAP116632	687632	90234	1.0	1.5	4/14/2009	ML-003	Radium-228	1.11	0.22	0.26	pCi/g	=
SAIC	IAAP116634-1	IAAP116632	687632	90234	1.0	1.5	4/14/2009	ML-003	Radium-228	1.14	0.19	0.22	pCi/g	=
SAIC	IAAP116634	IAAP116632	687632	90234	1.0	1.5	4/14/2009	ML-003	Thorium-228	1.11	0.22	0.26	pCi/g	=
SAIC	IAAP116634-1	IAAP116632	687632	90234	1.0	1.5	4/14/2009	ML-003	Thorium-228	1.14	0.19	0.22	pCi/g	=
SAIC	IAAP116634	IAAP116632	687632	90234	1.0	1.5	4/14/2009	ML-003	Thorium-230	-6.25	11.40	18.40	pCi/g	UJ
SAIC	IAAP116634-1	IAAP116632	687632	90234	1.0	1.5	4/14/2009	ML-003	Thorium-230	3.02	11.90	20.40	pCi/g	UJ
SAIC	IAAP116634	IAAP116632	687632	90234	1.0	1.5	4/14/2009	ML-003	Thorium-232	1.11	0.22	0.26	pCi/g	=
SAIC	IAAP116634-1	IAAP116632	687632	90234	1.0	1.5	4/14/2009	ML-003	Thorium-232	1.14	0.19	0.22	pCi/g	=
SAIC	IAAP116635	IAAP116632	687632	90234	1.5	2.0	4/14/2009	ML-015	Uranium-234	1.13	0.57	0.15	pCi/g	J
SAIC	IAAP116635	IAAP116632	687632	90234	1.5	2.0	4/14/2009	ML-015	Uranium-235	0.07	0.14	0.19	pCi/g	UJ
SAIC	IAAP116635	IAAP116632	687632	90234	1.5	2.0	4/14/2009	ML-015	Uranium-238	1.47	0.67	0.15	pCi/g	=
SAIC	IAAP116635	IAAP116632	687632	90234	1.5	2.0	4/14/2009	ML-003	Actinium-227	0.04	0.10	0.16	pCi/g	UJ
SAIC	IAAP116635	IAAP116632	687632	90234	1.5	2.0	4/14/2009	ML-003	Americium-241	0.01	0.02	0.03	pCi/g	UJ
SAIC	IAAP116635	IAAP116632	687632	90234	1.5	2.0	4/14/2009	ML-003	Cesium-137	0.01	0.01	0.02	pCi/g	UJ
SAIC	IAAP116635	IAAP116632	687632	90234	1.5	2.0	4/14/2009	ML-003	Potassium-40	13.00	0.71	0.14	pCi/g	=
SAIC	IAAP116635	IAAP116632	687632	90234	1.5	2.0	4/14/2009	ML-003	Protactinium-231	0.14	0.26	0.41	pCi/g	UJ
SAIC	IAAP116635	IAAP116632	687632	90234	1.5	2.0	4/14/2009	ML-003	Radium-226	0.95	0.24	0.04	pCi/g	=
SAIC	IAAP116635	IAAP116632	687632	90234	1.5	2.0	4/14/2009	ML-003	Radium-228	0.85	0.05	0.05	pCi/g	=
SAIC	IAAP116635	IAAP116632	687632	90234	1.5	2.0	4/14/2009	ML-003	Thorium-228	0.85	0.05	0.05	pCi/g	=
SAIC	IAAP116635	IAAP116632	687632	90234	1.5	2.0	4/14/2009	ML-003	Thorium-230	0.28	1.82	3.16	pCi/g	UJ
SAIC	IAAP116635	IAAP116632	687632	90234	1.5	2.0	4/14/2009	ML-003	Thorium-232	0.85	0.05	0.05	pCi/g	=
SAIC	IAAP116636	IAAP116636	687617	90259	0.0	0.5	4/14/2009	ML-015	Uranium-234	0.54	0.34	0.23	pCi/g	J
SAIC	IAAP116636	IAAP116636	687617	90259	0.0	0.5	4/14/2009	ML-015	Uranium-235	0.06	0.12	0.15	pCi/g	UJ
SAIC	IAAP116636	IAAP116636	687617	90259	0.0	0.5	4/14/2009	ML-015	Uranium-238	0.62	0.37	0.28	pCi/g	J
SAIC	IAAP116636	IAAP116636	687617	90259	0.0	0.5	4/14/2009	ML-003	Actinium-227	0.03	0.10	0.16	pCi/g	UJ
SAIC	IAAP116636	IAAP116636	687617	90259	0.0	0.5	4/14/2009	ML-003	Americium-241	0.00	0.02	0.03	pCi/g	UJ
SAIC	IAAP116636	IAAP116636	687617	90259	0.0	0.5	4/14/2009	ML-003	Cesium-137	0.03	0.02	0.02	pCi/g	J
SAIC	IAAP116636	IAAP116636	687617	90259	0.0	0.5	4/14/2009	ML-003	Potassium-40	13.10	0.73	0.11	pCi/g	=
SAIC	IAAP116636	IAAP116636	687617	90259	0.0	0.5	4/14/2009	ML-003	Protactinium-231	0.07	0.28	0.43	pCi/g	UJ
SAIC	IAAP116636	IAAP116636	687617	90259	0.0	0.5	4/14/2009	ML-003	Radium-226	0.89	0.23	0.04	pCi/g	=
SAIC	IAAP116636	IAAP116636	687617	90259	0.0	0.5	4/14/2009	ML-003	Radium-228	0.86	0.05	0.05	pCi/g	=
SAIC	IAAP116636	IAAP116636	687617	90259	0.0	0.5	4/14/2009	ML-003	Thorium-228	0.86	0.05	0.05	pCi/g	=
SAIC	IAAP116636	IAAP116636	687617	90259	0.0	0.5	4/14/2009	ML-003	Thorium-230	-0.45	1.81	3.11	pCi/g	UJ
SAIC	IAAP116636	IAAP116636	687617	90259	0.0	0.5	4/14/2009	ML-003	Thorium-232	0.86	0.05	0.05	pCi/g	=
SAIC	IAAP116637	IAAP116636	687617	90259	0.5	1.0	4/14/2009	ML-015	Uranium-234	0.77	0.45	0.15	pCi/g	J
SAIC	IAAP116637	IAAP116636	687617	90259	0.5	1.0	4/14/2009	ML-015	Uranium-235	0.00	0.00	0.18	pCi/g	U
SAIC	IAAP116637	IAAP116636	687617	90259	0.5	1.0	4/14/2009	ML-015	Uranium-238	0.93	0.50	0.15	pCi/g	J
SAIC	IAAP116637	IAAP116636	687617	90259	0.5	1.0	4/14/2009	ML-003	Actinium-227	-0.02	0.09	0.14	pCi/g	UJ
SAIC	IAAP116637	IAAP116636	687617	90259	0.5	1.0	4/14/2009	ML-003	Americium-241	0.02	0.02	0.03	pCi/g	UJ
SAIC	IAAP116637	IAAP116636	687617	90259	0.5	1.0	4/14/2009	ML-003	Cesium-137	0.12	0.02	0.01	pCi/g	=
SAIC	IAAP116637	IAAP116636	687617	90259	0.5	1.0	4/14/2009	ML-003	Potassium-40	11.30	0.67	0.13	pCi/g	=
SAIC	IAAP116637	IAAP116636	687617	90259	0.5	1.0	4/14/2009	ML-003	Protactinium-231	0.04	0.26	0.40	pCi/g	UJ
SAIC	IAAP116637	IAAP116636	687617	90259	0.5	1.0	4/14/2009	ML-003	Radium-226	0.82	0.21	0.03	pCi/g	=
SAIC	IAAP116637	IAAP116636	687617	90259	0.5	1.0	4/14/2009	ML-003	Radium-228	0.73	0.05	0.05	pCi/g	=
SAIC	IAAP116637	IAAP116636	687617	90259	0.5	1.0	4/14/2009	ML-003	Thorium-228	0.73	0.05	0.05	pCi/g	=
SAIC	IAAP116637	IAAP116636	687617	90259	0.5	1.0	4/14/2009	ML-003	Thorium-230	1.42	1.67	2.95	pCi/g	UJ
SAIC	IAAP116637	IAAP116636	687617	90259	0.5	1.0	4/14/2009	ML-003	Thorium-232	0.73	0.05	0.05	pCi/g	=
SAIC	IAAP116638	IAAP116636	687617	90259	1.0	1.5	4/14/2009	ML-015	Uranium-234	0.96	0.51	0.27	pCi/g	J
SAIC	IAAP116638	IAAP116636	687617	90259	1.0	1.5	4/14/2009	ML-015	Uranium-235	-0.02	0.03	0.33	pCi/g	UJ
SAIC	IAAP116638	IAAP116636	687617	90259	1.0	1.5	4/14/2009	ML-015	Uranium-238	0.70	0.42	0.15	pCi/g	J
SAIC	IAAP116638	IAAP116636	687617	90259	1.0	1.5	4/14/2009	ML-003	Actinium-227	-0.01	0.11	0.17	pCi/g	UJ
SAIC	IAAP116638	IAAP116636	687617	90259	1.0	1.5	4/14/2009	ML-003	Americium-241	0.00	0.02	0.03	pCi/g	UJ
SAIC	IAAP116638	IAAP116636	687617	90259	1.0	1.5	4/14/2009	ML-003	Cesium-137	0.03	0.01	0.02	pCi/g	J
SAIC	IAAP116638	IAAP116636	687617	90259	1.0	1.5	4/14/2009	ML-003	Potassium-40	13.60	0.78	0.15	pCi/g	=
SAIC	IAAP116638	IAAP116636	687617	90259	1.0	1.5	4/14/2009	ML-003	Protactinium-231	0.01	0.29	0.46	pCi/g	UJ

Table A-4-1. Firing Site 6 Area DU

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier
SAIC	IAAP116638	IAAP116636	687617	90259	1.0	1.5	4/14/2009	ML-003	Radium-226	1.02	0.26	0.04	pCi/g	=
SAIC	IAAP116638	IAAP116636	687617	90259	1.0	1.5	4/14/2009	ML-003	Radium-228	0.93	0.05	0.05	pCi/g	=
SAIC	IAAP116638	IAAP116636	687617	90259	1.0	1.5	4/14/2009	ML-003	Thorium-228	0.93	0.05	0.05	pCi/g	=
SAIC	IAAP116638	IAAP116636	687617	90259	1.0	1.5	4/14/2009	ML-003	Thorium-230	0.24	1.98	3.44	pCi/g	UJ
SAIC	IAAP116638	IAAP116636	687617	90259	1.0	1.5	4/14/2009	ML-003	Thorium-232	0.93	0.05	0.05	pCi/g	=
SAIC	IAAP116639	IAAP116636	687617	90259	1.5	2.0	4/14/2009	ML-015	Uranium-234	0.80	0.47	0.16	pCi/g	J
SAIC	IAAP116639	IAAP116636	687617	90259	1.5	2.0	4/14/2009	ML-015	Uranium-235	0.00	0.00	0.19	pCi/g	U
SAIC	IAAP116639	IAAP116636	687617	90259	1.5	2.0	4/14/2009	ML-015	Uranium-238	1.18	0.59	0.29	pCi/g	J
SAIC	IAAP116639	IAAP116636	687617	90259	1.5	2.0	4/14/2009	ML-003	Actinium-227	0.08	0.11	0.16	pCi/g	UJ
SAIC	IAAP116639	IAAP116636	687617	90259	1.5	2.0	4/14/2009	ML-003	Americium-241	0.01	0.02	0.03	pCi/g	UJ
SAIC	IAAP116639	IAAP116636	687617	90259	1.5	2.0	4/14/2009	ML-003	Cesium-137	0.00	0.01	0.02	pCi/g	UJ
SAIC	IAAP116639	IAAP116636	687617	90259	1.5	2.0	4/14/2009	ML-003	Potassium-40	14.00	0.79	0.13	pCi/g	=
SAIC	IAAP116639	IAAP116636	687617	90259	1.5	2.0	4/14/2009	ML-003	Protactinium-231	0.00	0.28	0.44	pCi/g	UJ
SAIC	IAAP116639	IAAP116636	687617	90259	1.5	2.0	4/14/2009	ML-003	Radium-226	1.16	0.29	0.04	pCi/g	=
SAIC	IAAP116639	IAAP116636	687617	90259	1.5	2.0	4/14/2009	ML-003	Radium-228	1.04	0.05	0.05	pCi/g	=
SAIC	IAAP116639	IAAP116636	687617	90259	1.5	2.0	4/14/2009	ML-003	Thorium-228	1.04	0.05	0.05	pCi/g	=
SAIC	IAAP116639	IAAP116636	687617	90259	1.5	2.0	4/14/2009	ML-003	Thorium-230	1.57	1.97	3.47	pCi/g	UJ
SAIC	IAAP116639	IAAP116636	687617	90259	1.5	2.0	4/14/2009	ML-003	Thorium-232	1.04	0.05	0.05	pCi/g	=
SAIC	IAAP116640	IAAP116640	687646	90259	0.0	0.5	4/14/2009	ML-015	Uranium-234	0.62	0.38	0.14	pCi/g	J
SAIC	IAAP116640	IAAP116640	687646	90259	0.0	0.5	4/14/2009	ML-015	Uranium-235	0.00	0.00	0.17	pCi/g	U
SAIC	IAAP116640	IAAP116640	687646	90259	0.0	0.5	4/14/2009	ML-015	Uranium-238	1.18	0.56	0.14	pCi/g	=
SAIC	IAAP116640	IAAP116640	687646	90259	0.0	0.5	4/14/2009	ML-003	Actinium-227	-0.01	0.09	0.14	pCi/g	UJ
SAIC	IAAP116640	IAAP116640	687646	90259	0.0	0.5	4/14/2009	ML-003	Americium-241	0.01	0.02	0.03	pCi/g	UJ
SAIC	IAAP116640	IAAP116640	687646	90259	0.0	0.5	4/14/2009	ML-003	Cesium-137	0.00	0.01	0.01	pCi/g	UJ
SAIC	IAAP116640	IAAP116640	687646	90259	0.0	0.5	4/14/2009	ML-003	Potassium-40	10.20	0.61	0.12	pCi/g	=
SAIC	IAAP116640	IAAP116640	687646	90259	0.0	0.5	4/14/2009	ML-003	Protactinium-231	0.27	0.31	0.39	pCi/g	UJ
SAIC	IAAP116640	IAAP116640	687646	90259	0.0	0.5	4/14/2009	ML-003	Radium-226	0.96	0.24	0.04	pCi/g	=
SAIC	IAAP116640	IAAP116640	687646	90259	0.0	0.5	4/14/2009	ML-003	Radium-228	0.72	0.05	0.05	pCi/g	=
SAIC	IAAP116640	IAAP116640	687646	90259	0.0	0.5	4/14/2009	ML-003	Thorium-228	0.72	0.05	0.05	pCi/g	=
SAIC	IAAP116640	IAAP116640	687646	90259	0.0	0.5	4/14/2009	ML-003	Thorium-230	1.56	1.65	2.93	pCi/g	UJ
SAIC	IAAP116640	IAAP116640	687646	90259	0.0	0.5	4/14/2009	ML-003	Thorium-232	0.72	0.05	0.05	pCi/g	=
SAIC	IAAP116641	IAAP116640	687646	90259	0.5	1.0	4/14/2009	ML-015	Uranium-234	0.92	0.56	0.19	pCi/g	J
SAIC	IAAP116641	IAAP116640	687646	90259	0.5	1.0	4/14/2009	ML-015	Uranium-235	0.00	0.00	0.24	pCi/g	U
SAIC	IAAP116641	IAAP116640	687646	90259	0.5	1.0	4/14/2009	ML-015	Uranium-238	1.20	0.66	0.19	pCi/g	J
SAIC	IAAP116641	IAAP116640	687646	90259	0.5	1.0	4/14/2009	ML-003	Actinium-227	-0.07	0.10	0.14	pCi/g	UJ
SAIC	IAAP116641	IAAP116640	687646	90259	0.5	1.0	4/14/2009	ML-003	Americium-241	0.01	0.02	0.03	pCi/g	UJ
SAIC	IAAP116641	IAAP116640	687646	90259	0.5	1.0	4/14/2009	ML-003	Cesium-137	0.02	0.02	0.01	pCi/g	J
SAIC	IAAP116641	IAAP116640	687646	90259	0.5	1.0	4/14/2009	ML-003	Potassium-40	10.30	0.63	0.13	pCi/g	=
SAIC	IAAP116641	IAAP116640	687646	90259	0.5	1.0	4/14/2009	ML-003	Protactinium-231	-0.05	0.26	0.40	pCi/g	UJ
SAIC	IAAP116641	IAAP116640	687646	90259	0.5	1.0	4/14/2009	ML-003	Radium-226	0.97	0.24	0.04	pCi/g	=
SAIC	IAAP116641	IAAP116640	687646	90259	0.5	1.0	4/14/2009	ML-003	Radium-228	0.73	0.05	0.05	pCi/g	=
SAIC	IAAP116641	IAAP116640	687646	90259	0.5	1.0	4/14/2009	ML-003	Thorium-228	0.73	0.05	0.05	pCi/g	=
SAIC	IAAP116641	IAAP116640	687646	90259	0.5	1.0	4/14/2009	ML-003	Thorium-230	1.18	1.79	3.14	pCi/g	UJ
SAIC	IAAP116641	IAAP116640	687646	90259	0.5	1.0	4/14/2009	ML-003	Thorium-232	0.73	0.05	0.05	pCi/g	=
SAIC	IAAP116642	IAAP116640	687646	90259	1.0	1.5	4/14/2009	ML-015	Uranium-234	0.83	0.43	0.12	pCi/g	J
SAIC	IAAP116642	IAAP116640	687646	90259	1.0	1.5	4/14/2009	ML-015	Uranium-235	-0.01	0.03	0.29	pCi/g	UJ
SAIC	IAAP116642	IAAP116640	687646	90259	1.0	1.5	4/14/2009	ML-015	Uranium-238	0.96	0.47	0.12	pCi/g	=
SAIC	IAAP116642	IAAP116640	687646	90259	1.0	1.5	4/14/2009	ML-003	Actinium-227	0.00	0.09	0.15	pCi/g	UJ
SAIC	IAAP116642	IAAP116640	687646	90259	1.0	1.5	4/14/2009	ML-003	Americium-241	0.00	0.02	0.03	pCi/g	UJ
SAIC	IAAP116642	IAAP116640	687646	90259	1.0	1.5	4/14/2009	ML-003	Cesium-137	0.00	0.01	0.02	pCi/g	UJ
SAIC	IAAP116642	IAAP116640	687646	90259	1.0	1.5	4/14/2009	ML-003	Potassium-40	10.90	0.64	0.14	pCi/g	=
SAIC	IAAP116642	IAAP116640	687646	90259	1.0	1.5	4/14/2009	ML-003	Protactinium-231	-0.09	0.27	0.41	pCi/g	UJ
SAIC	IAAP116642	IAAP116640	687646	90259	1.0	1.5	4/14/2009	ML-003	Radium-226	1.09	0.27	0.04	pCi/g	=
SAIC	IAAP116642	IAAP116640	687646	90259	1.0	1.5	4/14/2009	ML-003	Radium-228	0.75	0.05	0.05	pCi/g	=
SAIC	IAAP116642	IAAP116640	687646	90259	1.0	1.5	4/14/2009	ML-003	Thorium-228	0.75	0.05	0.05	pCi/g	=
SAIC	IAAP116642	IAAP116640	687646	90259	1.0	1.5	4/14/2009	ML-003	Thorium-230	0.71	1.79	3.12	pCi/g	UJ
SAIC	IAAP116642	IAAP116640	687646	90259	1.0	1.5	4/14/2009	ML-003	Thorium-232	0.75	0.05	0.05	pCi/g	=

Table A-4-1. Firing Site 6 Area DU

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier
SAIC	IAAP116647	IAAP116640	687646	90259	1.5	2.0	4/14/2009	ML-015	Uranium-234	0.91	0.46	0.23	pCi/g	J
SAIC	IAAP116647	IAAP116640	687646	90259	1.5	2.0	4/14/2009	ML-015	Uranium-235	0.00	0.00	0.15	pCi/g	U
SAIC	IAAP116647	IAAP116640	687646	90259	1.5	2.0	4/14/2009	ML-015	Uranium-238	0.92	0.45	0.12	pCi/g	=
SAIC	IAAP116647	IAAP116640	687646	90259	1.5	2.0	4/14/2009	ML-003	Actinium-227	-0.04	0.09	0.14	pCi/g	UJ
SAIC	IAAP116647	IAAP116640	687646	90259	1.5	2.0	4/14/2009	ML-003	Americium-241	0.01	0.02	0.03	pCi/g	UJ
SAIC	IAAP116647	IAAP116640	687646	90259	1.5	2.0	4/14/2009	ML-003	Cesium-137	0.01	0.01	0.02	pCi/g	UJ
SAIC	IAAP116647	IAAP116640	687646	90259	1.5	2.0	4/14/2009	ML-003	Potassium-40	10.50	0.61	0.13	pCi/g	=
SAIC	IAAP116647	IAAP116640	687646	90259	1.5	2.0	4/14/2009	ML-003	Protactinium-231	0.07	0.23	0.36	pCi/g	UJ
SAIC	IAAP116647	IAAP116640	687646	90259	1.5	2.0	4/14/2009	ML-003	Radium-226	1.00	0.24	0.03	pCi/g	=
SAIC	IAAP116647	IAAP116640	687646	90259	1.5	2.0	4/14/2009	ML-003	Radium-228	0.76	0.04	0.05	pCi/g	=
SAIC	IAAP116647	IAAP116640	687646	90259	1.5	2.0	4/14/2009	ML-003	Thorium-228	0.76	0.04	0.05	pCi/g	=
SAIC	IAAP116647	IAAP116640	687646	90259	1.5	2.0	4/14/2009	ML-003	Thorium-230	2.83	2.59	2.75	pCi/g	J
SAIC	IAAP116647	IAAP116640	687646	90259	1.5	2.0	4/14/2009	ML-003	Thorium-232	0.76	0.04	0.05	pCi/g	=
SAIC	IAAP116651	IAAP116651	687632	90284	0.0	0.5	4/14/2009	ML-015	Uranium-234	0.49	0.36	0.17	pCi/g	J
SAIC	IAAP116651	IAAP116651	687632	90284	0.0	0.5	4/14/2009	ML-015	Uranium-235	0.00	0.00	0.20	pCi/g	U
SAIC	IAAP116651	IAAP116651	687632	90284	0.0	0.5	4/14/2009	ML-015	Uranium-238	1.21	0.61	0.16	pCi/g	J
SAIC	IAAP116651	IAAP116651	687632	90284	0.0	0.5	4/14/2009	ML-003	Actinium-227	-0.02	0.09	0.14	pCi/g	UJ
SAIC	IAAP116651	IAAP116651	687632	90284	0.0	0.5	4/14/2009	ML-003	Americium-241	0.01	0.02	0.03	pCi/g	UJ
SAIC	IAAP116651	IAAP116651	687632	90284	0.0	0.5	4/14/2009	ML-003	Cesium-137	0.00	0.01	0.01	pCi/g	UJ
SAIC	IAAP116651	IAAP116651	687632	90284	0.0	0.5	4/14/2009	ML-003	Potassium-40	13.10	0.72	0.11	pCi/g	=
SAIC	IAAP116651	IAAP116651	687632	90284	0.0	0.5	4/14/2009	ML-003	Protactinium-231	-0.21	0.23	0.37	pCi/g	UJ
SAIC	IAAP116651	IAAP116651	687632	90284	0.0	0.5	4/14/2009	ML-003	Radium-226	0.96	0.24	0.04	pCi/g	=
SAIC	IAAP116651	IAAP116651	687632	90284	0.0	0.5	4/14/2009	ML-003	Radium-228	0.78	0.05	0.05	pCi/g	=
SAIC	IAAP116651	IAAP116651	687632	90284	0.0	0.5	4/14/2009	ML-003	Thorium-228	0.78	0.05	0.05	pCi/g	=
SAIC	IAAP116651	IAAP116651	687632	90284	0.0	0.5	4/14/2009	ML-003	Thorium-230	-0.83	1.65	2.81	pCi/g	UJ
SAIC	IAAP116651	IAAP116651	687632	90284	0.0	0.5	4/14/2009	ML-003	Thorium-232	0.78	0.05	0.05	pCi/g	=
SAIC	IAAP116652	IAAP116651	687632	90284	0.5	1.0	4/14/2009	ML-003	Actinium-227	-0.03	0.10	0.17	pCi/g	UJ
SAIC	IAAP116652	IAAP116651	687632	90284	0.5	1.0	4/14/2009	ML-003	Americium-241	0.00	0.03	0.04	pCi/g	UJ
SAIC	IAAP116652	IAAP116651	687632	90284	0.5	1.0	4/14/2009	ML-003	Cesium-137	-0.01	0.01	0.02	pCi/g	UJ
SAIC	IAAP116652	IAAP116651	687632	90284	0.5	1.0	4/14/2009	ML-003	Potassium-40	12.70	0.82	0.16	pCi/g	=
SAIC	IAAP116652	IAAP116651	687632	90284	0.5	1.0	4/14/2009	ML-003	Protactinium-231	0.02	0.31	0.52	pCi/g	UJ
SAIC	IAAP116652	IAAP116651	687632	90284	0.5	1.0	4/14/2009	ML-003	Radium-226	0.93	0.25	0.05	pCi/g	=
SAIC	IAAP116652	IAAP116651	687632	90284	0.5	1.0	4/14/2009	ML-003	Radium-228	0.88	0.07	0.06	pCi/g	=
SAIC	IAAP116652	IAAP116651	687632	90284	0.5	1.0	4/14/2009	ML-003	Thorium-228	0.88	0.07	0.06	pCi/g	=
SAIC	IAAP116652	IAAP116651	687632	90284	0.5	1.0	4/14/2009	ML-003	Thorium-230	2.56	3.08	3.82	pCi/g	UJ
SAIC	IAAP116652	IAAP116651	687632	90284	0.5	1.0	4/14/2009	ML-003	Thorium-232	0.88	0.07	0.06	pCi/g	=
SAIC	IAAP116652	IAAP116651	687632	90284	0.5	1.0	4/14/2009	ML-015	Uranium-234	1.53	0.71	0.30	pCi/g	=
SAIC	IAAP116652	IAAP116651	687632	90284	0.5	1.0	4/14/2009	ML-015	Uranium-235	0.07	0.15	0.20	pCi/g	UJ
SAIC	IAAP116652	IAAP116651	687632	90284	0.5	1.0	4/14/2009	ML-003	Uranium-235	0.09	0.15	0.24	pCi/g	UJ
SAIC	IAAP116652	IAAP116651	687632	90284	0.5	1.0	4/14/2009	ML-015	Uranium-238	1.25	0.62	0.16	pCi/g	=
SAIC	IAAP116652	IAAP116651	687632	90284	0.5	1.0	4/14/2009	ML-003	Uranium-238	0.60	0.38	0.39	pCi/g	J
SAIC	IAAP116653	IAAP116651	687632	90284	1.0	1.5	4/14/2009	ML-003	Actinium-227	0.03	0.11	0.19	pCi/g	UJ
SAIC	IAAP116653	IAAP116651	687632	90284	1.0	1.5	4/14/2009	ML-003	Americium-241	0.05	0.04	0.04	pCi/g	J
SAIC	IAAP116653	IAAP116651	687632	90284	1.0	1.5	4/14/2009	ML-003	Cesium-137	0.00	0.01	0.02	pCi/g	UJ
SAIC	IAAP116653	IAAP116651	687632	90284	1.0	1.5	4/14/2009	ML-003	Potassium-40	12.10	0.80	0.20	pCi/g	=
SAIC	IAAP116653	IAAP116651	687632	90284	1.0	1.5	4/14/2009	ML-003	Protactinium-231	0.24	0.34	0.54	pCi/g	UJ
SAIC	IAAP116653	IAAP116651	687632	90284	1.0	1.5	4/14/2009	ML-003	Radium-226	0.88	0.24	0.05	pCi/g	=
SAIC	IAAP116653	IAAP116651	687632	90284	1.0	1.5	4/14/2009	ML-003	Radium-228	0.71	0.06	0.07	pCi/g	=
SAIC	IAAP116653	IAAP116651	687632	90284	1.0	1.5	4/14/2009	ML-003	Thorium-228	0.71	0.06	0.07	pCi/g	=
SAIC	IAAP116653	IAAP116651	687632	90284	1.0	1.5	4/14/2009	ML-003	Thorium-230	0.14	2.62	3.97	pCi/g	UJ
SAIC	IAAP116653	IAAP116651	687632	90284	1.0	1.5	4/14/2009	ML-003	Thorium-232	0.71	0.06	0.07	pCi/g	=
SAIC	IAAP116653	IAAP116651	687632	90284	1.0	1.5	4/14/2009	ML-015	Uranium-234	0.82	0.44	0.13	pCi/g	J
SAIC	IAAP116653	IAAP116651	687632	90284	1.0	1.5	4/14/2009	ML-015	Uranium-235	0.12	0.17	0.16	pCi/g	UJ
SAIC	IAAP116653	IAAP116651	687632	90284	1.0	1.5	4/14/2009	ML-003	Uranium-235	-0.08	0.15	0.22	pCi/g	UJ
SAIC	IAAP116653	IAAP116651	687632	90284	1.0	1.5	4/14/2009	ML-015	Uranium-238	0.82	0.44	0.13	pCi/g	J
SAIC	IAAP116653	IAAP116651	687632	90284	1.0	1.5	4/14/2009	ML-003	Uranium-238	0.51	0.46	0.40	pCi/g	J
SAIC	IAAP116654	IAAP116651	687632	90284	1.5	2.0	4/14/2009	ML-003	Actinium-227	-0.02	0.12	0.19	pCi/g	UJ

Table A-4-1. Firing Site 6 Area DU

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier
SAIC	IAAP116654	IAAP116651	687632	90284	1.5	2.0	4/14/2009	ML-003	Americium-241	0.01	0.03	0.04	pCi/g	UJ
SAIC	IAAP116654	IAAP116651	687632	90284	1.5	2.0	4/14/2009	ML-003	Cesium-137	0.00	0.01	0.02	pCi/g	UJ
SAIC	IAAP116654	IAAP116651	687632	90284	1.5	2.0	4/14/2009	ML-003	Potassium-40	13.20	0.83	0.18	pCi/g	=
SAIC	IAAP116654	IAAP116651	687632	90284	1.5	2.0	4/14/2009	ML-003	Protactinium-231	0.08	0.35	0.53	pCi/g	UJ
SAIC	IAAP116654	IAAP116651	687632	90284	1.5	2.0	4/14/2009	ML-003	Radium-226	1.05	0.28	0.05	pCi/g	=
SAIC	IAAP116654	IAAP116651	687632	90284	1.5	2.0	4/14/2009	ML-003	Radium-228	0.92	0.07	0.06	pCi/g	=
SAIC	IAAP116654	IAAP116651	687632	90284	1.5	2.0	4/14/2009	ML-003	Thorium-228	0.92	0.07	0.06	pCi/g	=
SAIC	IAAP116654	IAAP116651	687632	90284	1.5	2.0	4/14/2009	ML-003	Thorium-230	4.38	4.06	3.74	pCi/g	J
SAIC	IAAP116654	IAAP116651	687632	90284	1.5	2.0	4/14/2009	ML-003	Thorium-232	0.92	0.07	0.06	pCi/g	=
SAIC	IAAP116654	IAAP116651	687632	90284	1.5	2.0	4/14/2009	ML-015	Uranium-234	0.86	0.43	0.12	pCi/g	J
SAIC	IAAP116654	IAAP116651	687632	90284	1.5	2.0	4/14/2009	ML-015	Uranium-235	0.00	0.00	0.15	pCi/g	U
SAIC	IAAP116654	IAAP116651	687632	90284	1.5	2.0	4/14/2009	ML-003	Uranium-235	0.03	0.15	0.24	pCi/g	UJ
SAIC	IAAP116654	IAAP116651	687632	90284	1.5	2.0	4/14/2009	ML-015	Uranium-238	0.84	0.43	0.23	pCi/g	J
SAIC	IAAP116654	IAAP116651	687632	90284	1.5	2.0	4/14/2009	ML-003	Uranium-238	1.29	0.55	0.38	pCi/g	J
SAIC	IAAP25000	IAAP25000	687623	90199	0.0	0.5	5/1/2001	ML-003	Bismuth-212	1.02	0.31	0.28	pCi/g	=
SAIC	IAAP25000	IAAP25000	687623	90199	0.0	0.5	5/1/2001	ML-003	Bismuth-214	0.65	0.08	0.04	pCi/g	=
SAIC	IAAP25000	IAAP25000	687623	90199	0.0	0.5	5/1/2001	ML-003	Cesium-137	0.13	0.03	0.02	pCi/g	=
SAIC	IAAP25000	IAAP25000	687623	90199	0.0	0.5	5/1/2001	ML-003	Lead-212	1.04	0.11	0.03	pCi/g	=
SAIC	IAAP25000	IAAP25000	687623	90199	0.0	0.5	5/1/2001	ML-003	Lead-214	0.70	0.07	0.04	pCi/g	=
SAIC	IAAP25000	IAAP25000	687623	90199	0.0	0.5	5/1/2001	ML-003	Potassium-40	14.10	1.49	0.20	pCi/g	=
SAIC	IAAP25000	IAAP25000	687623	90199	0.0	0.5	5/1/2001	ML-003	Radium-224	2.83	0.63	0.36	pCi/g	=
SAIC	IAAP25000	IAAP25000	687623	90199	0.0	0.5	5/1/2001	ML-003	Radium-228	1.02	0.13	0.08	pCi/g	=
SAIC	IAAP25000	IAAP25000	687623	90199	0.0	0.5	5/1/2001	ML-003	Thallium-208	0.88	0.12	0.06	pCi/g	=
SAIC	IAAP25000	IAAP25000	687623	90199	0.0	0.5	5/1/2001	ML-003	Thorium-228	1.02	0.13	0.08	pCi/g	=
SAIC	IAAP25000	IAAP25000	687623	90199	0.0	0.5	5/1/2001	ML-003	Thorium-232	1.02	0.13	0.08	pCi/g	=
SAIC	IAAP25000	IAAP25000	687623	90199	0.0	0.5	5/1/2001	ML-003	Uranium-234	9.23	12.10	13.40	pCi/g	R
SAIC	IAAP25000	IAAP25000	687623	90199	0.0	0.5	5/1/2001	ML-003	Uranium-235	0.20	0.03	0.03	pCi/g	=
SAIC	IAAP25000	IAAP25000	687623	90199	0.0	0.5	5/1/2001	ML-003	Uranium-238	4.74	0.46	0.29	pCi/g	=
SAIC	IAAP25001	IAAP25001	687618	90233	0.0	0.5	5/1/2001	ML-003	Bismuth-211	0.01	0.27	0.09	pCi/g	R
SAIC	IAAP25001	IAAP25001	687618	90233	0.0	0.5	5/1/2001	ML-003	Bismuth-212	0.77	0.24	0.31	pCi/g	=
SAIC	IAAP25001	IAAP25001	687618	90233	0.0	0.5	5/1/2001	ML-003	Bismuth-214	0.47	0.06	0.03	pCi/g	=
SAIC	IAAP25001	IAAP25001	687618	90233	0.0	0.5	5/1/2001	ML-003	Cesium-137	0.11	0.03	0.02	pCi/g	=
SAIC	IAAP25001	IAAP25001	687618	90233	0.0	0.5	5/1/2001	ML-003	Lead-212	0.77	0.08	0.03	pCi/g	=
SAIC	IAAP25001	IAAP25001	687618	90233	0.0	0.5	5/1/2001	ML-003	Lead-214	0.49	0.07	0.03	pCi/g	=
SAIC	IAAP25001	IAAP25001	687618	90233	0.0	0.5	5/1/2001	ML-003	Potassium-40	12.40	1.30	0.68	pCi/g	=
SAIC	IAAP25001	IAAP25001	687618	90233	0.0	0.5	5/1/2001	ML-003	Radium-223	0.21	0.08	0.08	pCi/g	=
SAIC	IAAP25001	IAAP25001	687618	90233	0.0	0.5	5/1/2001	ML-003	Radium-224	1.59	0.40	0.30	pCi/g	=
SAIC	IAAP25001	IAAP25001	687618	90233	0.0	0.5	5/1/2001	ML-003	Radium-228	0.77	0.09	0.06	pCi/g	=
SAIC	IAAP25001	IAAP25001	687618	90233	0.0	0.5	5/1/2001	ML-003	Thallium-208	0.72	0.09	0.05	pCi/g	=
SAIC	IAAP25001	IAAP25001	687618	90233	0.0	0.5	5/1/2001	ML-003	Thorium-228	0.77	0.09	0.06	pCi/g	=
SAIC	IAAP25001	IAAP25001	687618	90233	0.0	0.5	5/1/2001	ML-003	Thorium-232	0.77	0.09	0.06	pCi/g	=
SAIC	IAAP25001	IAAP25001	687618	90233	0.0	0.5	5/1/2001	ML-003	Uranium-235	0.12	0.03	0.02	pCi/g	=
SAIC	IAAP25001	IAAP25001	687618	90233	0.0	0.5	5/1/2001	ML-003	Uranium-238	1.96	0.24	0.21	pCi/g	=
SAIC	IAAP25002	IAAP25002	687596	90222	0.0	0.5	5/1/2001	ML-003	Bismuth-211	0.11	0.46	0.20	pCi/g	R
SAIC	IAAP25002	IAAP25002	687596	90222	0.0	0.5	5/1/2001	ML-003	Bismuth-212	0.90	0.30	0.39	pCi/g	=
SAIC	IAAP25002	IAAP25002	687596	90222	0.0	0.5	5/1/2001	ML-003	Bismuth-214	0.49	0.06	0.06	pCi/g	=
SAIC	IAAP25002	IAAP25002	687596	90222	0.0	0.5	5/1/2001	ML-003	Cesium-137	0.20	0.04	0.03	pCi/g	=
SAIC	IAAP25002	IAAP25002	687596	90222	0.0	0.5	5/1/2001	ML-003	Lead-212	0.66	0.09	0.06	pCi/g	=
SAIC	IAAP25002	IAAP25002	687596	90222	0.0	0.5	5/1/2001	ML-003	Lead-214	0.39	0.14	0.07	pCi/g	=
SAIC	IAAP25002	IAAP25002	687596	90222	0.0	0.5	5/1/2001	ML-003	Potassium-40	11.50	1.23	0.17	pCi/g	=
SAIC	IAAP25002	IAAP25002	687596	90222	0.0	0.5	5/1/2001	ML-003	Radium-224	0.79	0.45	0.69	pCi/g	J
SAIC	IAAP25002	IAAP25002	687596	90222	0.0	0.5	5/1/2001	ML-003	Radium-228	0.69	0.11	0.09	pCi/g	=
SAIC	IAAP25002	IAAP25002	687596	90222	0.0	0.5	5/1/2001	ML-003	Thallium-208	0.69	0.13	0.09	pCi/g	=
SAIC	IAAP25002	IAAP25002	687596	90222	0.0	0.5	5/1/2001	ML-003	Thorium-228	0.69	0.11	0.09	pCi/g	=
SAIC	IAAP25002	IAAP25002	687596	90222	0.0	0.5	5/1/2001	ML-003	Thorium-232	0.69	0.11	0.09	pCi/g	=
SAIC	IAAP25002	IAAP25002	687596	90222	0.0	0.5	5/1/2001	ML-003	Uranium-235	0.85	0.09	0.05	pCi/g	=
SAIC	IAAP25002	IAAP25002	687596	90222	0.0	0.5	5/1/2001	ML-003	Uranium-238	31.00	2.23	0.65	pCi/g	=

Table A-4-1. Firing Site 6 Area DU

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier
SAIC	IAAP25003	IAAP25003	687577	90203	0.0	0.5	5/1/2001	ML-003	Bismuth-212	0.84	0.31	0.24	pCi/g	=
SAIC	IAAP25003	IAAP25003	687577	90203	0.0	0.5	5/1/2001	ML-003	Bismuth-214	0.51	0.07	0.04	pCi/g	=
SAIC	IAAP25003	IAAP25003	687577	90203	0.0	0.5	5/1/2001	ML-003	Cesium-137	0.33	0.06	0.02	pCi/g	=
SAIC	IAAP25003	IAAP25003	687577	90203	0.0	0.5	5/1/2001	ML-003	Lead-212	0.81	0.09	0.03	pCi/g	=
SAIC	IAAP25003	IAAP25003	687577	90203	0.0	0.5	5/1/2001	ML-003	Lead-214	0.52	0.06	0.04	pCi/g	=
SAIC	IAAP25003	IAAP25003	687577	90203	0.0	0.5	5/1/2001	ML-003	Potassium-40	13.60	1.44	0.17	pCi/g	=
SAIC	IAAP25003	IAAP25003	687577	90203	0.0	0.5	5/1/2001	ML-003	Radium-224	2.04	0.58	0.36	pCi/g	=
SAIC	IAAP25003	IAAP25003	687577	90203	0.0	0.5	5/1/2001	ML-003	Radium-228	0.80	0.11	0.08	pCi/g	=
SAIC	IAAP25003	IAAP25003	687577	90203	0.0	0.5	5/1/2001	ML-003	Thallium-208	0.70	0.10	0.06	pCi/g	=
SAIC	IAAP25003	IAAP25003	687577	90203	0.0	0.5	5/1/2001	ML-003	Thorium-228	0.80	0.11	0.08	pCi/g	=
SAIC	IAAP25003	IAAP25003	687577	90203	0.0	0.5	5/1/2001	ML-003	Thorium-232	0.80	0.11	0.08	pCi/g	=
SAIC	IAAP25003	IAAP25003	687577	90203	0.0	0.5	5/1/2001	ML-003	Uranium-235	0.21	0.04	0.03	pCi/g	=
SAIC	IAAP25003	IAAP25003	687577	90203	0.0	0.5	5/1/2001	ML-003	Uranium-238	6.24	0.52	0.35	pCi/g	=
SAIC	IAAP25004	IAAP25004	687579	90196	0.0	0.5	5/1/2001	ML-003	Bismuth-214	0.90	0.14	0.16	pCi/g	=
SAIC	IAAP25004	IAAP25004	687579	90196	0.0	0.5	5/1/2001	ML-003	Cesium-137	0.28	0.08	0.09	pCi/g	=
SAIC	IAAP25004	IAAP25004	687579	90196	0.0	0.5	5/1/2001	ML-003	Lead-212	0.83	0.16	0.16	pCi/g	=
SAIC	IAAP25004	IAAP25004	687579	90196	0.0	0.5	5/1/2001	ML-003	Lead-214	0.81	0.15	0.18	pCi/g	=
SAIC	IAAP25004	IAAP25004	687579	90196	0.0	0.5	5/1/2001	ML-003	Potassium-40	13.60	1.59	0.38	pCi/g	=
SAIC	IAAP25004	IAAP25004	687579	90196	0.0	0.5	5/1/2001	ML-003	Radium-224	1.46	1.15	1.89	pCi/g	U
SAIC	IAAP25004	IAAP25004	687579	90196	0.0	0.5	5/1/2001	ML-003	Radium-228	0.90	0.24	0.20	pCi/g	=
SAIC	IAAP25004	IAAP25004	687579	90196	0.0	0.5	5/1/2001	ML-003	Thallium-208	0.98	0.26	0.24	pCi/g	=
SAIC	IAAP25004	IAAP25004	687579	90196	0.0	0.5	5/1/2001	ML-003	Thorium-228	0.90	0.24	0.20	pCi/g	=
SAIC	IAAP25004	IAAP25004	687579	90196	0.0	0.5	5/1/2001	ML-003	Thorium-232	0.90	0.24	0.20	pCi/g	=
SAIC	IAAP25004	IAAP25004	687579	90196	0.0	0.5	5/1/2001	ML-015	Uranium-234	67.70	15.60	0.84	pCi/g	=
SAIC	IAAP25004	IAAP25004	687579	90196	0.0	0.5	5/1/2001	ML-015	Uranium-235	16.70	5.08	0.56	pCi/g	=
SAIC	IAAP25004	IAAP25004	687579	90196	0.0	0.5	5/1/2001	ML-003	Uranium-235	9.78	0.64	0.14	pCi/g	=
SAIC	IAAP25004	IAAP25004	687579	90196	0.0	0.5	5/1/2001	ML-015	Uranium-238	620.00	130.00	1.00	pCi/g	=
SAIC	IAAP25004	IAAP25004	687579	90196	0.0	0.5	5/1/2001	ML-003	Uranium-238	660.00	39.70	3.19	pCi/g	=
SAIC	IAAP116615	IAAP25004	687579	90196	0.5	1.0	4/13/2009	ML-015	Uranium-234	0.76	0.42	0.28	pCi/g	J
SAIC	IAAP116615	IAAP25004	687579	90196	0.5	1.0	4/13/2009	ML-015	Uranium-235	0.00	0.00	0.16	pCi/g	U
SAIC	IAAP116615	IAAP25004	687579	90196	0.5	1.0	4/13/2009	ML-015	Uranium-238	0.63	0.37	0.23	pCi/g	J
SAIC	IAAP116615	IAAP25004	687579	90196	0.5	1.0	4/13/2009	ML-003	Actinium-227	-0.02	0.11	0.18	pCi/g	UJ
SAIC	IAAP116615	IAAP25004	687579	90196	0.5	1.0	4/13/2009	ML-003	Americium-241	0.00	0.03	0.04	pCi/g	UJ
SAIC	IAAP116615	IAAP25004	687579	90196	0.5	1.0	4/13/2009	ML-003	Cesium-137	0.01	0.01	0.02	pCi/g	UJ
SAIC	IAAP116615	IAAP25004	687579	90196	0.5	1.0	4/13/2009	ML-003	Potassium-40	12.10	0.77	0.16	pCi/g	=
SAIC	IAAP116615	IAAP25004	687579	90196	0.5	1.0	4/13/2009	ML-003	Protactinium-231	0.14	0.33	0.51	pCi/g	UJ
SAIC	IAAP116615	IAAP25004	687579	90196	0.5	1.0	4/13/2009	ML-003	Radium-226	0.93	0.25	0.04	pCi/g	=
SAIC	IAAP116615	IAAP25004	687579	90196	0.5	1.0	4/13/2009	ML-003	Radium-228	0.84	0.06	0.06	pCi/g	=
SAIC	IAAP116615	IAAP25004	687579	90196	0.5	1.0	4/13/2009	ML-003	Thorium-228	0.84	0.06	0.06	pCi/g	=
SAIC	IAAP116615	IAAP25004	687579	90196	0.5	1.0	4/13/2009	ML-003	Thorium-230	-0.26	2.52	3.79	pCi/g	UJ
SAIC	IAAP116615	IAAP25004	687579	90196	0.5	1.0	4/13/2009	ML-003	Thorium-232	0.84	0.06	0.06	pCi/g	=
SAIC	IAAP116615	IAAP25004	687579	90196	0.5	1.0	4/13/2009	ML-003	Uranium-235	0.10	0.15	0.24	pCi/g	UJ
SAIC	IAAP116615	IAAP25004	687579	90196	0.5	1.0	4/13/2009	ML-003	Uranium-238	0.99	0.49	0.38	pCi/g	=
SAIC	IAAP116616	IAAP25004	687579	90196	1.0	1.5	4/13/2009	ML-015	Uranium-234	0.78	0.47	0.16	pCi/g	J
SAIC	IAAP116616	IAAP25004	687579	90196	1.0	1.5	4/13/2009	ML-015	Uranium-235	0.00	0.00	0.20	pCi/g	U
SAIC	IAAP116616	IAAP25004	687579	90196	1.0	1.5	4/13/2009	ML-015	Uranium-238	0.84	0.49	0.16	pCi/g	J
SAIC	IAAP116616	IAAP25004	687579	90196	1.0	1.5	4/13/2009	ML-003	Actinium-227	-0.05	0.11	0.17	pCi/g	UJ
SAIC	IAAP116616	IAAP25004	687579	90196	1.0	1.5	4/13/2009	ML-003	Americium-241	0.02	0.03	0.04	pCi/g	UJ
SAIC	IAAP116616	IAAP25004	687579	90196	1.0	1.5	4/13/2009	ML-003	Cesium-137	0.02	0.02	0.02	pCi/g	J
SAIC	IAAP116616	IAAP25004	687579	90196	1.0	1.5	4/13/2009	ML-003	Potassium-40	12.50	0.78	0.17	pCi/g	=
SAIC	IAAP116616	IAAP25004	687579	90196	1.0	1.5	4/13/2009	ML-003	Protactinium-231	-0.01	0.32	0.53	pCi/g	UJ
SAIC	IAAP116616	IAAP25004	687579	90196	1.0	1.5	4/13/2009	ML-003	Radium-226	1.15	0.30	0.05	pCi/g	=
SAIC	IAAP116616	IAAP25004	687579	90196	1.0	1.5	4/13/2009	ML-003	Radium-228	0.98	0.07	0.06	pCi/g	=
SAIC	IAAP116616	IAAP25004	687579	90196	1.0	1.5	4/13/2009	ML-003	Thorium-228	0.98	0.07	0.06	pCi/g	=
SAIC	IAAP116616	IAAP25004	687579	90196	1.0	1.5	4/13/2009	ML-003	Thorium-230	-2.33	2.73	4.01	pCi/g	UJ
SAIC	IAAP116616	IAAP25004	687579	90196	1.0	1.5	4/13/2009	ML-003	Thorium-232	0.98	0.07	0.06	pCi/g	=
SAIC	IAAP116616	IAAP25004	687579	90196	1.0	1.5	4/13/2009	ML-003	Uranium-235	0.09	0.16	0.26	pCi/g	UJ

Table A-4-1. Firing Site 6 Area DU

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier
SAIC	IAAP116616	IAAP25004	687579	90196	1.0	1.5	4/13/2009	ML-003	Uranium-238	0.64	0.49	0.41	pCi/g	J
SAIC	IAAP116617	IAAP25004	687579	90196	1.5	2.0	4/13/2009	ML-015	Uranium-234	0.89	0.50	0.16	pCi/g	J
SAIC	IAAP116617	IAAP25004	687579	90196	1.5	2.0	4/13/2009	ML-015	Uranium-235	0.05	0.15	0.37	pCi/g	UJ
SAIC	IAAP116617	IAAP25004	687579	90196	1.5	2.0	4/13/2009	ML-015	Uranium-238	0.88	0.50	0.16	pCi/g	J
SAIC	IAAP116617	IAAP25004	687579	90196	1.5	2.0	4/13/2009	ML-003	Actinium-227	-0.04	0.09	0.15	pCi/g	UJ
SAIC	IAAP116617	IAAP25004	687579	90196	1.5	2.0	4/13/2009	ML-003	Americium-241	0.02	0.02	0.04	pCi/g	U
SAIC	IAAP116617	IAAP25004	687579	90196	1.5	2.0	4/13/2009	ML-003	Cesium-137	0.01	0.01	0.02	pCi/g	UJ
SAIC	IAAP116617	IAAP25004	687579	90196	1.5	2.0	4/13/2009	ML-003	Potassium-40	9.70	0.70	0.19	pCi/g	=
SAIC	IAAP116617	IAAP25004	687579	90196	1.5	2.0	4/13/2009	ML-003	Protactinium-231	-0.36	0.29	0.45	pCi/g	UJ
SAIC	IAAP116617	IAAP25004	687579	90196	1.5	2.0	4/13/2009	ML-003	Radium-226	0.62	0.18	0.04	pCi/g	J
SAIC	IAAP116617	IAAP25004	687579	90196	1.5	2.0	4/13/2009	ML-003	Radium-228	0.62	0.06	0.06	pCi/g	=
SAIC	IAAP116617	IAAP25004	687579	90196	1.5	2.0	4/13/2009	ML-003	Thorium-228	0.62	0.06	0.06	pCi/g	=
SAIC	IAAP116617	IAAP25004	687579	90196	1.5	2.0	4/13/2009	ML-003	Thorium-230	-2.95	2.12	3.30	pCi/g	UJ
SAIC	IAAP116617	IAAP25004	687579	90196	1.5	2.0	4/13/2009	ML-003	Thorium-232	0.62	0.06	0.06	pCi/g	=
SAIC	IAAP116617	IAAP25004	687579	90196	1.5	2.0	4/13/2009	ML-003	Uranium-235	0.02	0.13	0.21	pCi/g	UJ
SAIC	IAAP116617	IAAP25004	687579	90196	1.5	2.0	4/13/2009	ML-003	Uranium-238	0.20	0.23	0.39	pCi/g	UJ
SAIC	IAAP25005	IAAP25005	687585	90194	0.0	0.5	5/1/2001	ML-003	Bismuth-211	0.21	0.31	0.10	pCi/g	U
SAIC	IAAP25005	IAAP25005	687585	90194	0.0	0.5	5/1/2001	ML-003	Bismuth-212	0.91	0.25	0.23	pCi/g	=
SAIC	IAAP25005	IAAP25005	687585	90194	0.0	0.5	5/1/2001	ML-003	Bismuth-214	0.65	0.07	0.03	pCi/g	=
SAIC	IAAP25005	IAAP25005	687585	90194	0.0	0.5	5/1/2001	ML-003	Cesium-137	0.06	0.02	0.02	pCi/g	=
SAIC	IAAP25005	IAAP25005	687585	90194	0.0	0.5	5/1/2001	ML-003	Lead-212	0.88	0.09	0.03	pCi/g	=
SAIC	IAAP25005	IAAP25005	687585	90194	0.0	0.5	5/1/2001	ML-003	Lead-214	0.55	0.08	0.03	pCi/g	=
SAIC	IAAP25005	IAAP25005	687585	90194	0.0	0.5	5/1/2001	ML-003	Potassium-40	12.70	1.35	0.17	pCi/g	=
SAIC	IAAP25005	IAAP25005	687585	90194	0.0	0.5	5/1/2001	ML-003	Radium-224	2.39	0.45	0.31	pCi/g	=
SAIC	IAAP25005	IAAP25005	687585	90194	0.0	0.5	5/1/2001	ML-003	Radium-228	0.92	0.11	0.07	pCi/g	=
SAIC	IAAP25005	IAAP25005	687585	90194	0.0	0.5	5/1/2001	ML-003	Thallium-208	0.82	0.11	0.05	pCi/g	=
SAIC	IAAP25005	IAAP25005	687585	90194	0.0	0.5	5/1/2001	ML-003	Thorium-228	0.92	0.11	0.07	pCi/g	=
SAIC	IAAP25005	IAAP25005	687585	90194	0.0	0.5	5/1/2001	ML-003	Thorium-232	0.92	0.11	0.07	pCi/g	=
SAIC	IAAP25005	IAAP25005	687585	90194	0.0	0.5	5/1/2001	ML-003	Uranium-235	0.13	0.03	0.03	pCi/g	U
SAIC	IAAP25005	IAAP25005	687585	90194	0.0	0.5	5/1/2001	ML-003	Uranium-238	2.57	0.28	0.22	pCi/g	=
SAIC	IAAP25006	IAAP25006	687606	90176	0.0	0.5	5/1/2001	ML-003	Bismuth-212	0.61	0.23	0.22	pCi/g	=
SAIC	IAAP25006	IAAP25006	687606	90176	0.0	0.5	5/1/2001	ML-003	Bismuth-214	0.54	0.06	0.03	pCi/g	=
SAIC	IAAP25006	IAAP25006	687606	90176	0.0	0.5	5/1/2001	ML-003	Cesium-137	0.00	0.01	0.02	pCi/g	U
SAIC	IAAP25006	IAAP25006	687606	90176	0.0	0.5	5/1/2001	ML-003	Lead-212	0.81	0.08	0.03	pCi/g	=
SAIC	IAAP25006	IAAP25006	687606	90176	0.0	0.5	5/1/2001	ML-003	Lead-214	0.54	0.05	0.03	pCi/g	=
SAIC	IAAP25006	IAAP25006	687606	90176	0.0	0.5	5/1/2001	ML-003	Potassium-40	12.70	1.33	0.14	pCi/g	=
SAIC	IAAP25006	IAAP25006	687606	90176	0.0	0.5	5/1/2001	ML-003	Radium-224	1.61	0.45	0.29	pCi/g	=
SAIC	IAAP25006	IAAP25006	687606	90176	0.0	0.5	5/1/2001	ML-003	Radium-228	0.80	0.09	0.07	pCi/g	=
SAIC	IAAP25006	IAAP25006	687606	90176	0.0	0.5	5/1/2001	ML-003	Thallium-208	0.74	0.10	0.05	pCi/g	=
SAIC	IAAP25006	IAAP25006	687606	90176	0.0	0.5	5/1/2001	ML-003	Thorium-228	0.80	0.09	0.07	pCi/g	=
SAIC	IAAP25006	IAAP25006	687606	90176	0.0	0.5	5/1/2001	ML-003	Thorium-232	0.80	0.09	0.07	pCi/g	=
SAIC	IAAP25006	IAAP25006	687606	90176	0.0	0.5	5/1/2001	ML-003	Uranium-235	0.09	0.03	0.03	pCi/g	U
SAIC	IAAP25006	IAAP25006	687606	90176	0.0	0.5	5/1/2001	ML-003	Uranium-238	0.98	0.19	0.21	pCi/g	=
SAIC	IAAP96821	IAAP96821	687523	90220	0.0	0.5	10/25/2006	ML-003	Actinium-227	0.01	0.08	0.12	pCi/g	UJ
SAIC	IAAP96821	IAAP96821	687523	90220	0.0	0.5	10/25/2006	ML-003	Americium-241	-0.01	0.02	0.02	pCi/g	UJ
SAIC	IAAP96821	IAAP96821	687523	90220	0.0	0.5	10/25/2006	ML-003	Cesium-137	-0.01	0.01	0.01	pCi/g	UJ
SAIC	IAAP96821	IAAP96821	687523	90220	0.0	0.5	10/25/2006	ML-003	Potassium-40	2.24	0.30	0.12	pCi/g	=
SAIC	IAAP96821	IAAP96821	687523	90220	0.0	0.5	10/25/2006	ML-003	Protactinium-231	-0.02	0.23	0.33	pCi/g	UJ
SAIC	IAAP96821	IAAP96821	687523	90220	0.0	0.5	10/25/2006	ML-003	Radium-226	0.42	0.12	0.03	pCi/g	J
SAIC	IAAP96821	IAAP96821	687523	90220	0.0	0.5	10/25/2006	ML-003	Radium-228	0.11	0.03	0.03	pCi/g	J
SAIC	IAAP96821	IAAP96821	687523	90220	0.0	0.5	10/25/2006	ML-003	Thorium-228	0.11	0.03	0.03	pCi/g	J
SAIC	IAAP96821	IAAP96821	687523	90220	0.0	0.5	10/25/2006	ML-003	Thorium-230	0.76	1.64	2.44	pCi/g	UJ
SAIC	IAAP96821	IAAP96821	687523	90220	0.0	0.5	10/25/2006	ML-003	Thorium-232	0.11	0.03	0.03	pCi/g	J
SAIC	IAAP96821	IAAP96821	687523	90220	0.0	0.5	10/25/2006	ML-015	Uranium-234	0.30	0.24	0.22	pCi/g	J
SAIC	IAAP96821	IAAP96821	687523	90220	0.0	0.5	10/25/2006	ML-015	Uranium-235	-0.03	0.04	0.33	pCi/g	UJ
SAIC	IAAP96821	IAAP96821	687523	90220	0.0	0.5	10/25/2006	ML-003	Uranium-235	0.01	0.09	0.15	pCi/g	UJ
SAIC	IAAP96821	IAAP96821	687523	90220	0.0	0.5	10/25/2006	ML-015	Uranium-238	0.39	0.28	0.12	pCi/g	J

Table A-4-1. Firing Site 6 Area DU

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier
SAIC	IAAP96821	IAAP96821	687523	90220	0.0	0.5	10/25/2006	ML-003	Uranium-238	0.28	0.28	0.23	pCi/g	J
SAIC	IAAP96822	IAAP96822	687514	90204	0.0	0.5	10/25/2006	ML-003	Actinium-227	0.02	0.10	0.17	pCi/g	UJ
SAIC	IAAP96822	IAAP96822	687514	90204	0.0	0.5	10/25/2006	ML-003	Americium-241	0.00	0.02	0.04	pCi/g	UJ
SAIC	IAAP96822	IAAP96822	687514	90204	0.0	0.5	10/25/2006	ML-003	Cesium-137	0.02	0.02	0.02	pCi/g	J
SAIC	IAAP96822	IAAP96822	687514	90204	0.0	0.5	10/25/2006	ML-003	Potassium-40	7.64	0.56	0.17	pCi/g	=
SAIC	IAAP96822	IAAP96822	687514	90204	0.0	0.5	10/25/2006	ML-003	Protactinium-231	0.09	0.31	0.47	pCi/g	UJ
SAIC	IAAP96822	IAAP96822	687514	90204	0.0	0.5	10/25/2006	ML-003	Radium-226	0.65	0.18	0.04	pCi/g	=
SAIC	IAAP96822	IAAP96822	687514	90204	0.0	0.5	10/25/2006	ML-003	Radium-228	0.45	0.05	0.05	pCi/g	=
SAIC	IAAP96822	IAAP96822	687514	90204	0.0	0.5	10/25/2006	ML-003	Thorium-228	0.45	0.05	0.05	pCi/g	=
SAIC	IAAP96822	IAAP96822	687514	90204	0.0	0.5	10/25/2006	ML-003	Thorium-230	0.38	2.17	3.41	pCi/g	UJ
SAIC	IAAP96822	IAAP96822	687514	90204	0.0	0.5	10/25/2006	ML-003	Thorium-232	0.45	0.05	0.05	pCi/g	=
SAIC	IAAP96822	IAAP96822	687514	90204	0.0	0.5	10/25/2006	ML-015	Uranium-234	0.40	0.28	0.12	pCi/g	J
SAIC	IAAP96822	IAAP96822	687514	90204	0.0	0.5	10/25/2006	ML-015	Uranium-235	0.00	0.00	0.15	pCi/g	U
SAIC	IAAP96822	IAAP96822	687514	90204	0.0	0.5	10/25/2006	ML-003	Uranium-235	0.06	0.14	0.23	pCi/g	UJ
SAIC	IAAP96822	IAAP96822	687514	90204	0.0	0.5	10/25/2006	ML-015	Uranium-238	0.39	0.28	0.22	pCi/g	J
SAIC	IAAP96822	IAAP96822	687514	90204	0.0	0.5	10/25/2006	ML-003	Uranium-238	0.35	0.24	0.41	pCi/g	U
SAIC	IAAP96823	IAAP96823	687569	90263	0.0	0.5	10/25/2006	ML-003	Actinium-227	-0.01	0.09	0.15	pCi/g	UJ
SAIC	IAAP96823	IAAP96823	687569	90263	0.0	0.5	10/25/2006	ML-003	Americium-241	0.01	0.02	0.03	pCi/g	UJ
SAIC	IAAP96823	IAAP96823	687569	90263	0.0	0.5	10/25/2006	ML-003	Cesium-137	0.00	0.01	0.02	pCi/g	UJ
SAIC	IAAP96823	IAAP96823	687569	90263	0.0	0.5	10/25/2006	ML-003	Potassium-40	6.70	0.54	0.16	pCi/g	=
SAIC	IAAP96823	IAAP96823	687569	90263	0.0	0.5	10/25/2006	ML-003	Protactinium-231	0.06	0.24	0.42	pCi/g	UJ
SAIC	IAAP96823	IAAP96823	687569	90263	0.0	0.5	10/25/2006	ML-003	Radium-226	0.45	0.13	0.04	pCi/g	J
SAIC	IAAP96823	IAAP96823	687569	90263	0.0	0.5	10/25/2006	ML-003	Radium-228	0.19	0.04	0.05	pCi/g	J
SAIC	IAAP96823	IAAP96823	687569	90263	0.0	0.5	10/25/2006	ML-003	Thorium-228	0.19	0.04	0.05	pCi/g	J
SAIC	IAAP96823	IAAP96823	687569	90263	0.0	0.5	10/25/2006	ML-003	Thorium-230	2.38	2.23	2.58	pCi/g	U
SAIC	IAAP96823	IAAP96823	687569	90263	0.0	0.5	10/25/2006	ML-003	Thorium-232	0.19	0.04	0.05	pCi/g	J
SAIC	IAAP96823	IAAP96823	687569	90263	0.0	0.5	10/25/2006	ML-015	Uranium-234	0.28	0.26	0.15	pCi/g	J
SAIC	IAAP96823	IAAP96823	687569	90263	0.0	0.5	10/25/2006	ML-015	Uranium-235	0.00	0.00	0.19	pCi/g	U
SAIC	IAAP96823	IAAP96823	687569	90263	0.0	0.5	10/25/2006	ML-003	Uranium-235	0.05	0.11	0.19	pCi/g	UJ
SAIC	IAAP96823	IAAP96823	687569	90263	0.0	0.5	10/25/2006	ML-015	Uranium-238	0.73	0.44	0.15	pCi/g	J
SAIC	IAAP96823	IAAP96823	687569	90263	0.0	0.5	10/25/2006	ML-003	Uranium-238	0.31	0.30	0.28	pCi/g	J
SAIC	IAAP96824	IAAP96824	687572	90260	0.0	0.5	10/25/2006	ML-003	Actinium-227	-0.10	0.08	0.12	pCi/g	UJ
SAIC	IAAP96824	IAAP96824	687572	90260	0.0	0.5	10/25/2006	ML-003	Americium-241	0.01	0.02	0.03	pCi/g	UJ
SAIC	IAAP96824	IAAP96824	687572	90260	0.0	0.5	10/25/2006	ML-003	Cesium-137	0.00	0.01	0.01	pCi/g	UJ
SAIC	IAAP96824	IAAP96824	687572	90260	0.0	0.5	10/25/2006	ML-003	Potassium-40	6.42	0.48	0.14	pCi/g	=
SAIC	IAAP96824	IAAP96824	687572	90260	0.0	0.5	10/25/2006	ML-003	Protactinium-231	-0.05	0.23	0.34	pCi/g	UJ
SAIC	IAAP96824	IAAP96824	687572	90260	0.0	0.5	10/25/2006	ML-003	Radium-226	0.68	0.18	0.04	pCi/g	=
SAIC	IAAP96824	IAAP96824	687572	90260	0.0	0.5	10/25/2006	ML-003	Radium-228	0.19	0.03	0.05	pCi/g	J
SAIC	IAAP96824	IAAP96824	687572	90260	0.0	0.5	10/25/2006	ML-003	Thorium-228	0.19	0.03	0.05	pCi/g	J
SAIC	IAAP96824	IAAP96824	687572	90260	0.0	0.5	10/25/2006	ML-003	Thorium-230	1.88	1.91	2.62	pCi/g	UJ
SAIC	IAAP96824	IAAP96824	687572	90260	0.0	0.5	10/25/2006	ML-003	Thorium-232	0.19	0.03	0.05	pCi/g	J
SAIC	IAAP96824	IAAP96824	687572	90260	0.0	0.5	10/25/2006	ML-015	Uranium-234	0.47	0.33	0.14	pCi/g	J
SAIC	IAAP96824	IAAP96824	687572	90260	0.0	0.5	10/25/2006	ML-015	Uranium-235	0.00	0.00	0.18	pCi/g	U
SAIC	IAAP96824	IAAP96824	687572	90260	0.0	0.5	10/25/2006	ML-003	Uranium-235	0.01	0.11	0.17	pCi/g	UJ
SAIC	IAAP96824	IAAP96824	687572	90260	0.0	0.5	10/25/2006	ML-015	Uranium-238	1.15	0.56	0.14	pCi/g	=
SAIC	IAAP96824	IAAP96824	687572	90260	0.0	0.5	10/25/2006	ML-003	Uranium-238	0.44	0.26	0.25	pCi/g	J
SAIC	IAAP96825	IAAP96825	687590	90263	0.0	0.5	10/25/2006	ML-003	Actinium-227	0.00	0.10	0.14	pCi/g	UJ
SAIC	IAAP96825	IAAP96825	687590	90263	0.0	0.5	10/25/2006	ML-003	Americium-241	0.01	0.02	0.03	pCi/g	UJ
SAIC	IAAP96825	IAAP96825	687590	90263	0.0	0.5	10/25/2006	ML-003	Cesium-137	0.00	0.01	0.01	pCi/g	UJ
SAIC	IAAP96825	IAAP96825	687590	90263	0.0	0.5	10/25/2006	ML-003	Potassium-40	4.13	0.40	0.14	pCi/g	=
SAIC	IAAP96825	IAAP96825	687590	90263	0.0	0.5	10/25/2006	ML-003	Protactinium-231	-0.08	0.25	0.42	pCi/g	UJ
SAIC	IAAP96825	IAAP96825	687590	90263	0.0	0.5	10/25/2006	ML-003	Radium-226	0.81	0.21	0.04	pCi/g	=
SAIC	IAAP96825	IAAP96825	687590	90263	0.0	0.5	10/25/2006	ML-003	Radium-228	0.15	0.03	0.06	pCi/g	J
SAIC	IAAP96825	IAAP96825	687590	90263	0.0	0.5	10/25/2006	ML-003	Thorium-228	0.15	0.03	0.06	pCi/g	J
SAIC	IAAP96825	IAAP96825	687590	90263	0.0	0.5	10/25/2006	ML-003	Thorium-230	0.77	1.73	2.76	pCi/g	UJ
SAIC	IAAP96825	IAAP96825	687590	90263	0.0	0.5	10/25/2006	ML-003	Thorium-232	0.15	0.03	0.06	pCi/g	J
SAIC	IAAP96825	IAAP96825	687590	90263	0.0	0.5	10/25/2006	ML-015	Uranium-234	0.62	0.37	0.13	pCi/g	J

Table A-4-1. Firing Site 6 Area DU

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier
SAIC	IAAP96825	IAAP96825	687590	90263	0.0	0.5	10/25/2006	ML-015	Uranium-235	0.06	0.12	0.16	pCi/g	UJ
SAIC	IAAP96825	IAAP96825	687590	90263	0.0	0.5	10/25/2006	ML-003	Uranium-235	0.00	0.12	0.19	pCi/g	UJ
SAIC	IAAP96825	IAAP96825	687590	90263	0.0	0.5	10/25/2006	ML-015	Uranium-238	0.95	0.47	0.13	pCi/g	=
SAIC	IAAP96825	IAAP96825	687590	90263	0.0	0.5	10/25/2006	ML-003	Uranium-238	0.64	0.27	0.26	pCi/g	=
SAIC	IAAP96826	IAAP96826	687637	90266	0.0	0.5	10/25/2006	ML-003	Actinium-227	0.01	0.08	0.13	pCi/g	UJ
SAIC	IAAP96826	IAAP96826	687637	90266	0.0	0.5	10/25/2006	ML-003	Americium-241	-0.01	0.02	0.02	pCi/g	UJ
SAIC	IAAP96826	IAAP96826	687637	90266	0.0	0.5	10/25/2006	ML-003	Cesium-137	0.00	0.01	0.01	pCi/g	UJ
SAIC	IAAP96826	IAAP96826	687637	90266	0.0	0.5	10/25/2006	ML-003	Potassium-40	7.91	0.53	0.11	pCi/g	=
SAIC	IAAP96826	IAAP96826	687637	90266	0.0	0.5	10/25/2006	ML-003	Protactinium-231	0.04	0.24	0.36	pCi/g	UJ
SAIC	IAAP96826	IAAP96826	687637	90266	0.0	0.5	10/25/2006	ML-003	Radium-226	0.29	0.09	0.03	pCi/g	J
SAIC	IAAP96826	IAAP96826	687637	90266	0.0	0.5	10/25/2006	ML-003	Radium-228	0.21	0.03	0.04	pCi/g	J
SAIC	IAAP96826	IAAP96826	687637	90266	0.0	0.5	10/25/2006	ML-003	Thorium-228	0.21	0.03	0.04	pCi/g	J
SAIC	IAAP96826	IAAP96826	687637	90266	0.0	0.5	10/25/2006	ML-003	Thorium-230	-0.34	1.53	2.36	pCi/g	UJ
SAIC	IAAP96826	IAAP96826	687637	90266	0.0	0.5	10/25/2006	ML-003	Thorium-232	0.21	0.03	0.04	pCi/g	J
SAIC	IAAP96826	IAAP96826	687637	90266	0.0	0.5	10/25/2006	ML-015	Uranium-234	0.15	0.18	0.14	pCi/g	J
SAIC	IAAP96826	IAAP96826	687637	90266	0.0	0.5	10/25/2006	ML-015	Uranium-235	0.00	0.00	0.17	pCi/g	U
SAIC	IAAP96826	IAAP96826	687637	90266	0.0	0.5	10/25/2006	ML-003	Uranium-235	0.00	0.10	0.16	pCi/g	UJ
SAIC	IAAP96826	IAAP96826	687637	90266	0.0	0.5	10/25/2006	ML-015	Uranium-238	0.35	0.28	0.14	pCi/g	J
SAIC	IAAP96826	IAAP96826	687637	90266	0.0	0.5	10/25/2006	ML-003	Uranium-238	0.14	0.17	0.29	pCi/g	UJ
SAIC	IAAP96827	IAAP96827	687643	90266	0.0	0.5	10/25/2006	ML-003	Actinium-227	0.03	0.07	0.11	pCi/g	UJ
SAIC	IAAP96827	IAAP96827	687643	90266	0.0	0.5	10/25/2006	ML-003	Americium-241	0.00	0.02	0.02	pCi/g	UJ
SAIC	IAAP96827	IAAP96827	687643	90266	0.0	0.5	10/25/2006	ML-003	Cesium-137	-0.01	0.01	0.01	pCi/g	UJ
SAIC	IAAP96827	IAAP96827	687643	90266	0.0	0.5	10/25/2006	ML-003	Potassium-40	9.36	0.57	0.09	pCi/g	=
SAIC	IAAP96827	IAAP96827	687643	90266	0.0	0.5	10/25/2006	ML-003	Protactinium-231	0.02	0.21	0.31	pCi/g	UJ
SAIC	IAAP96827	IAAP96827	687643	90266	0.0	0.5	10/25/2006	ML-003	Radium-226	0.21	0.07	0.03	pCi/g	J
SAIC	IAAP96827	IAAP96827	687643	90266	0.0	0.5	10/25/2006	ML-003	Radium-228	0.18	0.03	0.04	pCi/g	J
SAIC	IAAP96827	IAAP96827	687643	90266	0.0	0.5	10/25/2006	ML-003	Thorium-228	0.18	0.03	0.04	pCi/g	J
SAIC	IAAP96827	IAAP96827	687643	90266	0.0	0.5	10/25/2006	ML-003	Thorium-230	1.13	1.52	2.28	pCi/g	UJ
SAIC	IAAP96827	IAAP96827	687643	90266	0.0	0.5	10/25/2006	ML-003	Thorium-232	0.18	0.03	0.04	pCi/g	J
SAIC	IAAP96827	IAAP96827	687643	90266	0.0	0.5	10/25/2006	ML-015	Uranium-234	0.33	0.31	0.36	pCi/g	U
SAIC	IAAP96827	IAAP96827	687643	90266	0.0	0.5	10/25/2006	ML-015	Uranium-235	0.00	0.00	0.20	pCi/g	U
SAIC	IAAP96827	IAAP96827	687643	90266	0.0	0.5	10/25/2006	ML-003	Uranium-235	-0.03	0.08	0.14	pCi/g	UJ
SAIC	IAAP96827	IAAP96827	687643	90266	0.0	0.5	10/25/2006	ML-015	Uranium-238	0.21	0.25	0.36	pCi/g	UJ
SAIC	IAAP96827	IAAP96827	687643	90266	0.0	0.5	10/25/2006	ML-003	Uranium-238	0.44	0.28	0.22	pCi/g	J
SAIC	IAAP96828	IAAP96828	687720	90270	0.0	0.5	10/25/2006	ML-003	Actinium-227	0.05	0.09	0.15	pCi/g	UJ
SAIC	IAAP96828	IAAP96828	687720	90270	0.0	0.5	10/25/2006	ML-003	Americium-241	0.00	0.02	0.03	pCi/g	UJ
SAIC	IAAP96828	IAAP96828	687720	90270	0.0	0.5	10/25/2006	ML-003	Cesium-137	-0.01	0.01	0.01	pCi/g	UJ
SAIC	IAAP96828	IAAP96828	687720	90270	0.0	0.5	10/25/2006	ML-003	Potassium-40	4.29	0.39	0.11	pCi/g	=
SAIC	IAAP96828	IAAP96828	687720	90270	0.0	0.5	10/25/2006	ML-003	Protactinium-231	-0.09	0.27	0.39	pCi/g	UJ
SAIC	IAAP96828	IAAP96828	687720	90270	0.0	0.5	10/25/2006	ML-003	Radium-226	0.85	0.22	0.04	pCi/g	=
SAIC	IAAP96828	IAAP96828	687720	90270	0.0	0.5	10/25/2006	ML-003	Radium-228	0.17	0.03	0.05	pCi/g	J
SAIC	IAAP96828	IAAP96828	687720	90270	0.0	0.5	10/25/2006	ML-003	Thorium-228	0.17	0.03	0.05	pCi/g	J
SAIC	IAAP96828	IAAP96828	687720	90270	0.0	0.5	10/25/2006	ML-003	Thorium-230	1.38	1.87	2.79	pCi/g	UJ
SAIC	IAAP96828	IAAP96828	687720	90270	0.0	0.5	10/25/2006	ML-003	Thorium-232	0.17	0.03	0.05	pCi/g	J
SAIC	IAAP96828	IAAP96828	687720	90270	0.0	0.5	10/25/2006	ML-015	Uranium-234	1.43	0.72	0.18	pCi/g	J
SAIC	IAAP96828	IAAP96828	687720	90270	0.0	0.5	10/25/2006	ML-015	Uranium-235	-0.02	0.04	0.42	pCi/g	UJ
SAIC	IAAP96828	IAAP96828	687720	90270	0.0	0.5	10/25/2006	ML-003	Uranium-235	-0.02	0.11	0.18	pCi/g	UJ
SAIC	IAAP96828	IAAP96828	687720	90270	0.0	0.5	10/25/2006	ML-015	Uranium-238	1.15	0.63	0.18	pCi/g	J
SAIC	IAAP96828	IAAP96828	687720	90270	0.0	0.5	10/25/2006	ML-003	Uranium-238	0.73	0.30	0.26	pCi/g	=
SAIC	IAAP96829	IAAP96829	687594	90216	0.0	0.5	10/25/2006	ML-003	Actinium-227	0.05	0.08	0.12	pCi/g	UJ
SAIC	IAAP96829	IAAP96829	687594	90216	0.0	0.5	10/25/2006	ML-003	Americium-241	0.00	0.02	0.02	pCi/g	UJ
SAIC	IAAP96829	IAAP96829	687594	90216	0.0	0.5	10/25/2006	ML-003	Cesium-137	0.00	0.01	0.02	pCi/g	UJ
SAIC	IAAP96829	IAAP96829	687594	90216	0.0	0.5	10/25/2006	ML-003	Potassium-40	6.53	0.49	0.09	pCi/g	=
SAIC	IAAP96829	IAAP96829	687594	90216	0.0	0.5	10/25/2006	ML-003	Protactinium-231	-0.04	0.24	0.40	pCi/g	UJ
SAIC	IAAP96829	IAAP96829	687594	90216	0.0	0.5	10/25/2006	ML-003	Radium-226	0.36	0.11	0.03	pCi/g	J
SAIC	IAAP96829	IAAP96829	687594	90216	0.0	0.5	10/25/2006	ML-003	Radium-228	0.21	0.03	0.05	pCi/g	J
SAIC	IAAP96829	IAAP96829	687594	90216	0.0	0.5	10/25/2006	ML-003	Thorium-228	0.21	0.03	0.05	pCi/g	J

Table A-4-1. Firing Site 6 Area DU

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier
SAIC	IAAP96829	IAAP96829	687594	90216	0.0	0.5	10/25/2006	ML-003	Thorium-230	-0.40	1.58	2.43	pCi/g	UJ
SAIC	IAAP96829	IAAP96829	687594	90216	0.0	0.5	10/25/2006	ML-003	Thorium-232	0.21	0.03	0.05	pCi/g	J
SAIC	IAAP96829	IAAP96829	687594	90216	0.0	0.5	10/25/2006	ML-015	Uranium-234	0.52	0.33	0.13	pCi/g	J
SAIC	IAAP96829	IAAP96829	687594	90216	0.0	0.5	10/25/2006	ML-015	Uranium-235	0.00	0.00	0.16	pCi/g	U
SAIC	IAAP96829	IAAP96829	687594	90216	0.0	0.5	10/25/2006	ML-003	Uranium-235	-0.02	0.11	0.17	pCi/g	UJ
SAIC	IAAP96829	IAAP96829	687594	90216	0.0	0.5	10/25/2006	ML-015	Uranium-238	0.65	0.38	0.24	pCi/g	J
SAIC	IAAP96829	IAAP96829	687594	90216	0.0	0.5	10/25/2006	ML-003	Uranium-238	0.35	0.23	0.25	pCi/g	J
SAIC	IAAP96830	IAAP96830	687622	90276	0.0	0.5	10/25/2006	ML-003	Actinium-227	0.02	0.42	0.67	pCi/g	UJ
SAIC	IAAP96830-1	IAAP96830	687622	90276	0.0	0.5	10/25/2006	ML-003	Actinium-227	-0.09	0.48	0.76	pCi/g	UJ
SAIC	IAAP96830	IAAP96830	687622	90276	0.0	0.5	10/25/2006	ML-003	Americium-241	0.00	0.10	0.14	pCi/g	UJ
SAIC	IAAP96830-1	IAAP96830	687622	90276	0.0	0.5	10/25/2006	ML-003	Americium-241	-0.06	0.10	0.14	pCi/g	UJ
SAIC	IAAP96830	IAAP96830	687622	90276	0.0	0.5	10/25/2006	ML-003	Cesium-137	0.15	0.06	0.06	pCi/g	=
SAIC	IAAP96830-1	IAAP96830	687622	90276	0.0	0.5	10/25/2006	ML-003	Cesium-137	0.11	0.06	0.08	pCi/g	J
SAIC	IAAP96830	IAAP96830	687622	90276	0.0	0.5	10/25/2006	ML-003	Potassium-40	11.20	1.58	0.81	pCi/g	=
SAIC	IAAP96830-1	IAAP96830	687622	90276	0.0	0.5	10/25/2006	ML-003	Potassium-40	12.70	1.78	0.78	pCi/g	=
SAIC	IAAP96830	IAAP96830	687622	90276	0.0	0.5	10/25/2006	ML-003	Protactinium-231	-0.90	1.22	1.94	pCi/g	UJ
SAIC	IAAP96830-1	IAAP96830	687622	90276	0.0	0.5	10/25/2006	ML-003	Protactinium-231	-0.63	1.41	2.29	pCi/g	UJ
SAIC	IAAP96830	IAAP96830	687622	90276	0.0	0.5	10/25/2006	ML-003	Radium-226	1.08	0.37	0.20	pCi/g	J
SAIC	IAAP96830-1	IAAP96830	687622	90276	0.0	0.5	10/25/2006	ML-003	Radium-226	1.45	0.48	0.22	pCi/g	=
SAIC	IAAP96830	IAAP96830	687622	90276	0.0	0.5	10/25/2006	ML-003	Radium-228	0.86	0.17	0.27	pCi/g	=
SAIC	IAAP96830-1	IAAP96830	687622	90276	0.0	0.5	10/25/2006	ML-003	Radium-228	0.92	0.18	0.31	pCi/g	=
SAIC	IAAP96830	IAAP96830	687622	90276	0.0	0.5	10/25/2006	ML-005	Thorium-228	1.07	0.46	0.11	pCi/g	=
SAIC	IAAP96830	IAAP96830	687622	90276	0.0	0.5	10/25/2006	ML-003	Thorium-228	0.86	0.17	0.27	pCi/g	=
SAIC	IAAP96830-1	IAAP96830	687622	90276	0.0	0.5	10/25/2006	ML-005	Thorium-228	0.72	0.38	0.26	pCi/g	J
SAIC	IAAP96830-1	IAAP96830	687622	90276	0.0	0.5	10/25/2006	ML-003	Thorium-228	0.92	0.18	0.31	pCi/g	=
SAIC	IAAP96830	IAAP96830	687622	90276	0.0	0.5	10/25/2006	ML-005	Thorium-230	0.69	0.36	0.21	pCi/g	J
SAIC	IAAP96830	IAAP96830	687622	90276	0.0	0.5	10/25/2006	ML-003	Thorium-230	10.00	10.70	11.00	pCi/g	UJ
SAIC	IAAP96830-1	IAAP96830	687622	90276	0.0	0.5	10/25/2006	ML-005	Thorium-230	1.08	0.48	0.22	pCi/g	=
SAIC	IAAP96830-1	IAAP96830	687622	90276	0.0	0.5	10/25/2006	ML-003	Thorium-230	-0.42	8.52	13.20	pCi/g	UJ
SAIC	IAAP96830	IAAP96830	687622	90276	0.0	0.5	10/25/2006	ML-005	Thorium-232	0.78	0.39	0.11	pCi/g	=
SAIC	IAAP96830	IAAP96830	687622	90276	0.0	0.5	10/25/2006	ML-003	Thorium-232	0.86	0.17	0.27	pCi/g	=
SAIC	IAAP96830-1	IAAP96830	687622	90276	0.0	0.5	10/25/2006	ML-005	Thorium-232	0.82	0.41	0.22	pCi/g	J
SAIC	IAAP96830-1	IAAP96830	687622	90276	0.0	0.5	10/25/2006	ML-003	Thorium-232	0.92	0.18	0.31	pCi/g	=
SAIC	IAAP96830	IAAP96830	687622	90276	0.0	0.5	10/25/2006	ML-015	Uranium-234	0.41	0.31	0.26	pCi/g	J
SAIC	IAAP96830-1	IAAP96830	687622	90276	0.0	0.5	10/25/2006	ML-015	Uranium-234	0.49	0.35	0.15	pCi/g	J
SAIC	IAAP96830	IAAP96830	687622	90276	0.0	0.5	10/25/2006	ML-015	Uranium-235	0.00	0.00	0.18	pCi/g	U
SAIC	IAAP96830	IAAP96830	687622	90276	0.0	0.5	10/25/2006	ML-003	Uranium-235	0.43	0.47	0.81	pCi/g	UJ
SAIC	IAAP96830-1	IAAP96830	687622	90276	0.0	0.5	10/25/2006	ML-015	Uranium-235	0.14	0.19	0.18	pCi/g	UJ
SAIC	IAAP96830-1	IAAP96830	687622	90276	0.0	0.5	10/25/2006	ML-003	Uranium-235	-0.18	0.56	0.90	pCi/g	UJ
SAIC	IAAP96830	IAAP96830	687622	90276	0.0	0.5	10/25/2006	ML-015	Uranium-238	1.36	0.61	0.14	pCi/g	=
SAIC	IAAP96830	IAAP96830	687622	90276	0.0	0.5	10/25/2006	ML-003	Uranium-238	1.57	1.55	1.24	pCi/g	J
SAIC	IAAP96830-1	IAAP96830	687622	90276	0.0	0.5	10/25/2006	ML-015	Uranium-238	1.09	0.55	0.15	pCi/g	J
SAIC	IAAP96830-1	IAAP96830	687622	90276	0.0	0.5	10/25/2006	ML-003	Uranium-238	2.01	1.51	1.21	pCi/g	J

Coordinates in NAD Iowa South State Plane (meters).

Results, error, and detection limit are rounded to 2 decimal places regardless of significant digits.

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ATTACHMENT A-5

Firing Site 12 Area DU Data

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Table A-5-1. Firing Site 12 Area DU

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier
SAIC	IAAP100198	IAAP100198	687402	90813	0.0	0.5	4/27/2007	ML-003	Actinium-227	0.22	0.242	0.36	pCi/g	UJ
SAIC	IAAP100198	IAAP100198	687402	90813	0.0	0.5	4/27/2007	ML-003	Americium-241	0.00	0.0688	0.11	pCi/g	UJ
SAIC	IAAP100198	IAAP100198	687402	90813	0.0	0.5	4/27/2007	ML-003	Cesium-137	0.37	0.0488	0.03	pCi/g	=
SAIC	IAAP100198	IAAP100198	687402	90813	0.0	0.5	4/27/2007	ML-003	Potassium-40	12.80	0.888	0.19	pCi/g	=
SAIC	IAAP100198	IAAP100198	687402	90813	0.0	0.5	4/27/2007	ML-003	Protactinium-231	0.40	0.604	0.93	pCi/g	UJ
SAIC	IAAP100198	IAAP100198	687402	90813	0.0	0.5	4/27/2007	ML-003	Radium-226	0.93	0.26	0.08	pCi/g	=
SAIC	IAAP100198	IAAP100198	687402	90813	0.0	0.5	4/27/2007	ML-003	Radium-228	0.87	0.0766	0.09	pCi/g	=
SAIC	IAAP100198	IAAP100198	687402	90813	0.0	0.5	4/27/2007	ML-003	Thorium-228	0.87	0.0766	0.09	pCi/g	=
SAIC	IAAP100198	IAAP100198	687402	90813	0.0	0.5	4/27/2007	ML-003	Thorium-230	-5.77	6.23	9.41	pCi/g	UJ
SAIC	IAAP100198	IAAP100198	687402	90813	0.0	0.5	4/27/2007	ML-003	Thorium-232	0.87	0.0766	0.09	pCi/g	=
SAIC	IAAP100198	IAAP100198	687402	90813	0.0	0.5	4/27/2007	ML-003	Uranium-235	0.63	0.296	0.48	pCi/g	=
SAIC	IAAP100198	IAAP100198	687402	90813	0.0	0.5	4/27/2007	ML-003	Uranium-238	34.50	1.95	0.96	pCi/g	=
SAIC	IAAP100199	IAAP100199	687417	90841	0.0	0.5	4/27/2007	ML-003	Actinium-227	0.17	0.183	0.30	pCi/g	UJ
SAIC	IAAP100199	IAAP100199	687417	90841	0.0	0.5	4/27/2007	ML-003	Americium-241	0.05	0.0553	0.08	pCi/g	UJ
SAIC	IAAP100199	IAAP100199	687417	90841	0.0	0.5	4/27/2007	ML-003	Cesium-137	0.19	0.0379	0.03	pCi/g	=
SAIC	IAAP100199	IAAP100199	687417	90841	0.0	0.5	4/27/2007	ML-003	Potassium-40	15.10	0.931	0.24	pCi/g	=
SAIC	IAAP100199	IAAP100199	687417	90841	0.0	0.5	4/27/2007	ML-003	Protactinium-231	0.51	0.48	0.75	pCi/g	U
SAIC	IAAP100199	IAAP100199	687417	90841	0.0	0.5	4/27/2007	ML-003	Radium-226	1.04	0.276	0.06	pCi/g	=
SAIC	IAAP100199	IAAP100199	687417	90841	0.0	0.5	4/27/2007	ML-003	Radium-228	0.96	0.0679	0.08	pCi/g	=
SAIC	IAAP100199	IAAP100199	687417	90841	0.0	0.5	4/27/2007	ML-003	Thorium-228	0.96	0.0679	0.08	pCi/g	=
SAIC	IAAP100199	IAAP100199	687417	90841	0.0	0.5	4/27/2007	ML-003	Thorium-230	0.62	4.25	6.79	pCi/g	UJ
SAIC	IAAP100199	IAAP100199	687417	90841	0.0	0.5	4/27/2007	ML-003	Thorium-232	0.96	0.0679	0.08	pCi/g	=
SAIC	IAAP100199	IAAP100199	687417	90841	0.0	0.5	4/27/2007	ML-015	Uranium-234	3.25	1.17	0.31	pCi/g	=
SAIC	IAAP100199	IAAP100199	687417	90841	0.0	0.5	4/27/2007	ML-015	Uranium-235	0.37	0.345	0.20	pCi/g	J
SAIC	IAAP100199	IAAP100199	687417	90841	0.0	0.5	4/27/2007	ML-003	Uranium-235	0.48	0.317	0.41	pCi/g	UJ
SAIC	IAAP100199	IAAP100199	687417	90841	0.0	0.5	4/27/2007	ML-015	Uranium-238	21.50	5.55	0.16	pCi/g	=
SAIC	IAAP100199	IAAP100199	687417	90841	0.0	0.5	4/27/2007	ML-003	Uranium-238	31.30	1.74	0.71	pCi/g	=
SAIC	IAAP100200	IAAP100200	687388	90795	0.0	0.5	4/27/2007	ML-003	Actinium-227	-0.03	0.175	0.28	pCi/g	UJ
SAIC	IAAP100200	IAAP100200	687388	90795	0.0	0.5	4/27/2007	ML-003	Americium-241	0.04	0.0501	0.08	pCi/g	UJ
SAIC	IAAP100200	IAAP100200	687388	90795	0.0	0.5	4/27/2007	ML-003	Cesium-137	0.37	0.0464	0.03	pCi/g	=
SAIC	IAAP100200	IAAP100200	687388	90795	0.0	0.5	4/27/2007	ML-003	Potassium-40	12.10	0.906	0.20	pCi/g	=
SAIC	IAAP100200	IAAP100200	687388	90795	0.0	0.5	4/27/2007	ML-003	Protactinium-231	0.26	0.521	0.80	pCi/g	UJ
SAIC	IAAP100200	IAAP100200	687388	90795	0.0	0.5	4/27/2007	ML-003	Radium-226	0.93	0.257	0.08	pCi/g	=
SAIC	IAAP100200	IAAP100200	687388	90795	0.0	0.5	4/27/2007	ML-003	Radium-228	0.84	0.0739	0.09	pCi/g	=
SAIC	IAAP100200	IAAP100200	687388	90795	0.0	0.5	4/27/2007	ML-003	Thorium-228	0.84	0.0739	0.09	pCi/g	=
SAIC	IAAP100200	IAAP100200	687388	90795	0.0	0.5	4/27/2007	ML-003	Thorium-230	-2.62	4.24	6.82	pCi/g	UJ
SAIC	IAAP100200	IAAP100200	687388	90795	0.0	0.5	4/27/2007	ML-003	Thorium-232	0.84	0.0739	0.09	pCi/g	=
SAIC	IAAP100200	IAAP100200	687388	90795	0.0	0.5	4/27/2007	ML-003	Uranium-235	0.33	0.166	0.38	pCi/g	U
SAIC	IAAP100200	IAAP100200	687388	90795	0.0	0.5	4/27/2007	ML-003	Uranium-238	17.70	1.26	0.70	pCi/g	=
SAIC	IAAP100201	IAAP100201	687406	90768	0.0	0.5	4/27/2007	ML-003	Actinium-227	0.03	0.192	0.27	pCi/g	UJ
SAIC	IAAP100201	IAAP100201	687406	90768	0.0	0.5	4/27/2007	ML-003	Americium-241	0.06	0.0437	0.07	pCi/g	U
SAIC	IAAP100201	IAAP100201	687406	90768	0.0	0.5	4/27/2007	ML-003	Cesium-137	0.10	0.0253	0.03	pCi/g	=
SAIC	IAAP100201	IAAP100201	687406	90768	0.0	0.5	4/27/2007	ML-003	Potassium-40	13.70	0.937	0.20	pCi/g	=
SAIC	IAAP100201	IAAP100201	687406	90768	0.0	0.5	4/27/2007	ML-003	Protactinium-231	0.19	0.498	0.76	pCi/g	UJ
SAIC	IAAP100201	IAAP100201	687406	90768	0.0	0.5	4/27/2007	ML-003	Radium-226	1.02	0.271	0.07	pCi/g	=
SAIC	IAAP100201	IAAP100201	687406	90768	0.0	0.5	4/27/2007	ML-003	Radium-228	0.97	0.0694	0.09	pCi/g	=
SAIC	IAAP100201	IAAP100201	687406	90768	0.0	0.5	4/27/2007	ML-003	Thorium-228	0.97	0.0694	0.09	pCi/g	=
SAIC	IAAP100201	IAAP100201	687406	90768	0.0	0.5	4/27/2007	ML-003	Thorium-230	1.09	4.19	6.50	pCi/g	UJ
SAIC	IAAP100201	IAAP100201	687406	90768	0.0	0.5	4/27/2007	ML-003	Thorium-232	0.97	0.0694	0.09	pCi/g	=
SAIC	IAAP100201	IAAP100201	687406	90768	0.0	0.5	4/27/2007	ML-003	Uranium-235	0.12	0.229	0.38	pCi/g	UJ
SAIC	IAAP100201	IAAP100201	687406	90768	0.0	0.5	4/27/2007	ML-003	Uranium-238	5.91	0.777	0.64	pCi/g	=
SAIC	IAAP100202	IAAP100202	687467	90828	0.0	0.5	4/27/2007	ML-003	Actinium-227	-0.04	0.461	0.72	pCi/g	UJ
SAIC	IAAP100202	IAAP100202	687467	90828	0.0	0.5	4/27/2007	ML-003	Americium-241	0.07	0.107	0.17	pCi/g	UJ
SAIC	IAAP100202	IAAP100202	687467	90828	0.0	0.5	4/27/2007	ML-003	Cesium-137	0.03	0.0502	0.09	pCi/g	UJ
SAIC	IAAP100202	IAAP100202	687467	90828	0.0	0.5	4/27/2007	ML-003	Potassium-40	14.50	1.74	0.49	pCi/g	=
SAIC	IAAP100202	IAAP100202	687467	90828	0.0	0.5	4/27/2007	ML-003	Protactinium-231	1.49	1.4	2.31	pCi/g	U
SAIC	IAAP100202	IAAP100202	687467	90828	0.0	0.5	4/27/2007	ML-003	Radium-226	1.32	0.439	0.17	pCi/g	=

Table A-5-1. Firing Site 12 Area DU

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier
SAIC	IAAP100202	IAAP100202	687467	90828	0.0	0.5	4/27/2007	ML-003	Radium-228	1.29	0.198	0.30	pCi/g	=
SAIC	IAAP100202	IAAP100202	687467	90828	0.0	0.5	4/27/2007	ML-003	Thorium-228	1.29	0.198	0.30	pCi/g	=
SAIC	IAAP100202	IAAP100202	687467	90828	0.0	0.5	4/27/2007	ML-003	Thorium-230	-7.57	10	14.70	pCi/g	UJ
SAIC	IAAP100202	IAAP100202	687467	90828	0.0	0.5	4/27/2007	ML-003	Thorium-232	1.29	0.198	0.30	pCi/g	=
SAIC	IAAP100202	IAAP100202	687467	90828	0.0	0.5	4/27/2007	ML-003	Uranium-235	0.05	0.538	0.88	pCi/g	UJ
SAIC	IAAP100202	IAAP100202	687467	90828	0.0	0.5	4/27/2007	ML-003	Uranium-238	4.33	1.8	1.56	pCi/g	=
SAIC	IAAP100203	IAAP100203	687491	90874	0.0	0.5	4/27/2007	ML-003	Actinium-227	0.06	0.147	0.24	pCi/g	UJ
SAIC	IAAP100203	IAAP100203	687491	90874	0.0	0.5	4/27/2007	ML-003	Americium-241	0.00	0.035	0.05	pCi/g	UJ
SAIC	IAAP100203	IAAP100203	687491	90874	0.0	0.5	4/27/2007	ML-003	Cesium-137	0.10	0.0265	0.02	pCi/g	=
SAIC	IAAP100203	IAAP100203	687491	90874	0.0	0.5	4/27/2007	ML-003	Potassium-40	14.90	0.93	0.19	pCi/g	=
SAIC	IAAP100203	IAAP100203	687491	90874	0.0	0.5	4/27/2007	ML-003	Protactinium-231	0.07	0.443	0.66	pCi/g	UJ
SAIC	IAAP100203	IAAP100203	687491	90874	0.0	0.5	4/27/2007	ML-003	Radium-226	1.21	0.307	0.06	pCi/g	=
SAIC	IAAP100203	IAAP100203	687491	90874	0.0	0.5	4/27/2007	ML-003	Radium-228	0.95	0.0674	0.08	pCi/g	=
SAIC	IAAP100203	IAAP100203	687491	90874	0.0	0.5	4/27/2007	ML-003	Thorium-228	0.95	0.0674	0.08	pCi/g	=
SAIC	IAAP100203	IAAP100203	687491	90874	0.0	0.5	4/27/2007	ML-003	Thorium-230	4.15	4.21	5.09	pCi/g	UJ
SAIC	IAAP100203	IAAP100203	687491	90874	0.0	0.5	4/27/2007	ML-003	Thorium-232	0.95	0.0674	0.08	pCi/g	=
SAIC	IAAP100203	IAAP100203	687491	90874	0.0	0.5	4/27/2007	ML-003	Uranium-235	0.08	0.186	0.31	pCi/g	UJ
SAIC	IAAP100203	IAAP100203	687491	90874	0.0	0.5	4/27/2007	ML-003	Uranium-238	3.03	0.623	0.50	pCi/g	=
SAIC	IAAP100204	IAAP100204	687471	90746	0.0	0.5	4/27/2007	ML-003	Actinium-227	-0.06	0.175	0.27	pCi/g	UJ
SAIC	IAAP100204	IAAP100204	687471	90746	0.0	0.5	4/27/2007	ML-003	Americium-241	-0.02	0.0434	0.07	pCi/g	UJ
SAIC	IAAP100204	IAAP100204	687471	90746	0.0	0.5	4/27/2007	ML-003	Cesium-137	0.19	0.0336	0.03	pCi/g	=
SAIC	IAAP100204	IAAP100204	687471	90746	0.0	0.5	4/27/2007	ML-003	Potassium-40	14.80	1.03	0.25	pCi/g	=
SAIC	IAAP100204	IAAP100204	687471	90746	0.0	0.5	4/27/2007	ML-003	Protactinium-231	0.19	0.499	0.76	pCi/g	UJ
SAIC	IAAP100204	IAAP100204	687471	90746	0.0	0.5	4/27/2007	ML-003	Radium-226	1.08	0.288	0.07	pCi/g	=
SAIC	IAAP100204	IAAP100204	687471	90746	0.0	0.5	4/27/2007	ML-003	Radium-228	1.05	0.0757	0.10	pCi/g	=
SAIC	IAAP100204	IAAP100204	687471	90746	0.0	0.5	4/27/2007	ML-003	Thorium-228	1.05	0.0757	0.10	pCi/g	=
SAIC	IAAP100204	IAAP100204	687471	90746	0.0	0.5	4/27/2007	ML-003	Thorium-230	2.00	3.92	6.14	pCi/g	UJ
SAIC	IAAP100204	IAAP100204	687471	90746	0.0	0.5	4/27/2007	ML-003	Thorium-232	1.05	0.0757	0.10	pCi/g	=
SAIC	IAAP100204	IAAP100204	687471	90746	0.0	0.5	4/27/2007	ML-003	Uranium-235	0.01	0.21	0.34	pCi/g	UJ
SAIC	IAAP100204	IAAP100204	687471	90746	0.0	0.5	4/27/2007	ML-003	Uranium-238	6.65	0.834	0.61	pCi/g	=
SAIC	IAAP100205	IAAP100205	687502	90789	0.0	0.5	4/27/2007	ML-003	Actinium-227	0.11	0.124	0.21	pCi/g	UJ
SAIC	IAAP100205	IAAP100205	687502	90789	0.0	0.5	4/27/2007	ML-003	Americium-241	-0.01	0.0279	0.04	pCi/g	UJ
SAIC	IAAP100205	IAAP100205	687502	90789	0.0	0.5	4/27/2007	ML-003	Cesium-137	0.09	0.0228	0.02	pCi/g	=
SAIC	IAAP100205	IAAP100205	687502	90789	0.0	0.5	4/27/2007	ML-003	Potassium-40	11.90	0.773	0.18	pCi/g	=
SAIC	IAAP100205	IAAP100205	687502	90789	0.0	0.5	4/27/2007	ML-003	Protactinium-231	-0.09	0.383	0.56	pCi/g	UJ
SAIC	IAAP100205	IAAP100205	687502	90789	0.0	0.5	4/27/2007	ML-003	Radium-226	0.93	0.244	0.05	pCi/g	=
SAIC	IAAP100205	IAAP100205	687502	90789	0.0	0.5	4/27/2007	ML-003	Radium-228	0.74	0.0572	0.08	pCi/g	=
SAIC	IAAP100205	IAAP100205	687502	90789	0.0	0.5	4/27/2007	ML-003	Thorium-228	0.74	0.0572	0.08	pCi/g	=
SAIC	IAAP100205	IAAP100205	687502	90789	0.0	0.5	4/27/2007	ML-003	Thorium-230	3.97	3.92	4.11	pCi/g	U
SAIC	IAAP100205	IAAP100205	687502	90789	0.0	0.5	4/27/2007	ML-003	Thorium-232	0.74	0.0572	0.08	pCi/g	=
SAIC	IAAP100205	IAAP100205	687502	90789	0.0	0.5	4/27/2007	ML-003	Uranium-235	0.06	0.16	0.27	pCi/g	UJ
SAIC	IAAP100205	IAAP100205	687502	90789	0.0	0.5	4/27/2007	ML-003	Uranium-238	1.19	0.375	0.40	pCi/g	=
SAIC	IAAP100206	IAAP100206	687391	90778	0.0	1.0	5/4/2007	ML-003	Actinium-227	-0.03	0.198	0.31	pCi/g	UJ
SAIC	IAAP100206	IAAP100206	687391	90778	0.0	1.0	5/4/2007	ML-003	Americium-241	0.00	0.0516	0.08	pCi/g	UJ
SAIC	IAAP100206	IAAP100206	687391	90778	0.0	1.0	5/4/2007	ML-003	Cesium-137	0.08	0.0301	0.03	pCi/g	=
SAIC	IAAP100206	IAAP100206	687391	90778	0.0	1.0	5/4/2007	ML-003	Potassium-40	13.00	1.01	0.26	pCi/g	=
SAIC	IAAP100206	IAAP100206	687391	90778	0.0	1.0	5/4/2007	ML-003	Protactinium-231	0.36	0.53	0.92	pCi/g	UJ
SAIC	IAAP100206	IAAP100206	687391	90778	0.0	1.0	5/4/2007	ML-003	Radium-226	1.28	0.335	0.08	pCi/g	=
SAIC	IAAP100206	IAAP100206	687391	90778	0.0	1.0	5/4/2007	ML-003	Radium-228	0.90	0.0773	0.12	pCi/g	=
SAIC	IAAP100206	IAAP100206	687391	90778	0.0	1.0	5/4/2007	ML-003	Thorium-228	0.90	0.0773	0.12	pCi/g	=
SAIC	IAAP100206	IAAP100206	687391	90778	0.0	1.0	5/4/2007	ML-003	Thorium-230	-2.18	4.62	6.64	pCi/g	UJ
SAIC	IAAP100206	IAAP100206	687391	90778	0.0	1.0	5/4/2007	ML-003	Thorium-232	0.90	0.0773	0.12	pCi/g	=
SAIC	IAAP100206	IAAP100206	687391	90778	0.0	1.0	5/4/2007	ML-003	Uranium-235	0.11	0.245	0.41	pCi/g	UJ
SAIC	IAAP100206	IAAP100206	687391	90778	0.0	1.0	5/4/2007	ML-003	Uranium-238	7.37	0.887	0.69	pCi/g	=
SAIC	IAAP100207	IAAP100206	687391	90778	1.0	2.0	5/4/2007	ML-003	Actinium-227	-0.20	0.195	0.29	pCi/g	UJ
SAIC	IAAP100207	IAAP100206	687391	90778	1.0	2.0	5/4/2007	ML-003	Americium-241	0.07	0.0423	0.07	pCi/g	U
SAIC	IAAP100207	IAAP100206	687391	90778	1.0	2.0	5/4/2007	ML-003	Cesium-137	0.03	0.0211	0.03	pCi/g	J

Table A-5-1. Firing Site 12 Area DU

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier
SAIC	IAAP100207	IAAP100206	687391	90778	1.0	2.0	5/4/2007	ML-003	Potassium-40	14.40	0.981	0.24	pCi/g	=
SAIC	IAAP100207	IAAP100206	687391	90778	1.0	2.0	5/4/2007	ML-003	Protactinium-231	0.41	0.541	0.85	pCi/g	UJ
SAIC	IAAP100207	IAAP100206	687391	90778	1.0	2.0	5/4/2007	ML-003	Radium-226	1.38	0.361	0.07	pCi/g	=
SAIC	IAAP100207	IAAP100206	687391	90778	1.0	2.0	5/4/2007	ML-003	Radium-228	0.99	0.0764	0.11	pCi/g	=
SAIC	IAAP100207	IAAP100206	687391	90778	1.0	2.0	5/4/2007	ML-003	Thorium-228	0.99	0.0764	0.11	pCi/g	=
SAIC	IAAP100207	IAAP100206	687391	90778	1.0	2.0	5/4/2007	ML-003	Thorium-230	2.21	4.08	6.14	pCi/g	UJ
SAIC	IAAP100207	IAAP100206	687391	90778	1.0	2.0	5/4/2007	ML-003	Thorium-232	0.99	0.0764	0.11	pCi/g	=
SAIC	IAAP100207	IAAP100206	687391	90778	1.0	2.0	5/4/2007	ML-003	Uranium-235	0.06	0.231	0.39	pCi/g	UJ
SAIC	IAAP100207	IAAP100206	687391	90778	1.0	2.0	5/4/2007	ML-003	Uranium-238	2.53	0.693	0.59	pCi/g	=
SAIC	IAAP100208	IAAP100206	687391	90778	2.0	3.0	5/4/2007	ML-003	Actinium-227	0.10	0.213	0.35	pCi/g	UJ
SAIC	IAAP100208	IAAP100206	687391	90778	2.0	3.0	5/4/2007	ML-003	Americium-241	0.03	0.0432	0.07	pCi/g	UJ
SAIC	IAAP100208	IAAP100206	687391	90778	2.0	3.0	5/4/2007	ML-003	Cesium-137	0.05	0.034	0.03	pCi/g	J
SAIC	IAAP100208	IAAP100206	687391	90778	2.0	3.0	5/4/2007	ML-003	Potassium-40	13.90	1.05	0.30	pCi/g	=
SAIC	IAAP100208	IAAP100206	687391	90778	2.0	3.0	5/4/2007	ML-003	Protactinium-231	0.48	0.603	0.95	pCi/g	UJ
SAIC	IAAP100208	IAAP100206	687391	90778	2.0	3.0	5/4/2007	ML-003	Radium-226	1.31	0.353	0.08	pCi/g	=
SAIC	IAAP100208	IAAP100206	687391	90778	2.0	3.0	5/4/2007	ML-003	Radium-228	1.00	0.0892	0.13	pCi/g	=
SAIC	IAAP100208	IAAP100206	687391	90778	2.0	3.0	5/4/2007	ML-003	Thorium-228	1.00	0.0892	0.13	pCi/g	=
SAIC	IAAP100208	IAAP100206	687391	90778	2.0	3.0	5/4/2007	ML-003	Thorium-230	2.20	4.43	6.68	pCi/g	UJ
SAIC	IAAP100208	IAAP100206	687391	90778	2.0	3.0	5/4/2007	ML-003	Thorium-232	1.00	0.0892	0.13	pCi/g	=
SAIC	IAAP100208	IAAP100206	687391	90778	2.0	3.0	5/4/2007	ML-003	Uranium-235	0.03	0.247	0.41	pCi/g	UJ
SAIC	IAAP100208	IAAP100206	687391	90778	2.0	3.0	5/4/2007	ML-003	Uranium-238	3.44	0.809	0.64	pCi/g	=
SAIC	IAAP100209	IAAP100206	687391	90778	3.0	4.0	5/4/2007	ML-003	Actinium-227	-0.12	0.215	0.33	pCi/g	UJ
SAIC	IAAP100209	IAAP100206	687391	90778	3.0	4.0	5/4/2007	ML-003	Americium-241	0.01	0.045	0.07	pCi/g	UJ
SAIC	IAAP100209	IAAP100206	687391	90778	3.0	4.0	5/4/2007	ML-003	Cesium-137	0.00	0.0191	0.03	pCi/g	UJ
SAIC	IAAP100209	IAAP100206	687391	90778	3.0	4.0	5/4/2007	ML-003	Potassium-40	15.90	1.17	0.27	pCi/g	=
SAIC	IAAP100209	IAAP100206	687391	90778	3.0	4.0	5/4/2007	ML-003	Protactinium-231	0.24	0.62	0.94	pCi/g	UJ
SAIC	IAAP100209	IAAP100206	687391	90778	3.0	4.0	5/4/2007	ML-003	Radium-226	1.13	0.312	0.08	pCi/g	=
SAIC	IAAP100209	IAAP100206	687391	90778	3.0	4.0	5/4/2007	ML-003	Radium-228	1.00	0.0855	0.13	pCi/g	=
SAIC	IAAP100209	IAAP100206	687391	90778	3.0	4.0	5/4/2007	ML-003	Thorium-228	1.00	0.0855	0.13	pCi/g	=
SAIC	IAAP100209	IAAP100206	687391	90778	3.0	4.0	5/4/2007	ML-003	Thorium-230	2.18	4.17	6.28	pCi/g	UJ
SAIC	IAAP100209	IAAP100206	687391	90778	3.0	4.0	5/4/2007	ML-003	Thorium-232	1.00	0.0855	0.13	pCi/g	=
SAIC	IAAP100209	IAAP100206	687391	90778	3.0	4.0	5/4/2007	ML-003	Uranium-235	-0.08	0.255	0.41	pCi/g	UJ
SAIC	IAAP100209	IAAP100206	687391	90778	3.0	4.0	5/4/2007	ML-003	Uranium-238	0.84	0.641	0.61	pCi/g	J
SAIC	IAAP100210	IAAP100210	687404	90831	0.0	1.0	5/4/2007	ML-003	Actinium-227	0.65	0.281	0.42	pCi/g	U
SAIC	IAAP100210	IAAP100210	687404	90831	0.0	1.0	5/4/2007	ML-003	Americium-241	0.11	0.125	0.19	pCi/g	UJ
SAIC	IAAP100210	IAAP100210	687404	90831	0.0	1.0	5/4/2007	ML-003	Cesium-137	0.05	0.0282	0.04	pCi/g	J
SAIC	IAAP100210	IAAP100210	687404	90831	0.0	1.0	5/4/2007	ML-003	Potassium-40	12.00	0.742	0.23	pCi/g	=
SAIC	IAAP100210	IAAP100210	687404	90831	0.0	1.0	5/4/2007	ML-003	Protactinium-231	0.16	0.671	1.00	pCi/g	UJ
SAIC	IAAP100210	IAAP100210	687404	90831	0.0	1.0	5/4/2007	ML-003	Radium-226	1.27	0.333	0.09	pCi/g	=
SAIC	IAAP100210	IAAP100210	687404	90831	0.0	1.0	5/4/2007	ML-003	Radium-228	0.90	0.0696	0.10	pCi/g	=
SAIC	IAAP100210	IAAP100210	687404	90831	0.0	1.0	5/4/2007	ML-003	Thorium-228	0.90	0.0696	0.10	pCi/g	=
SAIC	IAAP100210	IAAP100210	687404	90831	0.0	1.0	5/4/2007	ML-003	Thorium-230	-3.05	8.86	14.10	pCi/g	UJ
SAIC	IAAP100210	IAAP100210	687404	90831	0.0	1.0	5/4/2007	ML-003	Thorium-232	0.90	0.0696	0.10	pCi/g	=
SAIC	IAAP100210	IAAP100210	687404	90831	0.0	1.0	5/4/2007	ML-003	Uranium-235	4.51	0.429	0.57	pCi/g	=
SAIC	IAAP100210	IAAP100210	687404	90831	0.0	1.0	5/4/2007	ML-003	Uranium-238	263.00	9.18	1.53	pCi/g	=
SAIC	IAAP100211	IAAP100210	687404	90831	1.0	2.0	5/4/2007	ML-003	Actinium-227	0.01	0.219	0.31	pCi/g	UJ
SAIC	IAAP100211	IAAP100210	687404	90831	1.0	2.0	5/4/2007	ML-003	Americium-241	0.04	0.0481	0.07	pCi/g	UJ
SAIC	IAAP100211	IAAP100210	687404	90831	1.0	2.0	5/4/2007	ML-003	Cesium-137	0.06	0.0302	0.03	pCi/g	=
SAIC	IAAP100211	IAAP100210	687404	90831	1.0	2.0	5/4/2007	ML-003	Potassium-40	12.90	0.955	0.27	pCi/g	=
SAIC	IAAP100211	IAAP100210	687404	90831	1.0	2.0	5/4/2007	ML-003	Protactinium-231	0.06	0.586	0.87	pCi/g	UJ
SAIC	IAAP100211	IAAP100210	687404	90831	1.0	2.0	5/4/2007	ML-003	Radium-226	1.42	0.374	0.07	pCi/g	=
SAIC	IAAP100211	IAAP100210	687404	90831	1.0	2.0	5/4/2007	ML-003	Radium-228	1.10	0.0762	0.10	pCi/g	=
SAIC	IAAP100211	IAAP100210	687404	90831	1.0	2.0	5/4/2007	ML-003	Thorium-228	1.10	0.0762	0.10	pCi/g	=
SAIC	IAAP100211	IAAP100210	687404	90831	1.0	2.0	5/4/2007	ML-003	Thorium-230	5.26	5.23	6.45	pCi/g	U
SAIC	IAAP100211	IAAP100210	687404	90831	1.0	2.0	5/4/2007	ML-003	Thorium-232	1.10	0.0762	0.10	pCi/g	=
SAIC	IAAP100211	IAAP100210	687404	90831	1.0	2.0	5/4/2007	ML-003	Uranium-235	0.24	0.254	0.43	pCi/g	UJ
SAIC	IAAP100211	IAAP100210	687404	90831	1.0	2.0	5/4/2007	ML-003	Uranium-238	7.46	0.874	0.65	pCi/g	=

Table A-5-1. Firing Site 12 Area DU

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier
SAIC	IAAP100212	IAAP100210	687404	90831	2.0	3.0	5/4/2007	ML-003	Actinium-227	-0.01	0.237	0.33	pCi/g	UJ
SAIC	IAAP100212	IAAP100210	687404	90831	2.0	3.0	5/4/2007	ML-003	Americium-241	0.01	0.0455	0.07	pCi/g	UJ
SAIC	IAAP100212	IAAP100210	687404	90831	2.0	3.0	5/4/2007	ML-003	Cesium-137	-0.01	0.0253	0.03	pCi/g	UJ
SAIC	IAAP100212	IAAP100210	687404	90831	2.0	3.0	5/4/2007	ML-003	Potassium-40	12.20	0.975	0.27	pCi/g	=
SAIC	IAAP100212	IAAP100210	687404	90831	2.0	3.0	5/4/2007	ML-003	Protactinium-231	-0.11	0.602	0.87	pCi/g	UJ
SAIC	IAAP100212	IAAP100210	687404	90831	2.0	3.0	5/4/2007	ML-003	Radium-226	1.51	0.396	0.08	pCi/g	=
SAIC	IAAP100212	IAAP100210	687404	90831	2.0	3.0	5/4/2007	ML-003	Radium-228	1.13	0.0887	0.11	pCi/g	=
SAIC	IAAP100212	IAAP100210	687404	90831	2.0	3.0	5/4/2007	ML-003	Thorium-228	1.13	0.0887	0.11	pCi/g	=
SAIC	IAAP100212	IAAP100210	687404	90831	2.0	3.0	5/4/2007	ML-003	Thorium-230	-1.97	4.07	6.34	pCi/g	UJ
SAIC	IAAP100212	IAAP100210	687404	90831	2.0	3.0	5/4/2007	ML-003	Thorium-232	1.13	0.0887	0.11	pCi/g	=
SAIC	IAAP100212	IAAP100210	687404	90831	2.0	3.0	5/4/2007	ML-003	Uranium-235	0.12	0.257	0.43	pCi/g	UJ
SAIC	IAAP100212	IAAP100210	687404	90831	2.0	3.0	5/4/2007	ML-003	Uranium-238	3.31	0.718	0.64	pCi/g	=
SAIC	IAAP100213	IAAP100210	687404	90831	3.0	4.0	5/4/2007	ML-003	Actinium-227	0.13	0.221	0.36	pCi/g	UJ
SAIC	IAAP100213	IAAP100210	687404	90831	3.0	4.0	5/4/2007	ML-003	Americium-241	0.00	0.0417	0.07	pCi/g	UJ
SAIC	IAAP100213	IAAP100210	687404	90831	3.0	4.0	5/4/2007	ML-003	Cesium-137	-0.01	0.0213	0.03	pCi/g	UJ
SAIC	IAAP100213	IAAP100210	687404	90831	3.0	4.0	5/4/2007	ML-003	Potassium-40	12.50	0.967	0.26	pCi/g	=
SAIC	IAAP100213	IAAP100210	687404	90831	3.0	4.0	5/4/2007	ML-003	Protactinium-231	-0.03	0.656	0.96	pCi/g	UJ
SAIC	IAAP100213	IAAP100210	687404	90831	3.0	4.0	5/4/2007	ML-003	Radium-226	1.53	0.403	0.08	pCi/g	=
SAIC	IAAP100213	IAAP100210	687404	90831	3.0	4.0	5/4/2007	ML-003	Radium-228	1.02	0.0834	0.12	pCi/g	=
SAIC	IAAP100213	IAAP100210	687404	90831	3.0	4.0	5/4/2007	ML-003	Thorium-228	1.02	0.0834	0.12	pCi/g	=
SAIC	IAAP100213	IAAP100210	687404	90831	3.0	4.0	5/4/2007	ML-003	Thorium-230	5.79	3.82	6.47	pCi/g	U
SAIC	IAAP100213	IAAP100210	687404	90831	3.0	4.0	5/4/2007	ML-003	Thorium-232	1.02	0.0834	0.12	pCi/g	=
SAIC	IAAP100213	IAAP100210	687404	90831	3.0	4.0	5/4/2007	ML-003	Uranium-235	0.02	0.263	0.43	pCi/g	UJ
SAIC	IAAP100213	IAAP100210	687404	90831	3.0	4.0	5/4/2007	ML-003	Uranium-238	1.05	0.514	0.63	pCi/g	=
SAIC	IAAP100214	IAAP100214	687485	90846	0.0	1.0	5/4/2007	ML-003	Actinium-227	0.00	0.208	0.33	pCi/g	UJ
SAIC	IAAP100214	IAAP100214	687485	90846	0.0	1.0	5/4/2007	ML-003	Americium-241	0.01	0.0453	0.07	pCi/g	UJ
SAIC	IAAP100214	IAAP100214	687485	90846	0.0	1.0	5/4/2007	ML-003	Cesium-137	-0.02	0.0201	0.03	pCi/g	UJ
SAIC	IAAP100214	IAAP100214	687485	90846	0.0	1.0	5/4/2007	ML-003	Potassium-40	14.20	1.06	0.27	pCi/g	=
SAIC	IAAP100214	IAAP100214	687485	90846	0.0	1.0	5/4/2007	ML-003	Protactinium-231	0.48	0.593	0.93	pCi/g	UJ
SAIC	IAAP100214	IAAP100214	687485	90846	0.0	1.0	5/4/2007	ML-003	Radium-226	1.68	0.436	0.08	pCi/g	=
SAIC	IAAP100214	IAAP100214	687485	90846	0.0	1.0	5/4/2007	ML-003	Radium-228	1.08	0.0838	0.10	pCi/g	=
SAIC	IAAP100214	IAAP100214	687485	90846	0.0	1.0	5/4/2007	ML-003	Thorium-228	1.08	0.0838	0.10	pCi/g	=
SAIC	IAAP100214	IAAP100214	687485	90846	0.0	1.0	5/4/2007	ML-003	Thorium-230	1.56	4.23	6.32	pCi/g	UJ
SAIC	IAAP100214	IAAP100214	687485	90846	0.0	1.0	5/4/2007	ML-003	Thorium-232	1.08	0.0838	0.10	pCi/g	=
SAIC	IAAP100214	IAAP100214	687485	90846	0.0	1.0	5/4/2007	ML-003	Uranium-235	0.33	0.255	0.44	pCi/g	U
SAIC	IAAP100214	IAAP100214	687485	90846	0.0	1.0	5/4/2007	ML-003	Uranium-238	2.58	0.644	0.62	pCi/g	=
SAIC	IAAP100215	IAAP100214	687485	90846	1.0	2.0	5/4/2007	ML-003	Actinium-227	0.02	0.257	0.41	pCi/g	UJ
SAIC	IAAP100215	IAAP100214	687485	90846	1.0	2.0	5/4/2007	ML-003	Americium-241	0.04	0.0523	0.08	pCi/g	UJ
SAIC	IAAP100215	IAAP100214	687485	90846	1.0	2.0	5/4/2007	ML-003	Cesium-137	0.01	0.0264	0.04	pCi/g	UJ
SAIC	IAAP100215	IAAP100214	687485	90846	1.0	2.0	5/4/2007	ML-003	Potassium-40	15.50	1.18	0.38	pCi/g	=
SAIC	IAAP100215	IAAP100214	687485	90846	1.0	2.0	5/4/2007	ML-003	Protactinium-231	0.78	0.735	1.18	pCi/g	U
SAIC	IAAP100215	IAAP100214	687485	90846	1.0	2.0	5/4/2007	ML-003	Radium-226	1.86	0.483	0.11	pCi/g	=
SAIC	IAAP100215	IAAP100214	687485	90846	1.0	2.0	5/4/2007	ML-003	Radium-228	1.24	0.106	0.15	pCi/g	=
SAIC	IAAP100215	IAAP100214	687485	90846	1.0	2.0	5/4/2007	ML-003	Thorium-228	1.24	0.106	0.15	pCi/g	=
SAIC	IAAP100215	IAAP100214	687485	90846	1.0	2.0	5/4/2007	ML-003	Thorium-230	8.25	7.8	7.28	pCi/g	J
SAIC	IAAP100215	IAAP100214	687485	90846	1.0	2.0	5/4/2007	ML-003	Thorium-232	1.24	0.106	0.15	pCi/g	=
SAIC	IAAP100215	IAAP100214	687485	90846	1.0	2.0	5/4/2007	ML-003	Uranium-235	0.05	0.303	0.50	pCi/g	UJ
SAIC	IAAP100215	IAAP100214	687485	90846	1.0	2.0	5/4/2007	ML-003	Uranium-238	2.78	0.856	0.75	pCi/g	=
SAIC	IAAP100216	IAAP100214	687485	90846	2.0	3.0	5/4/2007	ML-003	Actinium-227	-0.18	0.29	0.44	pCi/g	UJ
SAIC	IAAP100216	IAAP100214	687485	90846	2.0	3.0	5/4/2007	ML-003	Americium-241	0.04	0.0578	0.09	pCi/g	UJ
SAIC	IAAP100216	IAAP100214	687485	90846	2.0	3.0	5/4/2007	ML-003	Cesium-137	-0.03	0.0248	0.04	pCi/g	UJ
SAIC	IAAP100216	IAAP100214	687485	90846	2.0	3.0	5/4/2007	ML-003	Potassium-40	19.00	1.37	0.33	pCi/g	=
SAIC	IAAP100216	IAAP100214	687485	90846	2.0	3.0	5/4/2007	ML-003	Protactinium-231	0.57	0.815	1.26	pCi/g	UJ
SAIC	IAAP100216	IAAP100214	687485	90846	2.0	3.0	5/4/2007	ML-003	Radium-226	2.35	0.601	0.11	pCi/g	=
SAIC	IAAP100216	IAAP100214	687485	90846	2.0	3.0	5/4/2007	ML-003	Radium-228	1.39	0.116	0.16	pCi/g	=
SAIC	IAAP100216	IAAP100214	687485	90846	2.0	3.0	5/4/2007	ML-003	Thorium-228	1.39	0.116	0.16	pCi/g	=
SAIC	IAAP100216	IAAP100214	687485	90846	2.0	3.0	5/4/2007	ML-003	Thorium-230	1.56	5.77	8.56	pCi/g	UJ

Table A-5-1. Firing Site 12 Area DU

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier
SAIC	IAAP100216	IAAP100214	687485	90846	2.0	3.0	5/4/2007	ML-003	Thorium-232	1.39	0.116	0.16	pCi/g	=
SAIC	IAAP100216	IAAP100214	687485	90846	2.0	3.0	5/4/2007	ML-003	Uranium-235	0.18	0.326	0.55	pCi/g	UJ
SAIC	IAAP100216	IAAP100214	687485	90846	2.0	3.0	5/4/2007	ML-003	Uranium-238	2.03	0.869	0.83	pCi/g	=
SAIC	IAAP100217	IAAP100214	687485	90846	3.0	4.0	5/4/2007	ML-003	Actinium-227	0.08	0.245	0.35	pCi/g	UJ
SAIC	IAAP100217	IAAP100214	687485	90846	3.0	4.0	5/4/2007	ML-003	Americium-241	-0.01	0.0474	0.07	pCi/g	UJ
SAIC	IAAP100217	IAAP100214	687485	90846	3.0	4.0	5/4/2007	ML-003	Cesium-137	-0.01	0.0198	0.03	pCi/g	UJ
SAIC	IAAP100217	IAAP100214	687485	90846	3.0	4.0	5/4/2007	ML-003	Potassium-40	15.60	1.09	0.36	pCi/g	=
SAIC	IAAP100217	IAAP100214	687485	90846	3.0	4.0	5/4/2007	ML-003	Protactinium-231	0.03	0.6	0.89	pCi/g	UJ
SAIC	IAAP100217	IAAP100214	687485	90846	3.0	4.0	5/4/2007	ML-003	Radium-226	1.91	0.484	0.09	pCi/g	=
SAIC	IAAP100217	IAAP100214	687485	90846	3.0	4.0	5/4/2007	ML-003	Radium-228	1.20	0.0876	0.12	pCi/g	=
SAIC	IAAP100217	IAAP100214	687485	90846	3.0	4.0	5/4/2007	ML-003	Thorium-228	1.20	0.0876	0.12	pCi/g	=
SAIC	IAAP100217	IAAP100214	687485	90846	3.0	4.0	5/4/2007	ML-003	Thorium-230	4.86	5.12	6.57	pCi/g	UJ
SAIC	IAAP100217	IAAP100214	687485	90846	3.0	4.0	5/4/2007	ML-003	Thorium-232	1.20	0.0876	0.12	pCi/g	=
SAIC	IAAP100217	IAAP100214	687485	90846	3.0	4.0	5/4/2007	ML-003	Uranium-235	0.21	0.264	0.45	pCi/g	UJ
SAIC	IAAP100217	IAAP100214	687485	90846	3.0	4.0	5/4/2007	ML-003	Uranium-238	1.19	0.609	0.68	pCi/g	J
SAIC	IAAP100218	IAAP100218	687474	90793	0.0	1.0	5/4/2007	ML-003	Actinium-227	-0.25	0.233	0.34	pCi/g	UJ
SAIC	IAAP100218	IAAP100218	687474	90793	0.0	1.0	5/4/2007	ML-003	Americium-241	0.01	0.0499	0.07	pCi/g	UJ
SAIC	IAAP100218	IAAP100218	687474	90793	0.0	1.0	5/4/2007	ML-003	Cesium-137	0.02	0.0192	0.04	pCi/g	UJ
SAIC	IAAP100218	IAAP100218	687474	90793	0.0	1.0	5/4/2007	ML-003	Potassium-40	15.60	1.13	0.32	pCi/g	=
SAIC	IAAP100218	IAAP100218	687474	90793	0.0	1.0	5/4/2007	ML-003	Protactinium-231	0.17	0.645	0.97	pCi/g	UJ
SAIC	IAAP100218	IAAP100218	687474	90793	0.0	1.0	5/4/2007	ML-003	Radium-226	1.64	0.427	0.10	pCi/g	=
SAIC	IAAP100218	IAAP100218	687474	90793	0.0	1.0	5/4/2007	ML-003	Radium-228	1.17	0.0888	0.12	pCi/g	=
SAIC	IAAP100218	IAAP100218	687474	90793	0.0	1.0	5/4/2007	ML-003	Thorium-228	1.17	0.0888	0.12	pCi/g	=
SAIC	IAAP100218	IAAP100218	687474	90793	0.0	1.0	5/4/2007	ML-003	Thorium-230	-2.01	4.84	6.95	pCi/g	UJ
SAIC	IAAP100218	IAAP100218	687474	90793	0.0	1.0	5/4/2007	ML-003	Thorium-232	1.17	0.0888	0.12	pCi/g	=
SAIC	IAAP100218	IAAP100218	687474	90793	0.0	1.0	5/4/2007	ML-003	Uranium-235	0.02	0.276	0.46	pCi/g	UJ
SAIC	IAAP100218	IAAP100218	687474	90793	0.0	1.0	5/4/2007	ML-003	Uranium-238	2.71	0.742	0.69	pCi/g	=
SAIC	IAAP100219	IAAP100218	687474	90793	1.0	2.0	5/4/2007	ML-003	Actinium-227	-0.27	0.242	0.35	pCi/g	UJ
SAIC	IAAP100219	IAAP100218	687474	90793	1.0	2.0	5/4/2007	ML-003	Americium-241	0.03	0.0493	0.08	pCi/g	UJ
SAIC	IAAP100219	IAAP100218	687474	90793	1.0	2.0	5/4/2007	ML-003	Cesium-137	-0.01	0.0231	0.04	pCi/g	UJ
SAIC	IAAP100219	IAAP100218	687474	90793	1.0	2.0	5/4/2007	ML-003	Potassium-40	16.10	1.21	0.31	pCi/g	=
SAIC	IAAP100219	IAAP100218	687474	90793	1.0	2.0	5/4/2007	ML-003	Protactinium-231	0.22	0.739	1.12	pCi/g	UJ
SAIC	IAAP100219	IAAP100218	687474	90793	1.0	2.0	5/4/2007	ML-003	Radium-226	2.00	0.509	0.10	pCi/g	=
SAIC	IAAP100219	IAAP100218	687474	90793	1.0	2.0	5/4/2007	ML-003	Radium-228	1.17	0.106	0.14	pCi/g	=
SAIC	IAAP100219	IAAP100218	687474	90793	1.0	2.0	5/4/2007	ML-003	Thorium-228	1.17	0.106	0.14	pCi/g	=
SAIC	IAAP100219	IAAP100218	687474	90793	1.0	2.0	5/4/2007	ML-003	Thorium-230	5.99	4.75	7.40	pCi/g	U
SAIC	IAAP100219	IAAP100218	687474	90793	1.0	2.0	5/4/2007	ML-003	Thorium-232	1.17	0.106	0.14	pCi/g	=
SAIC	IAAP100219	IAAP100218	687474	90793	1.0	2.0	5/4/2007	ML-003	Uranium-235	0.01	0.29	0.48	pCi/g	UJ
SAIC	IAAP100219	IAAP100218	687474	90793	1.0	2.0	5/4/2007	ML-003	Uranium-238	1.37	0.721	0.71	pCi/g	J
SAIC	IAAP100220	IAAP100218	687474	90793	2.0	3.0	5/4/2007	ML-003	Actinium-227	0.34	0.31	0.35	pCi/g	U
SAIC	IAAP100220	IAAP100218	687474	90793	2.0	3.0	5/4/2007	ML-003	Americium-241	-0.03	0.0421	0.07	pCi/g	UJ
SAIC	IAAP100220	IAAP100218	687474	90793	2.0	3.0	5/4/2007	ML-003	Cesium-137	-0.03	0.0213	0.03	pCi/g	UJ
SAIC	IAAP100220	IAAP100218	687474	90793	2.0	3.0	5/4/2007	ML-003	Potassium-40	16.30	1.13	0.31	pCi/g	=
SAIC	IAAP100220	IAAP100218	687474	90793	2.0	3.0	5/4/2007	ML-003	Protactinium-231	0.53	0.613	0.96	pCi/g	UJ
SAIC	IAAP100220	IAAP100218	687474	90793	2.0	3.0	5/4/2007	ML-003	Radium-226	1.74	0.454	0.09	pCi/g	=
SAIC	IAAP100220	IAAP100218	687474	90793	2.0	3.0	5/4/2007	ML-003	Radium-228	1.09	0.0843	0.12	pCi/g	=
SAIC	IAAP100220	IAAP100218	687474	90793	2.0	3.0	5/4/2007	ML-003	Thorium-228	1.09	0.0843	0.12	pCi/g	=
SAIC	IAAP100220	IAAP100218	687474	90793	2.0	3.0	5/4/2007	ML-003	Thorium-230	4.32	4.46	6.82	pCi/g	UJ
SAIC	IAAP100220	IAAP100218	687474	90793	2.0	3.0	5/4/2007	ML-003	Thorium-232	1.09	0.0843	0.12	pCi/g	=
SAIC	IAAP100220	IAAP100218	687474	90793	2.0	3.0	5/4/2007	ML-003	Uranium-235	0.17	0.254	0.43	pCi/g	UJ
SAIC	IAAP100220	IAAP100218	687474	90793	2.0	3.0	5/4/2007	ML-003	Uranium-238	1.02	0.599	0.66	pCi/g	J
SAIC	IAAP100221	IAAP100218	687474	90793	3.0	4.0	5/4/2007	ML-003	Actinium-227	-0.07	0.202	0.31	pCi/g	UJ
SAIC	IAAP100221	IAAP100218	687474	90793	3.0	4.0	5/4/2007	ML-003	Americium-241	0.01	0.0417	0.06	pCi/g	UJ
SAIC	IAAP100221	IAAP100218	687474	90793	3.0	4.0	5/4/2007	ML-003	Cesium-137	-0.01	0.0207	0.03	pCi/g	UJ
SAIC	IAAP100221	IAAP100218	687474	90793	3.0	4.0	5/4/2007	ML-003	Potassium-40	15.70	1.07	0.27	pCi/g	=
SAIC	IAAP100221	IAAP100218	687474	90793	3.0	4.0	5/4/2007	ML-003	Protactinium-231	0.18	0.569	0.86	pCi/g	UJ
SAIC	IAAP100221	IAAP100218	687474	90793	3.0	4.0	5/4/2007	ML-003	Radium-226	1.67	0.424	0.08	pCi/g	=

Table A-5-1. Firing Site 12 Area DU

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier
SAIC	IAAP100221	IAAP100218	687474	90793	3.0	4.0	5/4/2007	ML-003	Radium-228	1.10	0.0793	0.10	pCi/g	=
SAIC	IAAP100221	IAAP100218	687474	90793	3.0	4.0	5/4/2007	ML-003	Thorium-228	1.10	0.0793	0.10	pCi/g	=
SAIC	IAAP100221	IAAP100218	687474	90793	3.0	4.0	5/4/2007	ML-003	Thorium-230	-0.37	4.2	6.13	pCi/g	UJ
SAIC	IAAP100221	IAAP100218	687474	90793	3.0	4.0	5/4/2007	ML-003	Thorium-232	1.10	0.0793	0.10	pCi/g	=
SAIC	IAAP100221	IAAP100218	687474	90793	3.0	4.0	5/4/2007	ML-003	Uranium-235	0.18	0.244	0.41	pCi/g	UJ
SAIC	IAAP100221	IAAP100218	687474	90793	3.0	4.0	5/4/2007	ML-003	Uranium-238	0.90	0.61	0.58	pCi/g	J
SAIC	IAAP25010	IAAP25010	687402	90883	0.0	0.5	5/3/2001	ML-003	Bismuth-212	1.29	0.44	0.42	pCi/g	=
SAIC	IAAP25010	IAAP25010	687402	90883	0.0	0.5	5/3/2001	ML-003	Bismuth-214	1.32	0.14	0.06	pCi/g	=
SAIC	IAAP25010	IAAP25010	687402	90883	0.0	0.5	5/3/2001	ML-003	Cesium-137	0.08	0.04	0.04	pCi/g	J
SAIC	IAAP25010	IAAP25010	687402	90883	0.0	0.5	5/3/2001	ML-003	Lead-212	1.05	0.13	0.06	pCi/g	=
SAIC	IAAP25010	IAAP25010	687402	90883	0.0	0.5	5/3/2001	ML-003	Lead-214	1.24	0.13	0.07	pCi/g	=
SAIC	IAAP25010	IAAP25010	687402	90883	0.0	0.5	5/3/2001	ML-003	Potassium-40	16.90	1.95	0.21	pCi/g	=
SAIC	IAAP25010	IAAP25010	687402	90883	0.0	0.5	5/3/2001	ML-003	Radium-224	3.86	1.02	0.72	pCi/g	=
SAIC	IAAP25010	IAAP25010	687402	90883	0.0	0.5	5/3/2001	ML-003	Radium-228	1.05	0.16	0.11	pCi/g	=
SAIC	IAAP25010	IAAP25010	687402	90883	0.0	0.5	5/3/2001	ML-003	Thallium-208	1.10	0.18	0.13	pCi/g	=
SAIC	IAAP25010	IAAP25010	687402	90883	0.0	0.5	5/3/2001	ML-003	Thorium-228	1.05	0.16	0.11	pCi/g	=
SAIC	IAAP25010	IAAP25010	687402	90883	0.0	0.5	5/3/2001	ML-003	Thorium-232	1.05	0.16	0.11	pCi/g	=
SAIC	IAAP25010	IAAP25010	687402	90883	0.0	0.5	5/3/2001	ML-015	Uranium-234	4.93	1.35	0.12	pCi/g	=
SAIC	IAAP25010	IAAP25010	687402	90883	0.0	0.5	5/3/2001	ML-015	Uranium-235	0.47	0.33	0.27	pCi/g	J
SAIC	IAAP25010	IAAP25010	687402	90883	0.0	0.5	5/3/2001	ML-003	Uranium-235	0.64	0.09	0.05	pCi/g	=
SAIC	IAAP25010	IAAP25010	687402	90883	0.0	0.5	5/3/2001	ML-015	Uranium-238	46.60	9.71	0.12	pCi/g	=
SAIC	IAAP25010	IAAP25010	687402	90883	0.0	0.5	5/3/2001	ML-003	Uranium-238	31.70	3.13	1.09	pCi/g	=
SAIC	IAAP25011	IAAP25011	687368	90821	0.0	0.5	5/3/2001	ML-003	Bismuth-212	0.95	0.4	0.36	pCi/g	=
SAIC	IAAP25011	IAAP25011	687368	90821	0.0	0.5	5/3/2001	ML-003	Bismuth-214	1.25	0.13	0.05	pCi/g	=
SAIC	IAAP25011	IAAP25011	687368	90821	0.0	0.5	5/3/2001	ML-003	Cesium-137	0.23	0.05	0.03	pCi/g	=
SAIC	IAAP25011	IAAP25011	687368	90821	0.0	0.5	5/3/2001	ML-003	Lead-212	1.01	0.12	0.04	pCi/g	=
SAIC	IAAP25011	IAAP25011	687368	90821	0.0	0.5	5/3/2001	ML-003	Lead-214	1.17	0.11	0.05	pCi/g	=
SAIC	IAAP25011	IAAP25011	687368	90821	0.0	0.5	5/3/2001	ML-003	Potassium-40	14.00	1.63	0.22	pCi/g	=
SAIC	IAAP25011	IAAP25011	687368	90821	0.0	0.5	5/3/2001	ML-003	Radium-224	3.26	0.69	0.50	pCi/g	=
SAIC	IAAP25011	IAAP25011	687368	90821	0.0	0.5	5/3/2001	ML-003	Radium-228	1.04	0.13	0.09	pCi/g	=
SAIC	IAAP25011	IAAP25011	687368	90821	0.0	0.5	5/3/2001	ML-003	Thallium-208	1.01	0.16	0.11	pCi/g	=
SAIC	IAAP25011	IAAP25011	687368	90821	0.0	0.5	5/3/2001	ML-003	Thorium-228	1.04	0.13	0.09	pCi/g	=
SAIC	IAAP25011	IAAP25011	687368	90821	0.0	0.5	5/3/2001	ML-003	Thorium-232	1.04	0.13	0.09	pCi/g	=
SAIC	IAAP25011	IAAP25011	687368	90821	0.0	0.5	5/3/2001	ML-015	Uranium-234	6.34	1.93	0.17	pCi/g	=
SAIC	IAAP25011	IAAP25011	687368	90821	0.0	0.5	5/3/2001	ML-015	Uranium-235	1.20	0.66	0.20	pCi/g	J
SAIC	IAAP25011	IAAP25011	687368	90821	0.0	0.5	5/3/2001	ML-003	Uranium-235	0.65	0.08	0.04	pCi/g	=
SAIC	IAAP25011	IAAP25011	687368	90821	0.0	0.5	5/3/2001	ML-015	Uranium-238	68.80	16.5	0.16	pCi/g	=
SAIC	IAAP25011	IAAP25011	687368	90821	0.0	0.5	5/3/2001	ML-003	Uranium-238	47.70	3.97	0.82	pCi/g	=
SAIC	IAAP25012	IAAP25012	687418	90843	0.5	1.0	5/3/2001	ML-003	Bismuth-212	1.17	0.31	0.31	pCi/g	=
SAIC	IAAP25012	IAAP25012	687418	90843	0.5	1.0	5/3/2001	ML-003	Bismuth-214	0.76	0.09	0.04	pCi/g	=
SAIC	IAAP25012	IAAP25012	687418	90843	0.5	1.0	5/3/2001	ML-003	Cesium-137	0.06	0.03	0.03	pCi/g	J
SAIC	IAAP25012	IAAP25012	687418	90843	0.5	1.0	5/3/2001	ML-003	Lead-212	1.07	0.11	0.04	pCi/g	=
SAIC	IAAP25012	IAAP25012	687418	90843	0.5	1.0	5/3/2001	ML-003	Lead-214	0.76	0.08	0.05	pCi/g	=
SAIC	IAAP25012	IAAP25012	687418	90843	0.5	1.0	5/3/2001	ML-003	Manganese-54	0.01	0.01	0.03	pCi/g	U
SAIC	IAAP25012	IAAP25012	687418	90843	0.5	1.0	5/3/2001	ML-003	Potassium-40	15.00	1.56	0.20	pCi/g	=
SAIC	IAAP25012	IAAP25012	687418	90843	0.5	1.0	5/3/2001	ML-003	Radium-224	2.56	0.54	0.42	pCi/g	=
SAIC	IAAP25012	IAAP25012	687418	90843	0.5	1.0	5/3/2001	ML-003	Radium-228	1.06	0.13	0.09	pCi/g	=
SAIC	IAAP25012	IAAP25012	687418	90843	0.5	1.0	5/3/2001	ML-003	Thallium-208	0.91	0.13	0.07	pCi/g	=
SAIC	IAAP25012	IAAP25012	687418	90843	0.5	1.0	5/3/2001	ML-003	Thorium-228	1.06	0.13	0.09	pCi/g	=
SAIC	IAAP25012	IAAP25012	687418	90843	0.5	1.0	5/3/2001	ML-003	Thorium-232	1.06	0.13	0.09	pCi/g	=
SAIC	IAAP25012	IAAP25012	687418	90843	0.5	1.0	5/3/2001	ML-003	Uranium-234	84.90	30.8	23.90	pCi/g	R
SAIC	IAAP25012	IAAP25012	687418	90843	0.5	1.0	5/3/2001	ML-003	Uranium-235	0.95	0.09	0.03	pCi/g	=
SAIC	IAAP25012	IAAP25012	687418	90843	0.5	1.0	5/3/2001	ML-003	Uranium-238	50.30	3.19	0.45	pCi/g	=
SAIC	IAAP25013-2	IAAP25013	687545	90813	0.0	0.5	5/4/2001	HASL AM-02 MOD	Actinium-227	0.65	0.47	0.74	pCi/g	U
SAIC	IAAP25013-2	IAAP25013	687545	90813	0.0	0.5	5/4/2001	HASL AM-02 MOD	Americium-241	0.01	0.145	0.25	pCi/g	U
SAIC	IAAP25013-1	IAAP25013	687545	90813	0.0	0.5	5/4/2001	ML-003	Bismuth-211	0.03	0.52	0.16	pCi/g	UJ
SAIC	IAAP25013-1	IAAP25013	687545	90813	0.0	0.5	5/4/2001	ML-003	Bismuth-212	1.16	0.45	0.36	pCi/g	=

Table A-5-1. Firing Site 12 Area DU

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier
SAIC	IAAP25013-1	IAAP25013	687545	90813	0.0	0.5	5/4/2001	ML-003	Bismuth-214	0.85	0.11	0.06	pCi/g	=
SAIC	IAAP25013-1	IAAP25013	687545	90813	0.0	0.5	5/4/2001	ML-003	Cesium-137	0.05	0.05	0.03	pCi/g	U
SAIC	IAAP25013-2	IAAP25013	687545	90813	0.0	0.5	5/4/2001	HASL AM-02 MOD	Cesium-137	0.02	0.069	0.14	pCi/g	UJ
SAIC	IAAP25013-1	IAAP25013	687545	90813	0.0	0.5	5/4/2001	ML-003	Lead-212	1.02	0.12	0.05	pCi/g	=
SAIC	IAAP25013-1	IAAP25013	687545	90813	0.0	0.5	5/4/2001	ML-003	Lead-214	0.82	0.14	0.06	pCi/g	=
SAIC	IAAP25013-1	IAAP25013	687545	90813	0.0	0.5	5/4/2001	ML-003	Potassium-40	16.30	1.86	0.28	pCi/g	=
SAIC	IAAP25013-2	IAAP25013	687545	90813	0.0	0.5	5/4/2001	HASL AM-02 MOD	Potassium-40	15.40	3	0.70	pCi/g	=
SAIC	IAAP25013-2	IAAP25013	687545	90813	0.0	0.5	5/4/2001	HASL AM-02 MOD	Protactinium-231	0.20	1.7	3.10	pCi/g	UJ
SAIC	IAAP25013-1	IAAP25013	687545	90813	0.0	0.5	5/4/2001	ML-003	Radium-224	2.50	0.72	0.52	pCi/g	=
SAIC	IAAP25013-2	IAAP25013	687545	90813	0.0	0.5	5/4/2001	HASL AM-02 MOD	Radium-226	1.04	0.3	0.20	pCi/g	=
SAIC	IAAP25013-1	IAAP25013	687545	90813	0.0	0.5	5/4/2001	ML-003	Radium-228	1.23	0.16	0.12	pCi/g	=
SAIC	IAAP25013-2	IAAP25013	687545	90813	0.0	0.5	5/4/2001	HASL AM-02 MOD	Radium-228	1.04	0.42	0.33	pCi/g	=
SAIC	IAAP25013-1	IAAP25013	687545	90813	0.0	0.5	5/4/2001	ML-003	Thallium-208	0.94	0.15	0.08	pCi/g	=
SAIC	IAAP25013-1	IAAP25013	687545	90813	0.0	0.5	5/4/2001	ML-003	Thorium-228	1.23	0.16	0.12	pCi/g	=
SAIC	IAAP25013-2	IAAP25013	687545	90813	0.0	0.5	5/4/2001	HASL AM-02 MOD	Thorium-228	0.87	0.52	0.23	pCi/g	J
SAIC	IAAP25013-2	IAAP25013	687545	90813	0.0	0.5	5/4/2001	HASL AM-02 MOD	Thorium-230	1.04	0.3	0.20	pCi/g	U
SAIC	IAAP25013-1	IAAP25013	687545	90813	0.0	0.5	5/4/2001	ML-003	Thorium-232	1.23	0.16	0.12	pCi/g	=
SAIC	IAAP25013-2	IAAP25013	687545	90813	0.0	0.5	5/4/2001	HASL AM-02 MOD	Thorium-232	0.87	0.52	0.23	pCi/g	J
SAIC	IAAP25013-1	IAAP25013	687545	90813	0.0	0.5	5/4/2001	ML-015	Uranium-234	1.54	0.41	0.05	pCi/g	=
SAIC	IAAP25013-2	IAAP25013	687545	90813	0.0	0.5	5/4/2001	NAS NS-3050 MOD	Uranium-234	0.86	0.42	0.28	pCi/g	=
SAIC	IAAP25013-1	IAAP25013	687545	90813	0.0	0.5	5/4/2001	ML-015	Uranium-235	0.03	0.07	0.15	pCi/g	UJ
SAIC	IAAP25013-1	IAAP25013	687545	90813	0.0	0.5	5/4/2001	ML-003	Uranium-235	0.19	0.05	0.06	pCi/g	=
SAIC	IAAP25013-2	IAAP25013	687545	90813	0.0	0.5	5/4/2001	NAS NS-3050 MOD	Uranium-235	-0.01	0.018	0.21	pCi/g	UJ
SAIC	IAAP25013-2	IAAP25013	687545	90813	0.0	0.5	5/4/2001	HASL AM-02 MOD	Uranium-235	0.03	0.31	0.15	pCi/g	UJ
SAIC	IAAP25013-1	IAAP25013	687545	90813	0.0	0.5	5/4/2001	ML-015	Uranium-238	2.96	0.64	0.05	pCi/g	=
SAIC	IAAP25013-1	IAAP25013	687545	90813	0.0	0.5	5/4/2001	ML-003	Uranium-238	2.46	0.51	0.47	pCi/g	=
SAIC	IAAP25013-2	IAAP25013	687545	90813	0.0	0.5	5/4/2001	NAS NS-3050 MOD	Uranium-238	1.97	0.73	0.20	pCi/g	=
SAIC	IAAP25013-2	IAAP25013	687545	90813	0.0	0.5	5/4/2001	HASL AM-02 MOD	Uranium-238	0.90	1.5	1.60	pCi/g	UJ
SAIC	IAAP25013	IAAP25013	687545	90813	0.5	1.0	5/4/2001	ML-003	Bismuth-212	0.86	0.54	0.41	pCi/g	J
SAIC	IAAP25013	IAAP25013	687545	90813	0.5	1.0	5/4/2001	ML-003	Bismuth-214	0.84	0.11	0.06	pCi/g	=
SAIC	IAAP25013	IAAP25013	687545	90813	0.5	1.0	5/4/2001	ML-003	Cesium-137	0.10	0.04	0.04	pCi/g	=
SAIC	IAAP25013	IAAP25013	687545	90813	0.5	1.0	5/4/2001	ML-003	Lead-212	1.00	0.12	0.05	pCi/g	=
SAIC	IAAP25013	IAAP25013	687545	90813	0.5	1.0	5/4/2001	ML-003	Lead-214	0.80	0.09	0.05	pCi/g	=
SAIC	IAAP25013	IAAP25013	687545	90813	0.5	1.0	5/4/2001	ML-003	Potassium-40	16.40	1.91	0.26	pCi/g	=
SAIC	IAAP25013	IAAP25013	687545	90813	0.5	1.0	5/4/2001	ML-003	Radium-224	2.90	0.78	0.56	pCi/g	=
SAIC	IAAP25013	IAAP25013	687545	90813	0.5	1.0	5/4/2001	ML-003	Radium-228	1.19	0.16	0.13	pCi/g	=
SAIC	IAAP25013	IAAP25013	687545	90813	0.5	1.0	5/4/2001	ML-003	Thallium-208	1.06	0.17	0.09	pCi/g	=
SAIC	IAAP25013	IAAP25013	687545	90813	0.5	1.0	5/4/2001	ML-003	Thorium-228	1.19	0.16	0.13	pCi/g	=
SAIC	IAAP25013	IAAP25013	687545	90813	0.5	1.0	5/4/2001	ML-003	Thorium-232	1.19	0.16	0.13	pCi/g	=
SAIC	IAAP25013	IAAP25013	687545	90813	0.5	1.0	5/4/2001	ML-015	Uranium-234	1.02	0.31	0.16	pCi/g	=
SAIC	IAAP25013	IAAP25013	687545	90813	0.5	1.0	5/4/2001	ML-015	Uranium-235	0.09	0.09	0.06	pCi/g	J
SAIC	IAAP25013	IAAP25013	687545	90813	0.5	1.0	5/4/2001	ML-003	Uranium-235	0.16	0.04	0.06	pCi/g	=
SAIC	IAAP25013	IAAP25013	687545	90813	0.5	1.0	5/4/2001	ML-015	Uranium-238	2.50	0.55	0.14	pCi/g	=
SAIC	IAAP25013	IAAP25013	687545	90813	0.5	1.0	5/4/2001	ML-003	Uranium-238	2.20	0.48	0.49	pCi/g	=
SAIC	IAAP25020	IAAP25013	687545	90813	1.5	2.0	5/4/2001	ML-003	Bismuth-211	0.15	0.45	0.12	pCi/g	U
SAIC	IAAP25020	IAAP25013	687545	90813	1.5	2.0	5/4/2001	ML-003	Bismuth-212	1.24	0.39	0.31	pCi/g	=
SAIC	IAAP25020	IAAP25013	687545	90813	1.5	2.0	5/4/2001	ML-003	Bismuth-214	0.84	0.1	0.05	pCi/g	=
SAIC	IAAP25020	IAAP25013	687545	90813	1.5	2.0	5/4/2001	ML-003	Cesium-137	-0.01	0.02	0.03	pCi/g	U
SAIC	IAAP25020	IAAP25013	687545	90813	1.5	2.0	5/4/2001	ML-003	Lead-212	1.32	0.13	0.04	pCi/g	=
SAIC	IAAP25020	IAAP25013	687545	90813	1.5	2.0	5/4/2001	ML-003	Lead-214	0.87	0.11	0.04	pCi/g	=
SAIC	IAAP25020	IAAP25013	687545	90813	1.5	2.0	5/4/2001	ML-003	Potassium-40	16.90	1.78	0.22	pCi/g	=
SAIC	IAAP25020	IAAP25013	687545	90813	1.5	2.0	5/4/2001	ML-003	Radium-224	2.90	0.59	0.42	pCi/g	=
SAIC	IAAP25020	IAAP25013	687545	90813	1.5	2.0	5/4/2001	ML-003	Radium-228	1.20	0.14	0.10	pCi/g	=
SAIC	IAAP25020	IAAP25013	687545	90813	1.5	2.0	5/4/2001	ML-003	Thallium-208	1.09	0.14	0.07	pCi/g	=
SAIC	IAAP25020	IAAP25013	687545	90813	1.5	2.0	5/4/2001	ML-003	Thorium-228	1.20	0.14	0.10	pCi/g	=
SAIC	IAAP25020	IAAP25013	687545	90813	1.5	2.0	5/4/2001	ML-003	Thorium-232	1.20	0.14	0.10	pCi/g	=
SAIC	IAAP25020	IAAP25013	687545	90813	1.5	2.0	5/4/2001	ML-003	Uranium-235	0.17	0.04	0.04	pCi/g	U

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Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier
SAIC	IAAP25020	IAAP25013	687545	90813	1.5	2.0	5/4/2001	ML-003	Uranium-238	1.73	0.27	0.28	pCi/g	=
SAIC	IAAP25014	IAAP25014	687402	90766	0.0	0.6	5/3/2001	ML-003	Bismuth-211	0.68	0.76	0.33	pCi/g	U
SAIC	IAAP25014	IAAP25014	687402	90766	0.0	0.6	5/3/2001	ML-003	Bismuth-212	1.58	0.61	0.86	pCi/g	=
SAIC	IAAP25014	IAAP25014	687402	90766	0.0	0.6	5/3/2001	ML-003	Bismuth-214	0.93	0.13	0.12	pCi/g	=
SAIC	IAAP25014	IAAP25014	687402	90766	0.0	0.6	5/3/2001	ML-003	Cesium-137	0.13	0.06	0.07	pCi/g	=
SAIC	IAAP25014	IAAP25014	687402	90766	0.0	0.6	5/3/2001	ML-003	Cobalt-57	0.06	0.04	0.06	pCi/g	U
SAIC	IAAP25014	IAAP25014	687402	90766	0.0	0.6	5/3/2001	ML-003	Lead-212	1.07	0.13	0.09	pCi/g	=
SAIC	IAAP25014	IAAP25014	687402	90766	0.0	0.6	5/3/2001	ML-003	Lead-214	0.68	0.22	0.11	pCi/g	=
SAIC	IAAP25014	IAAP25014	687402	90766	0.0	0.6	5/3/2001	ML-003	Potassium-40	15.50	1.65	0.37	pCi/g	=
SAIC	IAAP25014	IAAP25014	687402	90766	0.0	0.6	5/3/2001	ML-003	Protactinium-234	1.35	0.13	0.59	pCi/g	=
SAIC	IAAP25014	IAAP25014	687402	90766	0.0	0.6	5/3/2001	ML-003	Radium-224	2.94	1.03	1.07	pCi/g	=
SAIC	IAAP25014	IAAP25014	687402	90766	0.0	0.6	5/3/2001	ML-003	Radium-228	1.14	0.2	0.21	pCi/g	=
SAIC	IAAP25014	IAAP25014	687402	90766	0.0	0.6	5/3/2001	ML-003	Thallium-208	0.95	0.2	0.19	pCi/g	=
SAIC	IAAP25014	IAAP25014	687402	90766	0.0	0.6	5/3/2001	ML-003	Thorium-228	1.14	0.2	0.21	pCi/g	=
SAIC	IAAP25014	IAAP25014	687402	90766	0.0	0.6	5/3/2001	ML-003	Thorium-232	1.14	0.2	0.21	pCi/g	=
SAIC	IAAP25014	IAAP25014	687402	90766	0.0	0.6	5/3/2001	ML-003	Uranium-234	329.00	80.2	84.10	pCi/g	R
SAIC	IAAP25014	IAAP25014	687402	90766	0.0	0.6	5/3/2001	ML-003	Uranium-235	9.73	0.55	0.08	pCi/g	=
SAIC	IAAP25014	IAAP25014	687402	90766	0.0	0.6	5/3/2001	ML-003	Uranium-238	715.00	42.9	1.70	pCi/g	=
SAIC	IAAP25015	IAAP25015	687440	90738	0.5	0.8	5/3/2001	ML-003	Bismuth-211	1.45	1.5	0.60	pCi/g	J
SAIC	IAAP25015	IAAP25015	687440	90738	0.5	0.8	5/3/2001	ML-003	Bismuth-214	1.32	0.212	0.22	pCi/g	=
SAIC	IAAP25015	IAAP25015	687440	90738	0.5	0.8	5/3/2001	ML-003	Cesium-137	0.14	0.104	0.13	pCi/g	J
SAIC	IAAP25015	IAAP25015	687440	90738	0.5	0.8	5/3/2001	ML-003	Lead-212	0.97	0.194	0.20	pCi/g	=
SAIC	IAAP25015	IAAP25015	687440	90738	0.5	0.8	5/3/2001	ML-003	Lead-214	0.79	0.456	0.21	pCi/g	U
SAIC	IAAP25015	IAAP25015	687440	90738	0.5	0.8	5/3/2001	ML-003	Niobium-95	11.10	1.62	0.19	pCi/g	=
SAIC	IAAP25015	IAAP25015	687440	90738	0.5	0.8	5/3/2001	ML-003	Potassium-40	13.90	1.74	0.52	pCi/g	=
SAIC	IAAP25015	IAAP25015	687440	90738	0.5	0.8	5/3/2001	ML-003	Protactinium-234	3.30	0.25	1.51	pCi/g	=
SAIC	IAAP25015	IAAP25015	687440	90738	0.5	0.8	5/3/2001	ML-003	Radium-224	2.10	1.53	2.22	pCi/g	U
SAIC	IAAP25015	IAAP25015	687440	90738	0.5	0.8	5/3/2001	ML-003	Radium-228	1.11	0.272	0.28	pCi/g	=
SAIC	IAAP25015	IAAP25015	687440	90738	0.5	0.8	5/3/2001	ML-003	Thorium-228	1.11	0.272	0.28	pCi/g	=
SAIC	IAAP25015	IAAP25015	687440	90738	0.5	0.8	5/3/2001	ML-003	Thorium-232	1.11	0.272	0.28	pCi/g	=
SAIC	IAAP25015	IAAP25015	687440	90738	0.5	0.8	5/3/2001	ML-015	Uranium-234	192.00	54	1.07	pCi/g	=
SAIC	IAAP25015	IAAP25015	687440	90738	0.5	0.8	5/3/2001	ML-015	Uranium-235	39.60	12.7	0.75	pCi/g	J
SAIC	IAAP25015	IAAP25015	687440	90738	0.5	0.8	5/3/2001	ML-003	Uranium-235	21.00	1.36	0.17	pCi/g	=
SAIC	IAAP25015	IAAP25015	687440	90738	0.5	0.8	5/3/2001	ML-015	Uranium-238	1939.00	532	1.07	pCi/g	=
SAIC	IAAP25015	IAAP25015	687440	90738	0.5	0.8	5/3/2001	ML-003	Uranium-238	1764.00	127	5.95	pCi/g	=
SAIC	IAAP25016	IAAP25016	687457	90780	0.5	1.0	5/3/2001	ML-003	Bismuth-212	1.13	0.46	0.47	pCi/g	=
SAIC	IAAP25016	IAAP25016	687457	90780	0.5	1.0	5/3/2001	ML-003	Bismuth-214	1.08	0.13	0.07	pCi/g	=
SAIC	IAAP25016	IAAP25016	687457	90780	0.5	1.0	5/3/2001	ML-003	Cesium-137	0.11	0.04	0.04	pCi/g	=
SAIC	IAAP25016	IAAP25016	687457	90780	0.5	1.0	5/3/2001	ML-003	Lead-212	0.91	0.12	0.06	pCi/g	=
SAIC	IAAP25016	IAAP25016	687457	90780	0.5	1.0	5/3/2001	ML-003	Lead-214	0.99	0.11	0.07	pCi/g	=
SAIC	IAAP25016	IAAP25016	687457	90780	0.5	1.0	5/3/2001	ML-003	Potassium-40	12.40	1.46	0.23	pCi/g	=
SAIC	IAAP25016	IAAP25016	687457	90780	0.5	1.0	5/3/2001	ML-003	Radium-224	2.90	0.72	0.70	pCi/g	=
SAIC	IAAP25016	IAAP25016	687457	90780	0.5	1.0	5/3/2001	ML-003	Radium-228	0.90	0.15	0.11	pCi/g	=
SAIC	IAAP25016	IAAP25016	687457	90780	0.5	1.0	5/3/2001	ML-003	Thallium-208	0.91	0.18	0.11	pCi/g	=
SAIC	IAAP25016	IAAP25016	687457	90780	0.5	1.0	5/3/2001	ML-003	Thorium-228	0.90	0.15	0.11	pCi/g	=
SAIC	IAAP25016	IAAP25016	687457	90780	0.5	1.0	5/3/2001	ML-003	Thorium-232	0.90	0.15	0.11	pCi/g	=
SAIC	IAAP25016	IAAP25016	687457	90780	0.5	1.0	5/3/2001	ML-015	Uranium-234	30.80	8.01	0.67	pCi/g	=
SAIC	IAAP25016	IAAP25016	687457	90780	0.5	1.0	5/3/2001	ML-015	Uranium-235	4.44	1.98	0.45	pCi/g	J
SAIC	IAAP25016	IAAP25016	687457	90780	0.5	1.0	5/3/2001	ML-003	Uranium-235	3.25	0.26	0.06	pCi/g	=
SAIC	IAAP25016	IAAP25016	687457	90780	0.5	1.0	5/3/2001	ML-015	Uranium-238	256.00	58.7	0.67	pCi/g	=
SAIC	IAAP25016	IAAP25016	687457	90780	0.5	1.0	5/3/2001	ML-003	Uranium-238	249.00	18.3	1.72	pCi/g	=
SAIC	IAAP25017	IAAP25017	687390	90615	0.0	0.5	5/4/2001	ML-003	Bismuth-212	0.99	0.3	0.22	pCi/g	=
SAIC	IAAP25017	IAAP25017	687390	90615	0.0	0.5	5/4/2001	ML-003	Bismuth-214	0.67	0.07	0.03	pCi/g	=
SAIC	IAAP25017	IAAP25017	687390	90615	0.0	0.5	5/4/2001	ML-003	Cesium-137	0.14	0.03	0.02	pCi/g	=
SAIC	IAAP25017	IAAP25017	687390	90615	0.0	0.5	5/4/2001	ML-003	Lead-212	0.88	0.09	0.03	pCi/g	=
SAIC	IAAP25017	IAAP25017	687390	90615	0.0	0.5	5/4/2001	ML-003	Lead-214	0.69	0.06	0.03	pCi/g	=
SAIC	IAAP25017	IAAP25017	687390	90615	0.0	0.5	5/4/2001	ML-003	Potassium-40	14.10	1.47	0.20	pCi/g	=

Table A-5-1. Firing Site 12 Area DU

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier
SAIC	IAAP25017	IAAP25017	687390	90615	0.0	0.5	5/4/2001	ML-003	Radium-223	0.24	0.08	0.09	pCi/g	=
SAIC	IAAP25017	IAAP25017	687390	90615	0.0	0.5	5/4/2001	ML-003	Radium-224	2.23	0.52	0.31	pCi/g	=
SAIC	IAAP25017	IAAP25017	687390	90615	0.0	0.5	5/4/2001	ML-003	Radium-228	0.91	0.11	0.07	pCi/g	=
SAIC	IAAP25017	IAAP25017	687390	90615	0.0	0.5	5/4/2001	ML-003	Thallium-208	0.78	0.1	0.05	pCi/g	=
SAIC	IAAP25017	IAAP25017	687390	90615	0.0	0.5	5/4/2001	ML-003	Thorium-228	0.91	0.11	0.07	pCi/g	=
SAIC	IAAP25017	IAAP25017	687390	90615	0.0	0.5	5/4/2001	ML-003	Thorium-232	0.91	0.11	0.07	pCi/g	=
SAIC	IAAP25017	IAAP25017	687390	90615	0.0	0.5	5/4/2001	ML-003	Uranium-235	0.12	0.03	0.03	pCi/g	U
SAIC	IAAP25017	IAAP25017	687390	90615	0.0	0.5	5/4/2001	ML-003	Uranium-238	1.57	0.22	0.19	pCi/g	=
SAIC	IAAP25018	IAAP25018	687389	90619	0.0	0.5	5/4/2001	ML-003	Bismuth-211	0.10	0.41	0.10	pCi/g	R
SAIC	IAAP25018	IAAP25018	687389	90619	0.0	0.5	5/4/2001	ML-003	Bismuth-212	1.02	0.35	0.25	pCi/g	=
SAIC	IAAP25018	IAAP25018	687389	90619	0.0	0.5	5/4/2001	ML-003	Bismuth-214	0.78	0.08	0.04	pCi/g	=
SAIC	IAAP25018	IAAP25018	687389	90619	0.0	0.5	5/4/2001	ML-003	Cesium-137	0.18	0.03	0.02	pCi/g	=
SAIC	IAAP25018	IAAP25018	687389	90619	0.0	0.5	5/4/2001	ML-003	Lead-212	1.04	0.1	0.03	pCi/g	=
SAIC	IAAP25018	IAAP25018	687389	90619	0.0	0.5	5/4/2001	ML-003	Lead-214	0.76	0.11	0.04	pCi/g	=
SAIC	IAAP25018	IAAP25018	687389	90619	0.0	0.5	5/4/2001	ML-003	Potassium-40	15.20	1.58	0.21	pCi/g	=
SAIC	IAAP25018	IAAP25018	687389	90619	0.0	0.5	5/4/2001	ML-003	Radium-224	2.47	0.47	0.34	pCi/g	=
SAIC	IAAP25018	IAAP25018	687389	90619	0.0	0.5	5/4/2001	ML-003	Radium-228	1.01	0.12	0.08	pCi/g	=
SAIC	IAAP25018	IAAP25018	687389	90619	0.0	0.5	5/4/2001	ML-003	Thallium-208	0.97	0.12	0.05	pCi/g	=
SAIC	IAAP25018	IAAP25018	687389	90619	0.0	0.5	5/4/2001	ML-003	Thorium-228	1.01	0.12	0.08	pCi/g	=
SAIC	IAAP25018	IAAP25018	687389	90619	0.0	0.5	5/4/2001	ML-003	Thorium-232	1.01	0.12	0.08	pCi/g	=
SAIC	IAAP25018	IAAP25018	687389	90619	0.0	0.5	5/4/2001	ML-003	Uranium-235	0.15	0.03	0.04	pCi/g	U
SAIC	IAAP25018	IAAP25018	687389	90619	0.0	0.5	5/4/2001	ML-003	Uranium-238	1.76	0.25	0.24	pCi/g	=
SAIC	IAAP25019	IAAP25019	687497	90819	0.0	0.5	5/4/2001	ML-003	Bismuth-211	0.10	0.41	0.11	pCi/g	R
SAIC	IAAP25019	IAAP25019	687497	90819	0.0	0.5	5/4/2001	ML-003	Bismuth-212	1.01	0.31	0.28	pCi/g	=
SAIC	IAAP25019	IAAP25019	687497	90819	0.0	0.5	5/4/2001	ML-003	Bismuth-214	0.68	0.08	0.04	pCi/g	=
SAIC	IAAP25019	IAAP25019	687497	90819	0.0	0.5	5/4/2001	ML-003	Cesium-137	0.13	0.03	0.02	pCi/g	=
SAIC	IAAP25019	IAAP25019	687497	90819	0.0	0.5	5/4/2001	ML-003	Lead-212	0.87	0.09	0.03	pCi/g	=
SAIC	IAAP25019	IAAP25019	687497	90819	0.0	0.5	5/4/2001	ML-003	Lead-214	0.72	0.11	0.04	pCi/g	=
SAIC	IAAP25019	IAAP25019	687497	90819	0.0	0.5	5/4/2001	ML-003	Potassium-40	13.20	1.39	0.18	pCi/g	=
SAIC	IAAP25019	IAAP25019	687497	90819	0.0	0.5	5/4/2001	ML-003	Radium-224	2.64	0.5	0.37	pCi/g	=
SAIC	IAAP25019	IAAP25019	687497	90819	0.0	0.5	5/4/2001	ML-003	Radium-228	0.90	0.11	0.07	pCi/g	=
SAIC	IAAP25019	IAAP25019	687497	90819	0.0	0.5	5/4/2001	ML-003	Thallium-208	0.84	0.11	0.06	pCi/g	=
SAIC	IAAP25019	IAAP25019	687497	90819	0.0	0.5	5/4/2001	ML-003	Thorium-228	0.90	0.11	0.07	pCi/g	=
SAIC	IAAP25019	IAAP25019	687497	90819	0.0	0.5	5/4/2001	ML-003	Thorium-232	0.90	0.11	0.07	pCi/g	=
SAIC	IAAP25019	IAAP25019	687497	90819	0.0	0.5	5/4/2001	ML-003	Uranium-234	41.90	19.3	18.20	pCi/g	R
SAIC	IAAP25019	IAAP25019	687497	90819	0.0	0.5	5/4/2001	ML-003	Uranium-235	0.58	0.06	0.03	pCi/g	=
SAIC	IAAP25019	IAAP25019	687497	90819	0.0	0.5	5/4/2001	ML-003	Uranium-238	31.10	2.01	0.37	pCi/g	=
SAIC	IAAP25021	IAAP25021	687425	90765	0.0	0.5	5/4/2001	ML-003	Bismuth-214	0.56	0.11	0.14	pCi/g	=
SAIC	IAAP25021	IAAP25021	687425	90765	0.0	0.5	5/4/2001	ML-003	Cesium-137	0.01	0.05	0.08	pCi/g	U
SAIC	IAAP25021	IAAP25021	687425	90765	0.0	0.5	5/4/2001	ML-003	Lead-212	0.27	0.11	0.13	pCi/g	=
SAIC	IAAP25021	IAAP25021	687425	90765	0.0	0.5	5/4/2001	ML-003	Lead-214	0.48	0.11	0.14	pCi/g	=
SAIC	IAAP25021	IAAP25021	687425	90765	0.0	0.5	5/4/2001	ML-003	Potassium-40	5.10	0.75	0.36	pCi/g	=
SAIC	IAAP25021	IAAP25021	687425	90765	0.0	0.5	5/4/2001	ML-003	Protactinium-234	2.31	0.17	0.74	pCi/g	=
SAIC	IAAP25021	IAAP25021	687425	90765	0.0	0.5	5/4/2001	ML-003	Radium-228	0.35	0.16	0.23	pCi/g	=
SAIC	IAAP25021	IAAP25021	687425	90765	0.0	0.5	5/4/2001	ML-003	Thorium-228	0.35	0.16	0.23	pCi/g	=
SAIC	IAAP25021	IAAP25021	687425	90765	0.0	0.5	5/4/2001	ML-003	Thorium-232	0.35	0.16	0.23	pCi/g	=
SAIC	IAAP25021	IAAP25021	687425	90765	0.0	0.5	5/4/2001	ML-003	Uranium-234	433.00	102	93.10	pCi/g	R
SAIC	IAAP25021	IAAP25021	687425	90765	0.0	0.5	5/4/2001	ML-003	Uranium-235	17.80	0.93	0.12	pCi/g	=
SAIC	IAAP25021	IAAP25021	687425	90765	0.0	0.5	5/4/2001	ML-003	Uranium-238	1037.00	62.8	2.13	pCi/g	=
SAIC	IAAP25023	IAAP25023	687442	90793	0.0	0.0	5/3/2001	ML-003	Bismuth-211	0.59	1.51	0.67	pCi/g	UJ
SAIC	IAAP25023	IAAP25023	687442	90793	0.0	0.0	5/3/2001	ML-003	Bismuth-214	1.56	0.27	0.24	pCi/g	=
SAIC	IAAP25023	IAAP25023	687442	90793	0.0	0.0	5/3/2001	ML-003	Cesium-137	0.14	0.14	0.14	pCi/g	U
SAIC	IAAP25023	IAAP25023	687442	90793	0.0	0.0	5/3/2001	ML-003	Lead-212	0.57	0.17	0.20	pCi/g	=
SAIC	IAAP25023	IAAP25023	687442	90793	0.0	0.0	5/3/2001	ML-003	Lead-214	0.85	0.44	0.23	pCi/g	J
SAIC	IAAP25023	IAAP25023	687442	90793	0.0	0.0	5/3/2001	ML-003	Potassium-40	6.38	1.61	1.82	pCi/g	=
SAIC	IAAP25023	IAAP25023	687442	90793	0.0	0.0	5/3/2001	ML-003	Radium-224	4.00	2.16	2.22	pCi/g	J
SAIC	IAAP25023	IAAP25023	687442	90793	0.0	0.0	5/3/2001	ML-003	Radium-228	0.72	0.51	0.53	pCi/g	J

Table A-5-1. Firing Site 12 Area DU

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier
SAIC	IAAP25023	IAAP25023	687442	90793	0.0	0.0	5/3/2001	ML-003	Thallium-208	0.58	0.43	0.35	pCi/g	J
SAIC	IAAP25023	IAAP25023	687442	90793	0.0	0.0	5/3/2001	ML-003	Thorium-228	0.72	0.51	0.53	pCi/g	J
SAIC	IAAP25023	IAAP25023	687442	90793	0.0	0.0	5/3/2001	ML-003	Thorium-232	0.72	0.51	0.53	pCi/g	J
SAIC	IAAP25023	IAAP25023	687442	90793	0.0	0.0	5/3/2001	ML-015	Uranium-234	48.80	13.7	0.50	pCi/g	=
SAIC	IAAP25023	IAAP25023	687442	90793	0.0	0.0	5/3/2001	ML-015	Uranium-235	7.20	3.14	1.09	pCi/g	=
SAIC	IAAP25023	IAAP25023	687442	90793	0.0	0.0	5/3/2001	ML-003	Uranium-235	6.28	0.54	0.17	pCi/g	=
SAIC	IAAP25023	IAAP25023	687442	90793	0.0	0.0	5/3/2001	ML-015	Uranium-238	371.00	95.2	0.50	pCi/g	=
SAIC	IAAP25023	IAAP25023	687442	90793	0.0	0.0	5/3/2001	ML-003	Uranium-238	452.00	29.3	4.12	pCi/g	=
SAIC	IAAP116659	IAAP116655	687497	90847	2.0	2.5	4/14/2009	ML-015	Uranium-234	17.50	4.64	0.37	pCi/g	=
SAIC	IAAP116660	IAAP116655	687497	90847	2.5	3.0	4/14/2009	ML-015	Uranium-234	10.00	2.83	0.16	pCi/g	=
SAIC	IAAP116661	IAAP116655	687497	90847	3.0	3.5	4/14/2009	ML-015	Uranium-234	22.30	5.85	0.17	pCi/g	=
SAIC	IAAP116664	IAAP116662	687480	90866	0.5	1.0	4/15/2009	ML-015	Uranium-234	1.32	0.57	0.23	pCi/g	=
SAIC	IAAP116667	IAAP116665	687445	90826	0.5	1.0	4/15/2009	ML-015	Uranium-234	9.48	2.75	0.17	pCi/g	=
SAIC	IAAP116668	IAAP116665	687445	90826	1.0	1.5	4/15/2009	ML-015	Uranium-234	12.50	4.50	0.29	pCi/g	=
SAIC	IAAP116669	IAAP116665	687445	90826	1.5	2.0	4/15/2009	ML-015	Uranium-234	8.00	2.39	0.31	pCi/g	=
SAIC	IAAP116674	IAAP116670	687412	90838	2.0	2.5	4/15/2009	ML-015	Uranium-234	4.23	1.07	0.09	pCi/g	=
SAIC	IAAP116678	IAAP116675	687412	90821	1.5	2.0	4/15/2009	ML-015	Uranium-234	15.10	3.00	0.08	pCi/g	=
SAIC	IAAP116682	IAAP116679	687465	90769	1.0	1.5	4/15/2009	ML-015	Uranium-234	8.37	1.70	0.16	pCi/g	=
SAIC	IAAP116686	IAAP116683	687439	90719	1.0	1.5	4/15/2009	ML-015	Uranium-234	25.00	4.56	0.07	pCi/g	=
SAIC	IAAP116687	IAAP116683	687439	90719	1.5	2.0	4/15/2009	ML-015	Uranium-234	9.88	1.92	0.15	pCi/g	=
SAIC	IAAP116688	IAAP116683	687439	90719	2.0	2.5	4/15/2009	ML-015	Uranium-234	3.67	0.91	0.08	pCi/g	=
SAIC	IAAP116692	IAAP116689	687373	90700	1.0	1.5	4/15/2009	ML-015	Uranium-234	27.70	5.41	0.09	pCi/g	=
SAIC	IAAP116693	IAAP116689	687373	90700	1.5	2.0	4/15/2009	ML-015	Uranium-234	15.70	2.84	0.06	pCi/g	=
SAIC	IAAP116694	IAAP116689	687373	90700	2.0	2.5	4/15/2009	ML-015	Uranium-234	4.65	1.01	0.18	pCi/g	=
SAIC	IAAP116659	IAAP116655	687497	90847	2.0	2.5	4/14/2009	ML-015	Uranium-235	2.40	1.02	0.20	pCi/g	=
SAIC	IAAP116660	IAAP116655	687497	90847	2.5	3.0	4/14/2009	ML-015	Uranium-235	1.31	0.69	0.20	pCi/g	J
SAIC	IAAP116661	IAAP116655	687497	90847	3.0	3.5	4/14/2009	ML-015	Uranium-235	1.95	0.91	0.38	pCi/g	=
SAIC	IAAP116664	IAAP116662	687480	90866	0.5	1.0	4/15/2009	ML-015	Uranium-235	0.00	0.00	0.15	pCi/g	U
SAIC	IAAP116667	IAAP116665	687445	90826	0.5	1.0	4/15/2009	ML-015	Uranium-235	1.60	0.80	0.21	pCi/g	=
SAIC	IAAP116668	IAAP116665	687445	90826	1.0	1.5	4/15/2009	ML-015	Uranium-235	1.71	1.09	0.36	pCi/g	J
SAIC	IAAP116669	IAAP116665	687445	90826	1.5	2.0	4/15/2009	ML-015	Uranium-235	0.91	0.57	0.21	pCi/g	J
SAIC	IAAP116674	IAAP116670	687412	90838	2.0	2.5	4/15/2009	ML-015	Uranium-235	0.59	0.32	0.11	pCi/g	J
SAIC	IAAP116678	IAAP116675	687412	90821	1.5	2.0	4/15/2009	ML-015	Uranium-235	1.53	0.54	0.10	pCi/g	=
SAIC	IAAP116682	IAAP116679	687465	90769	1.0	1.5	4/15/2009	ML-015	Uranium-235	0.88	0.37	0.19	pCi/g	=
SAIC	IAAP116686	IAAP116683	687439	90719	1.0	1.5	4/15/2009	ML-015	Uranium-235	2.94	0.80	0.09	pCi/g	=
SAIC	IAAP116687	IAAP116683	687439	90719	1.5	2.0	4/15/2009	ML-015	Uranium-235	0.93	0.37	0.08	pCi/g	=
SAIC	IAAP116688	IAAP116683	687439	90719	2.0	2.5	4/15/2009	ML-015	Uranium-235	0.14	0.14	0.09	pCi/g	J
SAIC	IAAP116692	IAAP116689	687373	90700	1.0	1.5	4/15/2009	ML-015	Uranium-235	3.55	0.99	0.11	pCi/g	=
SAIC	IAAP116693	IAAP116689	687373	90700	1.5	2.0	4/15/2009	ML-015	Uranium-235	2.83	0.74	0.08	pCi/g	=
SAIC	IAAP116694	IAAP116689	687373	90700	2.0	2.5	4/15/2009	ML-015	Uranium-235	0.47	0.25	0.08	pCi/g	J
SAIC	IAAP116659	IAAP116655	687497	90847	2.0	2.5	4/14/2009	ML-015	Uranium-238	99.90	24.30	0.31	pCi/g	=
SAIC	IAAP116660	IAAP116655	687497	90847	2.5	3.0	4/14/2009	ML-015	Uranium-238	52.80	13.00	0.16	pCi/g	=
SAIC	IAAP116661	IAAP116655	687497	90847	3.0	3.5	4/14/2009	ML-015	Uranium-238	152.00	37.00	0.17	pCi/g	=
SAIC	IAAP116664	IAAP116662	687480	90866	0.5	1.0	4/15/2009	ML-015	Uranium-238	1.24	0.54	0.12	pCi/g	=
SAIC	IAAP116667	IAAP116665	687445	90826	0.5	1.0	4/15/2009	ML-015	Uranium-238	59.70	14.90	0.37	pCi/g	=
SAIC	IAAP116668	IAAP116665	687445	90826	1.0	1.5	4/15/2009	ML-015	Uranium-238	88.80	28.10	0.29	pCi/g	=
SAIC	IAAP116669	IAAP116665	687445	90826	1.5	2.0	4/15/2009	ML-015	Uranium-238	50.20	12.60	0.17	pCi/g	=
SAIC	IAAP116674	IAAP116670	687412	90838	2.0	2.5	4/15/2009	ML-015	Uranium-238	27.60	5.39	0.23	pCi/g	=
SAIC	IAAP116678	IAAP116675	687412	90821	1.5	2.0	4/15/2009	ML-015	Uranium-238	93.00	16.80	0.08	pCi/g	=
SAIC	IAAP116682	IAAP116679	687465	90769	1.0	1.5	4/15/2009	ML-015	Uranium-238	53.70	9.43	0.07	pCi/g	=
SAIC	IAAP116686	IAAP116683	687439	90719	1.0	1.5	4/15/2009	ML-015	Uranium-238	146.00	25.30	0.07	pCi/g	=
SAIC	IAAP116687	IAAP116683	687439	90719	1.5	2.0	4/15/2009	ML-015	Uranium-238	59.80	10.20	0.07	pCi/g	=
SAIC	IAAP116688	IAAP116683	687439	90719	2.0	2.5	4/15/2009	ML-015	Uranium-238	23.30	4.37	0.17	pCi/g	=
SAIC	IAAP116692	IAAP116689	687373	90700	1.0	1.5	4/15/2009	ML-015	Uranium-238	266.00	49.00	0.19	pCi/g	=
SAIC	IAAP116693	IAAP116689	687373	90700	1.5	2.0	4/15/2009	ML-015	Uranium-238	142.00	23.50	0.14	pCi/g	=
SAIC	IAAP116694	IAAP116689	687373	90700	2.0	2.5	4/15/2009	ML-015	Uranium-238	35.40	6.08	0.06	pCi/g	=
SAIC	IAAP116655	IAAP116655	687497	90847	0.0	0.5	4/14/2009	ML-003	Actinium-227	125.00	168.00	26.80	pCi/g	U

Table A-5-1. Firing Site 12 Area DU

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier
SAIC	IAAP116656	IAAP116655	687497	90847	0.5	1.0	4/14/2009	ML-003	Actinium-227	0.82	0.55	0.83	pCi/g	U
SAIC	IAAP116657	IAAP116655	687497	90847	1.0	1.5	4/14/2009	ML-003	Actinium-227	0.28	0.24	0.40	pCi/g	U
SAIC	IAAP116658	IAAP116655	687497	90847	1.5	2.0	4/14/2009	ML-003	Actinium-227	0.22	0.30	0.45	pCi/g	UJ
SAIC	IAAP116659	IAAP116655	687497	90847	2.0	2.5	4/14/2009	ML-003	Actinium-227	0.05	0.17	0.26	pCi/g	UJ
SAIC	IAAP116660	IAAP116655	687497	90847	2.5	3.0	4/14/2009	ML-003	Actinium-227	0.20	0.20	0.23	pCi/g	U
SAIC	IAAP116661	IAAP116655	687497	90847	3.0	3.5	4/14/2009	ML-003	Actinium-227	0.28	0.20	0.31	pCi/g	U
SAIC	IAAP116662	IAAP116662	687480	90866	0.0	0.1	4/15/2009	ML-003	Actinium-227	330.00	452.00	148.00	pCi/g	U
SAIC	IAAP116663	IAAP116662	687480	90866	0.0	0.5	4/15/2009	ML-003	Actinium-227	0.22	0.30	0.45	pCi/g	UJ
SAIC	IAAP116664	IAAP116662	687480	90866	0.5	1.0	4/15/2009	ML-003	Actinium-227	0.02	0.09	0.15	pCi/g	UJ
SAIC	IAAP116665	IAAP116665	687445	90826	0.0	0.1	4/15/2009	ML-003	Actinium-227	24.00	32.90	16.50	pCi/g	U
SAIC	IAAP116666	IAAP116665	687445	90826	0.0	0.5	4/15/2009	ML-003	Actinium-227	30.20	41.10	11.00	pCi/g	U
SAIC	IAAP116667	IAAP116665	687445	90826	0.5	1.0	4/15/2009	ML-003	Actinium-227	0.00	0.12	0.18	pCi/g	UJ
SAIC	IAAP116668	IAAP116665	687445	90826	1.0	1.5	4/15/2009	ML-003	Actinium-227	0.09	0.13	0.20	pCi/g	UJ
SAIC	IAAP116669	IAAP116665	687445	90826	1.5	2.0	4/15/2009	ML-003	Actinium-227	0.03	0.11	0.16	pCi/g	UJ
SAIC	IAAP116670	IAAP116670	687412	90838	0.0	0.5	4/15/2009	ML-003	Actinium-227	66.70	89.70	15.20	pCi/g	U
SAIC	IAAP116671	IAAP116670	687412	90838	0.5	1.0	4/15/2009	ML-003	Actinium-227	5.39	8.09	5.46	pCi/g	UJ
SAIC	IAAP116672	IAAP116670	687412	90838	1.0	1.5	4/15/2009	ML-003	Actinium-227	0.47	0.45	0.68	pCi/g	U
SAIC	IAAP116673	IAAP116670	687412	90838	1.5	2.0	4/15/2009	ML-003	Actinium-227	0.19	0.28	0.42	pCi/g	UJ
SAIC	IAAP116674	IAAP116670	687412	90838	2.0	2.5	4/15/2009	ML-003	Actinium-227	-0.04	0.13	0.18	pCi/g	UJ
SAIC	IAAP116675	IAAP116675	687412	90821	0.0	0.5	4/15/2009	ML-003	Actinium-227	62.80	84.40	13.20	pCi/g	U
SAIC	IAAP116676	IAAP116675	687412	90821	0.5	1.0	4/15/2009	ML-003	Actinium-227	9.38	13.00	5.43	pCi/g	U
SAIC	IAAP116677	IAAP116675	687412	90821	1.0	1.5	4/15/2009	ML-003	Actinium-227	0.37	0.17	0.41	pCi/g	U
SAIC	IAAP116678	IAAP116675	687412	90821	1.5	2.0	4/15/2009	ML-003	Actinium-227	0.10	0.15	0.22	pCi/g	UJ
SAIC	IAAP116679	IAAP116679	687465	90769	0.0	0.1	4/15/2009	ML-003	Actinium-227	21.60	29.40	12.80	pCi/g	U
SAIC	IAAP116680	IAAP116679	687465	90769	0.0	0.5	4/15/2009	ML-003	Actinium-227	29.00	39.50	11.20	pCi/g	U
SAIC	IAAP116681	IAAP116679	687465	90769	0.5	1.0	4/15/2009	ML-003	Actinium-227	0.54	0.21	0.33	pCi/g	U
SAIC	IAAP116682	IAAP116679	687465	90769	1.0	1.5	4/15/2009	ML-003	Actinium-227	-0.05	0.15	0.21	pCi/g	UJ
SAIC	IAAP116683	IAAP116683	687439	90719	0.0	0.1	4/15/2009	ML-003	Actinium-227	44.90	61.50	19.50	pCi/g	U
SAIC	IAAP116684	IAAP116683	687439	90719	0.0	0.5	4/15/2009	ML-003	Actinium-227	27.00	36.60	9.64	pCi/g	U
SAIC	IAAP116685	IAAP116683	687439	90719	0.5	1.0	4/15/2009	ML-003	Actinium-227	10.20	14.00	5.35	pCi/g	U
SAIC	IAAP116686	IAAP116683	687439	90719	1.0	1.5	4/15/2009	ML-003	Actinium-227	0.42	0.22	0.34	pCi/g	UJ
SAIC	IAAP116687	IAAP116683	687439	90719	1.5	2.0	4/15/2009	ML-003	Actinium-227	0.10	0.14	0.21	pCi/g	UJ
SAIC	IAAP116688	IAAP116683	687439	90719	2.0	2.5	4/15/2009	ML-003	Actinium-227	0.35	0.23	0.19	pCi/g	UJ
SAIC	IAAP116689	IAAP116689	687373	90700	0.0	0.1	4/15/2009	ML-003	Actinium-227	22.20	32.00	21.80	pCi/g	U
SAIC	IAAP116690	IAAP116689	687373	90700	0.0	0.5	4/15/2009	ML-003	Actinium-227	88.50	119.00	20.70	pCi/g	U
SAIC	IAAP116691	IAAP116689	687373	90700	0.5	1.0	4/15/2009	ML-003	Actinium-227	1.50	0.37	0.58	pCi/g	U
SAIC	IAAP116692	IAAP116689	687373	90700	1.0	1.5	4/15/2009	ML-003	Actinium-227	2.18	0.35	0.30	pCi/g	U
SAIC	IAAP116693	IAAP116689	687373	90700	1.5	2.0	4/15/2009	ML-003	Actinium-227	0.27	0.16	0.24	pCi/g	UJ
SAIC	IAAP116694	IAAP116689	687373	90700	2.0	2.5	4/15/2009	ML-003	Actinium-227	0.08	0.11	0.18	pCi/g	UJ
SAIC	IAAP116655	IAAP116655	687497	90847	0.0	0.5	4/14/2009	ML-003	Americium-241	24.20	4.73	6.63	pCi/g	U
SAIC	IAAP116656	IAAP116655	687497	90847	0.5	1.0	4/14/2009	ML-003	Americium-241	14.70	1.31	0.45	pCi/g	J
SAIC	IAAP116657	IAAP116655	687497	90847	1.0	1.5	4/14/2009	ML-003	Americium-241	1.06	0.19	0.21	pCi/g	J
SAIC	IAAP116658	IAAP116655	687497	90847	1.5	2.0	4/14/2009	ML-003	Americium-241	2.49	0.23	0.29	pCi/g	UJ
SAIC	IAAP116659	IAAP116655	687497	90847	2.0	2.5	4/14/2009	ML-003	Americium-241	0.42	0.12	0.11	pCi/g	J
SAIC	IAAP116660	IAAP116655	687497	90847	2.5	3.0	4/14/2009	ML-003	Americium-241	0.04	0.06	0.10	pCi/g	UJ
SAIC	IAAP116661	IAAP116655	687497	90847	3.0	3.5	4/14/2009	ML-003	Americium-241	0.94	0.25	0.14	pCi/g	J
SAIC	IAAP116662	IAAP116662	687480	90866	0.0	0.1	4/15/2009	ML-003	Americium-241	32.20	17.20	27.70	pCi/g	UJ
SAIC	IAAP116663	IAAP116662	687480	90866	0.0	0.5	4/15/2009	ML-003	Americium-241	4.12	0.52	0.24	pCi/g	J
SAIC	IAAP116664	IAAP116662	687480	90866	0.5	1.0	4/15/2009	ML-003	Americium-241	-0.01	0.02	0.04	pCi/g	UJ
SAIC	IAAP116665	IAAP116665	687445	90826	0.0	0.1	4/15/2009	ML-003	Americium-241	15.00	2.34	2.90	pCi/g	U
SAIC	IAAP116666	IAAP116665	687445	90826	0.0	0.5	4/15/2009	ML-003	Americium-241	7.67	2.51	3.91	pCi/g	U
SAIC	IAAP116667	IAAP116665	687445	90826	0.5	1.0	4/15/2009	ML-003	Americium-241	0.23	0.05	0.09	pCi/g	UJ
SAIC	IAAP116668	IAAP116665	687445	90826	1.0	1.5	4/15/2009	ML-003	Americium-241	0.01	0.06	0.10	pCi/g	UJ
SAIC	IAAP116669	IAAP116665	687445	90826	1.5	2.0	4/15/2009	ML-003	Americium-241	0.03	0.05	0.07	pCi/g	UJ
SAIC	IAAP116670	IAAP116670	687412	90838	0.0	0.5	4/15/2009	ML-003	Americium-241	14.70	2.78	3.84	pCi/g	U
SAIC	IAAP116671	IAAP116670	687412	90838	0.5	1.0	4/15/2009	ML-003	Americium-241	2.79	1.67	2.70	pCi/g	UJ
SAIC	IAAP116672	IAAP116670	687412	90838	1.0	1.5	4/15/2009	ML-003	Americium-241	7.25	0.56	0.46	pCi/g	UJ

Table A-5-1. Firing Site 12 Area DU

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier
SAIC	IAAP116673	IAAP116670	687412	90838	1.5	2.0	4/15/2009	ML-003	Americium-241	2.97	0.46	0.22	pCi/g	J
SAIC	IAAP116674	IAAP116670	687412	90838	2.0	2.5	4/15/2009	ML-003	Americium-241	0.00	0.04	0.07	pCi/g	UJ
SAIC	IAAP116675	IAAP116675	687412	90821	0.0	0.5	4/15/2009	ML-003	Americium-241	12.40	2.47	3.49	pCi/g	U
SAIC	IAAP116676	IAAP116675	687412	90821	0.5	1.0	4/15/2009	ML-003	Americium-241	2.80	1.70	2.75	pCi/g	UJ
SAIC	IAAP116677	IAAP116675	687412	90821	1.0	1.5	4/15/2009	ML-003	Americium-241	0.13	0.13	0.21	pCi/g	U
SAIC	IAAP116678	IAAP116675	687412	90821	1.5	2.0	4/15/2009	ML-003	Americium-241	0.02	0.05	0.09	pCi/g	UJ
SAIC	IAAP116679	IAAP116679	687465	90769	0.0	0.1	4/15/2009	ML-003	Americium-241	9.94	1.78	2.40	pCi/g	U
SAIC	IAAP116680	IAAP116679	687465	90769	0.0	0.5	4/15/2009	ML-003	Americium-241	6.78	2.52	3.98	pCi/g	U
SAIC	IAAP116681	IAAP116679	687465	90769	0.5	1.0	4/15/2009	ML-003	Americium-241	0.07	0.09	0.15	pCi/g	UJ
SAIC	IAAP116682	IAAP116679	687465	90769	1.0	1.5	4/15/2009	ML-003	Americium-241	-0.01	0.05	0.08	pCi/g	UJ
SAIC	IAAP116683	IAAP116683	687439	90719	0.0	0.1	4/15/2009	ML-003	Americium-241	20.50	2.98	3.44	pCi/g	U
SAIC	IAAP116684	IAAP116683	687439	90719	0.0	0.5	4/15/2009	ML-003	Americium-241	7.41	2.37	3.69	pCi/g	U
SAIC	IAAP116685	IAAP116683	687439	90719	0.5	1.0	4/15/2009	ML-003	Americium-241	3.59	1.74	2.80	pCi/g	U
SAIC	IAAP116686	IAAP116683	687439	90719	1.0	1.5	4/15/2009	ML-003	Americium-241	-0.02	0.09	0.14	pCi/g	UJ
SAIC	IAAP116687	IAAP116683	687439	90719	1.5	2.0	4/15/2009	ML-003	Americium-241	0.04	0.05	0.08	pCi/g	UJ
SAIC	IAAP116688	IAAP116683	687439	90719	2.0	2.5	4/15/2009	ML-003	Americium-241	0.00	0.04	0.06	pCi/g	UJ
SAIC	IAAP116689	IAAP116689	687373	90700	0.0	0.1	4/15/2009	ML-003	Americium-241	15.40	2.86	3.95	pCi/g	U
SAIC	IAAP116690	IAAP116689	687373	90700	0.0	0.5	4/15/2009	ML-003	Americium-241	17.70	3.95	5.78	pCi/g	U
SAIC	IAAP116691	IAAP116689	687373	90700	0.5	1.0	4/15/2009	ML-003	Americium-241	0.17	0.17	0.27	pCi/g	U
SAIC	IAAP116692	IAAP116689	687373	90700	1.0	1.5	4/15/2009	ML-003	Americium-241	0.05	0.08	0.14	pCi/g	UJ
SAIC	IAAP116693	IAAP116689	687373	90700	1.5	2.0	4/15/2009	ML-003	Americium-241	0.00	0.06	0.10	pCi/g	UJ
SAIC	IAAP116694	IAAP116689	687373	90700	2.0	2.5	4/15/2009	ML-003	Americium-241	0.01	0.04	0.06	pCi/g	UJ
SAIC	IAAP116655	IAAP116655	687497	90847	0.0	0.5	4/14/2009	ML-003	Cesium-137	-0.50	1.10	1.74	pCi/g	UJ
SAIC	IAAP116656	IAAP116655	687497	90847	0.5	1.0	4/14/2009	ML-003	Cesium-137	-0.03	0.04	0.07	pCi/g	UJ
SAIC	IAAP116657	IAAP116655	687497	90847	1.0	1.5	4/14/2009	ML-003	Cesium-137	0.00	0.02	0.03	pCi/g	UJ
SAIC	IAAP116658	IAAP116655	687497	90847	1.5	2.0	4/14/2009	ML-003	Cesium-137	0.01	0.02	0.04	pCi/g	UJ
SAIC	IAAP116659	IAAP116655	687497	90847	2.0	2.5	4/14/2009	ML-003	Cesium-137	0.01	0.01	0.02	pCi/g	UJ
SAIC	IAAP116660	IAAP116655	687497	90847	2.5	3.0	4/14/2009	ML-003	Cesium-137	-0.01	0.01	0.02	pCi/g	UJ
SAIC	IAAP116661	IAAP116655	687497	90847	3.0	3.5	4/14/2009	ML-003	Cesium-137	0.00	0.01	0.02	pCi/g	UJ
SAIC	IAAP116662	IAAP116662	687480	90866	0.0	0.1	4/15/2009	ML-003	Cesium-137	-1.68	7.44	11.90	pCi/g	UJ
SAIC	IAAP116663	IAAP116662	687480	90866	0.0	0.5	4/15/2009	ML-003	Cesium-137	0.09	0.04	0.04	pCi/g	=
SAIC	IAAP116664	IAAP116662	687480	90866	0.5	1.0	4/15/2009	ML-003	Cesium-137	0.00	0.01	0.01	pCi/g	UJ
SAIC	IAAP116665	IAAP116665	687445	90826	0.0	0.1	4/15/2009	ML-003	Cesium-137	-0.22	1.08	1.73	pCi/g	UJ
SAIC	IAAP116666	IAAP116665	687445	90826	0.0	0.5	4/15/2009	ML-003	Cesium-137	0.19	0.42	0.68	pCi/g	UJ
SAIC	IAAP116667	IAAP116665	687445	90826	0.5	1.0	4/15/2009	ML-003	Cesium-137	0.01	0.02	0.02	pCi/g	UJ
SAIC	IAAP116668	IAAP116665	687445	90826	1.0	1.5	4/15/2009	ML-003	Cesium-137	0.00	0.01	0.02	pCi/g	UJ
SAIC	IAAP116669	IAAP116665	687445	90826	1.5	2.0	4/15/2009	ML-003	Cesium-137	0.00	0.01	0.01	pCi/g	UJ
SAIC	IAAP116670	IAAP116670	687412	90838	0.0	0.5	4/15/2009	ML-003	Cesium-137	-0.27	0.65	1.03	pCi/g	UJ
SAIC	IAAP116671	IAAP116670	687412	90838	0.5	1.0	4/15/2009	ML-003	Cesium-137	-0.15	0.23	0.36	pCi/g	UJ
SAIC	IAAP116672	IAAP116670	687412	90838	1.0	1.5	4/15/2009	ML-003	Cesium-137	0.00	0.03	0.06	pCi/g	UJ
SAIC	IAAP116673	IAAP116670	687412	90838	1.5	2.0	4/15/2009	ML-003	Cesium-137	0.01	0.02	0.04	pCi/g	UJ
SAIC	IAAP116674	IAAP116670	687412	90838	2.0	2.5	4/15/2009	ML-003	Cesium-137	0.10	0.03	0.02	pCi/g	=
SAIC	IAAP116675	IAAP116675	687412	90821	0.0	0.5	4/15/2009	ML-003	Cesium-137	-0.49	0.55	0.87	pCi/g	UJ
SAIC	IAAP116676	IAAP116675	687412	90821	0.5	1.0	4/15/2009	ML-003	Cesium-137	0.11	0.23	0.37	pCi/g	UJ
SAIC	IAAP116677	IAAP116675	687412	90821	1.0	1.5	4/15/2009	ML-003	Cesium-137	-0.01	0.02	0.03	pCi/g	UJ
SAIC	IAAP116678	IAAP116675	687412	90821	1.5	2.0	4/15/2009	ML-003	Cesium-137	0.00	0.01	0.02	pCi/g	UJ
SAIC	IAAP116679	IAAP116679	687465	90769	0.0	0.1	4/15/2009	ML-003	Cesium-137	-0.13	0.83	1.26	pCi/g	UJ
SAIC	IAAP116680	IAAP116679	687465	90769	0.0	0.5	4/15/2009	ML-003	Cesium-137	0.19	0.49	0.70	pCi/g	UJ
SAIC	IAAP116681	IAAP116679	687465	90769	0.5	1.0	4/15/2009	ML-003	Cesium-137	0.05	0.03	0.03	pCi/g	=
SAIC	IAAP116682	IAAP116679	687465	90769	1.0	1.5	4/15/2009	ML-003	Cesium-137	-0.01	0.01	0.02	pCi/g	UJ
SAIC	IAAP116683	IAAP116683	687439	90719	0.0	0.1	4/15/2009	ML-003	Cesium-137	-0.57	1.34	2.14	pCi/g	UJ
SAIC	IAAP116684	IAAP116683	687439	90719	0.0	0.5	4/15/2009	ML-003	Cesium-137	-0.39	0.38	0.60	pCi/g	UJ
SAIC	IAAP116685	IAAP116683	687439	90719	0.5	1.0	4/15/2009	ML-003	Cesium-137	0.05	0.22	0.35	pCi/g	UJ
SAIC	IAAP116686	IAAP116683	687439	90719	1.0	1.5	4/15/2009	ML-003	Cesium-137	0.00	0.02	0.03	pCi/g	UJ
SAIC	IAAP116687	IAAP116683	687439	90719	1.5	2.0	4/15/2009	ML-003	Cesium-137	0.00	0.01	0.02	pCi/g	UJ
SAIC	IAAP116688	IAAP116683	687439	90719	2.0	2.5	4/15/2009	ML-003	Cesium-137	0.00	0.01	0.02	pCi/g	UJ
SAIC	IAAP116689	IAAP116689	687373	90700	0.0	0.1	4/15/2009	ML-003	Cesium-137	0.48	1.41	2.26	pCi/g	UJ

Table A-5-1. Firing Site 12 Area DU

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier
SAIC	IAAP116690	IAAP116689	687373	90700	0.0	0.5	4/15/2009	ML-003	Cesium-137	0.25	0.85	1.36	pCi/g	UJ
SAIC	IAAP116691	IAAP116689	687373	90700	0.5	1.0	4/15/2009	ML-003	Cesium-137	0.07	0.05	0.04	pCi/g	J
SAIC	IAAP116692	IAAP116689	687373	90700	1.0	1.5	4/15/2009	ML-003	Cesium-137	0.01	0.02	0.03	pCi/g	UJ
SAIC	IAAP116693	IAAP116689	687373	90700	1.5	2.0	4/15/2009	ML-003	Cesium-137	0.00	0.01	0.02	pCi/g	UJ
SAIC	IAAP116694	IAAP116689	687373	90700	2.0	2.5	4/15/2009	ML-003	Cesium-137	0.00	0.01	0.02	pCi/g	UJ
SAIC	IAAP116655	IAAP116655	687497	90847	0.0	0.5	4/14/2009	ML-003	Potassium-40	9.81	5.97	7.26	pCi/g	J
SAIC	IAAP116656	IAAP116655	687497	90847	0.5	1.0	4/14/2009	ML-003	Potassium-40	14.50	0.82	0.26	pCi/g	=
SAIC	IAAP116657	IAAP116655	687497	90847	1.0	1.5	4/14/2009	ML-003	Potassium-40	15.00	0.83	0.16	pCi/g	=
SAIC	IAAP116658	IAAP116655	687497	90847	1.5	2.0	4/14/2009	ML-003	Potassium-40	14.30	0.78	0.17	pCi/g	=
SAIC	IAAP116659	IAAP116655	687497	90847	2.0	2.5	4/14/2009	ML-003	Potassium-40	15.30	0.81	0.13	pCi/g	=
SAIC	IAAP116660	IAAP116655	687497	90847	2.5	3.0	4/14/2009	ML-003	Potassium-40	15.30	0.81	0.15	pCi/g	=
SAIC	IAAP116661	IAAP116655	687497	90847	3.0	3.5	4/14/2009	ML-003	Potassium-40	15.70	0.85	0.14	pCi/g	=
SAIC	IAAP116662	IAAP116662	687480	90866	0.0	0.1	4/15/2009	ML-003	Potassium-40	2.54	27.40	45.10	pCi/g	UJ
SAIC	IAAP116663	IAAP116662	687480	90866	0.0	0.5	4/15/2009	ML-003	Potassium-40	15.30	0.83	0.18	pCi/g	=
SAIC	IAAP116664	IAAP116662	687480	90866	0.5	1.0	4/15/2009	ML-003	Potassium-40	13.70	0.71	0.14	pCi/g	=
SAIC	IAAP116665	IAAP116665	687445	90826	0.0	0.1	4/15/2009	ML-003	Potassium-40	-3.38	5.95	9.62	pCi/g	UJ
SAIC	IAAP116666	IAAP116665	687445	90826	0.0	0.5	4/15/2009	ML-003	Potassium-40	10.30	4.43	2.55	pCi/g	J
SAIC	IAAP116667	IAAP116665	687445	90826	0.5	1.0	4/15/2009	ML-003	Potassium-40	12.40	0.68	0.12	pCi/g	=
SAIC	IAAP116668	IAAP116665	687445	90826	1.0	1.5	4/15/2009	ML-003	Potassium-40	12.20	0.66	0.11	pCi/g	=
SAIC	IAAP116669	IAAP116665	687445	90826	1.5	2.0	4/15/2009	ML-003	Potassium-40	10.00	0.56	0.09	pCi/g	=
SAIC	IAAP116670	IAAP116670	687412	90838	0.0	0.5	4/15/2009	ML-003	Potassium-40	8.10	5.04	4.22	pCi/g	J
SAIC	IAAP116671	IAAP116670	687412	90838	0.5	1.0	4/15/2009	ML-003	Potassium-40	12.70	3.44	1.24	pCi/g	=
SAIC	IAAP116672	IAAP116670	687412	90838	1.0	1.5	4/15/2009	ML-003	Potassium-40	14.90	0.83	0.24	pCi/g	=
SAIC	IAAP116673	IAAP116670	687412	90838	1.5	2.0	4/15/2009	ML-003	Potassium-40	15.60	0.83	0.18	pCi/g	=
SAIC	IAAP116674	IAAP116670	687412	90838	2.0	2.5	4/15/2009	ML-003	Potassium-40	11.80	0.72	0.14	pCi/g	=
SAIC	IAAP116675	IAAP116675	687412	90821	0.0	0.5	4/15/2009	ML-003	Potassium-40	11.10	4.53	3.43	pCi/g	J
SAIC	IAAP116676	IAAP116675	687412	90821	0.5	1.0	4/15/2009	ML-003	Potassium-40	9.41	3.22	1.47	pCi/g	=
SAIC	IAAP116677	IAAP116675	687412	90821	1.0	1.5	4/15/2009	ML-003	Potassium-40	11.30	0.72	0.20	pCi/g	=
SAIC	IAAP116678	IAAP116675	687412	90821	1.5	2.0	4/15/2009	ML-003	Potassium-40	14.00	0.78	0.17	pCi/g	=
SAIC	IAAP116679	IAAP116679	687465	90769	0.0	0.1	4/15/2009	ML-003	Potassium-40	-0.45	3.78	6.33	pCi/g	UJ
SAIC	IAAP116680	IAAP116679	687465	90769	0.0	0.5	4/15/2009	ML-003	Potassium-40	8.89	4.47	2.51	pCi/g	J
SAIC	IAAP116681	IAAP116679	687465	90769	0.5	1.0	4/15/2009	ML-003	Potassium-40	9.80	0.64	0.19	pCi/g	=
SAIC	IAAP116682	IAAP116679	687465	90769	1.0	1.5	4/15/2009	ML-003	Potassium-40	11.20	0.72	0.15	pCi/g	=
SAIC	IAAP116683	IAAP116683	687439	90719	0.0	0.1	4/15/2009	ML-003	Potassium-40	4.88	7.98	13.30	pCi/g	UJ
SAIC	IAAP116684	IAAP116683	687439	90719	0.0	0.5	4/15/2009	ML-003	Potassium-40	9.57	3.89	2.11	pCi/g	J
SAIC	IAAP116685	IAAP116683	687439	90719	0.5	1.0	4/15/2009	ML-003	Potassium-40	14.00	4.13	1.51	pCi/g	=
SAIC	IAAP116686	IAAP116683	687439	90719	1.0	1.5	4/15/2009	ML-003	Potassium-40	13.40	0.86	0.18	pCi/g	=
SAIC	IAAP116687	IAAP116683	687439	90719	1.5	2.0	4/15/2009	ML-003	Potassium-40	12.00	0.71	0.15	pCi/g	=
SAIC	IAAP116688	IAAP116683	687439	90719	2.0	2.5	4/15/2009	ML-003	Potassium-40	12.90	0.75	0.15	pCi/g	=
SAIC	IAAP116689	IAAP116689	687373	90700	0.0	0.1	4/15/2009	ML-003	Potassium-40	2.27	7.46	12.50	pCi/g	UJ
SAIC	IAAP116690	IAAP116689	687373	90700	0.0	0.5	4/15/2009	ML-003	Potassium-40	11.60	6.44	5.04	pCi/g	J
SAIC	IAAP116691	IAAP116689	687373	90700	0.5	1.0	4/15/2009	ML-003	Potassium-40	13.10	0.82	0.27	pCi/g	=
SAIC	IAAP116692	IAAP116689	687373	90700	1.0	1.5	4/15/2009	ML-003	Potassium-40	12.00	0.71	0.15	pCi/g	=
SAIC	IAAP116693	IAAP116689	687373	90700	1.5	2.0	4/15/2009	ML-003	Potassium-40	11.50	0.66	0.13	pCi/g	=
SAIC	IAAP116694	IAAP116689	687373	90700	2.0	2.5	4/15/2009	ML-003	Potassium-40	12.40	0.74	0.12	pCi/g	=
SAIC	IAAP116655	IAAP116655	687497	90847	0.0	0.5	4/14/2009	ML-003	Protactinium-231	-15.20	41.80	65.40	pCi/g	UJ
SAIC	IAAP116656	IAAP116655	687497	90847	0.5	1.0	4/14/2009	ML-003	Protactinium-231	0.07	1.43	2.09	pCi/g	UJ
SAIC	IAAP116657	IAAP116655	687497	90847	1.0	1.5	4/14/2009	ML-003	Protactinium-231	0.08	0.68	1.00	pCi/g	UJ
SAIC	IAAP116658	IAAP116655	687497	90847	1.5	2.0	4/14/2009	ML-003	Protactinium-231	-0.20	0.80	1.16	pCi/g	UJ
SAIC	IAAP116659	IAAP116655	687497	90847	2.0	2.5	4/14/2009	ML-003	Protactinium-231	0.27	0.47	0.71	pCi/g	UJ
SAIC	IAAP116660	IAAP116655	687497	90847	2.5	3.0	4/14/2009	ML-003	Protactinium-231	0.18	0.37	0.57	pCi/g	UJ
SAIC	IAAP116661	IAAP116655	687497	90847	3.0	3.5	4/14/2009	ML-003	Protactinium-231	-0.30	0.52	0.74	pCi/g	UJ
SAIC	IAAP116662	IAAP116662	687480	90866	0.0	0.1	4/15/2009	ML-003	Protactinium-231	-14.60	238.00	407.00	pCi/g	UJ
SAIC	IAAP116663	IAAP116662	687480	90866	0.0	0.5	4/15/2009	ML-003	Protactinium-231	0.26	0.80	1.18	pCi/g	UJ
SAIC	IAAP116664	IAAP116662	687480	90866	0.5	1.0	4/15/2009	ML-003	Protactinium-231	0.01	0.28	0.41	pCi/g	UJ
SAIC	IAAP116665	IAAP116665	687445	90826	0.0	0.1	4/15/2009	ML-003	Protactinium-231	-11.10	29.90	46.70	pCi/g	UJ
SAIC	IAAP116666	IAAP116665	687445	90826	0.0	0.5	4/15/2009	ML-003	Protactinium-231	-0.64	15.40	26.30	pCi/g	UJ

Table A-5-1. Firing Site 12 Area DU

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier
SAIC	IAAP116667	IAAP116665	687445	90826	0.5	1.0	4/15/2009	ML-003	Protactinium-231	0.02	0.34	0.49	pCi/g	UJ
SAIC	IAAP116668	IAAP116665	687445	90826	1.0	1.5	4/15/2009	ML-003	Protactinium-231	0.22	0.33	0.50	pCi/g	UJ
SAIC	IAAP116669	IAAP116665	687445	90826	1.5	2.0	4/15/2009	ML-003	Protactinium-231	-0.15	0.30	0.43	pCi/g	UJ
SAIC	IAAP116670	IAAP116670	687412	90838	0.0	0.5	4/15/2009	ML-003	Protactinium-231	-2.94	22.00	37.20	pCi/g	UJ
SAIC	IAAP116671	IAAP116670	687412	90838	0.5	1.0	4/15/2009	ML-003	Protactinium-231	2.73	7.89	12.60	pCi/g	UJ
SAIC	IAAP116672	IAAP116670	687412	90838	1.0	1.5	4/15/2009	ML-003	Protactinium-231	0.28	1.17	1.72	pCi/g	UJ
SAIC	IAAP116673	IAAP116670	687412	90838	1.5	2.0	4/15/2009	ML-003	Protactinium-231	0.33	0.76	1.12	pCi/g	UJ
SAIC	IAAP116674	IAAP116670	687412	90838	2.0	2.5	4/15/2009	ML-003	Protactinium-231	-0.13	0.36	0.55	pCi/g	UJ
SAIC	IAAP116675	IAAP116675	687412	90821	0.0	0.5	4/15/2009	ML-003	Protactinium-231	-9.66	21.50	31.90	pCi/g	UJ
SAIC	IAAP116676	IAAP116675	687412	90821	0.5	1.0	4/15/2009	ML-003	Protactinium-231	2.03	7.60	12.50	pCi/g	UJ
SAIC	IAAP116677	IAAP116675	687412	90821	1.0	1.5	4/15/2009	ML-003	Protactinium-231	-0.66	0.60	1.00	pCi/g	UJ
SAIC	IAAP116678	IAAP116675	687412	90821	1.5	2.0	4/15/2009	ML-003	Protactinium-231	0.20	0.36	0.58	pCi/g	UJ
SAIC	IAAP116679	IAAP116679	687465	90769	0.0	0.1	4/15/2009	ML-003	Protactinium-231	-4.84	21.60	35.80	pCi/g	UJ
SAIC	IAAP116680	IAAP116679	687465	90769	0.0	0.5	4/15/2009	ML-003	Protactinium-231	5.99	16.80	26.50	pCi/g	UJ
SAIC	IAAP116681	IAAP116679	687465	90769	0.5	1.0	4/15/2009	ML-003	Protactinium-231	0.01	0.48	0.75	pCi/g	UJ
SAIC	IAAP116682	IAAP116679	687465	90769	1.0	1.5	4/15/2009	ML-003	Protactinium-231	0.00	0.37	0.57	pCi/g	UJ
SAIC	IAAP116683	IAAP116683	687439	90719	0.0	0.1	4/15/2009	ML-003	Protactinium-231	-6.76	33.40	55.80	pCi/g	UJ
SAIC	IAAP116684	IAAP116683	687439	90719	0.0	0.5	4/15/2009	ML-003	Protactinium-231	4.76	14.10	22.50	pCi/g	UJ
SAIC	IAAP116685	IAAP116683	687439	90719	0.5	1.0	4/15/2009	ML-003	Protactinium-231	-3.58	8.17	12.10	pCi/g	UJ
SAIC	IAAP116686	IAAP116683	687439	90719	1.0	1.5	4/15/2009	ML-003	Protactinium-231	-0.26	0.49	0.74	pCi/g	UJ
SAIC	IAAP116687	IAAP116683	687439	90719	1.5	2.0	4/15/2009	ML-003	Protactinium-231	-0.01	0.33	0.51	pCi/g	UJ
SAIC	IAAP116688	IAAP116683	687439	90719	2.0	2.5	4/15/2009	ML-003	Protactinium-231	0.07	0.32	0.50	pCi/g	UJ
SAIC	IAAP116689	IAAP116689	687373	90700	0.0	0.1	4/15/2009	ML-003	Protactinium-231	4.68	36.20	61.30	pCi/g	UJ
SAIC	IAAP116690	IAAP116689	687373	90700	0.0	0.5	4/15/2009	ML-003	Protactinium-231	-6.99	29.90	49.40	pCi/g	UJ
SAIC	IAAP116691	IAAP116689	687373	90700	0.5	1.0	4/15/2009	ML-003	Protactinium-231	0.14	0.75	1.30	pCi/g	UJ
SAIC	IAAP116692	IAAP116689	687373	90700	1.0	1.5	4/15/2009	ML-003	Protactinium-231	0.32	0.42	0.67	pCi/g	UJ
SAIC	IAAP116693	IAAP116689	687373	90700	1.5	2.0	4/15/2009	ML-003	Protactinium-231	-0.02	0.35	0.55	pCi/g	UJ
SAIC	IAAP116694	IAAP116689	687373	90700	2.0	2.5	4/15/2009	ML-003	Protactinium-231	0.09	0.31	0.49	pCi/g	UJ
SAIC	IAAP116655	IAAP116655	687497	90847	0.0	0.5	4/14/2009	ML-003	Radium-226	2.09	4.38	5.96	pCi/g	UJ
SAIC	IAAP116656	IAAP116655	687497	90847	0.5	1.0	4/14/2009	ML-003	Radium-226	1.40	0.41	0.19	pCi/g	=
SAIC	IAAP116657	IAAP116655	687497	90847	1.0	1.5	4/14/2009	ML-003	Radium-226	1.26	0.34	0.10	pCi/g	=
SAIC	IAAP116658	IAAP116655	687497	90847	1.5	2.0	4/14/2009	ML-003	Radium-226	1.26	0.35	0.11	pCi/g	=
SAIC	IAAP116659	IAAP116655	687497	90847	2.0	2.5	4/14/2009	ML-003	Radium-226	1.26	0.32	0.06	pCi/g	=
SAIC	IAAP116660	IAAP116655	687497	90847	2.5	3.0	4/14/2009	ML-003	Radium-226	1.49	0.37	0.05	pCi/g	=
SAIC	IAAP116661	IAAP116655	687497	90847	3.0	3.5	4/14/2009	ML-003	Radium-226	1.42	0.36	0.07	pCi/g	=
SAIC	IAAP116662	IAAP116662	687480	90866	0.0	0.1	4/15/2009	ML-003	Radium-226	-15.40	23.50	38.50	pCi/g	UJ
SAIC	IAAP116663	IAAP116662	687480	90866	0.0	0.5	4/15/2009	ML-003	Radium-226	1.33	0.36	0.10	pCi/g	=
SAIC	IAAP116664	IAAP116662	687480	90866	0.5	1.0	4/15/2009	ML-003	Radium-226	1.16	0.28	0.04	pCi/g	=
SAIC	IAAP116665	IAAP116665	687445	90826	0.0	0.1	4/15/2009	ML-003	Radium-226	-0.02	2.73	4.63	pCi/g	UJ
SAIC	IAAP116666	IAAP116665	687445	90826	0.0	0.5	4/15/2009	ML-003	Radium-226	0.10	1.43	2.38	pCi/g	UJ
SAIC	IAAP116667	IAAP116665	687445	90826	0.5	1.0	4/15/2009	ML-003	Radium-226	0.99	0.25	0.05	pCi/g	=
SAIC	IAAP116668	IAAP116665	687445	90826	1.0	1.5	4/15/2009	ML-003	Radium-226	1.06	0.27	0.05	pCi/g	=
SAIC	IAAP116669	IAAP116665	687445	90826	1.5	2.0	4/15/2009	ML-003	Radium-226	1.03	0.26	0.04	pCi/g	=
SAIC	IAAP116670	IAAP116670	687412	90838	0.0	0.5	4/15/2009	ML-003	Radium-226	0.87	2.32	3.40	pCi/g	UJ
SAIC	IAAP116671	IAAP116670	687412	90838	0.5	1.0	4/15/2009	ML-003	Radium-226	1.30	1.73	1.18	pCi/g	UJ
SAIC	IAAP116672	IAAP116670	687412	90838	1.0	1.5	4/15/2009	ML-003	Radium-226	1.50	0.41	0.15	pCi/g	=
SAIC	IAAP116673	IAAP116670	687412	90838	1.5	2.0	4/15/2009	ML-003	Radium-226	1.46	0.38	0.10	pCi/g	=
SAIC	IAAP116674	IAAP116670	687412	90838	2.0	2.5	4/15/2009	ML-003	Radium-226	1.10	0.29	0.05	pCi/g	=
SAIC	IAAP116675	IAAP116675	687412	90821	0.0	0.5	4/15/2009	ML-003	Radium-226	0.87	2.06	2.93	pCi/g	UJ
SAIC	IAAP116676	IAAP116675	687412	90821	0.5	1.0	4/15/2009	ML-003	Radium-226	1.79	2.30	1.20	pCi/g	UJ
SAIC	IAAP116677	IAAP116675	687412	90821	1.0	1.5	4/15/2009	ML-003	Radium-226	0.96	0.27	0.10	pCi/g	=
SAIC	IAAP116678	IAAP116675	687412	90821	1.5	2.0	4/15/2009	ML-003	Radium-226	1.31	0.33	0.05	pCi/g	=
SAIC	IAAP116679	IAAP116679	687465	90769	0.0	0.1	4/15/2009	ML-003	Radium-226	-0.13	2.04	3.49	pCi/g	UJ
SAIC	IAAP116680	IAAP116679	687465	90769	0.0	0.5	4/15/2009	ML-003	Radium-226	-0.15	1.36	2.34	pCi/g	UJ
SAIC	IAAP116681	IAAP116679	687465	90769	0.5	1.0	4/15/2009	ML-003	Radium-226	1.09	0.28	0.07	pCi/g	=
SAIC	IAAP116682	IAAP116679	687465	90769	1.0	1.5	4/15/2009	ML-003	Radium-226	1.17	0.30	0.05	pCi/g	=
SAIC	IAAP116683	IAAP116683	687439	90719	0.0	0.1	4/15/2009	ML-003	Radium-226	3.38	5.12	5.58	pCi/g	UJ

Table A-5-1. Firing Site 12 Area DU

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier
SAIC	IAAP116684	IAAP116683	687439	90719	0.0	0.5	4/15/2009	ML-003	Radium-226	0.85	1.57	2.02	pCi/g	UJ
SAIC	IAAP116685	IAAP116683	687439	90719	0.5	1.0	4/15/2009	ML-003	Radium-226	1.63	2.02	1.19	pCi/g	UJ
SAIC	IAAP116686	IAAP116683	687439	90719	1.0	1.5	4/15/2009	ML-003	Radium-226	0.98	0.27	0.07	pCi/g	=
SAIC	IAAP116687	IAAP116683	687439	90719	1.5	2.0	4/15/2009	ML-003	Radium-226	0.87	0.23	0.05	pCi/g	=
SAIC	IAAP116688	IAAP116683	687439	90719	2.0	2.5	4/15/2009	ML-003	Radium-226	0.90	0.23	0.05	pCi/g	=
SAIC	IAAP116689	IAAP116689	687373	90700	0.0	0.1	4/15/2009	ML-003	Radium-226	0.42	3.69	6.08	pCi/g	UJ
SAIC	IAAP116690	IAAP116689	687373	90700	0.0	0.5	4/15/2009	ML-003	Radium-226	-0.30	2.62	4.52	pCi/g	UJ
SAIC	IAAP116691	IAAP116689	687373	90700	0.5	1.0	4/15/2009	ML-003	Radium-226	1.21	0.34	0.12	pCi/g	=
SAIC	IAAP116692	IAAP116689	687373	90700	1.0	1.5	4/15/2009	ML-003	Radium-226	1.07	0.28	0.06	pCi/g	=
SAIC	IAAP116693	IAAP116689	687373	90700	1.5	2.0	4/15/2009	ML-003	Radium-226	0.89	0.23	0.05	pCi/g	=
SAIC	IAAP116694	IAAP116689	687373	90700	2.0	2.5	4/15/2009	ML-003	Radium-226	1.04	0.26	0.04	pCi/g	=
SAIC	IAAP116655	IAAP116655	687497	90847	0.0	0.5	4/14/2009	ML-003	Radium-228	2.06	2.62	4.37	pCi/g	UJ
SAIC	IAAP116656	IAAP116655	687497	90847	0.5	1.0	4/14/2009	ML-003	Radium-228	0.99	0.11	0.15	pCi/g	=
SAIC	IAAP116657	IAAP116655	687497	90847	1.0	1.5	4/14/2009	ML-003	Radium-228	1.24	0.09	0.09	pCi/g	=
SAIC	IAAP116658	IAAP116655	687497	90847	1.5	2.0	4/14/2009	ML-003	Radium-228	1.21	0.09	0.10	pCi/g	=
SAIC	IAAP116659	IAAP116655	687497	90847	2.0	2.5	4/14/2009	ML-003	Radium-228	1.12	0.07	0.06	pCi/g	=
SAIC	IAAP116660	IAAP116655	687497	90847	2.5	3.0	4/14/2009	ML-003	Radium-228	1.08	0.06	0.05	pCi/g	=
SAIC	IAAP116661	IAAP116655	687497	90847	3.0	3.5	4/14/2009	ML-003	Radium-228	1.14	0.08	0.06	pCi/g	=
SAIC	IAAP116662	IAAP116662	687480	90866	0.0	0.1	4/15/2009	ML-003	Radium-228	-0.62	17.50	29.20	pCi/g	UJ
SAIC	IAAP116663	IAAP116662	687480	90866	0.0	0.5	4/15/2009	ML-003	Radium-228	1.01	0.08	0.08	pCi/g	=
SAIC	IAAP116664	IAAP116662	687480	90866	0.5	1.0	4/15/2009	ML-003	Radium-228	1.01	0.05	0.05	pCi/g	=
SAIC	IAAP116665	IAAP116665	687445	90826	0.0	0.1	4/15/2009	ML-003	Radium-228	0.67	3.04	5.06	pCi/g	UJ
SAIC	IAAP116666	IAAP116665	687445	90826	0.0	0.5	4/15/2009	ML-003	Radium-228	0.64	0.97	1.64	pCi/g	UJ
SAIC	IAAP116667	IAAP116665	687445	90826	0.5	1.0	4/15/2009	ML-003	Radium-228	0.88	0.05	0.05	pCi/g	=
SAIC	IAAP116668	IAAP116665	687445	90826	1.0	1.5	4/15/2009	ML-003	Radium-228	0.86	0.05	0.05	pCi/g	=
SAIC	IAAP116669	IAAP116665	687445	90826	1.5	2.0	4/15/2009	ML-003	Radium-228	0.77	0.05	0.05	pCi/g	=
SAIC	IAAP116670	IAAP116670	687412	90838	0.0	0.5	4/15/2009	ML-003	Radium-228	0.16	1.55	2.58	pCi/g	UJ
SAIC	IAAP116671	IAAP116670	687412	90838	0.5	1.0	4/15/2009	ML-003	Radium-228	1.63	0.98	1.00	pCi/g	UJ
SAIC	IAAP116672	IAAP116670	687412	90838	1.0	1.5	4/15/2009	ML-003	Radium-228	1.12	0.11	0.13	pCi/g	=
SAIC	IAAP116673	IAAP116670	687412	90838	1.5	2.0	4/15/2009	ML-003	Radium-228	1.05	0.09	0.09	pCi/g	=
SAIC	IAAP116674	IAAP116670	687412	90838	2.0	2.5	4/15/2009	ML-003	Radium-228	0.95	0.06	0.06	pCi/g	=
SAIC	IAAP116675	IAAP116675	687412	90821	0.0	0.5	4/15/2009	ML-003	Radium-228	-0.07	1.30	2.16	pCi/g	UJ
SAIC	IAAP116676	IAAP116675	687412	90821	0.5	1.0	4/15/2009	ML-003	Radium-228	0.27	0.55	0.94	pCi/g	UJ
SAIC	IAAP116677	IAAP116675	687412	90821	1.0	1.5	4/15/2009	ML-003	Radium-228	0.76	0.08	0.09	pCi/g	=
SAIC	IAAP116678	IAAP116675	687412	90821	1.5	2.0	4/15/2009	ML-003	Radium-228	0.98	0.06	0.06	pCi/g	=
SAIC	IAAP116679	IAAP116679	687465	90769	0.0	0.1	4/15/2009	ML-003	Radium-228	-3.69	2.21	3.49	pCi/g	UJ
SAIC	IAAP116680	IAAP116679	687465	90769	0.0	0.5	4/15/2009	ML-003	Radium-228	1.03	0.98	1.65	pCi/g	UJ
SAIC	IAAP116681	IAAP116679	687465	90769	0.5	1.0	4/15/2009	ML-003	Radium-228	0.80	0.06	0.07	pCi/g	=
SAIC	IAAP116682	IAAP116679	687465	90769	1.0	1.5	4/15/2009	ML-003	Radium-228	0.92	0.06	0.06	pCi/g	=
SAIC	IAAP116683	IAAP116683	687439	90719	0.0	0.1	4/15/2009	ML-003	Radium-228	-0.68	3.91	6.51	pCi/g	UJ
SAIC	IAAP116684	IAAP116683	687439	90719	0.0	0.5	4/15/2009	ML-003	Radium-228	0.79	0.89	1.50	pCi/g	UJ
SAIC	IAAP116685	IAAP116683	687439	90719	0.5	1.0	4/15/2009	ML-003	Radium-228	2.05	1.06	0.97	pCi/g	UJ
SAIC	IAAP116686	IAAP116683	687439	90719	1.0	1.5	4/15/2009	ML-003	Radium-228	0.90	0.07	0.07	pCi/g	=
SAIC	IAAP116687	IAAP116683	687439	90719	1.5	2.0	4/15/2009	ML-003	Radium-228	0.80	0.06	0.06	pCi/g	=
SAIC	IAAP116688	IAAP116683	687439	90719	2.0	2.5	4/15/2009	ML-003	Radium-228	0.85	0.06	0.06	pCi/g	=
SAIC	IAAP116689	IAAP116689	687373	90700	0.0	0.1	4/15/2009	ML-003	Radium-228	0.90	3.96	6.59	pCi/g	UJ
SAIC	IAAP116690	IAAP116689	687373	90700	0.0	0.5	4/15/2009	ML-003	Radium-228	1.75	2.03	3.39	pCi/g	UJ
SAIC	IAAP116691	IAAP116689	687373	90700	0.5	1.0	4/15/2009	ML-003	Radium-228	0.92	0.10	0.12	pCi/g	=
SAIC	IAAP116692	IAAP116689	687373	90700	1.0	1.5	4/15/2009	ML-003	Radium-228	0.73	0.06	0.07	pCi/g	=
SAIC	IAAP116693	IAAP116689	687373	90700	1.5	2.0	4/15/2009	ML-003	Radium-228	0.64	0.05	0.06	pCi/g	=
SAIC	IAAP116694	IAAP116689	687373	90700	2.0	2.5	4/15/2009	ML-003	Radium-228	0.81	0.05	0.06	pCi/g	=
SAIC	IAAP116655	IAAP116655	687497	90847	0.0	0.5	4/14/2009	ML-003	Thorium-228	2.06	2.62	4.37	pCi/g	UJ
SAIC	IAAP116656	IAAP116655	687497	90847	0.5	1.0	4/14/2009	ML-003	Thorium-228	0.99	0.11	0.15	pCi/g	=
SAIC	IAAP116657	IAAP116655	687497	90847	1.0	1.5	4/14/2009	ML-003	Thorium-228	1.24	0.09	0.09	pCi/g	=
SAIC	IAAP116658	IAAP116655	687497	90847	1.5	2.0	4/14/2009	ML-003	Thorium-228	1.21	0.09	0.10	pCi/g	=
SAIC	IAAP116659	IAAP116655	687497	90847	2.0	2.5	4/14/2009	ML-003	Thorium-228	1.12	0.07	0.06	pCi/g	=
SAIC	IAAP116660	IAAP116655	687497	90847	2.5	3.0	4/14/2009	ML-003	Thorium-228	1.08	0.06	0.05	pCi/g	=

Table A-5-1. Firing Site 12 Area DU

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier
SAIC	IAAP116661	IAAP116655	687497	90847	3.0	3.5	4/14/2009	ML-003	Thorium-228	1.14	0.08	0.06	pCi/g	=
SAIC	IAAP116662	IAAP116662	687480	90866	0.0	0.1	4/15/2009	ML-003	Thorium-228	-0.62	17.50	29.20	pCi/g	UJ
SAIC	IAAP116663	IAAP116662	687480	90866	0.0	0.5	4/15/2009	ML-003	Thorium-228	1.01	0.08	0.08	pCi/g	=
SAIC	IAAP116664	IAAP116662	687480	90866	0.5	1.0	4/15/2009	ML-003	Thorium-228	1.01	0.05	0.05	pCi/g	=
SAIC	IAAP116665	IAAP116665	687445	90826	0.0	0.1	4/15/2009	ML-003	Thorium-228	0.67	3.04	5.06	pCi/g	UJ
SAIC	IAAP116666	IAAP116665	687445	90826	0.0	0.5	4/15/2009	ML-003	Thorium-228	0.64	0.97	1.64	pCi/g	UJ
SAIC	IAAP116667	IAAP116665	687445	90826	0.5	1.0	4/15/2009	ML-003	Thorium-228	0.88	0.05	0.05	pCi/g	=
SAIC	IAAP116668	IAAP116665	687445	90826	1.0	1.5	4/15/2009	ML-003	Thorium-228	0.86	0.05	0.05	pCi/g	=
SAIC	IAAP116669	IAAP116665	687445	90826	1.5	2.0	4/15/2009	ML-003	Thorium-228	0.77	0.05	0.05	pCi/g	=
SAIC	IAAP116670	IAAP116670	687412	90838	0.0	0.5	4/15/2009	ML-003	Thorium-228	0.16	1.55	2.58	pCi/g	UJ
SAIC	IAAP116671	IAAP116670	687412	90838	0.5	1.0	4/15/2009	ML-003	Thorium-228	1.63	0.98	1.00	pCi/g	UJ
SAIC	IAAP116672	IAAP116670	687412	90838	1.0	1.5	4/15/2009	ML-003	Thorium-228	1.12	0.11	0.13	pCi/g	=
SAIC	IAAP116673	IAAP116670	687412	90838	1.5	2.0	4/15/2009	ML-003	Thorium-228	1.05	0.09	0.09	pCi/g	=
SAIC	IAAP116674	IAAP116670	687412	90838	2.0	2.5	4/15/2009	ML-003	Thorium-228	0.95	0.06	0.06	pCi/g	=
SAIC	IAAP116675	IAAP116675	687412	90821	0.0	0.5	4/15/2009	ML-003	Thorium-228	-0.07	1.30	2.16	pCi/g	UJ
SAIC	IAAP116676	IAAP116675	687412	90821	0.5	1.0	4/15/2009	ML-003	Thorium-228	0.27	0.55	0.94	pCi/g	UJ
SAIC	IAAP116677	IAAP116675	687412	90821	1.0	1.5	4/15/2009	ML-003	Thorium-228	0.76	0.08	0.09	pCi/g	=
SAIC	IAAP116678	IAAP116675	687412	90821	1.5	2.0	4/15/2009	ML-003	Thorium-228	0.98	0.06	0.06	pCi/g	=
SAIC	IAAP116679	IAAP116679	687465	90769	0.0	0.1	4/15/2009	ML-003	Thorium-228	-3.69	2.21	3.49	pCi/g	UJ
SAIC	IAAP116680	IAAP116679	687465	90769	0.0	0.5	4/15/2009	ML-003	Thorium-228	1.03	0.98	1.65	pCi/g	U
SAIC	IAAP116681	IAAP116679	687465	90769	0.5	1.0	4/15/2009	ML-003	Thorium-228	0.80	0.06	0.07	pCi/g	=
SAIC	IAAP116682	IAAP116679	687465	90769	1.0	1.5	4/15/2009	ML-003	Thorium-228	0.92	0.06	0.06	pCi/g	=
SAIC	IAAP116683	IAAP116683	687439	90719	0.0	0.1	4/15/2009	ML-003	Thorium-228	-0.68	3.91	6.51	pCi/g	UJ
SAIC	IAAP116684	IAAP116683	687439	90719	0.0	0.5	4/15/2009	ML-003	Thorium-228	0.79	0.89	1.50	pCi/g	UJ
SAIC	IAAP116685	IAAP116683	687439	90719	0.5	1.0	4/15/2009	ML-003	Thorium-228	2.05	1.06	0.97	pCi/g	UJ
SAIC	IAAP116686	IAAP116683	687439	90719	1.0	1.5	4/15/2009	ML-003	Thorium-228	0.90	0.07	0.07	pCi/g	=
SAIC	IAAP116687	IAAP116683	687439	90719	1.5	2.0	4/15/2009	ML-003	Thorium-228	0.80	0.06	0.06	pCi/g	=
SAIC	IAAP116688	IAAP116683	687439	90719	2.0	2.5	4/15/2009	ML-003	Thorium-228	0.85	0.06	0.06	pCi/g	=
SAIC	IAAP116689	IAAP116689	687373	90700	0.0	0.1	4/15/2009	ML-003	Thorium-228	0.90	3.96	6.59	pCi/g	UJ
SAIC	IAAP116690	IAAP116689	687373	90700	0.0	0.5	4/15/2009	ML-003	Thorium-228	1.75	2.03	3.39	pCi/g	UJ
SAIC	IAAP116691	IAAP116689	687373	90700	0.5	1.0	4/15/2009	ML-003	Thorium-228	0.92	0.10	0.12	pCi/g	=
SAIC	IAAP116692	IAAP116689	687373	90700	1.0	1.5	4/15/2009	ML-003	Thorium-228	0.73	0.06	0.07	pCi/g	=
SAIC	IAAP116693	IAAP116689	687373	90700	1.5	2.0	4/15/2009	ML-003	Thorium-228	0.64	0.05	0.06	pCi/g	=
SAIC	IAAP116694	IAAP116689	687373	90700	2.0	2.5	4/15/2009	ML-003	Thorium-228	0.81	0.05	0.06	pCi/g	=
SAIC	IAAP116655	IAAP116655	687497	90847	0.0	0.5	4/14/2009	ML-003	Thorium-230	53.30	362.00	625.00	pCi/g	UJ
SAIC	IAAP116656	IAAP116655	687497	90847	0.5	1.0	4/14/2009	ML-003	Thorium-230	143.00	27.00	42.10	pCi/g	U
SAIC	IAAP116657	IAAP116655	687497	90847	1.0	1.5	4/14/2009	ML-003	Thorium-230	16.50	13.40	19.10	pCi/g	U
SAIC	IAAP116658	IAAP116655	687497	90847	1.5	2.0	4/14/2009	ML-003	Thorium-230	29.10	13.50	21.50	pCi/g	U
SAIC	IAAP116659	IAAP116655	687497	90847	2.0	2.5	4/14/2009	ML-003	Thorium-230	-4.00	7.08	11.10	pCi/g	UJ
SAIC	IAAP116660	IAAP116655	687497	90847	2.5	3.0	4/14/2009	ML-003	Thorium-230	2.44	4.83	8.26	pCi/g	UJ
SAIC	IAAP116661	IAAP116655	687497	90847	3.0	3.5	4/14/2009	ML-003	Thorium-230	-12.90	8.39	13.00	pCi/g	UJ
SAIC	IAAP116662	IAAP116662	687480	90866	0.0	0.1	4/15/2009	ML-003	Thorium-230	58.00	1524.00	2636.00	pCi/g	UJ
SAIC	IAAP116663	IAAP116662	687480	90866	0.0	0.5	4/15/2009	ML-003	Thorium-230	57.00	13.90	22.30	pCi/g	U
SAIC	IAAP116664	IAAP116662	687480	90866	0.5	1.0	4/15/2009	ML-003	Thorium-230	0.81	2.40	4.11	pCi/g	UJ
SAIC	IAAP116665	IAAP116665	687445	90826	0.0	0.1	4/15/2009	ML-003	Thorium-230	-325.00	232.00	256.00	pCi/g	UJ
SAIC	IAAP116666	IAAP116665	687445	90826	0.0	0.5	4/15/2009	ML-003	Thorium-230	339.00	368.00	350.00	pCi/g	UJ
SAIC	IAAP116667	IAAP116665	687445	90826	0.5	1.0	4/15/2009	ML-003	Thorium-230	-1.74	4.16	7.02	pCi/g	UJ
SAIC	IAAP116668	IAAP116665	687445	90826	1.0	1.5	4/15/2009	ML-003	Thorium-230	-0.93	4.98	7.85	pCi/g	UJ
SAIC	IAAP116669	IAAP116665	687445	90826	1.5	2.0	4/15/2009	ML-003	Thorium-230	2.06	3.54	6.06	pCi/g	UJ
SAIC	IAAP116670	IAAP116670	687412	90838	0.0	0.5	4/15/2009	ML-003	Thorium-230	57.30	212.00	363.00	pCi/g	UJ
SAIC	IAAP116671	IAAP116670	687412	90838	0.5	1.0	4/15/2009	ML-003	Thorium-230	13.20	139.00	240.00	pCi/g	UJ
SAIC	IAAP116672	IAAP116670	687412	90838	1.0	1.5	4/15/2009	ML-003	Thorium-230	47.20	24.70	34.90	pCi/g	UJ
SAIC	IAAP116673	IAAP116670	687412	90838	1.5	2.0	4/15/2009	ML-003	Thorium-230	52.20	12.80	20.60	pCi/g	U
SAIC	IAAP116674	IAAP116670	687412	90838	2.0	2.5	4/15/2009	ML-003	Thorium-230	-3.71	3.29	5.16	pCi/g	UJ
SAIC	IAAP116675	IAAP116675	687412	90821	0.0	0.5	4/15/2009	ML-003	Thorium-230	18.10	190.00	329.00	pCi/g	UJ
SAIC	IAAP116676	IAAP116675	687412	90821	0.5	1.0	4/15/2009	ML-003	Thorium-230	12.60	141.00	243.00	pCi/g	UJ
SAIC	IAAP116677	IAAP116675	687412	90821	1.0	1.5	4/15/2009	ML-003	Thorium-230	15.30	10.10	16.30	pCi/g	U

Table A-5-1. Firing Site 12 Area DU

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier
SAIC	IAAP116678	IAAP116675	687412	90821	1.5	2.0	4/15/2009	ML-003	Thorium-230	0.29	3.99	6.90	pCi/g	UJ
SAIC	IAAP116679	IAAP116679	687465	90769	0.0	0.1	4/15/2009	ML-003	Thorium-230	13.30	127.00	219.00	pCi/g	UJ
SAIC	IAAP116680	IAAP116679	687465	90769	0.0	0.5	4/15/2009	ML-003	Thorium-230	219.00	246.00	378.00	pCi/g	UJ
SAIC	IAAP116681	IAAP116679	687465	90769	0.5	1.0	4/15/2009	ML-003	Thorium-230	-5.67	6.75	11.60	pCi/g	UJ
SAIC	IAAP116682	IAAP116679	687465	90769	1.0	1.5	4/15/2009	ML-003	Thorium-230	-0.58	3.74	6.44	pCi/g	UJ
SAIC	IAAP116683	IAAP116683	687439	90719	0.0	0.1	4/15/2009	ML-003	Thorium-230	-340.00	255.00	297.00	pCi/g	UJ
SAIC	IAAP116684	IAAP116683	687439	90719	0.0	0.5	4/15/2009	ML-003	Thorium-230	136.00	212.00	346.00	pCi/g	UJ
SAIC	IAAP116685	IAAP116683	687439	90719	0.5	1.0	4/15/2009	ML-003	Thorium-230	49.60	143.00	244.00	pCi/g	UJ
SAIC	IAAP116686	IAAP116683	687439	90719	1.0	1.5	4/15/2009	ML-003	Thorium-230	5.33	6.49	11.30	pCi/g	UJ
SAIC	IAAP116687	IAAP116683	687439	90719	1.5	2.0	4/15/2009	ML-003	Thorium-230	1.36	3.79	6.57	pCi/g	UJ
SAIC	IAAP116688	IAAP116683	687439	90719	2.0	2.5	4/15/2009	ML-003	Thorium-230	0.18	2.93	5.07	pCi/g	UJ
SAIC	IAAP116689	IAAP116689	687373	90700	0.0	0.1	4/15/2009	ML-003	Thorium-230	-312.00	271.00	350.00	pCi/g	UJ
SAIC	IAAP116690	IAAP116689	687373	90700	0.0	0.5	4/15/2009	ML-003	Thorium-230	79.80	319.00	548.00	pCi/g	UJ
SAIC	IAAP116691	IAAP116689	687373	90700	0.5	1.0	4/15/2009	ML-003	Thorium-230	57.90	13.00	20.90	pCi/g	U
SAIC	IAAP116692	IAAP116689	687373	90700	1.0	1.5	4/15/2009	ML-003	Thorium-230	4.07	6.06	10.50	pCi/g	UJ
SAIC	IAAP116693	IAAP116689	687373	90700	1.5	2.0	4/15/2009	ML-003	Thorium-230	8.14	4.93	8.07	pCi/g	UJ
SAIC	IAAP116694	IAAP116689	687373	90700	2.0	2.5	4/15/2009	ML-003	Thorium-230	2.92	2.88	5.05	pCi/g	U
SAIC	IAAP116655	IAAP116655	687497	90847	0.0	0.5	4/14/2009	ML-003	Thorium-232	2.06	2.62	4.37	pCi/g	UJ
SAIC	IAAP116656	IAAP116655	687497	90847	0.5	1.0	4/14/2009	ML-003	Thorium-232	0.99	0.11	0.15	pCi/g	=
SAIC	IAAP116657	IAAP116655	687497	90847	1.0	1.5	4/14/2009	ML-003	Thorium-232	1.24	0.09	0.09	pCi/g	=
SAIC	IAAP116658	IAAP116655	687497	90847	1.5	2.0	4/14/2009	ML-003	Thorium-232	1.21	0.09	0.10	pCi/g	=
SAIC	IAAP116659	IAAP116655	687497	90847	2.0	2.5	4/14/2009	ML-003	Thorium-232	1.12	0.07	0.06	pCi/g	=
SAIC	IAAP116660	IAAP116655	687497	90847	2.5	3.0	4/14/2009	ML-003	Thorium-232	1.08	0.06	0.05	pCi/g	=
SAIC	IAAP116661	IAAP116655	687497	90847	3.0	3.5	4/14/2009	ML-003	Thorium-232	1.14	0.08	0.06	pCi/g	=
SAIC	IAAP116662	IAAP116662	687480	90866	0.0	0.1	4/15/2009	ML-003	Thorium-232	-0.62	17.50	29.20	pCi/g	UJ
SAIC	IAAP116663	IAAP116662	687480	90866	0.0	0.5	4/15/2009	ML-003	Thorium-232	1.01	0.08	0.08	pCi/g	=
SAIC	IAAP116664	IAAP116662	687480	90866	0.5	1.0	4/15/2009	ML-003	Thorium-232	1.01	0.05	0.05	pCi/g	=
SAIC	IAAP116665	IAAP116665	687445	90826	0.0	0.1	4/15/2009	ML-003	Thorium-232	0.67	3.04	5.06	pCi/g	UJ
SAIC	IAAP116666	IAAP116665	687445	90826	0.0	0.5	4/15/2009	ML-003	Thorium-232	0.64	0.97	1.64	pCi/g	UJ
SAIC	IAAP116667	IAAP116665	687445	90826	0.5	1.0	4/15/2009	ML-003	Thorium-232	0.88	0.05	0.05	pCi/g	=
SAIC	IAAP116668	IAAP116665	687445	90826	1.0	1.5	4/15/2009	ML-003	Thorium-232	0.86	0.05	0.05	pCi/g	=
SAIC	IAAP116669	IAAP116665	687445	90826	1.5	2.0	4/15/2009	ML-003	Thorium-232	0.77	0.05	0.05	pCi/g	=
SAIC	IAAP116670	IAAP116670	687412	90838	0.0	0.5	4/15/2009	ML-003	Thorium-232	0.16	1.55	2.58	pCi/g	UJ
SAIC	IAAP116671	IAAP116670	687412	90838	0.5	1.0	4/15/2009	ML-003	Thorium-232	1.63	0.98	1.00	pCi/g	UJ
SAIC	IAAP116672	IAAP116670	687412	90838	1.0	1.5	4/15/2009	ML-003	Thorium-232	1.12	0.11	0.13	pCi/g	=
SAIC	IAAP116673	IAAP116670	687412	90838	1.5	2.0	4/15/2009	ML-003	Thorium-232	1.05	0.09	0.09	pCi/g	=
SAIC	IAAP116674	IAAP116670	687412	90838	2.0	2.5	4/15/2009	ML-003	Thorium-232	0.95	0.06	0.06	pCi/g	=
SAIC	IAAP116675	IAAP116675	687412	90821	0.0	0.5	4/15/2009	ML-003	Thorium-232	-0.07	1.30	2.16	pCi/g	UJ
SAIC	IAAP116676	IAAP116675	687412	90821	0.5	1.0	4/15/2009	ML-003	Thorium-232	0.27	0.55	0.94	pCi/g	UJ
SAIC	IAAP116677	IAAP116675	687412	90821	1.0	1.5	4/15/2009	ML-003	Thorium-232	0.76	0.08	0.09	pCi/g	=
SAIC	IAAP116678	IAAP116675	687412	90821	1.5	2.0	4/15/2009	ML-003	Thorium-232	0.98	0.06	0.06	pCi/g	=
SAIC	IAAP116679	IAAP116679	687465	90769	0.0	0.1	4/15/2009	ML-003	Thorium-232	-3.69	2.21	3.49	pCi/g	UJ
SAIC	IAAP116680	IAAP116679	687465	90769	0.0	0.5	4/15/2009	ML-003	Thorium-232	1.03	0.98	1.65	pCi/g	UJ
SAIC	IAAP116681	IAAP116679	687465	90769	0.5	1.0	4/15/2009	ML-003	Thorium-232	0.80	0.06	0.07	pCi/g	=
SAIC	IAAP116682	IAAP116679	687465	90769	1.0	1.5	4/15/2009	ML-003	Thorium-232	0.92	0.06	0.06	pCi/g	=
SAIC	IAAP116683	IAAP116683	687439	90719	0.0	0.1	4/15/2009	ML-003	Thorium-232	-0.68	3.91	6.51	pCi/g	UJ
SAIC	IAAP116684	IAAP116683	687439	90719	0.0	0.5	4/15/2009	ML-003	Thorium-232	0.79	0.89	1.50	pCi/g	UJ
SAIC	IAAP116685	IAAP116683	687439	90719	0.5	1.0	4/15/2009	ML-003	Thorium-232	2.05	1.06	0.97	pCi/g	UJ
SAIC	IAAP116686	IAAP116683	687439	90719	1.0	1.5	4/15/2009	ML-003	Thorium-232	0.90	0.07	0.07	pCi/g	=
SAIC	IAAP116687	IAAP116683	687439	90719	1.5	2.0	4/15/2009	ML-003	Thorium-232	0.80	0.06	0.06	pCi/g	=
SAIC	IAAP116688	IAAP116683	687439	90719	2.0	2.5	4/15/2009	ML-003	Thorium-232	0.85	0.06	0.06	pCi/g	=
SAIC	IAAP116689	IAAP116689	687373	90700	0.0	0.1	4/15/2009	ML-003	Thorium-232	0.90	3.96	6.59	pCi/g	UJ
SAIC	IAAP116690	IAAP116689	687373	90700	0.0	0.5	4/15/2009	ML-003	Thorium-232	1.75	2.03	3.39	pCi/g	UJ
SAIC	IAAP116691	IAAP116689	687373	90700	0.5	1.0	4/15/2009	ML-003	Thorium-232	0.92	0.10	0.12	pCi/g	=
SAIC	IAAP116692	IAAP116689	687373	90700	1.0	1.5	4/15/2009	ML-003	Thorium-232	0.73	0.06	0.07	pCi/g	=
SAIC	IAAP116693	IAAP116689	687373	90700	1.5	2.0	4/15/2009	ML-003	Thorium-232	0.64	0.05	0.06	pCi/g	=
SAIC	IAAP116694	IAAP116689	687373	90700	2.0	2.5	4/15/2009	ML-003	Thorium-232	0.81	0.05	0.06	pCi/g	=

Table A-5-1. Firing Site 12 Area DU

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Validation Qualifier
SAIC	IAAP116655	IAAP116655	687497	90847	0.0	0.5	4/14/2009	ML-003	Uranium-235	555.00	658.00	35.80	pCi/g	J
SAIC	IAAP116655	IAAP116655	687497	90847	0.0	0.5	4/14/2009	ML-003	Uranium-238	22290.00	3867.00	58.70	pCi/g	=
SAIC	IAAP116662	IAAP116662	687480	90866	0.0	0.1	4/15/2009	ML-003	Uranium-235	735.00	1282.00	182.00	pCi/g	U
SAIC	IAAP116662	IAAP116662	687480	90866	0.0	0.1	4/15/2009	ML-003	Uranium-238	34120.00	7378.00	255.00	pCi/g	=
SAIC	IAAP116665	IAAP116665	687445	90826	0.0	0.1	4/15/2009	ML-003	Uranium-235	57.70	101.00	19.20	pCi/g	U
SAIC	IAAP116665	IAAP116665	687445	90826	0.0	0.1	4/15/2009	ML-003	Uranium-238	3162.00	708.00	25.50	pCi/g	=
SAIC	IAAP116666	IAAP116665	687445	90826	0.0	0.5	4/15/2009	ML-003	Uranium-235	185.00	218.00	16.90	pCi/g	J
SAIC	IAAP116666	IAAP116665	687445	90826	0.0	0.5	4/15/2009	ML-003	Uranium-238	8828.00	1407.00	34.80	pCi/g	=
SAIC	IAAP116670	IAAP116670	687412	90838	0.0	0.5	4/15/2009	ML-003	Uranium-235	354.00	417.00	20.50	pCi/g	J
SAIC	IAAP116670	IAAP116670	687412	90838	0.0	0.5	4/15/2009	ML-003	Uranium-238	14160.00	2459.00	33.90	pCi/g	=
SAIC	IAAP116671	IAAP116670	687412	90838	0.5	1.0	4/15/2009	ML-003	Uranium-235	91.70	108.00	8.71	pCi/g	J
SAIC	IAAP116671	IAAP116670	687412	90838	0.5	1.0	4/15/2009	ML-003	Uranium-238	5252.00	753.00	23.30	pCi/g	=
SAIC	IAAP116675	IAAP116675	687412	90821	0.0	0.5	4/15/2009	ML-003	Uranium-235	282.00	333.00	18.20	pCi/g	J
SAIC	IAAP116675	IAAP116675	687412	90821	0.0	0.5	4/15/2009	ML-003	Uranium-238	12460.00	2111.00	30.80	pCi/g	=
SAIC	IAAP116676	IAAP116675	687412	90821	0.5	1.0	4/15/2009	ML-003	Uranium-235	86.30	101.00	8.72	pCi/g	J
SAIC	IAAP116676	IAAP116675	687412	90821	0.5	1.0	4/15/2009	ML-003	Uranium-238	4818.00	683.00	23.80	pCi/g	=
SAIC	IAAP116679	IAAP116679	687465	90769	0.0	0.1	4/15/2009	ML-003	Uranium-235	54.20	94.70	15.70	pCi/g	U
SAIC	IAAP116679	IAAP116679	687465	90769	0.0	0.1	4/15/2009	ML-003	Uranium-238	3210.00	705.00	21.20	pCi/g	=
SAIC	IAAP116680	IAAP116679	687465	90769	0.0	0.5	4/15/2009	ML-003	Uranium-235	234.00	274.00	17.00	pCi/g	J
SAIC	IAAP116680	IAAP116679	687465	90769	0.0	0.5	4/15/2009	ML-003	Uranium-238	11860.00	1801.00	35.30	pCi/g	=
SAIC	IAAP116683	IAAP116683	687439	90719	0.0	0.1	4/15/2009	ML-003	Uranium-235	74.00	88.90	21.90	pCi/g	J
SAIC	IAAP116683	IAAP116683	687439	90719	0.0	0.1	4/15/2009	ML-003	Uranium-238	3680.00	818.00	29.80	pCi/g	=
SAIC	IAAP116684	IAAP116683	687439	90719	0.0	0.5	4/15/2009	ML-003	Uranium-235	208.00	244.00	14.80	pCi/g	J
SAIC	IAAP116684	IAAP116683	687439	90719	0.0	0.5	4/15/2009	ML-003	Uranium-238	11030.00	1635.00	32.50	pCi/g	=
SAIC	IAAP116685	IAAP116683	687439	90719	0.5	1.0	4/15/2009	ML-003	Uranium-235	67.60	79.40	8.79	pCi/g	J
SAIC	IAAP116685	IAAP116683	687439	90719	0.5	1.0	4/15/2009	ML-003	Uranium-238	3986.00	572.00	23.80	pCi/g	=
SAIC	IAAP116689	IAAP116689	687373	90700	0.0	0.1	4/15/2009	ML-003	Uranium-235	50.50	89.80	25.50	pCi/g	U
SAIC	IAAP116689	IAAP116689	687373	90700	0.0	0.1	4/15/2009	ML-003	Uranium-238	3844.00	850.00	34.80	pCi/g	=
SAIC	IAAP116690	IAAP116689	687373	90700	0.0	0.5	4/15/2009	ML-003	Uranium-235	407.00	476.00	28.60	pCi/g	J
SAIC	IAAP116690	IAAP116689	687373	90700	0.0	0.5	4/15/2009	ML-003	Uranium-238	21860.00	3526.00	51.30	pCi/g	=
SAIC	IAAP116656	IAAP116655	687497	90847	0.5	1.0	4/14/2009	ML-003	Uranium-235	37.60	1.40	1.39	pCi/g	=
SAIC	IAAP116656	IAAP116655	687497	90847	0.5	1.0	4/14/2009	ML-003	Uranium-238	2645.00	73.50	4.09	pCi/g	=
SAIC	IAAP116657	IAAP116655	687497	90847	1.0	1.5	4/14/2009	ML-003	Uranium-235	6.79	0.51	0.64	pCi/g	=
SAIC	IAAP116657	IAAP116655	687497	90847	1.0	1.5	4/14/2009	ML-003	Uranium-238	451.00	14.50	1.88	pCi/g	=
SAIC	IAAP116658	IAAP116655	687497	90847	1.5	2.0	4/14/2009	ML-003	Uranium-235	9.41	0.58	0.73	pCi/g	=
SAIC	IAAP116658	IAAP116655	687497	90847	1.5	2.0	4/14/2009	ML-003	Uranium-238	627.00	19.10	2.12	pCi/g	=
SAIC	IAAP116663	IAAP116662	687480	90866	0.0	0.5	4/15/2009	ML-003	Uranium-235	9.44	0.57	0.73	pCi/g	=
SAIC	IAAP116663	IAAP116662	687480	90866	0.0	0.5	4/15/2009	ML-003	Uranium-238	711.00	21.30	2.20	pCi/g	=
SAIC	IAAP116672	IAAP116670	687412	90838	1.0	1.5	4/15/2009	ML-003	Uranium-235	25.60	1.05	1.13	pCi/g	=
SAIC	IAAP116672	IAAP116670	687412	90838	1.0	1.5	4/15/2009	ML-003	Uranium-238	1814.00	51.20	3.40	pCi/g	=
SAIC	IAAP116673	IAAP116670	687412	90838	1.5	2.0	4/15/2009	ML-003	Uranium-235	8.72	0.55	0.68	pCi/g	=
SAIC	IAAP116673	IAAP116670	687412	90838	1.5	2.0	4/15/2009	ML-003	Uranium-238	584.00	17.90	2.03	pCi/g	=
SAIC	IAAP116677	IAAP116675	687412	90821	1.0	1.5	4/15/2009	ML-003	Uranium-235	8.53	0.58	0.64	pCi/g	=
SAIC	IAAP116677	IAAP116675	687412	90821	1.0	1.5	4/15/2009	ML-003	Uranium-238	589.00	17.80	1.77	pCi/g	=
SAIC	IAAP116681	IAAP116679	687465	90769	0.5	1.0	4/15/2009	ML-003	Uranium-235	3.71	0.33	0.44	pCi/g	=
SAIC	IAAP116681	IAAP116679	687465	90769	0.5	1.0	4/15/2009	ML-003	Uranium-238	246.00	8.27	1.22	pCi/g	=
SAIC	IAAP116691	IAAP116689	687373	90700	0.5	1.0	4/15/2009	ML-003	Uranium-235	9.30	0.63	0.77	pCi/g	=
SAIC	IAAP116691	IAAP116689	687373	90700	0.5	1.0	4/15/2009	ML-003	Uranium-238	778.00	23.50	2.19	pCi/g	=

Coordinates in NAD Iowa South State Plane (meters).
Results, error, and detection limit are rounded to 2 decimal places regardless of significant digits.

ATTACHMENT A-6

Building 1-11 DU (Sediment and Water) Data

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Table A-6-1. Building 1-11 DU (Sediment and Water)

Company	Sample Name	Station Name	Easting	Northing	Start Depth (ft)	End Depth (ft)	Collect Date	Method	Analyte	Result	Error	Detection Limit	Units	Lab Qualifier
SAIC	IAAP117014	IAAP117014	-	-	0.0	0.0	4/23/2009	ML-003	Actinium-227	-0.01	0.28	0.44	pCi/g	UJ
SAIC	IAAP117014	IAAP117014	-	-	0.0	0.0	4/23/2009	ML-003	Americium-241	0.01	0.08	0.13	pCi/g	UJ
SAIC	IAAP117014	IAAP117014	-	-	0.0	0.0	4/23/2009	ML-003	Cesium-137	0.02	0.03	0.05	pCi/g	UJ
SAIC	IAAP117014	IAAP117014	-	-	0.0	0.0	4/23/2009	ML-003	Potassium-40	4.48	0.83	0.37	pCi/g	=
SAIC	IAAP117014	IAAP117014	-	-	0.0	0.0	4/23/2009	ML-003	Protactinium-231	0.40	0.78	1.40	pCi/g	UJ
SAIC	IAAP117014	IAAP117014	-	-	0.0	0.0	4/23/2009	ML-003	Radium-226	0.61	0.29	0.25	pCi/g	UJ
SAIC	IAAP117014	IAAP117014	-	-	0.0	0.0	4/23/2009	ML-003	Radium-228	0.46	0.13	0.15	pCi/g	J
SAIC	IAAP117014	IAAP117014	-	-	0.0	0.0	4/23/2009	ML-003	Thorium-228	0.46	0.13	0.15	pCi/g	J
SAIC	IAAP117014	IAAP117014	-	-	0.0	0.0	4/23/2009	ML-003	Thorium-230	-5.71	6.29	10.20	pCi/g	UJ
SAIC	IAAP117014	IAAP117014	-	-	0.0	0.0	4/23/2009	ML-003	Thorium-232	0.46	0.13	0.15	pCi/g	J
SAIC	IAAP117014	IAAP117014	-	-	0.0	0.0	4/23/2009	ML-015	Uranium-234	2.36	0.80	0.11	pCi/g	=
SAIC	IAAP117014	IAAP117014	-	-	0.0	0.0	4/23/2009	ML-015	Uranium-235	0.24	0.24	0.26	pCi/g	U
SAIC	IAAP117014	IAAP117014	-	-	0.0	0.0	4/23/2009	ML-003	Uranium-235	0.43	0.38	0.67	pCi/g	U
SAIC	IAAP117014	IAAP117014	-	-	0.0	0.0	4/23/2009	ML-015	Uranium-238	10.70	2.59	0.21	pCi/g	=
SAIC	IAAP117014	IAAP117014	-	-	0.0	0.0	4/23/2009	ML-003	Uranium-238	19.90	2.12	1.14	pCi/g	=
SAIC	IAAP117015	IAAP117015	-	-	0.0	0.0	4/23/2009	ML-015	Uranium-234	1.36	0.94	0.41	pCi/L	J
SAIC	IAAP117015	IAAP117015	-	-	0.0	0.0	4/23/2009	ML-015	Uranium-235	0.19	0.38	0.51	pCi/L	UJ
SAIC	IAAP117015	IAAP117015	-	-	0.0	0.0	4/23/2009	ML-015	Uranium-238	2.26	1.23	0.41	pCi/L	J
SAIC	IAAP117015	IAAP117015	-	-	0.0	0.0	4/23/2009	ML-003	Actinium-227	-23.60	74.70	113.00	pCi/L	UJ
SAIC	IAAP117015	IAAP117015	-	-	0.0	0.0	4/23/2009	ML-003	Americium-241	-2.30	7.86	13.30	pCi/L	UJ
SAIC	IAAP117015	IAAP117015	-	-	0.0	0.0	4/23/2009	ML-003	Cesium-137	4.01	6.60	11.60	pCi/L	UJ
SAIC	IAAP117015	IAAP117015	-	-	0.0	0.0	4/23/2009	ML-003	Potassium-40	-10.30	101.00	197.00	pCi/L	UJ
SAIC	IAAP117015	IAAP117015	-	-	0.0	0.0	4/23/2009	ML-003	Protactinium-231	-206.00	210.00	281.00	pCi/L	UJ
SAIC	IAAP117015	IAAP117015	-	-	0.0	0.0	4/23/2009	ML-003	Radium-226	52.00	54.70	44.20	pCi/L	U
SAIC	IAAP117015	IAAP117015	-	-	0.0	0.0	4/23/2009	ML-003	Radium-228	-4.76	27.60	46.40	pCi/L	UJ
SAIC	IAAP117015	IAAP117015	-	-	0.0	0.0	4/23/2009	ML-003	Thorium-228	-4.76	27.60	46.40	pCi/L	UJ
SAIC	IAAP117015	IAAP117015	-	-	0.0	0.0	4/23/2009	ML-003	Thorium-230	-1561.00	876.00	1211.00	pCi/L	UJ
SAIC	IAAP117015	IAAP117015	-	-	0.0	0.0	4/23/2009	ML-003	Thorium-232	-4.76	27.60	46.40	pCi/L	UJ

Results, error, and detection limit are rounded to 2 decimal places regardless of significant digits.

Samples were collected from sump under grate in Line 1 Building 1-11.

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ATTACHMENT A-7

Building Survey Results and Surveys

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Table A-7-1. Building Survey Results and Surveys

Sample ID	Sample Location	Total Alpha (dpm/100 cm^2)	Total Beta (dpm/100 cm^2)	Total Alpha and Beta (dpm/100 cm^2)	Removable Alpha (dpm/100 cm^2)	Removable Beta (dpm/100 cm^2)	Comments	Survey Number
1	1-11 south raised dock floor	97	0	97	<60	<600		10/26-1
2	1-11 north end railroad track	187	0	187	<60	<600		10/26-1
3	1-77 area D floor	119	0	119	<60	<600		10/26-1
1	1-67-2 center floor	52	0	52	<60	<600		V-12202006-01
1	1-64-5 center on floor	142	0	142	<60	<600		V-12202006-02
1	1-67-3 on floor	7	0	7	<60	<600		V-12202006-03
2	1-67-3 on wall	7	0	7	<60	<600		V-12202006-03
1	1-67-1 on floor	7	116	123	<60	<600		V-12202006-04
1	1-12 floor near drain	116	621	737	<60	<600		1-25-1
2	1-12 exit door	142	1032	1174	<60	<600		1-25-1
3	1-12 hallway outside of M2	232	1305	1537	<60	<600		1-25-1
1	1-18 near large door and crane	97	116	213	<60	<600		1-25-3
2	1-18 by exit doors	52	695	747	<60	<600		1-25-3
3	1-18 on concrete floor by doors	97	1663	1760	<60	<600		1-25-3
4	1-18 on concrete floor by scales	97	1537	1634	<60	<600		1-25-3
1	1-63-7 floor near drain near entrance	119	495	614	<60	<600		1-25-2
2	1-63-7 concrete floor	300	368	668	<60	<600		1-25-2
3	1-63-7 on floor near drain to circular room entrance	232	474	706	<60	<600		1-25-2
1	1-66-1 floor in middle of room	187	326	513	<60	<600		1-25-2
2	1-66-1 on back concrete wall in middle	255	116	371	<60	<600		1-25-2
3	1-66-1 floor near entrance	165	653	818	<60	<600		1-25-2
1	1-100-2 floor right side of room 10 ft from wall	255	1011	1266	<60	<600		1-25-2
2	1-100-2 floor next to radiological material area	435	16011	16446	<60	<600	Near radioactive area	1-25-2
3	1-100-2 on floor 4 ft from sample no 2	277	1621	1898	<60	<600	Near radioactive area	1-25-2
4	1-100-2 floor near cabinets marked high rad area	187	1800	1987	<60	<600	Near radioactive area	1-25-2

Table A-7-1. Building Survey Results and Surveys

Sample ID	Sample Location	Total Alpha (dpm/100 cm^2)	Total Beta (dpm/100 cm^2)	Total Alpha and Beta (dpm/100 cm^2)	Removable Alpha (dpm/100 cm^2)	Removable Beta (dpm/100 cm^2)	Comments	Survey Number
5	1-100-2 back wall	435	884	1319	<60	<600		1-25-2
6	1-100-2 floor by huge door to x-ray area	412	126	538	<60	<600		1-25-2
7	1-100-2 floor drain	232	768	1000	<60	<600		1-25-2
1	1-13 floor between bays C and D	390	1126	1516	<60	<600		1-25-2
2	1-13 floor bay C near door	412	1295	1707	<60	<600		1-25-2
3	1-13 floor by truck loading door	435	1274	1709	<60	<600		1-25-2
4	1-13 3rd pole 10 ft from A on floor	210	1053	1263	<60	<600		1-25-2
5	1-13 floor by Bay A rail loading doors	457	1495	1952	<60	<600		1-25-2
6	1-13 Bay B exit doors	277	895	1172	<60	<600		1-25-2
1	1-19-1 floor by doors	457	74	531	<60	<600		1-25-2
2	1-19-1 floor by work bench	412	253	665	<60	<600		1-25-2
1	1-19-2 floor in middle of room	457	358	815	<60	<600		1-25-2
2	1-19-2 floors by doors to main room	322	0	322	<60	<600		1-25-2
1	1-19-3 floor of step to press	525	0	525	<60	<600		1-25-2
2	1-19-3 floor by doors	638	0	638	<60	<600		1-25-2
1	1-19-4 steps to press	457	0	457	<60	<600		1-25-2
2	1-19-4 by doors on floor to larger room	345	168	513	<60	<600		1-25-2
1	1-19-5 floor to steps	390	158	548	<60	<600		1-25-2
2	1-19-5 concrete floor by work bench	345	526	871	<60	<600		1-25-2
3	1-19-5 floor by entrance doors	232	1053	1285	<60	<600		1-25-2
1	1-19-6 steel plate on floor by marble bench	165	0	165	<60	<600		1-25-2
2	1-19-6 floor by doors to larger room	367	0	367	<60	<600		1-25-2
3	1-19-6 by main doors	97	0	97	<60	<600		1-25-2
1	1-19-7 floor by doors into larger room	97	63	160	<60	<600		1-25-2
2	1-19-7 floor by machine	119	0	119	<60	<600		1-25-2
3	1-19-7 floor by door to entrance	165	0	165	<60	<600		1-25-2
1	1-100-1 right corner floor	165	758	923	<60	<600		1-25-2

Table A-7-1. Building Survey Results and Surveys

Sample ID	Sample Location	Total Alpha (dpm/100 cm^2)	Total Beta (dpm/100 cm^2)	Total Alpha and Beta (dpm/100 cm^2)	Removable Alpha (dpm/100 cm^2)	Removable Beta (dpm/100 cm^2)	Comments	Survey Number
2	1-100-1 right side 10 ft from wall floor	187	558	745	<60	<600		1-25-2
3	1-100-1 floor entrance	165	989	1154	<60	<600		1-25-2
4	1-100-1entrance	255	579	834	<60	<600		1-25-2
1	1-65-4 left drain back	548	484	1032	<60	<600		1-25-2
2	1-65-4 5 ft from crane	525	1453	1978	<60	<600		1-25-2
3	1-65-4 right drain near back wall (3')	638	400	1038	<60	<600		1-25-2
4	1-65-4 near munitions	480	11905	12385	<60	<600	Rad item on pallet	1-25-2
1	1-65-3 single door in rear on floor	345	705	1050	<60	<600		1-25-2
2	1-65-3 top step of platform	367	0	367	<60	<600		1-25-2
3	1-65-3 bottom of step in center of room	412	432	844	<60	<600		1-25-2
4	1-65-3 floor at entrance of double doors	412	684	1096	<60	<600		1-25-2
1	1-63-5 near drain grate	210	505	715	<60	<600		1-25-2
2	1-63-5 near other drain grate	210	474	684	<60	<600		1-25-2
3	1-63-5 middle of floor in press room	300	95	395	<60	<600		1-25-2
1	1-63-4 floor in press room	367	463	830	<60	<600		1-25-2
2	1-63-4 by grate	322	379	701	<60	<600		1-25-2
3	1-63-4 drain grate	165	832	997	<60	<600		1-25-2
1	1-63-3 drain grate	300	1316	1616	<60	<600		1-25-2
2	1-63-3 by sump	300	758	1058	<60	<600		1-25-2
3	1-63-3 drain grate near press room	390	768	1158	<60	<600		1-25-2
1	1-63-2 grate	300	1042	1342	<60	<600		1-25-2
2	1-63-2 drain near press room	367	779	1146	<60	<600		1-25-2
3	1-63-2 middle of press room floor	367	1253	1620	<60	<600		1-25-2
1	1-63-1 drain grate	593	916	1509	<60	<600		1-25-2
2	1-63-1 grate in front of circular room	570	1105	1675	<60	<600		1-25-2
3	1-63-1 press room floor	412	1011	1423	<60	<600		1-25-2
1	1-64-3 floor entrance	165	600	765	<60	<600		1-25-2
2	1-64-3 middle of floor	232	411	643	<60	<600		1-25-2
3	1-64-3 back wall	277	0	277	<60	<600		1-25-2

Table A-7-1. Building Survey Results and Surveys

Sample ID	Sample Location	Total Alpha (dpm/100 cm^2)	Total Beta (dpm/100 cm^2)	Total Alpha and Beta (dpm/100 cm^2)	Removable Alpha (dpm/100 cm^2)	Removable Beta (dpm/100 cm^2)	Comments	Survey Number
1	1-64-4 middle of floor	165	337	502	<60	<600		1-25-2
2	1-64-4 entrance floor	165	137	302	<60	<600		1-25-2
3	1-64-4 floor on left 15 ft from front	165	84	249	<60	<600		1-25-2
1	1-64-2 floor right side middle	345	768	1113	<60	<600		1-25-2
2	1-64-2 left floor back of room	277	189	466	<60	<600		1-25-2
3	1-64-2 floor at entrance	187	905	1092	<60	<600		1-25-2
1	1-64-1 floor right side	142	1000	1142	<60	<600		1-25-2
2	1-64-1 left side of room floor near wall	74	663	737	<60	<600		1-25-2
3	1-64-1 left floor back of room	187	1253	1440	<60	<600		1-25-2
4	1-64-1 floor middle	142	989	1131	<60	<600		1-25-2
1	1-65-7 middle of floor	300	747	1047	<60	<600		1-25-2
2	1-65-7 right side floor near drain 7 ft from back wall	165	421	586	<60	<600		1-25-2
3	1-65-7 floor entrance	593	1663	2256	<60	<600		1-25-2
1	1-65-6 floor 5 ft from entrance	210	1316	1526	<60	<600		1-25-2
2	1-65-6 right corner near drain	345	2305	2650	<60	<600		1-25-2
3	1-65-6 right floor middle near drain	187	2937	3124	<60	<600		1-25-2
4	1-65-6 middle floor	97	10968	11065	<60	<600	Pallets with 30000 cpm	1-25-2
5	1-65-6 right floor 20 ft from rear wall 6 ft from sidewall	300	5979	6279	<60	<600	Pallets with 30000 cpm	1-25-2
6	1-65-6 left floor 25 ft from front near drain	232	3526	3758	<60	<600	Pallets with 30000 cpm	1-25-2
7	1-65-6 right corner back drain	300	3211	3511	<60	<600	Pallets with 30000cpm	1-25-2
1	1-65-1 floor near back 2 ft from wall	142	316	458	<60	<600		1-25-2
2	1-65-1 floor towards back	74	1011	1085	<60	<600		1-25-2
3	1-65-1 floor entrance	300	937	1237	<60	<600		1-25-2
1	1-65-2 left floor front	119	379	498	<60	<600		1-25-2

Table A-7-1. Building Survey Results and Surveys

Sample ID	Sample Location	Total Alpha (dpm/100 cm^2)	Total Beta (dpm/100 cm^2)	Total Alpha and Beta (dpm/100 cm^2)	Removable Alpha (dpm/100 cm^2)	Removable Beta (dpm/100 cm^2)	Comments	Survey Number
2	1-65-2 middle of floor	142	716	858	<60	<600		1-25-2
3	1-65-2 back wall	165	379	544	<60	<600		1-25-2
1	1-65-5 drain near double doors	300	1337	1637	<60	<600		1-25-2
2	1-65-5 single door on floor	210	232	442	<60	<600		1-25-2
3	1-65-5 right floor middle by drain	322	126	448	<60	<600		1-25-2
4	1-65-5 floor 2.5 ft from drain	322	13632	13954	<60	<600		1-25-2
1	1-61 northeast floor in bay	210	421	631	<60	<600		B 1-61, 1-40
2	1-61 northeast dock door floor	255	411	666	<60	<600		B 1-61, 1-40
3	1-61 center floor under conveyor	74	1495	1569	<60	<600		B 1-61, 1-40
4	1-61 basement break room floor	7	1653	1660	<60	<600		B 1-61, 1-40
5	1-61 basement south end floor	142	1063	1205	<60	<600		B 1-61, 1-40
1	1-40 next to yellow tanks	142	705	847	<60	<600		B 1-61, 1-40
2	1-40 next to red carts	187	547	734	<60	<600		B 1-61, 1-40
3	1-40 hallways to bays on floor	119	674	793	<60	<600		B 1-61, 1-40
4	1-40 Bay C in cylinder floor	232	158	390	<60	<600		B 1-61, 1-40
5	1-40 hallway floor next to fence	187	653	840	<60	<600		B 1-61, 1-40
6	1-40 hallway outside of Bays J and I	142	0	142	<60	<600		B 1-61, 1-40
7	1-40 Bay V vent on wall	345	1158	1503	<60	<600		B 1-61, 1-40
8	1-40 Bay U floor	322	11	333	<60	<600		B 1-61, 1-40
9	1-40 Bay R floor	232	0	232	<60	<600		B 1-61, 1-40
10	1-40 hallway outside of Bays T and S	322	232	554	<60	<600		B 1-61, 1-40
1	1-148 under tool/dye machine	119	389	508	<60	<600		B 1-148
2	1-148 floor at dock door	97	758	855	<60	<600		B 1-148
3	1-148 floor equipment room	52	537	589	<60	<600		B 1-148
4	1-148 sander floor area	165	1674	1839	<60	<600		B 1-148
5	1-148 floor entering another building	165	1368	1533	<60	<600		B 1-148
1	1-137-4 left hallway floor	210	3095	3305	<60	<600		B 1-137-4
2	1-137-4 cafeteria ceramic floor	97	2337	2434	<60	<600		B 1-137-4
3	1-137-4 center drain cafeteria	210	305	515	<60	<600		B 1-137-4
4	1-137-4 back hallway floor	255	1453	1708	<60	<600		B 1-137-4

Table A-7-1. Building Survey Results and Surveys

Sample ID	Sample Location	Total Alpha (dpm/100 cm^2)	Total Beta (dpm/100 cm^2)	Total Alpha and Beta (dpm/100 cm^2)	Removable Alpha (dpm/100 cm^2)	Removable Beta (dpm/100 cm^2)	Comments	Survey Number
5	1-137-4 show stall floor	300	3337	3637	<60	<600		B 1-137-4
6	1-137-4 left entrance floor	142	2295	2437	<60	<600		B 1-137-4
1	1-63-6 air vent filter in large circular room	119	12274	12393	<60	<600		6-06-02
2	1-63-6 concrete floor in large circular room where old equipment would have been	52	1232	1284	<60	<600		6-06-02
3	1-63-6 on floor at entrance to circular room	7	789	796	<60	<600		6-06-02
4	1-63-6 floor of storage area	0	937	937	<60	<600		6-06-02
5	1-63-6 floor of entrance way	7	1474	1481	<60	<600		6-06-02
1	1-11 on steel grate above pit	142	75895	76037	<60	<600	Pit area marked with rad tape	6-06-03
2	1-11 on concrete floor below sample number 1	165	3516	3681	<60	<600	Pit area marked with rad tape	6-06-03
3	1-11 on steel grate	187	53611	53798	<60	<600	Pit area marked with rad tape	6-06-03
4	1-11 on floor (ORISE fixed point 2 location)	119	1663	1782	<60	<600		6-06-03
5	on seam 3 ft from wall	97	8895	8992	<60	<600	Pit area marked with rad tape	6-06-03
1	1-137-4 tile floor of shower room	142	3084	3226	<60	<600		6-06-04
2	1-137-4 tile floor of locker room	142	2558	2700	<60	<600		6-06-04
3	1-137-4 tile floor near water fountain	142	2979	3121	<60	<600		6-06-04
1	1-65-5 floor 8 ft from drain	9	34	43	-	-		CC04272009-01
2	1-65-5 floor 4 ft from drain	53	0	53	-	-		CC04272009-01
3	1-65-5 floor 6 ft from drain	9	0	9	-	-		CC04272009-01

Table A-7-1. Building Survey Results and Surveys

Sample ID	Sample Location	Total Alpha (dpm/100 cm^2)	Total Beta (dpm/100 cm^2)	Total Alpha and Beta (dpm/100 cm^2)	Removable Alpha (dpm/100 cm^2)	Removable Beta (dpm/100 cm^2)	Comments	Survey Number
4	1-65-5 floor 9 ft from drain	9	0	9	-	-		CC04272009-01
5	1-65-5 floor 12 ft from drain	0	0	0	-	-		CC04272009-01
6	1-65-5 floor 10 ft from drain	9	34	43	-	-		CC04272009-01
7	1-65-5 floor 6 ft from drain	44	123	167	-	-		CC04272009-01
8	1-65-5 floor 3 ft from drain	9	0	9	-	-		CC04272009-01
9	1-65-5 floor 2 ft from drain	35	0	35	-	-		CC04272009-01
10	1-65-5 floor 1 ft from drain	0	0	0	-	-		CC04272009-01
1	1-63-6 floor in manway	35	334	369	-	-		CC04272009-01
2	1-63-6 floor in room C	0	102	102	-	-		CC04272009-01
3	1-63-6 floor grate	0	0	0	-	-		CC04272009-01
4	1-63-6 Sump lid	0	0	0	-	-		CC04272009-01
5	1-63-6 floor in round room	0	123	123	-	-		CC04272009-01
6	1-63-6 floor mechanical room	27	171	198	-	-		CC04272009-01
7	1-63-6 north side of air filter		Average 25566	25566	-	-		CC04272009-01
8	1-63-6 west side of air filter		Average 11920	11920	-	-		CC04272009-01
9	1-63-6 east side of air filter		Average 18743	18743	-	-		CC04272009-01
10	1-63-6 south side of air filter		Average 11920	11920	-	-		CC04272009-01
1	1-11 grate	0	4,653	4653	-	-		CC04272009-02
2	1-11 grate	35	7,683	7718	-	-		CC04272009-02
3	1-11 grate	27	16,505	16532	-	-		CC04272009-02
4	1-11 grate	9	6,932	6941	-	-		CC04272009-02
5	1-11 grate	0	6,687	6687	-	-		CC04272009-02
6	1-11 grate	27	17,658	17685	-	-		CC04272009-02
7	1-11 grate	0	3,466	3466	-	-		CC04272009-02
8	1-11 grate	18	31,864	31882	-	-		CC04272009-02
9	1-11 grate	9	2,354	2363	-	-		CC04272009-02
10	1-11 grate	0	1,801	1801	-	-		CC04272009-02
11	1-11 grate	9	328	337	-	-		CC04272009-02
12	1-11 grate	0	68	68	-	-		CC04272009-02
13	1-11 grate	35	1,556	1591	-	-		CC04272009-02
14	1-11 grate	0	846	846	-	-		CC04272009-02
15	1-11 grate	0	3,487	3487	-	-		CC04272009-02

Table A-7-1. Building Survey Results and Surveys

Sample ID	Sample Location	Total Alpha (dpm/100 cm^2)	Total Beta (dpm/100 cm^2)	Total Alpha and Beta (dpm/100 cm^2)	Removable Alpha (dpm/100 cm^2)	Removable Beta (dpm/100 cm^2)	Comments	Survey Number
16	1-11 grate	0	396	396	-	-		CC04272009-02
17	1-11 grate	0	0	0	-	-		CC04272009-02
18	1-11 grate	53	2,668	2721	-	-		CC04272009-02
19	1-11 grate	9	0	9	-	-		CC04272009-02
20	1-11 grate	20	0	20	-	-		CC04272009-02
21	1-11 grate	3	0	3	-	-		CC04272009-02
22	1-11 grate	3	0	3	-	-		CC04272009-02
23	1-11 grate	11	0	11	-	-		CC04272009-02
24	1-11 grate	11	0	11	-	-		CC04272009-02
25	1-11 grate	0	0	0	-	-		CC04272009-02
26	1-11 grate	3	0	3	-	-		CC04272009-02
27	1-11 grate	0	159	159	-	-		CC04272009-02
28	1-11 grate	11	0	11	-	-		CC04272009-02
29	1-11 grate	3	0	3	-	-		CC04272009-02
30	1-11 grate	20	0	20	-	-		CC04272009-02
31	1-11 grate	11	0	11	-	-		CC04272009-02
32	1-11 grate	0	0	0	-	-		CC04272009-02

Table A-7-1. Building Survey Results and Surveys

Sample ID	Sample Location	Total Alpha (dpm/100 cm^2)	Total Beta (dpm/100 cm^2)	Total Alpha and Beta (dpm/100 cm^2)	Removable Alpha (dpm/100 cm^2)	Removable Beta (dpm/100 cm^2)	Comments	Survey Number
33	1-11 grate	0	0	0	-	-		CC04272009-02
34	1-11 grate	11	0	11	-	-		CC04272009-02
35	1-11 grate	3	0	3	-	-		CC04272009-02
36	1-11 grate	0	0	0	-	-		CC04272009-02
37	1-11 grate	37	0	37	-	-		CC04272009-02
38	1-11 grate	20	0	20	-	-		CC04272009-02
39	1-11 grate	11	0	11	-	-		CC04272009-02
40	1-11 concrete next to grate	37	1,396	1433	-	-		CC04272009-02
41	1-11 concrete next to grate	63	3,563	3626	-	-		CC04272009-02
42	1-11 2.5 ft from grate in crack	63	7,407	7470	-	-		CC04272009-02
43	1-11 12 ft from grate in crack	11	16,720	16731	-	-		CC04272009-02
44	1-11 2.5 ft from grate	37	663	700	-	-		CC04272009-02
45	1-11 4 ft from grate	20	586	606	-	-		CC04272009-02
46	1-11 12 ft from grate	37	841	878	-	-		CC04272009-02
47	1-11 floor outside grate room	0	408	408	-	-		CC04272009-02
48	1-11 floor outside grate room	11	274	285	-	-		CC04272009-02
49	1-11 next to interior center building	20	287	307	-	-		CC04272009-02
50	1-11 off the corner of interior center building	63	287	350	-	-		CC04272009-02
51	1-11 next to exterior door	3	191	194	-	-		CC04272009-02
52	1-11 off corner of interior building	11	478	489	-	-		CC04272009-02
53	1-11 in front of interior building	3	223	226	-	-		CC04272009-02
54	1-11 off front corner of interior building	80	159	239	-	-		CC04272009-02
55	1-11 between interior building and loading docks	20	121	141	-	-		CC04272009-02
56	1-11 inside interior building	3	134	137	-	-		CC04272009-02
57	1-11 next to loading dock	27	3,425	3452	-	-		CC04272009-02
58	1-11 next to loading dock	18	621	639	-	-		CC04272009-02
59	1-11 next to loading dock	18	280	298	-	-		CC04272009-02
60	1-11 next to loading dock	35	41	76	-	-		CC04272009-02
61	1-11 next to loading dock	27	328	355	-	-		CC04272009-02

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ATTACHMENT A-8

HHRA Addendum: Evaluation of Chromium Risks in Firing Site 6 Area Soil Using Supplemental Investigation Data

(On the CD-ROM on the Back Cover of this Report)

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Table A-8-1. Soil EPC Calculation for RI and Supplemental Investigation Chromium Data (0-1.5 ft)
Firing Site 6 Area

User Selected Options			
From File	P:\Task 02 - Decision Docs (Danielson)\IAAAP Documents\IAAAP RI Addendum\FS-6 Cr EPC Calcula		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations			2000
Chromium			
General Statistics			
Number of Valid Observations	69	Number of Distinct Observations	65
Raw Statistics		**Log-transformed Statistics**	
Minimum	5.3	Minimum of Log Data	1.668
Maximum	6620	Maximum of Log Data	8.798
Mean	415.8	Mean of log Data	4.145
Median	27.1	SD of log Data	1.869
SD	1018		
Coefficient of Variation	2.449		
Skewness	4.254		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.343	Lilliefors Test Statistic	0.19
Lilliefors Critical Value	0.107	Lilliefors Critical Value	0.107
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	620.2	95% H-UCL	745.4
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	832.1
95% Adjusted-CLT UCL	684.5	97.5% Chebyshev (MVUE) UCL	1045
95% Modified-t UCL	630.7	99% Chebyshev (MVUE) UCL	1464
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.35	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	1188		
nu star	48.28		
Approximate Chi Square Value (.05)	33.33	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0465	95% CLT UCL	617.5
Adjusted Chi Square Value	33.07	95% Jackknife UCL	620.2
		95% Standard Bootstrap UCL	620.2
Anderson-Darling Test Statistic	6.396	95% Bootstrap-t UCL	781.7
Anderson-Darling 5% Critical Value	0.852	95% Hall's Bootstrap UCL	1038
Kolmogorov-Smirnov Test Statistic	0.26	95% Percentile Bootstrap UCL	639.7
Kolmogorov-Smirnov 5% Critical Value	0.116	95% BCA Bootstrap UCL	703.8
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	950.2
		97.5% Chebyshev(Mean, Sd) UCL	1181
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	1636
95% Approximate Gamma UCL	602.3		
95% Adjusted Gamma UCL	607.1		
Potential UCL to Use		Use 97.5% Chebyshev (Mean, Sd) UCL	1181

Table A-8-2. Daily Intake Calculations: Current and Future Site Worker
Ingestion of Chemicals in Surface Soil
Firing Site 6 Area, Iowa Army Ammunition Plant, Middletown, Iowa

Equation	DIingestion =	[	CS	x	IR	x	FI	x	CF	x	EF	x	ED	] / [	BW	x	AT	]
Units	**mg/kg-day**		**mg/kg**		**mg soil/day**		**unitless**		**kg/mg**		**days/year**		**years**		**kg**		**days**	
CARCINOGENIC EFFECTS																		
Chromium	2.1E-04	= [	1.2E+03	x	50	x	1.0	x	1.0E-06	x	250	x	25	] / [	70	x	25,550	]
NON-CARCINOGENIC EFFECTS																		
Chromium	5.8E-04	= [	1.2E+03	x	50	x	1.0	x	1.0E-06	x	250	x	25	] / [	70	x	9,125	]

DIingestion = Daily chemical intake via soil ingestion.
CS = Chemical concentration in soil.
IR = Soil ingestion rate.
FI = Fraction of intake.
CF = Conversion factor.
EF = Exposure frequency.
ED = Exposure duration.
BW = Body weight.
AT = Averaging time.

Table A-8-3. Daily Intake Calculations: Future Construction Worker
Ingestion of Chemicals in Surface and Subsurface Soil
Firing Site 6 Area, Iowa Army Ammunition Plant, Middletown, Iowa

Equation	DIingestion	=	[	CS	x	IR	x	FI	x	CF	x	EF	x	ED	]	/	[	BW	x	AT	]
Units	**mg/kg-day**			**mg/kg**		**mg soil/day**		**unitless**		**kg/mg**		**days/year**		**years**				**kg**		**days**	
CARCINOGENIC EFFECTS																					
Chromium	8.0E-05	=	[	1.2E+03	x	480	x	1.0	x	1.0E-06	x	250	x	1	]	/	[	70	x	25550	]
NON-CARCINOGENIC EFFECTS																					
Chromium	5.6E-03	=	[	1.2E+03	x	480	x	1.0	x	1.0E-06	x	250	x	1	]	/	[	70	x	365	]

DIingestion = Daily chemical intake via soil ingestion.
CS = Chemical concentration in soil.
IR = Soil ingestion rate.
FI = Fraction of intake.
CF = Conversion factor.
EF = Exposure frequency.
ED = Exposure duration.
BW = Body weight.
AT = Averaging time.

Table A-8-4. Daily Intake Calculations: Current and Future Site Worker
Dermal Contact with Chemicals in Surface Soil
Firing Site 6 Area, Iowa Army Ammunition Plant, Middletown, Iowa

Equation	AD_{dermal}	= [	CS	x	CF	x	SA	x	AF	x	ABS_d	x	EF	x	ED	] / [	BW	x	AT	]
Units	**mg/kg-day**		**mg/kg**		**kg/mg**		**cm^2**		**mg/cm^2**		**unitless**		**days/year**		**years**		**kg**		**days**	
CARCINOGENIC EFFECTS																				
Chromium	3.5E-04	= [	1.2E+03	x	1.0E-06	x	3,300	x	0.2	x	0.13	x	250	x	25	] / [	70	x	25,550	]
NON-CARCINOGENIC EFFECTS																				
Chromium	9.9E-04	= [	1.2E+03	x	1.0E-06	x	3,300	x	0.2	x	0.13	x	250	x	25	] / [	70	x	9,125	]

AD_{dermal} = Daily absorbed chemical dose.
CS = Chemical concentration in soil.
CF = Conversion factor.
SA = Skin surface area available for contact (OSWER Directive 9355.4-24, USEPA 2002).
AF = Soil to skin adherence factor (EFH; USEPA 1997).
ABS_d = Recommended dermal absorption fraction from soil ("RAGS E"; USEPA 2004) or RAIS website (http://ornl.rais.risk).
EF = Exposure frequency.
ED = Exposure duration.
BW = Body weight.
AT = Averaging time.

Table A-8-5. Daily Intake Calculations: Future Construction Worker
Dermal Contact with Chemicals in Surface and Subsurface Soil
Firing Site 6 Area, Iowa Army Ammunition Plant, Middletown, Iowa

Equation	ADdermal =	[	CS	x	CF	x	SA	x	AF	x	ABS_d	x	EF	x	ED	]	/	[	BW	x	AT	]
Units	**mg/kg-day**		**mg/kg**		**kg/mg**		**cm2**		**mg/cm^2**		**unitless**		**days/year**		**years**				**kg**		**days**	
CARCINOGENIC EFFECTS																						
Chromium	1.4E-05	= [	1.2E+03	x	1.0E-06	x	3,300	x	0.2	x	0.13	x	250	x	1	]	/	[	70	x	25,550	]
NON-CARCINOGENIC EFFECTS																						
Chromium	1.0E-03	= [	1.2E+03	x	1.0E-06	x	3,300	x	0.2	x	0.13	x	250	x	1	]	/	[	70	x	365	]

ADdermal = Daily absorbed chemical dose.
CS = Chemical concentration in soil.
CF = Conversion factor.
SA = Skin surface area available for contact (OSWER Directive 9355.4-24, USEPA 2002).
AF = Soil to skin adherence factor (EFH; USEPA 1997).
ABS_d = Recommended dermal absorption fraction from soil ("RAGS E"; USEPA 2004).
EF = Exposure frequency.
ED = Exposure duration.
BW = Body weight.
AT = Averaging time.

Table A-8-6. Daily Intake Calculations: Current and Future Site Worker
Inhalation of Chemicals in Surface Soil
Firing Site 6 Area, Iowa Army Ammunition Plant, Middletown, Iowa

Equation	$DI_{inhalation}$	= [	CA	x	IR	x	EF	x	ET	x	ED	] / [	BW	x	AT	]
Units	**mg/kg-day**		**mg/m^3**		**m^3/hour**		**days/year**		**hours/day**		**years**		**kg**		**days**	
CARCINOGENIC EFFECTS																
Chromium	2.0E-08	= [	8.7E-07	x	0.83	x	250	x	8	x	25	] / [	70	x	25,550	]
NON-CARCINOGENIC EFFECTS																
Chromium	5.7E-08	= [	8.7E-07	x	0.83	x	250	x	8	x	25	] / [	70	x	9,125	]

$DI_{inhalation}$ = Daily chemical intake via inhalation.
CA = Chemical concentration in air (see Appendix C, Table 7).
IR = Inhalation rate; 0.83 m^3/hr based on the standard assumption of 20 m^3/day.
EF = Exposure frequency.
ET = Exposure time.
ED = Exposure duration.
BW = Body weight.
AT = Averaging time.

Table A-8-7. Daily Intake Calculations: Future Construction Worker
Inhalation of Chemicals in Surface and Subsurface Soil
Firing Site 6 Area, Iowa Army Ammunition Plant, Middletown, Iowa

Equation	$DI_{inhalation}$	= [	CA	x	IR	x	EF	x	ET	x	ED	] / [	BW	x	AT	]
Units	**mg/kg-day**		**mg/m^3**		**m^3/hour**		**days/year**		**hours/day**		**years**		**kg**		**days**	
CARCINOGENIC EFFECTS																
Chromium	8.1E-10	= [	8.7E-07	x	0.83	x	250	x	8	x	1	] / [	70	x	25,550	]
NON-CARCINOGENIC EFFECTS																
Chromium	5.7E-08	= [	8.7E-07	x	0.83	x	250	x	8	x	1	] / [	70	x	365	]

$DI_{inhalation}$ = Daily chemical intake via inhalation.
CA = Chemical concentration in air (see Appendix C, Table 7).
IR = Inhalation rate; site-specific parameter for operator riding equipment.
EF = Exposure frequency.
ET = Exposure time.
ED = Exposure duration.
BW = Body weight.
AT = Averaging time.

Table A-8-8. Chemical Concentrations in Air Calculations
Firing Site 6 Area, Iowa Army Ammunition Plant, Middletown, Iowa

Equation	CA	=	CS	x	[	(	1	/	PEF	)	+	(	1	/	VF	)	]
Units	**mg/m^3**		**mg/kg**						**m^3/kg**						**m^3/kg**		
Surface Soil - Current and Future Site Workers																	
Chromium	8.7E-07	=	1.2E+03	x	[	(	1	/	1.4E+09	)	+	(	1	/	ND	)	]
Surface and Subsurface Soil - Construction Workers																	
Chromium	8.7E-07	=	1.2E+03	x	[	(	1	/	1.4E+09	)	+	(	1	/	ND	)	]

CA = Chemical concentration in air.

CS = Chemical concentration in soil.

PEF = Obtained/derived based on USEPA's *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (2002)* .

The default value of 1.36E+09 mg/kg is used to calculate air concentrations for the site worker scenario. The value used for determining air concentrations for the construction worker scenario (6.58E+08 m3/kg) was derived assuming 0% vegetative cover at a construction/excavation site.

VF = Volatilization factor (OSWER Directive 9285.7-01B, USEPA 1991c).

NA = Not applicable.

ND = No data.

Table A-8-9. K_D Values[(1)]
Firing Site 6 Area, Iowa Army Ammunition Plant, Middletown, Iowa

Equation Units	K_d[1] L/kg	=	K_{OC}[2] L/kg	x	f_{OC}[3] g/g
Surface Soil					
Chromium	ND	=	ND	x	0.006
Surface and Subsurface Soil (Combined)					
Chromium	ND	=	ND	x	0.002

[(1)]K_d = Soil-water partition coefficient, $cm^3/g = K_{OC} \times f_{OC}$, formula from USEPA 1996.

[(2)]K_{OC} = Soil organic carbon partition coefficient (L/kg), chemical-specific value from USEPA 2002, Exhibit C-1 or Oak Ridge National Laboratory; Risk Assessment Information System (http://rais.ornl.gov).

f_{OC} = Fraction organic carbon in soil (g/g), 0.006 for surface soil, 0.002 for subsurface soil.

Table A-8-10. Volatility Factors[1]
Firing Site 6 Area, Iowa Army Ammunition Plant, Middletown, Iowa

Equation	**VF**	**=**	**[**	**Q/C_{vol}**	**x**	**(**	**3.14**	**x**	**D_A**	**x**	**T**	**$)^{1/2}$**	**x**	**CF**	**]**	**/**	**(**	**2**	**x**	**ρ_b**	**x**	**D_A**	**)**
Units	m3/kg			see below			π		cm^2/sec		sec			m^2/cm^2						g/cm^3		cm^2/sec	
Surface Soil - Current and Future Site Workers																							
Chromium	ND	=	[	68.18	x	(	3.14	x	ND	x	9.5E+08	$)^{1/2}$	x	1.0E-04	]	/	(	2	x	1.5	x	ND	)
Surface and Subsurface Soil - Construction Workers																							
Chromium	ND	=	[	68.18	x	(	3.14	x	ND	x	9.5E+08	$)^{1/2}$	x	1.0E-04	]	/	(	2	x	1.5	x	ND	)

[1]VF = Volatilization factor, formula obtained from USEPA 1996. Soil Screening Guidance: User's Guide. Publication 9355.4-23. July 1996.

Q/C_{vol} = Assumes a 0.5-acre emission source (g/m^2-sec per kg/m^3); 68.18 represents the 90th percentile value based on 29 meteorological stations used in dispersion model analysis.

D_A = Apparent diffusivity (cm^2/sec) (see Appendix C, Table 10).

[2]Values for the following parameters obtained from:

USEPA 2002. *Supplemental Guidance Developing Soil Screening Levels for Superfund Sites, Appendix C.* OSWER 9355.4-24. December 2002.

T = Exposure interval (sec); 9.5E+08 for site workers and construction workers (Equation 4-8).

CF = Conversion factor, 10^{-4} m^2/cm^2.

ρ_b = Dry soil bulk density (g/cm^3) = 1.5 g/cm^3 (Equation 4-8).

ND = No data; physical/chemical parameters not available for all chemicals.

Table A-8-11. Apparent Diffusivity[1]
Firing Site 6 Area, Iowa Army Ammunition Plant, Middletown, Iowa

Equation[2][3]	DA	= [((	$\theta_a^{10/3}$	x	D_i	x	H'	) + (	$\theta_w^{10/3}$	x	D_w	)) /	n^2	] / [(	ρ_b	x	K_d	) +	θ_w	+ (	θ_a	x	H'	)]
Units	**cm^2/sec**		**L_{air}/L_{soil}**		**cm^2/s**		**dimen-sionless**		**L_{water}/L_{soil}**		**cm^2/sec**				**g/cm^3**		**L/kg**		**L_{water}/L_{soil}**		**L_{air}/L_{soil}**		**dimen-sionless**	
Surface Soil - Current and Future Site Workers																								
Chromium	ND	= [((	1.4E-02	x	ND	x	ND	) + (	1.8E-03	x	ND	)) /	1.8E-01	] / [(	1.5E+00	x	ND	) +	1.5E-01	+ (	2.8E-01	x	ND	)]
Surface and Subsurface Soil - Construction Workers																								
Chromium	ND	= [((	1.1E-03	x	ND	x	ND	) + (	1.8E-02	x	ND	)) /	1.8E-01	] / [(	1.5E+00	x	ND	) +	3.0E-01	+ (	1.3E-01	x	ND	)]

[1]DA = Apparent diffusivity; formula was obtained from USEPA 1996. Soil Screening Guidance: User's Guide. Publication 9355.4-23. July 19

[2]Values for the following soil physical parameters obtained from:

USEPA 2002. *Supplemental Guidance Developing Soil Screening Levels for Superfund Sites, Appendix C.* OSWER 9355.4-24. December 2002.

θ_a = Air filled porosity (L_{air}/L_{soil}) = 0.28 for surface soil, 0.13 for subsurface soil.

θ_w = Water-filled porosity (L_{water}/L_{soil}) = 0.15 for surface soil, 0.30 for subsurface soil.

n = Total soil porosity (L_{pore}/L_{soil}) = 0.43.

ρ_b = Dry soil bulk density (g/cm^3) = 1.5 g/cm^3.

ρ_s = Soil particle density (g/cm^3) = 2.65 g/cm^3.

D_i = Diffusivity in air (cm^2/sec) from USEPA 2002 or RAIS website (http://rais.ornl.gov).

ND = No data; physical/chemical parameters not available for all chemicals.

[3]The following chemical-specific values obtained from the following sources:

DOE,2007. *Risk Assessment Information System* (Last Updated May 2007) (http://rais.ornl.gov/).

D_i = Diffusivity in air (cm^2/sec), chemical-specific.

H' = Henrys law constant, unitless, chemical-specific.

D_w = Diffusivity in water (cm^2/sec), chemical-specific.

Kd = Soil-water partition coefficient, (cm3/g), chemical specific (see Appendix C, Table 8).

Table A-8-12. Risk Characterization
Current and Future Site Worker Exposed to Surface Soil
Firing Site 6 Area, Iowa Army Ammunition Plant, Middletown, Iowa

	Carcinogenic Effects					Non-carcinogenic Effects				
Equation	**DI**	**x**	**SF**	**=**	**CR**	**DI**	**/**	**RfD**	**=**	**HQ**
Units	**mg/kg-day**		**(mg/kg-day)$^{-1}$**		**unitless**	**mg/kg-day**		**mg/kg-day**		**unitless**
Ingestion of Chemicals in Soil										
Chromium	2.1E-04	x	ND	=	NA	5.8E-04	/	3.0E-03	=	0.19
			Pathway total risk	=	NA			Pathway total HI	=	**0.2**
Dermal Contact with Chemicals in Soil										
Chromium	3.5E-04	x	ND	=	NA	9.9E-04	/	3.0E-03	=	0.33
			Pathway total risk	=	NA			Pathway total HI	=	**0.3**
Inhalation of Chemicals in Soil										
Chromium	2.0E-08	x	4.2E+01	=	**8.5E-07**	5.7E-08	/	2.2E-06	=	0.026
			Pathway total risk	=	**8.5E-07**			Pathway total HI	=	0.03
Firing Site 6 Totals										
Chromium			Sum of all pathway risks	=	**8.5E-07**			Sum of all pathway HIs	=	**0.5**

DI = Chemical daily intake; from tables.
SF = Cancer slope factor; from tables.
CR = Cancer risk.
RfD = Non-cancer reference dose; from tables.
HQ = Hazard quotient.
HI = Hazard index (i.e., sum of HQs).
ND = No data.
NA = Not applicable.
Bold indicates carcinogenic risk exceeding 1E-06 and non-carcinogenic risk (HQ or HI) exceeding 1.0.

[NOTE: Chemical totals for non-carcinogenic risk (HI) are presented for illustrative purposes only. It may not be appropriate to consider HIs for HQs summed over COPCs that represent adverse health effects for differing target organ effects.]

Table A-8-13. Risk Characterization
Future Construction Worker Exposed to Surface and Subsurface Soil
Firing Site 6 Area, Iowa Army Ammunition Plant, Middletown, Iowa

	Carcinogenic Effects					Non-carcinogenic Effects				
Equation	**DI**	**x**	**SF**	**=**	**CR**	**DI**	**/**	**RfD**	**=**	**HQ**
Units	**mg/kg-day**		**(mg/kg-day)$^{-1}$**		**unitless**	**mg/kg-day**		**mg/kg-day**		**unitless**
Ingestion of Chemicals in Soil										
Chromium	8.0E-05	x	ND	=	NA	5.6E-03	/	3.0E-03	=	**1.9**
			Pathway total risk	=	NA			Pathway total HI	=	**1.9**
Dermal Contact with Chemicals in Soil										
Chromium	1.4E-05	x	ND	=	NA	1.0E-03	/	3.0E-03	=	0.33
			Pathway total risk	=	NA			Pathway total HI	=	**0.3**
Inhalation of Chemicals in Soil										
Chromium	8.1E-10	x	4.2E+01	=	3.4E-08	5.7E-08	/	2.2E-06	=	0.03
			Pathway total risk	=	3.4E-08			Pathway total HI	=	0.03
Firing Site 6 Totals										
Chromium			Sum of all pathway risks	=	3.4E-08			Sum of all pathway HIs	=	**2.2**

DI = Chemical daily intake; from tables.
SF = Cancer slope factor; from tables.
CR = Cancer risk.
RfD = Non-cancer reference dose; from tables.
HQ = Hazard quotient.
HI = Hazard index (i.e., sum of HQs).
ND = No data.
NA = Not applicable.

Bold indicates carcinogenic risk exceeding 1E-06 and non-carcinogenic risk (HQ or HI) exceeding 1.0.

[NOTE: Chemical totals for non-carcinogenic risk (HI) are presented for illustrative purposes only. It may not be appropriate to consider HIs for HQs summed over COPCs that represent adverse health effects for differing target organ effects.]

Table A-8-14. Human Health Baseline Risk Assessment Summary for RI Supplemental Chromium Data
Current and Future Receptors
Cumulative Risks Summed for all Pathways
Firing Site 6 Area, Iowa Army Ammunition Plant, Middletown, Iowa

Chemical	Current and Future Site Worker[(1)]				Future Construction Worker[(1)]			
	Carcinogenic Risks	% of Total CR	Non-cancer HIs	% of HI	Carcinogenic Risks	% of Total CR	Non-cancer HIs	% of HI
Chromium	**8.5E-07**	NA	**0.5**	NA	3.4E-08	NA	**2.2**	NA

[(1)]Current and future site workers were evaluated for exposures to COPCs in surface soil. Future construction workers were evaluated for exposures to COPCs in surface and subsurface soil (i.e., soil from the 0 to 10-ft below ground surface depth interval).

NA = Not applicable; either no toxicity value exists or pathway not pertinent to this receptor.

Bold indicates carcinogenic risk exceeding 1E-06 and non-carcinogenic risk (HQ or HI) exceeding 1.0.

[NOTE: Chemical totals for non-carcinogenic risk (HI) are presented for illustrative purposes only. It may not be appropriate to consider HIs for HQs summed over COPCs that represent adverse health effects for differing target organ effects.]

ATTACHMENT A-9

Supplemental Streamlined ERA: Evaluation of HMX in Yards C and G Soil

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Table A-9-1. ProUCL Output - IAAAP Yard C HMX EPCs from RI and Supplemental Investigation Data (mg/kg)

User Selected Options			
From File	C:\Documents and Settings\moroneyp\My Documents\IAAAP\RI Addendum\Supplemental RI Data_Info\Yards C & G Eco Re-Evaluations\EPC Recalculations for HMX.wst		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations			2000
Yard C HMX			
General Statistics			
Number of Valid Observations	24	Number of Distinct Observations	12
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.14	Minimum of Log Data	-1.966
Maximum	7.99	Maximum of Log Data	2.078
Mean	0.513	Mean of log Data	-1.551
Median	0.17	SD of log Data	0.809
SD	1.594		
Coefficient of Variation	3.108		
Skewness	4.886		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.232	Shapiro Wilk Test Statistic	0.396
Shapiro Wilk Critical Value	0.916	Shapiro Wilk Critical Value	0.916
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	1.071	95% H-UCL	0.432
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.517
95% Adjusted-CLT UCL	1.395	97.5% Chebyshev (MVUE) UCL	0.615
95% Modified-t UCL	1.125	99% Chebyshev (MVUE) UCL	0.809
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.628	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	0.817		
nu star	30.15		
Approximate Chi Square Value (.05)	18.61	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0392	95% CLT UCL	1.048
Adjusted Chi Square Value	17.98	95% Jackknife UCL	1.071
		95% Standard Bootstrap UCL	1.036
Anderson-Darling Test Statistic	7.445	95% Bootstrap-t UCL	26.17
Anderson-Darling 5% Critical Value	0.789	95% Hall's Bootstrap UCL	11.28
Kolmogorov-Smirnov Test Statistic	0.481	95% Percentile Bootstrap UCL	1.158
Kolmogorov-Smirnov 5% Critical Value	0.186	95% BCA Bootstrap UCL	1.51
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	1.931
		97.5% Chebyshev(Mean, Sd) UCL	2.545
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	3.75
95% Approximate Gamma UCL	0.831		
95% Adjusted Gamma UCL	0.86		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	1.931

Table A-9-2. ProUCL Output - IAAAP Yard G HMX EPCs from RI and Supplemental Investigation Data (mg/kg)

Yard G HMX			
General Statistics			
Number of Valid Observations	12	Number of Distinct Observations	8
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.0165	Minimum of Log Data	-4.104
Maximum	4.32	Maximum of Log Data	1.463
Mean	0.488	Mean of log Data	-1.815
Median	0.163	SD of log Data	1.233
SD	1.208		
Coefficient of Variation	2.477		
Skewness	3.454		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.359	Shapiro Wilk Test Statistic	0.694
Shapiro Wilk Critical Value	0.859	Shapiro Wilk Critical Value	0.859
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	1.114	95% H-UCL	1.214
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.849
95% Adjusted-CLT UCL	1.433	97.5% Chebyshev (MVUE) UCL	1.08
95% Modified-t UCL	1.172	99% Chebyshev (MVUE) UCL	1.533
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.482	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	1.013		
nu star	11.56		
Approximate Chi Square Value (.05)	4.937	**Nonparametric Statistics**	
Adjusted Level of Significance	0.029	95% CLT UCL	1.061
Adjusted Chi Square Value	4.296	95% Jackknife UCL	1.114
		95% Standard Bootstrap UCL	1.027
Anderson-Darling Test Statistic	2.734	95% Bootstrap-t UCL	15.27
Anderson-Darling 5% Critical Value	0.78	95% Hall's Bootstrap UCL	15.43
Kolmogorov-Smirnov Test Statistic	0.499	95% Percentile Bootstrap UCL	1.181
Kolmogorov-Smirnov 5% Critical Value	0.258	95% BCA Bootstrap UCL	1.52
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	2.007
		97.5% Chebyshev(Mean, Sd) UCL	2.665
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	3.957
95% Approximate Gamma UCL	1.141		
95% Adjusted Gamma UCL	1.312		
Potential UCL to Use		Use 99% Chebyshev (Mean, Sd) UCL	3.957

Table A-9-3. Summary of Ecological Evaluation Results for HMX in Yards C and G

Site	Eco CC (mg/kg)	Streamlined ERA		Streamlined ERA Addendum	
		EPC (mg/kg)	EPC/CC Ratio	EPC (mg/kg)	EPC/CC Ratio
Yard C HMX	15.2	42.99	**2.83**	1.93	0.127
Yard G HMX	15.2	46.55	**3.06**	3.96	0.261

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APPENDIX B

SUPPLEMENTAL ECOLOGICAL RISK EVALUATION FOR THE FIRING SITES AREA

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SUPPLEMENTAL ECOLOGICAL RISK EVALUATION FOR THE FIRING SITES AREA

INTRODUCTION

As discussed in Section 2.3.6.2 of this FS, the outcome of the streamlined ERA, which was conducted to evaluate potential FSA-wide risks to the juvenile Indiana bat as part of the RI Report (USACE 2008a), was the identification of selenium and TNT as ecological COCs in the FSA. However, risks estimated for the Indiana bat using an FSA-wide approach are likely to be overestimated. This is because the FSA-wide approach conservatively assumes that the Indiana bat ingests insects that have bioaccumulated selenium and TNT from only FSA soil, because the entire foraging range (70 acres) for the juvenile bat is encompassed within the larger area of the FSA. In other words, the bat is assumed to spend 100 percent of its forging time within the FSA. The reason for evaluating risks to the Indiana bat using the FSA-wide model was to address the following uncertainties:

- the actual boundary and size of each of the individual firing site is estimated;
- the distances between individual firing sites are estimated because the individual firing site boundaries are estimated; and
- the infinite number of possibilities that can exist for the locations of Indiana bat foraging areas that could occur within the FSA.

Without specific knowledge of the foraging and habitat/roosting patterns of each individual Indiana bat at the FSA (i.e., during the non-hibernation period from April through October), as well as the fraction of flying insect biomass that the bat will ingest over the course of a lifetime that could be impacted by selenium and TNT present in soil at the FSA, all of the above combined uncertainties leave open an equal probability that exposures to an individual Indiana bat could occur anywhere within the FSA, and not outside of the FSA. This seems unrealistic, especially when considering adult Indiana bats, which can forage over much larger territories than juvenile bats.

Aside from forging areas, another factor that is not considered using the FSA-wide approach is that EPCs estimated for selenium and TNT that exceeded the ecological CCs in the streamlined ERA are driven predominantly by small localized areas of contamination within the Firing Site 6 Area, with other individual sample exceedances occurring in each of the other firing sites, except for the Firing Sites 3, 4, and 5 Area. Furthermore, the actual area of TNT soil contamination at the Firing Site 6 Area is located beneath gravel, which even further reduces the potential for biouptake by insect prey of the Indiana bat. Finally, the continued use of the Firing Site 6 Area as an active testing range also serves as a deterrent to the Indiana bat from foraging at the site. Not considering the active status of the Firing Site 6 Area results in overestimations of exposures and risks to the Indiana bat.

Given the previously discussed uncertainties, and in order to demonstrate that the FSA-wide approach used in the streamlined ERA overestimated risks to the Indiana bat, it is appropriate that further evaluations are conducted that consider the sizes of the individual firing sites, as well as the sizes of the separate areas of contaminated areas within the Firing Site 6 Area, relative to the size of foraging area of the Indiana bat. This is done through a tiered application of USEPA's (1997e) area use factor (AUF) to the derivations of ecological CCs. The AUF is the ratio of the site area to foraging area. For sites such as the FSA, which are larger than the 70-acre Indiana bat foraging territory, USEPA assigns a default value of 1.0 to the AUF, indicating the assumption

that the bat ingests only insect prey that have been exposed to contaminants from on-site soil. During derivation of the ecological CCs in the streamlined ERA, an AUF of 1.0 was conservatively assumed for the combined FSA. An AUF of less than 1.0 indicates that the site area is smaller than the 70-acre foraging area; therefore, it is assumed that the bat ingests insect prey from the site, as well as from other areas. The use of site-specific AUFs to determine CCs and/or ecological risk is consistent with USEPA (1997e) guidance. Application of AUFs is also consistent with methods applied by the U.S. Army at other IAAAP sites, as described by the BERA and information contained within Appendix M of the BERA (USACE 2004), as well as the ecological ESD (Tetra Tech 2007a) to the ROD for OU-1 soils, which was prepared for and signed by AEC.

Therefore, this supplemental ERA has been conducted using a three-tiered approach that progressively applies AUFs to the FSA-wide ecological CCs to derive CCs that reflect more realistic firing-site-specific and contaminated area-specific risks to the Indiana bat. The supplemental ERA uses the results of the streamlined ERA as the starting point (Tier 1) for first developing firing site-specific ecological critical concentrations (CCs) (Tier 2), and finally, contaminated area-specific ecological CCs (Tier 3) for the Indiana bat.

Following the calculations of CCs, each tier of evaluation compares the tier-specific EPCs to the corresponding CCs, with the comparisons being expressed as EPC-to-CC (EPC/CC) ratios. EPCs were calculated as the lesser of the 95% UCL and the maximum detected concentration. 95% UCLs were calculated using USEPA's ProUCL version 4.00.04 software. An EPC/CC ratio that is less than or equal to 1.0 indicates the EPC is less than or equal to the corresponding CC. However, an EPC/CC ratio that is greater than 1.0 indicates the EPC is greater than the corresponding CC. The following items describe the progressive three-tiered application of AUFs used to derive tier-specific CCs, and the use of EPC/CC ratios to estimate potential risk to the Indiana bat for each tier:

- **Tier 1:** Tier 1 is the FSA-wide approach used in the streamlined ERA. Because the FSA is much larger than the 70-acre foraging territory, the USEPA default value for the AUF (1.0) was applied to the derivations of all CCs for the FSA. Following the derivations of Tier 1 CCs, FSA-wide EPCs were calculated. Potential risks to the Indiana bat were determined by calculations of FSA-wide EPC/CC ratios. If the EPC/CC ratio for a contaminant was less than or equal to 1.0, no further evaluation was conducted. If the EPC/CC ratio was greater than 1.0, then a Tier 2 evaluation was conducted for that contaminant.
- **Tier 2:** The Tier 2 AUFs applied to all CC derivations for each individual firing was calculated as the ratio of the size of the individual firing site to the 70-acre foraging area of the Indiana bat. Following the derivations of Tier 2 CCs, potential risks to the Indiana bat were determined by calculations of firing site-specific EPC/CC ratios. If the EPC/CC ratio for a contaminant was less than or equal to 1.0, no further evaluation was conducted. If the EPC/CC ratio was greater than 1.0, then a Tier 3 evaluation was conducted for the contaminant.
- **Tier 3:** The Tier 3 AUFs applied to all CC derivations for each separate selenium- and TNT- contaminated area in the Firing Site 6 Area were calculated as the ratio of the size of the individual area of contamination to the 70-acre foraging area of the Indiana bat. Following the derivations of Tier 3 CCs, potential risks to the Indiana bat were determined by calculations of contaminated area-specific EPC/CC ratios. If the EPC/CC ratio for a contaminant was less than or equal to 1.0, the contaminant was not identified

as an ecological COC for the FS. If the EPC/CC ratio was greater than 1.0, then the contaminant was identified as a COC for the FS.

The following sections and Table B-1 summarize the site-specific, three-tiered CC approach and the results for each evaluation tier.

TIER 1 FSA-WIDE ECOLOGICAL RISK EVALUATION

Based on the nature and extent of soil contamination at the FSA, ecological CCs were developed and presented for selenium and TNT during the streamlined ERA in the RI Report (USACE 2008a). The Tier 1 evaluation involved comparison of the FSA-wide EPCs that were also calculated during the streamlined ERA, using USEPA's ProUCL version 4.00.04 software, to the FSA-wide CCs, as EPC/CC ratios. Table B-1 shows that Tier 1 (FSA-wide) EPC/CC ratios of 5.6 and 60.3 were estimated for selenium and TNT. These ratios indicate that the FSA-wide EPCs exceed the ecological CCs for the FSA. Additionally, Figure B-1 shows that individual sample exceedances of the Tier 1 CC occur for selenium in the Firing Sites 1 and 2 Area, Firing Site 6 Area, Firing Site 12, and Firing Site 14. Figure B-1 also shows that individual sample exceedances of the Tier 1 CC for TNT occur only in the Firing Site 6 Area.

Because of exceedances of both the selenium and TNT Tier 1 CCs by corresponding FSA-wide EPCs, as well as by individual sample concentrations (based on an AUF of 1.0) of selenium in the Firing Sites 1 and 2 Area, Firing Site 6 Area, Firing Site 12, and Firing Site 14, and TNT in the Firing Site 6 Area, a Tier 2 evaluation was performed for those areas, as discussed in Section B-3.0. Because there were no individual samples exceedances of Tier 1 CCs in the Firing Sites 3, 4, and 5 Area, a Tier 2 evaluation of this area is not necessary.

TIER 2 FIRING SITE-SPECIFIC ECOLOGICAL RISK EVALUATION

The Tier 2 evaluation focused the ecological evaluation onto the individual firing site areas, where individual sample exceedances of CCs were noted during the Tier 1 (FSA-wide) evaluation. The FSA-wide CCs identified during the Tier 1 evaluation were refined during the Tier 2 evaluation by application of firing site-specific AUFs determined for the juvenile Indiana bat, per the following equation:

$$CC_{T2} = \frac{CC_{T1}}{AUF_{FS}}$$

where:

$CC_{T2} =$ Tier 2 (firing site-specific) critical concentration (mg/kg)

$CC_{T1} =$ Tier 1 (FSA-wide) critical concentration (mg/kg)

$AUF_{FS} =$ Area use factor for specific firing site

Calculations of the Tier 2 ecological AUFs and CCs are presented in Table B-2. Likewise, firing site area-specific EPCs were calculated using USEPA's ProUCL version 4.00.04 software and then compared to the corresponding Tier 2 CCs as EPC/CC ratios.

Table B-1 shows that Tier 2 selenium EPC/CC ratios were calculated for the Firing Sites 1 and 2 Area (0.013), Firing Site 6 Area (2.54), Firing Site 12 (0.754), and Firing Site 14 (0.106). A Tier 2 TNT EPC/CC ratio (11.6) was calculated for only the Firing Site 6 Area. Based on the EPC/CC ratios, selenium EPCs are less than corresponding CCs for the Firing Sites 1 & 2 Area, Firing Site 12, and Firing Site 14, but the selenium EPC exceeds the CC for the Firing Site 6 Area.

Table B-1. Three-Tiered Ecological Risk Evaluation of the Indiana Bat at the Firing Sites Area

	Tier 1 (FSA-Wide Evaluation)[1]			Tier 2 (Firing Site-Specific Evaluation)			Tier 3 (Contaminated Area-Specific Evaluation)		
Ecological COC	EPC[2] (mg/kg)	CC[3] (mg/kg)	EPC/CC Ratio[4] (unitless)	EPC[2] (mg/kg)	CC[5] (mg/kg)	EPC/CC Ratio[4] (unitless)	EPC[2] (mg/kg)	CC[6] (mg/kg)	EPC/CC Ratio[4] (unitless)
FSA									
Selenium	9.028	1.61	***5.6***	na2	na2	na2	na3	na3	na3
2,4,6-Trinitrotoluene	214.2	3.55	***60.3***	na2	na2	na2	na3	na3	na3
Firing Sites 1 & 2 Area									
Selenium	na1	na1	na1	0.966	75.1	0.013	na3	na3	na3
2,4,6-Trinitrotoluene	na1	na1	na1	na2	na2	na2	na3	na3	na3
Firing Sites 3, 4, & 5 Area									
Selenium	na1	na1	na1	na2	na2	na2	na3	na3	na3
2,4,6-Trinitrotoluene	na1	na1	na1	na2	na2	na2	na3	na3	na3
Firing Site 6 Area									
Selenium	na1	na1	na1	66.7	26.2	***2.54***	76.3	125	0.61
2,4,6-Trinitrotoluene	na1	na1	na1	669	57.8	***11.6***	2,600	12,425	0.2
Firing Site 12									
Selenium	na1	na1	na1	1.24	1.64	0.754	na3	na3	na3
2,4,6-Trinitrotoluene	na1	na1	na1	na2	na2	na2	na3	na3	na3
Firing Site 14									
Selenium	na1	na1	na1	2.14	20.1	0.106	na3	na3	na3
2,4,6-Trinitrotoluene	na1	na1	na1	na2	na2	na2	na3	na3	na3

[1]FSA = Firing Site Area (all individual firing sites combined).

[2]EPC = Exposure point concentration, calculated as the lesser of the 95% UCL and the maximum detected concentration using data from within the FSA, individual firing site, or contaminated area, as applicable to the Tier 1, Tier 2, or Tier 3 evaluation respectively.

[3]Tier 1 critical concentration (CC) for the FSA was calculated as the ratio of the ecological CC from the streamlined ERA to an AUF of 1.0 (i.e., Tier 1 ecological CC = ecological CC from streamlined ERA).

[4]An EPC/CC ratio that is less than or equal to 1.0 indicates EPC does not exceed CC. An EPC/CC ratio that is greater than 1.0 (presented in ***bold italics***) indicates the EPC is greater than the CC.

[5]Tier 2 CCs for individual firing sites were calculated as the ratio of the Tier 1 CC (from the streamlined ERA) to the area use factor (AUF). The AUF for the Firing Sites 1 & 2 Area = 0.021; the AUF for the Firing Site 6 Area = 0.061; the AUF for Firing Site 12 = 0.98; and the AUF for Firing Site 14 = 0.08. The AUF is the ratio of the site area to the 70-acre foraging area of the juvenile Indiana bat. No Tier 2 CC was calculated for the Firing Sites 3, 4, & 5 Area because of there were no Tier 1 CC exceedances by individual sample concentrations.

[6]Tier 3 CCs for the selenium and 2,4,6-trinitrotoluene contaminated areas in the Firing Site 6 Area were calculated as the ratio of the respective Tier 1 CC (from the streamlined ERA) to AUFs of 0.013 and 0.0003, respectively.

na1 - Tier 1 evaluation for individual firing site is not applicable because only the FSA is evaluated.

na2 - Tier 2 evaluation for FSA is not applicable because only individual firing sites are evaluated. Evaluation for Firing Sites 3, 4, & 5 Area is not applicable because there were no exceedances of Tier 1 CCs by individual sample concentrations.

na3 - Tier 3 evaluation for FSA is not applicable because only individual contaminant areas are evaluated. Tier 3 evaluations for the Firing Sites 1 & 2 Area, Firing Site 12, and Firing Site 14 are not applicable because there were no exceedances of Tier 2 CCs by individual sample concentrations.

Table B-2. Calculations of Tier 2 (Firing Site-Specific) Ecological Critical Concentrations for the Indiana Bat

Ecological COC	Tier 1 CC[1] (AUF = 1.0) (mg/kg)	Indiana Bat Foraging Area (Acres)	Tier 2 CC Calculations[2]		
			Site Area (Acres)	Tier 2 AUF[3] (unitless)	Tier 2 CC[4] (mg/kg)
Firing Sites 1 & 2 Area					
Selenium	1.61	70	1.5	0.021	75.1
2,4,6-Trinitrotoluene	3.55	70	na	na	na
Firing Site 6 Area					
Selenium	1.61	70	4.3	0.061	26.2
2,4,6-Trinitrotoluene	3.55	70	4.3	0.061	57.8
Firing Site 12					
Selenium	1.61	70	68.6	0.980	1.6
2,4,6-Trinitrotoluene	3.55	70	na	na	na
Firing Site 14					
Selenium	1.61	70	5.6	0.080	20.1
2,4,6-Trinitrotoluene	3.55	70	na	na	na

[1]Tier 1 CC (critical concentration) = Ecological critical concentration (CC) from Streamlined ERA in RI Report (USACE 2008a).

[2]Tier 2 (firing site-specific) CCs are determined for COCs identified during the RI Report (USACE 2008a), in firing site areas in which individual sample exceedances of Tier 1 CCs were observed.

[3]AUF = Area use factor (ratio of site area to foraging area, per USEPA (1997e). The site areas used for the Tier 2 evaluation of each of the Firing Sites are the areas within the red boundaries presented on Figure B-2.

[4]Tier 2 CC = Ratio of Tier 1 CC to Tier 2 AUF for firing site.

na - Tier 2 CC calculation is not applicable because chemical was not identified as a COC in area.

Likewise, the Tier 2 EPC for TNT exceeds the CC in the Firing Site 6 Area. Therefore, selenium and TNT in the Firing Site 6 Area were retained for the Tier 3 evaluation.

Figure B-2 shows that individual sample concentrations of selenium exceed Tier 2 CCs in the Firing Site 6 Area and Firing Site 12. Figure B-2 also shows that individual sample concentrations of TNT exceed the Tier 2 CC derived for the Firing Site 6 Area.

TIER 3 FIRING SITE 6 CONTAMINATED AREA-SPECIFIC ECOLOGICAL RISK EVALUATION

The Tier 3 evaluation focused the ecological evaluation to the distinct areas of selenium and TNT contamination within the Firing Site 6 Area, as determined from the results of the Tier 2 evaluation. Under Tier 3, the Tier 1 FSA CCs were further refined by application of AUFs specific to each contaminated area, per the following equation:

$$CC_{T3} = \frac{CC_{T1}}{AUF_{CA}}$$

where:

CC_{T3} = Tier 3 (contaminated area-specific) critical concentration (mg/kg)

CC_{T1} = Tier 1 (FSA-wide) critical concentration (mg/kg)

AUF_{CA} = Area use factor for specific contaminated area (i.e., selenium or TNT at the Firing Site 6 Area

Calculations of the Tier 3 ecological AUFs and CCs are presented in Table B-3. The Tier 3 CCs were then compared to corresponding EPCs calculated for each area of contamination in the Firing Site 6 Area. Because of the small numbers of samples collected each within the selenium and TNT contamination areas, the EPCs for both areas were represented by the maximum detected concentration. Table B-1 shows that based on the selenium and TNT Tier 3 EPC/CC ratios of 0.61 and 0.2, respectively, selenium and TNT EPCs did not exceed the corresponding Tier 3 CCs. Additionally, Figure B-3 also shows that there are no exceedances of the selenium or TNT CCs, respectively, in the Firing Site 6 Area, by individual sample concentrations. Therefore, selenium and TNT are not retained as COCs in the FS.

SUMMARY OF SUPPLEMENTAL ECOLOGICAL RISK ASSESSMENT RESULTS

The site-specific consideration of the sizes of foraging areas relative to the sizes of actual areas of soil contamination at the firing sites is factored into the calculations of refined CCs, which, along with the other previously described lines of evidence, indicate that selenium and TNT concentrations present in soil at the firing sites, including the Firing Site 6 Area, are not likely to result in adverse impacts to the Indiana bat under the conditions characterized during the RI. Other lines of evidence include the following:

- Much of the area where TNT soil contamination exists in the Firing Site 6 Area is covered with gravel, which further reduces the potential for biouptake by insect prey.
- Continued use of the Firing Site 6 Area as an active range could serve as a deterrent to Indiana bats foraging at the site, especially during periods of peak human activity.

Therefore, in conclusion, RAOs presented in this FS Report for the firing sites focus only on protection of human health and ground water.

Table B-3. Calculations of Tier 3 (Firing Site 6 Contaminated Area-Specific) Ecological Critical Concentrations for the Indiana Bat

Ecological COC[1]	Tier 1 CC[1] (AUF = 1.0) (mg/kg)	Indiana Bat Foraging Area (Acres)	Tier 3 CC Calculations[2]		
			Site Area (Acres)	Tier 3 AUF[3] (unitless)	Tier 3 CC[4] (mg/kg)
Selenium	1.61	70	0.9	0.013	125
2,4,6-Trinitrotoluene	3.55	70	0.02	0.0003	12,425

[1]Tier 1 CC (critical concentration) = Ecological critical concentration (CC) from Streamlined ERA in RI Report (USACE 2008a).

[2]Tier 3 (contaminated area-specific) CCs are determined for COCs identified during the RI Report (USACE 2008a), in the Firing Site 6 Area contaminated areas in which individual sample exceedances of Tier 2 CCs were observed.

[3]AUF = Area use factor (ratio of site area to foraging area, per USEPA (1997e). The site areas used for selenium and TNT in the the Firing Site 6 Area are the contaminated areas of elevated concentrations represented by the cross-hatched areas in Figure B-3.

[4]Tier 3 CC = Ratio of Tier 1 CC to Tier 3 AUF for contaminated area of Firing Site 6 Area.

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APPENDIX B

FIGURES

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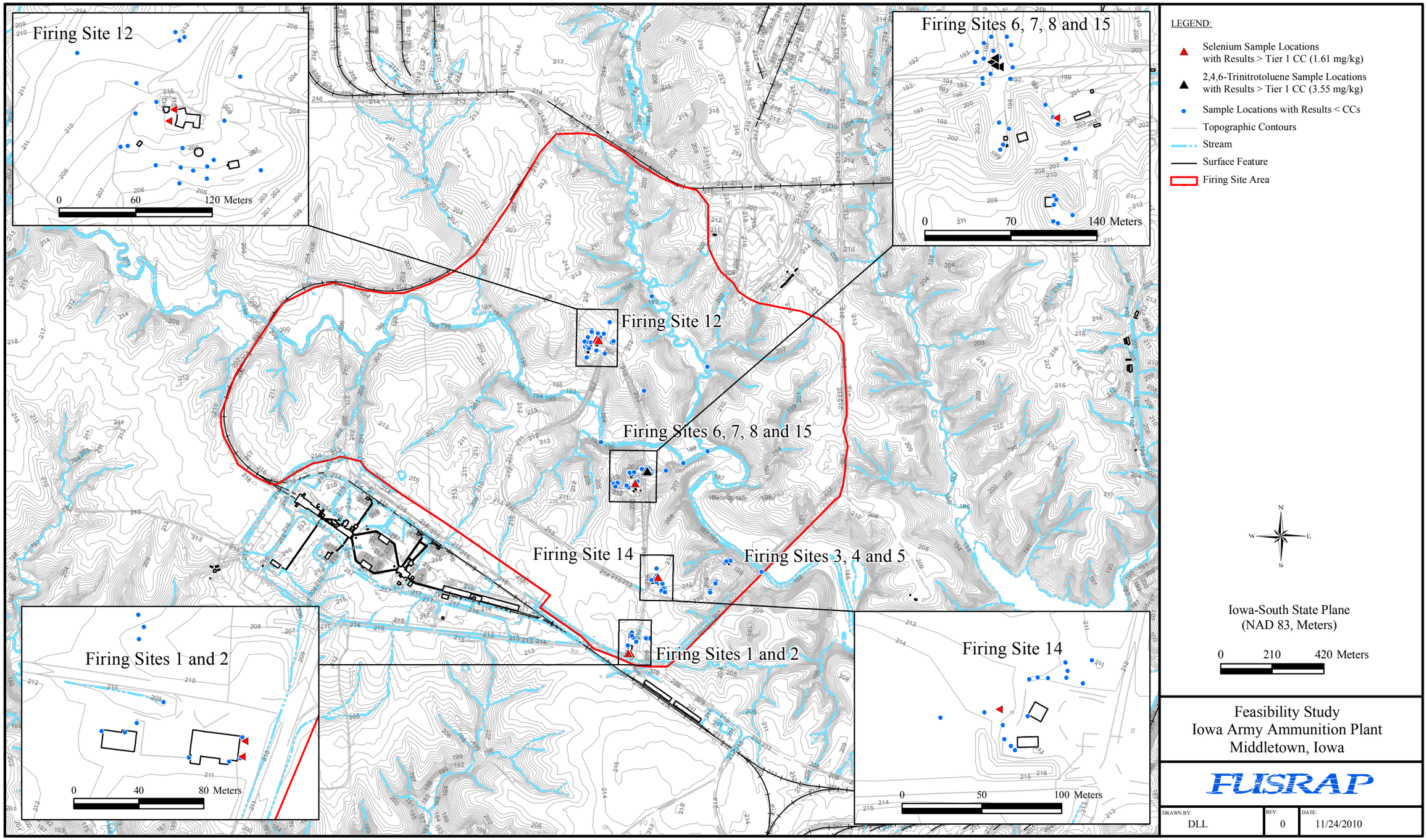
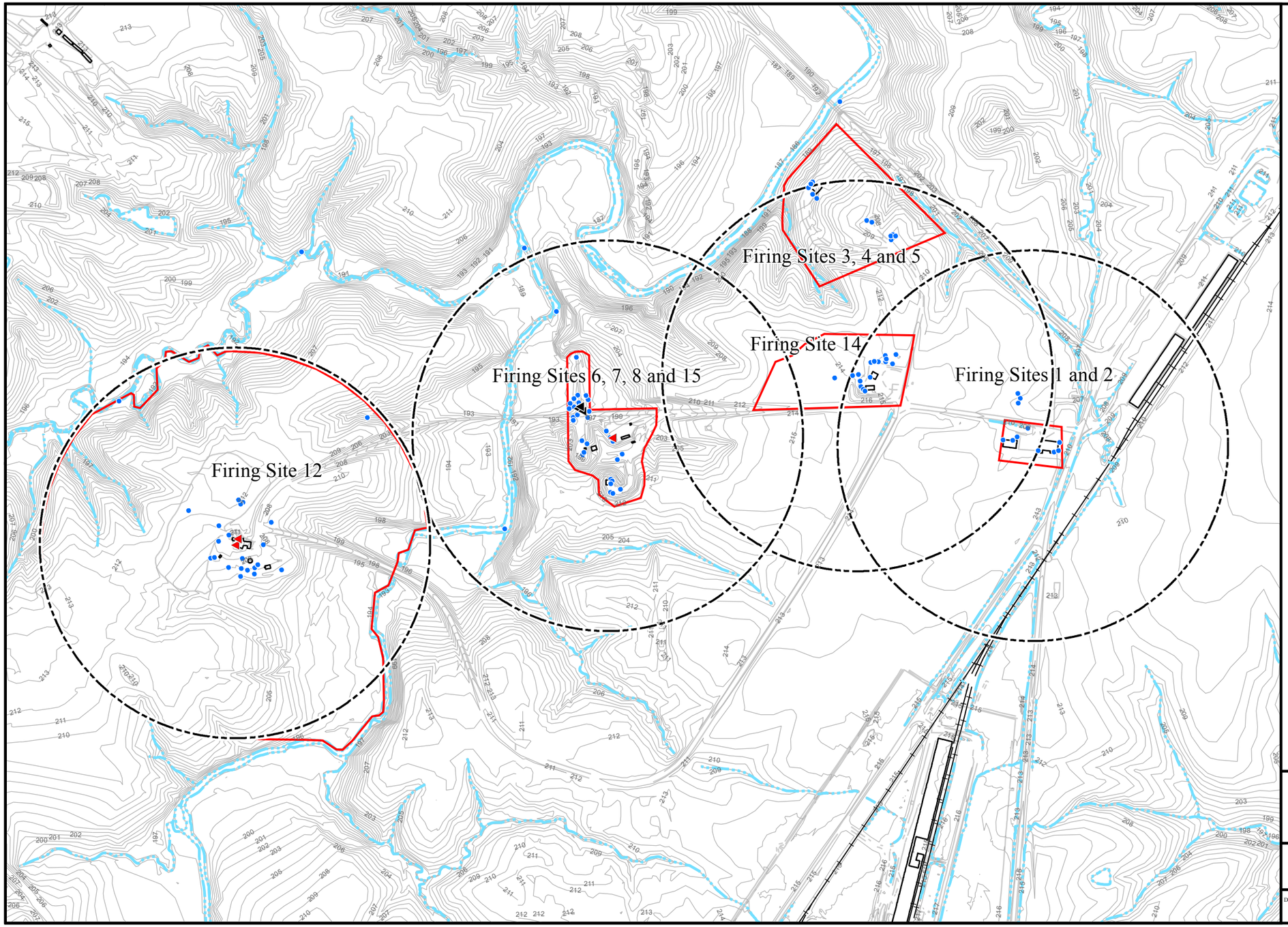


Figure B-1.
Exceedances of the Tier 1 (Firing Site Area-Wide)
Indiana Bat CCs for Selenium and 2,4,6-Trinitrotoluene in Soil



LEGEND:

- Selenium Sample Locations with Results > Tier 2 CC
- 2,4,6-Trinitrotoluene Sample Locations with Results > Tier 2 CC
- Sample Locations with Results < Tier 2 CC
- Firing Site Boundaries
- Topographic Contours
- Stream
- Surface Feature
- 70- Acre Indiana Bat Foraging Territory

Firing Site	Selenium Tier 2 CC (mg/kg)	TNT Tier 2 CC (mg/kg)
Firing Sites 1 & 2	75.1	NA
Firing Sites 3, 4 & 5	NA	NA
Firing Sites 6, 7, 8 & 15	26.2	57.8
Firing Site 12	1.64	NA
Firing Site 14	20.1	NA

NA - Tier 2 evaluation is not applicable to firing site due to no sample exceedences of Tier 1 RG.

N E S W

Iowa-South State Plane
(NAD 83, Meters)

0 90 180 Meters

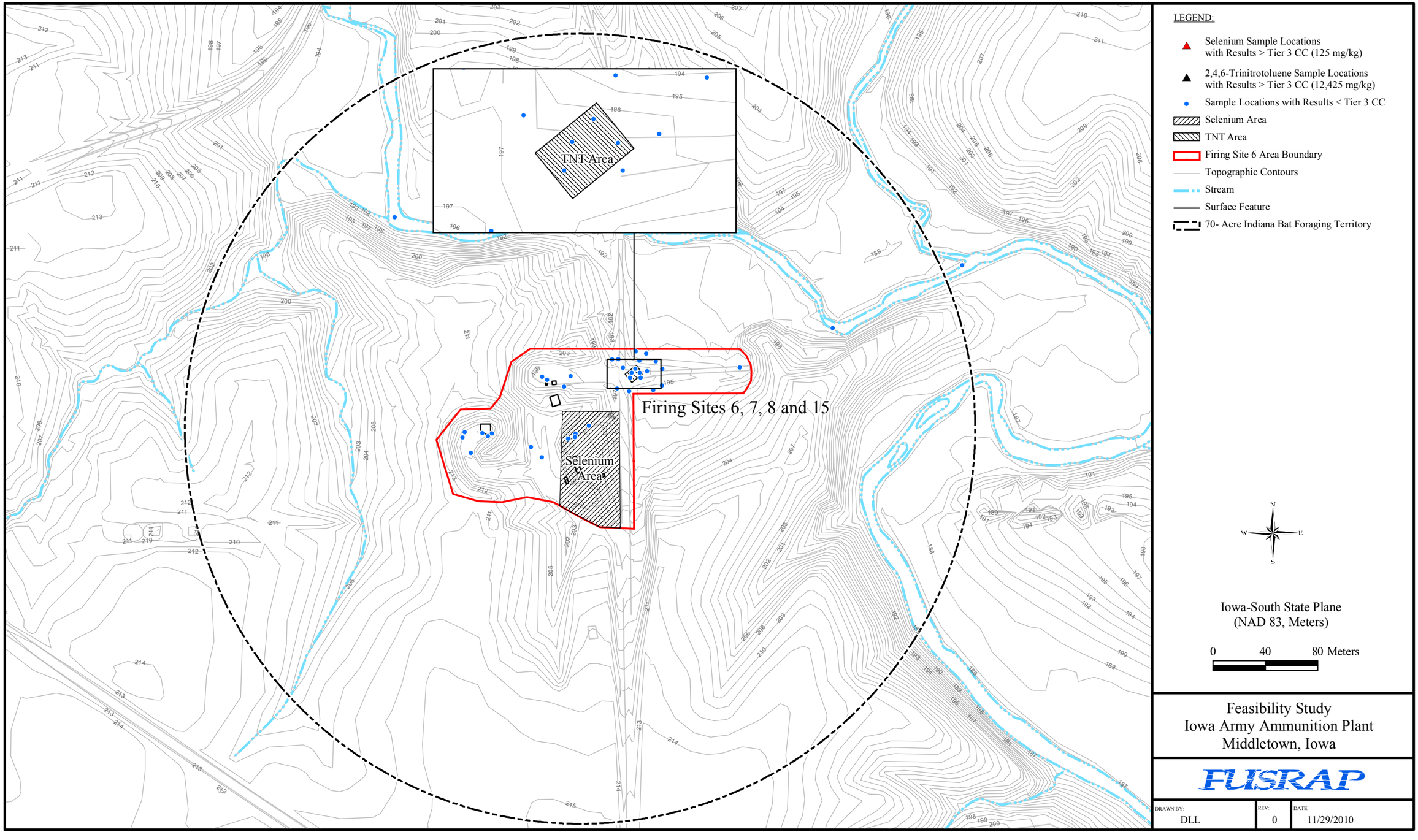
Feasibility Study
Iowa Army Ammunition Plant
Middletown, Iowa

FUSRAP

DRAWN BY:	REV:	DATE:
DLL	0	11/29/2010

U:\GPS\IAAAP\Feasibility Study\Projects\New\November 2010\Figure B-2 Exceedances of Ecological RG for Selenium and TNT.mxd

Figure B-2.
Exceedances of the Tier 2 (Firing Site-specific)
Indiana Bat CCs for Selenium and 2,4,6-Trinitrotoluene in Soil



U:\GPS\IAAAP\Feasibility Study\Projects\New\November 2010\Figure B-3 Exceedances of Ecological RG for Selenium and TNT.mxd

Figure B-3.
Exceedances of the Tier 3 (Firing Site-specific)
Indiana Bat CCs for Selenium and 2,4,6-Trinitrotoluene in Soil

APPENDIX C

RADIOLOGICAL RG DEVELOPMENT FOR SOIL

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DETERMINATION OF DERIVED CONCENTRATION GUIDELINE LEVELS FOR DEPLETED URANIUM IN SOIL AT THE IOWA ARMY AMMUNITION PLANT

INTRODUCTION

This appendix presents the results of DCGL calculations for DU that is present in soil at the FUSRAP areas of the IAAAP. In determining the DCGLs presented in this report, several receptor scenarios such as the site worker and construction worker scenarios were evaluated. The DCGLs presented in this document are based on the following:

- release under restricted conditions set forth by NRC in 10 *CFR* Part 20.1403(b), which states: "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 (0.25 mSv)] per year".
- USEPA defines the CERCLA target risk range as 10^{-6} to 10^{-4} where "the upper boundary of the risk range is not a discrete line at 1×10^{-4}. A specific risk estimate around 10^{-4} may be considered acceptable if justified based on site-specific conditions" (USEPA 1997d).

METHODOLOGY

The principal radiological contaminant in soil at the FSA is DU. DU is the byproduct remaining after the extraction of U-235 from naturally occurring uranium. DU typically contains about 99.799, 0.200, and 0.001% by weight U-238, U-235, and U-234, respectively, with corresponding activity percentages of 90.14, 1.45, and 8.40. Natural uranium, by comparison, consists of about 99.284, 0.711, and 0.005 weight percent U-238, U-235, and U-234, respectively, with corresponding activity percentages of 48.6, 2.2, and 49.2 for the stated radioisotopes.

The DCGL for DU was determined by using U-238 because the activity percentage was 90.14 of the total.

DETERMINATION OF THE DERIVED CONCENTRATION GUIDELINE LEVEL FOR DEPLETED URANIUM

Risk and Dose Assessment Model

RESRAD, version 6.4, was used to derive the DCGL for DU. RESRAD is a computer code developed at Argonne National Laboratory for DOE to determine site-specific residual radiation guidelines and dose to an on-site receptor at sites that are contaminated with residual radioactive materials.

Source Term

Based on Table 2-1 of *Guide of Good Practices for Occupational Radiological Protection in Uranium Facilities* (DOE 2000), DU is the sum of 99.8% of U-238, 0.0007% of U-234, and 0.2% of U-235 with respect to percentages by weight with corresponding activity percentages of 90.14, 1.45, and 8.40. Because U-238 accounts for over 90% of the DU activity, only U-238 DCGLs equivalent to the relative dose/risk limit were developed (i.e., the U-238 DCGLs will be based on relative dose/risk values that are less than the limit to account for dose/risk from U-234

and U-235) and will be protective considering associated U-234 and U-235. Therefore, soil analysis needs only account for U-238 to compare to the DCGL.

Site Physical Parameters

For this evaluation, the RESRAD parameters selected are consistent with those used in the RI Report (USACE 2008a), as well as USEPA's (1997f) *Exposure Factors Handbook*, USEPA's (2000b) *Soil Screening Guidance for Radionuclides*, and *Argonne National Laboratory's Data Collection Handbook to Support Modeling Impacts of Radioactive Material in Soil* (ANL 1993). Site-specific information is given the first preference for selection of site physical parameter values for RESRAD input parameters. The input parameters selected for the site worker and construction worker scenarios are the default RESRAD input parameters with the exception of inhalation and ingestion rate, exposure durations, and indoor/outdoor time fractions. The non-default RESRAD input parameters for the receptor scenarios are presented below in Table C-1.

Table C-1. RESRAD Input Parameters for Risk and Dose Assessments

Category	Parameter	Values	
Physical Parameters	Area of contaminated zone (m^2)	Firing Sites	354,695
	Thickness of the contaminated zone (m)	Firing Sites	0.9
Exposure Parameters		**Site Worker**	**Construction Worker**
	Inhalation rate[a] [cubic meters per year (m^3/yr)]	7,300	7,300
	Exposure duration (yr)	25	1
	Indoor time fraction	0	0
	Outdoor time fraction[b]	0.2283	0.2283
	Soil ingestion [grams per year (g/yr)][c]	18.25	175.2

[a] Inhalation rate is based upon 20 m^3/day * 365 day/year = 7,300 m^3/year.
[b] Fraction of time outdoor per year = (8 hr/day x 250 days/year) / (24 hr/day x 365 day/year) = 0.2283.
[c] Site worker soil ingestion = 50 mg/day x 365 day/year x g/1000 mg = 18.25 g/year.
Construction worker soil ingestion = 480 mg/day x 365 day/year x g/1000 mg = 175.2 g/year.

Receptor Scenarios

Based on the current and future land use, the site worker and construction worker receptors are modeled for this assessment.

Site Worker

The site worker scenario assumes that the critical receptor is a typical site worker who works 250 days/year for 25 years (USEPA 1991b). During a typical working day, the worker is assumed to spend 8 hours (hr) outdoors and will ingest 50 mg of soil. The site worker may be exposed to radioactive contamination through several exposure pathways relative to site soil. Members of the site worker critical group can incur a radiation dose via the following pathways:

- Direct radiation from radionuclides in the soil,
- Inhalation of re-suspended dust present on contaminated soil, and
- Direct ingestion of contaminated soil.

Construction Worker

The construction worker scenario assumes that the critical receptor is a typical construction worker who works 8 hr/day for 250 days. During a typical working day, the worker will ingest 480 mg of soil. A construction worker may be exposed to radioactive contamination through

several exposure pathways relative to site soil. Members of the construction worker critical group can incur a radiation dose via the following pathways:

- Direct radiation from radionuclides in the soil,
- Inhalation of re-suspended dust present on contaminated soil, and
- Direct ingestion of contaminated soil.

Development of a Soil Remediation Goal

In the risk and dose assessment of the RI Report (USACE 2008a), the carcinogenic risk and dose calculated for the site worker at the FSA as a result of exposure to site soil were $4x10^{-4}$ and 27 mrem/year, respectively. Additionally, a carcinogenic risk and dose of $2x10^{-5}$ and 36 mrem/year, respectively, were also calculated for the construction worker at the FSA. The risk estimated for the site worker marginally exceeds the CERCLA risk range and 10 *CFR* 20.1403(b) dose criteria without regard to exposures associated with structures or other carcinogenic contaminants; therefore, the site worker has been selected as the limiting receptor. Using the RESRAD Model, version 6.4, site-specific RGs (also known as DCGLs) for DU were developed for both receptor scenarios (site worker and construction worker) that were evaluated in the risk and dose assessment of the RI Report (USACE 2008a). These RGs, which are based on the known activity percentages of the uranium isotopes, are presented in Table C-2. Additionally, to comply with the CERCLA risk range of 10^{-6} to 10^{-4}, RGs based on target cancer risks of 1×10^{-6}, 1×10^{-5}, and 1×10^{-4} have also been calculated for FSA soil and are presented in Table C-2. To be health-protective of U-234 and U-235, the risk-based soil DCGLs also consider the activity percent contribution of U-238.

Table C-3 presents the risk-based soil DCGL for U-238 that is protective of all DU constituents. Using RESRAD, risk-to-source ratios were developed for each radionuclide. A relative DU risk was then calculated by multiplying the risk-to-source ratio and the DU activity concentration. An equivalent risk was then calculated by dividing the isotopic relative DU risk by the sum of the isotopic DU risks and multiplying by the risk limit. (In Table C-3, the risk limit of 1E-4 was used. Other risk-based DCGLs provided in Table C-4 were calculated using the same methodology.) The U-238 DCGL (equivalent to 1E-4 DU risk) was calculated by dividing the isotopic equivalent risk by the associated risk-to-source ratio.

Table C-2. Dose- and Risk-Based Derived Concentration Guideline Levels for Consideration as Soil Remediation Goals

Scenario	TEDE = 22.5 mrem/year (pCi/g)	TR = 1 x 10^{-6} (pCi/g)	TR = 1 x 10^{-5} (pCi/g)	TR = 1 x 10^{-4} (pCi/g)
Site Worker	575	2	15	150
Construction Worker	461	30	295	2950

NOTE: Construction worker DCGLs were calculated in the same way as the site worker DCGLs.

Table C-3. Iowa Army Ammunition Plant Risk-Based Derived Concentration Guideline Levels

Isotope	RSR Risk/pCi/g	DU Activity Concentration (%)	Relative DU Risk (Risk/pCi/g) (%)		1.00E-04 Isotopic Equivalent Risk	DCGL (pCi/g)
U-234	3.60E-08	0.084	3.02E-09	1	5.02E-07	
U-235	2.84E-06	0.0145	4.12E-08	7	6.84E-06	

U-238	6.19E-07	0.9014	5.58E-07	93	9.27E-05	**150**
		Total	6.03E-07			

RSR = Risk-to-source ratio.

The dose DCGL for U-238 is calculated the same as the risk DCGL. Table C-4 shows these calculations.

Table C-4. Iowa Army Ammunition Plant Dose-Based Derived Concentration Guideline Levels

Isotope	DSR (mrem/year/pCi/g)	DU Activity Concentration (%)	Relative DU Dose (mrem/year/pCi/g) (%)		25-mrem/year Isotopic Equivalent Dose	DCGL (pCi/g)
U-234	6.57E-03	0.084	5.52E-04	1	3.52E-01	
U-235	1.77E-01	0.0145	2.57E-03	7	1.64E+00	
U-238	4.00E-02	0.9014	3.61E-02	92	2.30E+01	**575**
		Total	3.92E-02			

DSR = Dose-to-source ratio.

Following a review of the soil DCGLs presented in Table C-2, the consideration of dose- and risk-based DCGLs was narrowed to include the site worker DCGLs of 575 and 150 pCi/g, respectively, for further evaluation to determine the selected FSA soil RG for the following reasons: the site worker has been identified as the limiting receptor, and the target risk of 1×10^{-4} is consistent with the current and expected future land of the IAAAP. Because the risk-based DCGL (150 pCi/g) is more restrictive (i.e., more health-conservative) than the dose-based DCGL (575 pCi/g), the risk-based DCGL of 150 pCi/g (U-238) has been selected as the DU RG for FSA soil.

RESRAD output files are included as Attachments B-1 and B-2.

ATTACHMENT C-1

Site Worker RESRAD Dose Output Report

(On the CD-ROM on the Back Cover of this Report)

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1RESRAD, Version 6.4 T½ Limit = 180 days 06/12/2009 09:00 Page 1

Summary : IAAAP Industrial Worker
File : C:\RESRAD\IAAAP INDUSTRIAL WORKER.RAD

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Summary : IAAAP Industrial Worker
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Dose Conversion Factor (and Related) Parameter Summary
Dose Library: FGR 11

0 Menu	Parameter	Current Value#	Base Case*	Parameter Name
A-1	DCF's for external ground radiation, (mrem/yr)/(pCi/g)			
A-1	Ac-227 (Source: FGR 12)	4.951E-04	4.951E-04	DCF1(1)
A-1	At-218 (Source: FGR 12)	5.847E-03	5.847E-03	DCF1(2)
A-1	Bi-210 (Source: FGR 12)	3.606E-03	3.606E-03	DCF1(3)
A-1	Bi-211 (Source: FGR 12)	2.559E-01	2.559E-01	DCF1(4)
A-1	Bi-214 (Source: FGR 12)	9.808E+00	9.808E+00	DCF1(5)
A-1	Fr-223 (Source: FGR 12)	1.980E-01	1.980E-01	DCF1(6)
A-1	Pa-231 (Source: FGR 12)	1.906E-01	1.906E-01	DCF1(7)
A-1	Pa-234 (Source: FGR 12)	1.155E+01	1.155E+01	DCF1(8)
A-1	Pa-234m (Source: FGR 12)	8.967E-02	8.967E-02	DCF1(9)
A-1	Pb-210 (Source: FGR 12)	2.447E-03	2.447E-03	DCF1(10)
A-1	Pb-211 (Source: FGR 12)	3.064E-01	3.064E-01	DCF1(11)
A-1	Pb-214 (Source: FGR 12)	1.341E+00	1.341E+00	DCF1(12)
A-1	Po-210 (Source: FGR 12)	5.231E-05	5.231E-05	DCF1(13)
A-1	Po-211 (Source: FGR 12)	4.764E-02	4.764E-02	DCF1(14)
A-1	Po-214 (Source: FGR 12)	5.138E-04	5.138E-04	DCF1(15)
A-1	Po-215 (Source: FGR 12)	1.016E-03	1.016E-03	DCF1(16)
A-1	Po-218 (Source: FGR 12)	5.642E-05	5.642E-05	DCF1(17)
A-1	Ra-223 (Source: FGR 12)	6.034E-01	6.034E-01	DCF1(18)
A-1	Ra-226 (Source: FGR 12)	3.176E-02	3.176E-02	DCF1(19)
A-1	Rn-219 (Source: FGR 12)	3.083E-01	3.083E-01	DCF1(20)
A-1	Rn-222 (Source: FGR 12)	2.354E-03	2.354E-03	DCF1(21)
A-1	Th-227 (Source: FGR 12)	5.212E-01	5.212E-01	DCF1(22)
A-1	Th-230 (Source: FGR 12)	1.209E-03	1.209E-03	DCF1(23)
A-1	Th-231 (Source: FGR 12)	3.643E-02	3.643E-02	DCF1(24)
A-1	Th-234 (Source: FGR 12)	2.410E-02	2.410E-02	DCF1(25)
A-1	Tl-207 (Source: FGR 12)	1.980E-02	1.980E-02	DCF1(26)
A-1	Tl-210 (Source: no data)	0.000E+00	-2.000E+00	DCF1(27)
A-1	U-234 (Source: FGR 12)	4.017E-04	4.017E-04	DCF1(28)
A-1	U-235 (Source: FGR 12)	7.211E-01	7.211E-01	DCF1(29)
A-1	U-238 (Source: FGR 12)	1.031E-04	1.031E-04	DCF1(30)
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ac-227+D	6.724E+00	6.700E+00	DCF2(1)
B-1	Pa-231	1.280E+00	1.280E+00	DCF2(2)
B-1	Pb-210+D	2.320E-02	1.360E-02	DCF2(3)
B-1	Ra-226+D	8.594E-03	8.580E-03	DCF2(4)
B-1	Th-230	3.260E-01	3.260E-01	DCF2(5)
B-1	U-234	1.320E-01	1.320E-01	DCF2(6)
B-1	U-235+D	1.230E-01	1.230E-01	DCF2(7)
B-1	U-238	1.180E-01	1.180E-01	DCF2(8)
B-1	U-238+D	1.180E-01	1.180E-01	DCF2(9)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ac-227+D	1.480E-02	1.410E-02	DCF3(1)
D-1	Pa-231	1.060E-02	1.060E-02	DCF3(2)
D-1	Pb-210+D	7.276E-03	5.370E-03	DCF3(3)
D-1	Ra-226+D	1.321E-03	1.320E-03	DCF3(4)
D-1	Th-230	5.480E-04	5.480E-04	DCF3(5)
D-1	U-234	2.830E-04	2.830E-04	DCF3(6)

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Summary : IAAAP Industrial Worker
File : C:\RESRAD\IAAAP INDUSTRIAL WORKER.RAD

Dose Conversion Factor (and Related) Parameter Summary (continued)
Dose Library: FGR 11

0 Menu	Parameter	Current Value#	Base Case*	Parameter Name
D-1	U-235+D	2.673E-04	2.660E-04	DCF3(7)
D-1	U-238	2.550E-04	2.550E-04	DCF3(8)
D-1	U-238+D	2.687E-04	2.550E-04	DCF3(9)
D-34	Food transfer factors:			
D-34	Ac-227+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(1,1)
D-34	Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,2)
D-34	Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,3)
D-34				
D-34	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(2,1)
D-34	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(2,2)
D-34	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(2,3)
D-34				
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(3,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(3,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(3,3)
D-34				
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(4,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(4,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(4,3)
D-34				
D-34	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(5,1)
D-34	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(5,2)
D-34	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(5,3)
D-34				
D-34	U-234 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(6,1)
D-34	U-234 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(6,2)
D-34	U-234 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(6,3)
D-34				
D-34	U-235+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(7,1)
D-34	U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(7,2)
D-34	U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(7,3)
D-34				
D-34	U-238 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(8,1)
D-34	U-238 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(8,2)
D-34	U-238 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(8,3)
D-34				
D-34	U-238+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(9,1)
D-34	U-238+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(9,2)
D-34	U-238+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(9,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Ac-227+D , fish	1.500E+01	1.500E+01	BIOFAC(1,1)
D-5	Ac-227+D , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(1,2)
D-5				
D-5	Pa-231 , fish	1.000E+01	1.000E+01	BIOFAC(2,1)
D-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC(2,2)
D-5				
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(3,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(3,2)

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Dose Conversion Factor (and Related) Parameter Summary (continued)
Dose Library: FGR 11

0 Menu	Parameter	Current Value#	Base Case*	Parameter Name
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(4,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(4,2)
D-5				
D-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC(5,1)
D-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(5,2)
D-5				
D-5	U-234 , fish	1.000E+01	1.000E+01	BIOFAC(6,1)
D-5	U-234 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(6,2)
D-5				
D-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(7,1)
D-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(7,2)
D-5				
D-5	U-238 , fish	1.000E+01	1.000E+01	BIOFAC(8,1)
D-5	U-238 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(8,2)
D-5				
D-5	U-238+D , fish	1.000E+01	1.000E+01	BIOFAC(9,1)
D-5	U-238+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(9,2)

#For DCF1(xxx) only, factors are for infinite depth & area. See ETFG table in Ground Pathway of Detailed Report.
*Base Case means Default.Lib w/o Associate Nuclide contributions.

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Site-Specific Parameter Summary

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	3.547E+05	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	9.000E-01	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	not used	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	2.500E+01	3.000E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): U-234	1.000E+00	0.000E+00	---	S1(6)
R012	Initial principal radionuclide (pCi/g): U-235	1.000E+00	0.000E+00	---	S1(7)
R012	Initial principal radionuclide (pCi/g): U-238	1.000E+00	0.000E+00	---	S1(8)
R012	Concentration in groundwater (pCi/L): U-234	not used	0.000E+00	---	W1(6)
R012	Concentration in groundwater (pCi/L): U-235	not used	0.000E+00	---	W1(7)
R012	Concentration in groundwater (pCi/L): U-238	not used	0.000E+00	---	W1(8)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	2.000E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	2.000E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	5.000E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.000E+00	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	2.000E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	not used	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	not used	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	not used	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	not used	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	not used	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	not used	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	not used	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	not used	2.000E-02	---	HGWT
R014	Saturated zone b parameter	not used	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	not used	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	not used	1.000E+01	---	DWIBWT

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Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	not used	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	not used	2.500E+02	---	UW
R015	Number of unsaturated zone strata	not used	1	---	NS
R015	Unsat. zone 1, thickness (m)	not used	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	not used	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	not used	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	not used	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	not used	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	not used	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	not used	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for U-234				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(6)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(6,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.376E-03	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
R016	Distribution coefficients for U-235				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(7)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(7,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(7)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.376E-03	ALEACH(7)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(7)
R016	Distribution coefficients for U-238				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(8)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(8,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(8)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.376E-03	ALEACH(8)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(8)
R016	Distribution coefficients for daughter Ac-227				
R016	Contaminated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	not used	2.000E+01	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	not used	2.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.832E-02	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for daughter Pa-231				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.376E-03	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)

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0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	not used	1.000E+02	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	not used	1.000E+02	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.696E-03	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for daughter Ra-226				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	not used	7.000E+01	---	DCNUCU(4,1)
R016	Saturated zone (cm**3/g)	not used	7.000E+01	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.275E-03	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R016	Distribution coefficients for daughter Th-230				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(5)
R016	Unsaturated zone 1 (cm**3/g)	not used	6.000E+04	---	DCNUCU(5,1)
R016	Saturated zone (cm**3/g)	not used	6.000E+04	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	6.173E-06	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R017	Inhalation rate (m**3/yr)	7.300E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	1.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	2.500E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	7.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	0.000E+00	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	2.283E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)

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0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	not used	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	not used	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	1.825E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	not used	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	not used	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	not used	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	not used	-1	---	FPLANT
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	not used	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	not used	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	not used	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	not used	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	not used	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	not used	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	not used	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	not used	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	not used	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	not used	8.000E-02	---	TE(3)

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Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R19B	Translocation Factor for Non-Leafy	not used	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	not used	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	not used	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	not used	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)
TITL	Number of graphical time points	32	---	---	NPTS

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Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
TITL	Maximum number of integration points for dose	17	---	---	LYMAX
TITL	Maximum number of integration points for risk	257	---	---	KYMAX

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	suppressed
4 -- meat ingestion	suppressed
5 -- milk ingestion	suppressed
6 -- aquatic foods	suppressed
7 -- drinking water	suppressed
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	active

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Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	354695.00 square meters	U-234	1.000E+00
Thickness:	0.90 meters	U-235	1.000E+00
Cover Depth:	0.00 meters	U-238	1.000E+00

0

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 2.500E+01 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	2.240E-01	2.223E-01	2.191E-01	2.081E-01	1.797E-01	1.078E-01	2.512E-02	0.000E+00
M(t):	8.959E-03	8.893E-03	8.763E-03	8.324E-03	7.189E-03	4.310E-03	1.005E-03	0.000E+00

0Maximum TDOSE(t): 2.240E-01 mrem/yr at t = 0.000E+00 years

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
0 Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	9.114E-05	0.0004	5.304E-03	0.0237	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.175E-03	0.0052
U-235	1.713E-01	0.7649	4.943E-03	0.0221	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.110E-03	0.0050
U-238	3.417E-02	0.1526	4.743E-03	0.0212	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.115E-03	0.0050
Total	2.056E-01	0.9179	1.499E-02	0.0669	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.401E-03	0.0152

0
Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
0 Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.570E-03	0.0293
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.774E-01	0.7919
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.003E-02	0.1787
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.240E-01	1.0000

0*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years
0 Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	9.048E-05	0.0004	5.265E-03	0.0237	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.166E-03	0.0052
U-235	1.701E-01	0.7649	4.908E-03	0.0221	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.103E-03	0.0050
U-238	3.392E-02	0.1526	4.708E-03	0.0212	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.107E-03	0.0050
Total	2.041E-01	0.9179	1.488E-02	0.0669	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.377E-03	0.0152

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years
0 Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.522E-03	0.0293
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.761E-01	0.7919
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.974E-02	0.1787
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.223E-01	1.0000

0*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years
0 Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	8.921E-05	0.0004	5.188E-03	0.0237	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.149E-03	0.0052
U-235	1.676E-01	0.7649	4.839E-03	0.0221	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.089E-03	0.0050
U-238	3.343E-02	0.1526	4.639E-03	0.0212	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.091E-03	0.0050
Total	2.011E-01	0.9179	1.467E-02	0.0669	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.329E-03	0.0152

0
Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years
0 Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.427E-03	0.0293
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.735E-01	0.7919
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.916E-02	0.1787
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.191E-01	1.0000

0*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years
0 Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	8.520E-05	0.0004	4.928E-03	0.0237	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.091E-03	0.0052
U-235	1.592E-01	0.7648	4.610E-03	0.0222	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.042E-03	0.0050
U-238	3.174E-02	0.1525	4.406E-03	0.0212	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.036E-03	0.0050
Total	1.910E-01	0.9178	1.394E-02	0.0670	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.169E-03	0.0152

0
Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years
0 Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.104E-03	0.0293
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.648E-01	0.7920
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.719E-02	0.1787
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.081E-01	1.0000

0*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years
0 Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	7.711E-05	0.0004	4.254E-03	0.0237	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.421E-04	0.0052
U-235	1.374E-01	0.7646	4.034E-03	0.0224	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.227E-04	0.0051
U-238	2.739E-02	0.1524	3.802E-03	0.0212	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.941E-04	0.0050
Total	1.649E-01	0.9174	1.209E-02	0.0673	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.759E-03	0.0154

0
Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years
0 Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.273E-03	0.0293
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.424E-01	0.7921
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.209E-02	0.1785
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.797E-01	1.0000

0*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years
0 Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	7.617E-05	0.0007	2.544E-03	0.0236	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.634E-04	0.0052
U-235	8.224E-02	0.7632	2.573E-03	0.0239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.113E-04	0.0057
U-238	1.634E-02	0.1517	2.269E-03	0.0211	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.336E-04	0.0050
Total	9.866E-02	0.9156	7.387E-03	0.0686	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.708E-03	0.0159

0
Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years
0 Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.184E-03	0.0295
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.543E-02	0.7928
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.915E-02	0.1777
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.078E-01	1.0000

0*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years
0 Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	1.447E-04	0.0058	5.941E-04	0.0236	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.325E-04	0.0053
U-235	1.899E-02	0.7558	7.049E-04	0.0281	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.812E-04	0.0072
U-238	3.738E-03	0.1488	5.194E-04	0.0207	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.221E-04	0.0049
Total	2.287E-02	0.9103	1.818E-03	0.0724	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.358E-04	0.0173

0
Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years
0 Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.712E-04	0.0347
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.987E-02	0.7910
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.379E-03	0.1743
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.512E-02	1.0000

0*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years
0 Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

0
Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years
0 Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

0*Sum of all water independent and dependent pathways.

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Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

0 Parent (i)	Product (j)	Thread Fraction	DSR(j,t) At Time in Years (mrem/yr)/(pCi/g) 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
U-234	U-234	1.000E+00	6.570E-03	6.522E-03	6.426E-03	6.103E-03	5.265E-03	3.141E-03	7.181E-04	0.000E+00
U-234	Th-230	1.000E+00	7.052E-08	2.109E-07	4.884E-07	1.428E-06	3.860E-06	1.002E-05	1.702E-05	0.000E+00
U-234	Ra-226+D	1.000E+00	1.636E-09	1.141E-08	5.982E-08	5.191E-07	4.015E-06	3.249E-05	1.347E-04	0.000E+00
U-234	Pb-210+D	1.000E+00	1.633E-13	2.424E-12	2.765E-11	6.759E-10	1.320E-08	2.350E-07	1.406E-06	0.000E+00
U-234	ΣDSR(j)		6.570E-03	6.522E-03	6.427E-03	6.104E-03	5.273E-03	3.184E-03	8.712E-04	0.000E+00
0U-235+D	U-235+D	1.000E+00	1.774E-01	1.761E-01	1.735E-01	1.648E-01	1.422E-01	8.483E-02	1.940E-02	0.000E+00
U-235+D	Pa-231	1.000E+00	1.463E-06	4.359E-06	1.003E-05	2.856E-05	7.158E-05	1.406E-04	9.599E-05	0.000E+00
U-235+D	Ac-227+D	1.000E+00	8.713E-08	5.987E-07	3.036E-06	2.347E-05	1.335E-04	4.579E-04	3.740E-04	0.000E+00
U-235+D	ΣDSR(j)		1.774E-01	1.761E-01	1.735E-01	1.648E-01	1.424E-01	8.543E-02	1.987E-02	0.000E+00
0U-238	U-238	5.400E-05	3.145E-07	3.122E-07	3.076E-07	2.921E-07	2.520E-07	1.504E-07	3.440E-08	0.000E+00
0U-238+D	U-238+D	9.999E-01	4.003E-02	3.974E-02	3.916E-02	3.718E-02	3.208E-02	1.915E-02	4.379E-03	0.000E+00
U-238+D	U-234	9.999E-01	9.301E-09	2.772E-08	6.375E-08	1.816E-07	4.553E-07	8.951E-07	6.120E-07	0.000E+00
U-238+D	Th-230	9.999E-01	6.655E-14	4.639E-13	2.429E-12	2.100E-11	1.607E-10	1.254E-09	4.773E-09	0.000E+00
U-238+D	Ra-226+D	9.999E-01	1.159E-15	1.731E-14	1.999E-13	5.117E-12	1.131E-10	2.851E-09	2.967E-08	0.000E+00
U-238+D	Pb-210+D	9.999E-01	9.262E-20	2.844E-18	7.017E-17	5.086E-15	2.920E-13	1.748E-11	2.897E-10	0.000E+00
U-238+D	ΣDSR(j)		4.003E-02	3.974E-02	3.916E-02	3.719E-02	3.209E-02	1.915E-02	4.379E-03	0.000E+00

The DSR includes contributions from associated (half-life ≤ 180 days) daughters.
0

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 2.500E+01 mrem/yr

0Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
U-234	3.805E+03	3.833E+03	3.890E+03	4.095E+03	4.741E+03	7.852E+03	2.870E+04	*6.247E+09
U-235	1.410E+02	1.420E+02	1.441E+02	1.517E+02	1.756E+02	2.926E+02	1.258E+03	*2.161E+06
U-238	6.245E+02	6.291E+02	6.385E+02	6.723E+02	7.792E+02	1.306E+03	5.709E+03	*3.361E+05

*At specific activity limit
0

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

0Nuclide (i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
U-234	1.000E+00	0.000E+00	6.570E-03	3.805E+03	6.570E-03	3.805E+03
U-235	1.000E+00	0.000E+00	1.774E-01	1.410E+02	1.774E-01	1.410E+02
U-238	1.000E+00	0.000E+00	4.003E-02	6.245E+02	4.003E-02	6.245E+02

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Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

0Nuclide (j)	Parent (i)	THF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
U-234	U-234	1.000E+00	6.570E-03	6.522E-03	6.426E-03	6.103E-03	5.265E-03	3.141E-03	7.181E-04	0.000E+00
U-234	U-238	9.999E-01	9.301E-09	2.772E-08	6.375E-08	1.816E-07	4.553E-07	8.951E-07	6.120E-07	0.000E+00
U-234	ΣDOSE(j)		6.570E-03	6.522E-03	6.426E-03	6.103E-03	5.266E-03	3.142E-03	7.187E-04	0.000E+00
0Th-230	U-234	1.000E+00	7.052E-08	2.109E-07	4.884E-07	1.428E-06	3.860E-06	1.002E-05	1.702E-05	0.000E+00
Th-230	U-238	9.999E-01	6.655E-14	4.639E-13	2.429E-12	2.100E-11	1.607E-10	1.254E-09	4.773E-09	0.000E+00
Th-230	ΣDOSE(j)		7.052E-08	2.109E-07	4.884E-07	1.428E-06	3.861E-06	1.003E-05	1.703E-05	0.000E+00
0Ra-226	U-234	1.000E+00	1.636E-09	1.141E-08	5.982E-08	5.191E-07	4.015E-06	3.249E-05	1.347E-04	0.000E+00
Ra-226	U-238	9.999E-01	1.159E-15	1.731E-14	1.999E-13	5.117E-12	1.131E-10	2.851E-09	2.967E-08	0.000E+00
Ra-226	ΣDOSE(j)		1.636E-09	1.141E-08	5.982E-08	5.191E-07	4.016E-06	3.249E-05	1.347E-04	0.000E+00
0Pb-210	U-234	1.000E+00	1.633E-13	2.424E-12	2.765E-11	6.759E-10	1.320E-08	2.350E-07	1.406E-06	0.000E+00
Pb-210	U-238	9.999E-01	9.262E-20	2.844E-18	7.017E-17	5.086E-15	2.920E-13	1.748E-11	2.897E-10	0.000E+00
Pb-210	ΣDOSE(j)		1.633E-13	2.424E-12	2.765E-11	6.759E-10	1.320E-08	2.350E-07	1.407E-06	0.000E+00
0U-235	U-235	1.000E+00	1.774E-01	1.761E-01	1.735E-01	1.648E-01	1.422E-01	8.483E-02	1.940E-02	0.000E+00
0Pa-231	U-235	1.000E+00	1.463E-06	4.359E-06	1.003E-05	2.856E-05	7.158E-05	1.406E-04	9.599E-05	0.000E+00
0Ac-227	U-235	1.000E+00	8.713E-08	5.987E-07	3.036E-06	2.347E-05	1.335E-04	4.579E-04	3.740E-04	0.000E+00
0U-238	U-238	5.400E-05	3.145E-07	3.122E-07	3.076E-07	2.921E-07	2.520E-07	1.504E-07	3.440E-08	0.000E+00
U-238	U-238	9.999E-01	4.003E-02	3.974E-02	3.916E-02	3.718E-02	3.208E-02	1.915E-02	4.379E-03	0.000E+00
U-238	ΣDOSE(j)		4.003E-02	3.974E-02	3.916E-02	3.719E-02	3.209E-02	1.915E-02	4.379E-03	0.000E+00

THF(i) is the thread fraction of the parent nuclide.

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Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

0Nuclide (j)	Parent (i)	THF(i)	S(j,t), pCi/g t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
U-234	U-234	1.000E+00	1.000E+00	9.926E-01	9.781E-01	9.289E-01	8.014E-01	4.781E-01	1.093E-01	6.244E-04
U-234	U-238	9.999E-01	0.000E+00	2.814E-06	8.318E-06	2.633E-05	6.816E-05	1.356E-04	9.300E-05	1.773E-06
U-234	ΣS(j):		1.000E+00	9.927E-01	9.781E-01	9.289E-01	8.015E-01	4.783E-01	1.094E-01	6.262E-04
0Th-230	U-234	1.000E+00	0.000E+00	8.969E-06	2.671E-05	8.677E-05	2.422E-04	6.361E-04	1.083E-03	1.203E-03
Th-230	U-238	9.999E-01	0.000E+00	1.270E-11	1.132E-10	1.215E-09	9.920E-09	7.921E-08	3.035E-07	4.613E-07
Th-230	ΣS(j):		0.000E+00	8.969E-06	2.671E-05	8.677E-05	2.422E-04	6.362E-04	1.084E-03	1.204E-03
0Ra-226	U-234	1.000E+00	0.000E+00	1.941E-09	1.732E-08	1.867E-07	1.541E-06	1.276E-05	5.328E-05	9.047E-05
Ra-226	U-238	9.999E-01	0.000E+00	1.833E-15	4.899E-14	1.751E-12	4.270E-11	1.115E-09	1.172E-08	3.395E-08
Ra-226	ΣS(j):		0.000E+00	1.941E-09	1.732E-08	1.867E-07	1.541E-06	1.276E-05	5.329E-05	9.050E-05
0Pb-210	U-234	1.000E+00	0.000E+00	1.996E-11	5.263E-10	1.796E-08	3.869E-07	7.125E-06	4.301E-05	8.070E-05
Pb-210	U-238	9.999E-01	0.000E+00	1.416E-17	1.122E-15	1.284E-13	8.414E-12	5.274E-10	8.847E-09	3.016E-08
Pb-210	ΣS(j):		0.000E+00	1.996E-11	5.263E-10	1.796E-08	3.869E-07	7.126E-06	4.302E-05	8.073E-05
0U-235	U-235	1.000E+00	1.000E+00	9.927E-01	9.781E-01	9.289E-01	8.015E-01	4.783E-01	1.094E-01	6.262E-04
0Pa-231	U-235	1.000E+00	0.000E+00	2.100E-05	6.208E-05	1.965E-04	5.086E-04	1.011E-03	6.922E-04	1.311E-05
0Ac-227	U-235	1.000E+00	0.000E+00	3.296E-07	2.842E-06	2.726E-05	1.653E-04	5.789E-04	4.751E-04	9.530E-06
0U-238	U-238	5.400E-05	5.400E-05	5.360E-05	5.282E-05	5.016E-05	4.328E-05	2.583E-05	5.908E-06	3.381E-08
U-238	U-238	9.999E-01	9.999E-01	9.926E-01	9.781E-01	9.288E-01	8.015E-01	4.782E-01	1.094E-01	6.262E-04
U-238	ΣS(j):		1.000E+00	9.927E-01	9.781E-01	9.289E-01	8.015E-01	4.783E-01	1.094E-01	6.262E-04

THF(i) is the thread fraction of the parent nuclide.
0RESCALC.EXE execution time = 2.25 seconds

CONSTRUCTION WORKER RESRAD DOSE OUTPUT REPORT

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Dose Conversion Factor (and Related) Parameter Summary
Dose Library: FGR 11

0 Menu	Parameter	Current Value#	Base Case*	Parameter Name
A-1	DCF's for external ground radiation, (mrem/yr)/(pCi/g)			
A-1	Ac-227 (Source: FGR 12)	4.951E-04	4.951E-04	DCF1(1)
A-1	At-218 (Source: FGR 12)	5.847E-03	5.847E-03	DCF1(2)
A-1	Bi-210 (Source: FGR 12)	3.606E-03	3.606E-03	DCF1(3)
A-1	Bi-211 (Source: FGR 12)	2.559E-01	2.559E-01	DCF1(4)
A-1	Bi-214 (Source: FGR 12)	9.808E+00	9.808E+00	DCF1(5)
A-1	Fr-223 (Source: FGR 12)	1.980E-01	1.980E-01	DCF1(6)
A-1	Pa-231 (Source: FGR 12)	1.906E-01	1.906E-01	DCF1(7)
A-1	Pa-234 (Source: FGR 12)	1.155E+01	1.155E+01	DCF1(8)
A-1	Pa-234m (Source: FGR 12)	8.967E-02	8.967E-02	DCF1(9)
A-1	Pb-210 (Source: FGR 12)	2.447E-03	2.447E-03	DCF1(10)
A-1	Pb-211 (Source: FGR 12)	3.064E-01	3.064E-01	DCF1(11)
A-1	Pb-214 (Source: FGR 12)	1.341E+00	1.341E+00	DCF1(12)
A-1	Po-210 (Source: FGR 12)	5.231E-05	5.231E-05	DCF1(13)
A-1	Po-211 (Source: FGR 12)	4.764E-02	4.764E-02	DCF1(14)
A-1	Po-214 (Source: FGR 12)	5.138E-04	5.138E-04	DCF1(15)
A-1	Po-215 (Source: FGR 12)	1.016E-03	1.016E-03	DCF1(16)
A-1	Po-218 (Source: FGR 12)	5.642E-05	5.642E-05	DCF1(17)
A-1	Ra-223 (Source: FGR 12)	6.034E-01	6.034E-01	DCF1(18)
A-1	Ra-226 (Source: FGR 12)	3.176E-02	3.176E-02	DCF1(19)
A-1	Rn-219 (Source: FGR 12)	3.083E-01	3.083E-01	DCF1(20)
A-1	Rn-222 (Source: FGR 12)	2.354E-03	2.354E-03	DCF1(21)
A-1	Th-227 (Source: FGR 12)	5.212E-01	5.212E-01	DCF1(22)
A-1	Th-230 (Source: FGR 12)	1.209E-03	1.209E-03	DCF1(23)
A-1	Th-231 (Source: FGR 12)	3.643E-02	3.643E-02	DCF1(24)
A-1	Th-234 (Source: FGR 12)	2.410E-02	2.410E-02	DCF1(25)
A-1	Tl-207 (Source: FGR 12)	1.980E-02	1.980E-02	DCF1(26)
A-1	Tl-210 (Source: no data)	0.000E+00	-2.000E+00	DCF1(27)
A-1	U-234 (Source: FGR 12)	4.017E-04	4.017E-04	DCF1(28)
A-1	U-235 (Source: FGR 12)	7.211E-01	7.211E-01	DCF1(29)
A-1	U-238 (Source: FGR 12)	1.031E-04	1.031E-04	DCF1(30)
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ac-227+D	6.724E+00	6.700E+00	DCF2(1)
B-1	Pa-231	1.280E+00	1.280E+00	DCF2(2)
B-1	Pb-210+D	2.320E-02	1.360E-02	DCF2(3)
B-1	Ra-226+D	8.594E-03	8.580E-03	DCF2(4)
B-1	Th-230	3.260E-01	3.260E-01	DCF2(5)
B-1	U-234	1.320E-01	1.320E-01	DCF2(6)
B-1	U-235+D	1.230E-01	1.230E-01	DCF2(7)
B-1	U-238	1.180E-01	1.180E-01	DCF2(8)
B-1	U-238+D	1.180E-01	1.180E-01	DCF2(9)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ac-227+D	1.480E-02	1.410E-02	DCF3(1)
D-1	Pa-231	1.060E-02	1.060E-02	DCF3(2)
D-1	Pb-210+D	7.276E-03	5.370E-03	DCF3(3)
D-1	Ra-226+D	1.321E-03	1.320E-03	DCF3(4)
D-1	Th-230	5.480E-04	5.480E-04	DCF3(5)
D-1	U-234	2.830E-04	2.830E-04	DCF3(6)

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Dose Conversion Factor (and Related) Parameter Summary (continued)
Dose Library: FGR 11

0 Menu	Parameter	Current Value#	Base Case*	Parameter Name
D-1	U-235+D	2.673E-04	2.660E-04	DCF3(7)
D-1	U-238	2.550E-04	2.550E-04	DCF3(8)
D-1	U-238+D	2.687E-04	2.550E-04	DCF3(9)
D-34	Food transfer factors:			
D-34	Ac-227+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(1,1)
D-34	Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,2)
D-34	Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,3)
D-34				
D-34	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(2,1)
D-34	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(2,2)
D-34	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(2,3)
D-34				
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(3,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(3,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(3,3)
D-34				
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(4,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(4,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(4,3)
D-34				
D-34	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(5,1)
D-34	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(5,2)
D-34	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(5,3)
D-34				
D-34	U-234 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(6,1)
D-34	U-234 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(6,2)
D-34	U-234 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(6,3)
D-34				
D-34	U-235+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(7,1)
D-34	U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(7,2)
D-34	U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(7,3)
D-34				
D-34	U-238 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(8,1)
D-34	U-238 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(8,2)
D-34	U-238 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(8,3)
D-34				
D-34	U-238+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(9,1)
D-34	U-238+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(9,2)
D-34	U-238+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(9,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Ac-227+D , fish	1.500E+01	1.500E+01	BIOFAC(1,1)
D-5	Ac-227+D , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(1,2)
D-5				
D-5	Pa-231 , fish	1.000E+01	1.000E+01	BIOFAC(2,1)
D-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC(2,2)
D-5				
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(3,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(3,2)

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Dose Conversion Factor (and Related) Parameter Summary (continued)
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0 Menu	Parameter	Current Value#	Base Case*	Parameter Name
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(4,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(4,2)
D-5				
D-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC(5,1)
D-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(5,2)
D-5				
D-5	U-234 , fish	1.000E+01	1.000E+01	BIOFAC(6,1)
D-5	U-234 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(6,2)
D-5				
D-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(7,1)
D-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(7,2)
D-5				
D-5	U-238 , fish	1.000E+01	1.000E+01	BIOFAC(8,1)
D-5	U-238 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(8,2)
D-5				
D-5	U-238+D , fish	1.000E+01	1.000E+01	BIOFAC(9,1)
D-5	U-238+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(9,2)

#For DCF1(xxx) only, factors are for infinite depth & area. See ETFG table in Ground Pathway of Detailed Report.
*Base Case means Default.Lib w/o Associate Nuclide contributions.

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Site-Specific Parameter Summary

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	3.547E+05	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	9.000E-01	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	not used	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	2.500E+01	3.000E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): U-234	1.000E+00	0.000E+00	---	S1(6)
R012	Initial principal radionuclide (pCi/g): U-235	1.000E+00	0.000E+00	---	S1(7)
R012	Initial principal radionuclide (pCi/g): U-238	1.000E+00	0.000E+00	---	S1(8)
R012	Concentration in groundwater (pCi/L): U-234	not used	0.000E+00	---	W1(6)
R012	Concentration in groundwater (pCi/L): U-235	not used	0.000E+00	---	W1(7)
R012	Concentration in groundwater (pCi/L): U-238	not used	0.000E+00	---	W1(8)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	2.000E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	2.000E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	5.000E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.000E+00	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	2.000E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	not used	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	not used	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	not used	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	not used	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	not used	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	not used	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	not used	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	not used	2.000E-02	---	HGWT
R014	Saturated zone b parameter	not used	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	not used	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	not used	1.000E+01	---	DWIBWT

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Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	not used	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	not used	2.500E+02	---	UW
R015	Number of unsaturated zone strata	not used	1	---	NS
R015	Unsat. zone 1, thickness (m)	not used	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	not used	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	not used	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	not used	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	not used	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	not used	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	not used	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for U-234				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(6)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(6,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.376E-03	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
R016	Distribution coefficients for U-235				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(7)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(7,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(7)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.376E-03	ALEACH(7)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(7)
R016	Distribution coefficients for U-238				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(8)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(8,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(8)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.376E-03	ALEACH(8)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(8)
R016	Distribution coefficients for daughter Ac-227				
R016	Contaminated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	not used	2.000E+01	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	not used	2.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.832E-02	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for daughter Pa-231				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.376E-03	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)

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Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	not used	1.000E+02	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	not used	1.000E+02	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.696E-03	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for daughter Ra-226				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	not used	7.000E+01	---	DCNUCU(4,1)
R016	Saturated zone (cm**3/g)	not used	7.000E+01	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.275E-03	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R016	Distribution coefficients for daughter Th-230				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(5)
R016	Unsaturated zone 1 (cm**3/g)	not used	6.000E+04	---	DCNUCU(5,1)
R016	Saturated zone (cm**3/g)	not used	6.000E+04	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	6.173E-06	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R017	Inhalation rate (m**3/yr)	7.300E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	1.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	1.000E+00	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	7.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	0.000E+00	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	2.283E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)

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0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	not used	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	not used	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	1.752E+02	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	not used	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	not used	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	not used	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	not used	-1	---	FPLANT
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	not used	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	not used	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	not used	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	not used	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	not used	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	not used	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	not used	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	not used	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	not used	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	not used	8.000E-02	---	TE(3)

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Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R19B	Translocation Factor for Non-Leafy	not used	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	not used	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	not used	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	not used	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)
TITL	Number of graphical time points	32	---	---	NPTS

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Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
TITL	Maximum number of integration points for dose	17	---	---	LYMAX
TITL	Maximum number of integration points for risk	257	---	---	KYMAX

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	suppressed
4 -- meat ingestion	suppressed
5 -- milk ingestion	suppressed
6 -- aquatic foods	suppressed
7 -- drinking water	suppressed
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	active

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Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	354695.00 square meters	U-234	1.000E+00
Thickness:	0.90 meters	U-235	1.000E+00
Cover Depth:	0.00 meters	U-238	1.000E+00

0

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 2.500E+01 mrem/yr

Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	2.532E-01	2.514E-01	2.477E-01	2.354E-01	2.034E-01	1.224E-01	2.887E-02	0.000E+00
M(t):	1.013E-02	1.005E-02	9.908E-03	9.414E-03	8.138E-03	4.898E-03	1.155E-03	0.000E+00

0Maximum TDOSE(t): 2.532E-01 mrem/yr at t = 0.000E+00 years

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
0 Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	9.114E-05	0.0004	5.304E-03	0.0209	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.128E-02	0.0445
U-235	1.713E-01	0.6766	4.943E-03	0.0195	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.066E-02	0.0421
U-238	3.417E-02	0.1350	4.743E-03	0.0187	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.071E-02	0.0423
Total	2.056E-01	0.8119	1.499E-02	0.0592	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.264E-02	0.1289

0
Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
0 Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.667E-02	0.0658
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.869E-01	0.7382
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.962E-02	0.1960
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.532E-01	1.0000

0*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years
0 Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	9.048E-05	0.0004	5.265E-03	0.0209	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.120E-02	0.0445
U-235	1.701E-01	0.6765	4.908E-03	0.0195	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.059E-02	0.0421
U-238	3.392E-02	0.1350	4.708E-03	0.0187	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.063E-02	0.0423
Total	2.041E-01	0.8118	1.488E-02	0.0592	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.241E-02	0.1290

0
Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years
0 Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.655E-02	0.0658
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.856E-01	0.7382
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.926E-02	0.1960
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.514E-01	1.0000

0*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years
0 Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	8.921E-05	0.0004	5.188E-03	0.0209	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.103E-02	0.0445
U-235	1.676E-01	0.6765	4.839E-03	0.0195	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.045E-02	0.0422
U-238	3.343E-02	0.1349	4.639E-03	0.0187	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.047E-02	0.0423
Total	2.011E-01	0.8118	1.467E-02	0.0592	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.196E-02	0.1290

0
Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years
0 Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.631E-02	0.0658
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.829E-01	0.7382
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.854E-02	0.1959
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.477E-01	1.0000

0*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years
0 Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	8.520E-05	0.0004	4.928E-03	0.0209	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.048E-02	0.0445
U-235	1.592E-01	0.6762	4.610E-03	0.0196	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.000E-02	0.0425
U-238	3.174E-02	0.1349	4.406E-03	0.0187	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.947E-03	0.0423
Total	1.910E-01	0.8115	1.394E-02	0.0592	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.043E-02	0.1293

0
Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years
0 Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.549E-02	0.0658
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.738E-01	0.7383
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.610E-02	0.1959
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.354E-01	1.0000

0*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years
0 Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	7.711E-05	0.0004	4.254E-03	0.0209	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.044E-03	0.0445
U-235	1.374E-01	0.6754	4.034E-03	0.0198	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.858E-03	0.0435
U-238	2.739E-02	0.1346	3.802E-03	0.0187	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.583E-03	0.0422
Total	1.649E-01	0.8104	1.209E-02	0.0594	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.649E-02	0.1302

0
Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years
0 Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.337E-02	0.0657
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.503E-01	0.7388
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.977E-02	0.1955
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.034E-01	1.0000

0*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years
0 Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	7.617E-05	0.0006	2.544E-03	0.0208	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.409E-03	0.0442
U-235	8.224E-02	0.6716	2.573E-03	0.0210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.868E-03	0.0479
U-238	1.634E-02	0.1335	2.269E-03	0.0185	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.123E-03	0.0418
Total	9.866E-02	0.8057	7.387E-03	0.0603	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.640E-02	0.1339

0
Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years
0 Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.030E-03	0.0656
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.068E-02	0.7406
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.374E-02	0.1938
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.224E-01	1.0000

0*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years
0 Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	1.447E-04	0.0050	5.941E-04	0.0206	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.272E-03	0.0441
U-235	1.899E-02	0.6577	7.049E-04	0.0244	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.739E-03	0.0602
U-238	3.738E-03	0.1295	5.194E-04	0.0180	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.173E-03	0.0406
Total	2.287E-02	0.7921	1.818E-03	0.0630	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.183E-03	0.1449

0
Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years
0 Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.011E-03	0.0696
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.143E-02	0.7423
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.430E-03	0.1881
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.887E-02	1.0000

0*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years
0 Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

0
Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years
0 Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

0*Sum of all water independent and dependent pathways.

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Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

0 Parent (i)	Product (j)	Thread Fraction	DSR(j,t) At Time in Years (mrem/yr)/(pCi/g) 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
U-234	U-234	1.000E+00	1.667E-02	1.655E-02	1.631E-02	1.549E-02	1.336E-02	7.972E-03	1.822E-03	0.000E+00
U-234	Th-230	1.000E+00	1.587E-07	4.745E-07	1.099E-06	3.214E-06	8.687E-06	2.256E-05	3.830E-05	0.000E+00
U-234	Ra-226+D	1.000E+00	1.667E-09	1.163E-08	6.094E-08	5.289E-07	4.091E-06	3.310E-05	1.372E-04	0.000E+00
U-234	Pb-210+D	1.000E+00	1.468E-12	2.179E-11	2.485E-10	6.075E-09	1.186E-07	2.112E-06	1.264E-05	0.000E+00
U-234	ΣDSR(j)		1.667E-02	1.655E-02	1.631E-02	1.549E-02	1.337E-02	8.030E-03	2.011E-03	0.000E+00
0U-235+D	U-235+D	1.000E+00	1.869E-01	1.855E-01	1.828E-01	1.736E-01	1.498E-01	8.939E-02	2.045E-02	0.000E+00
U-235+D	Pa-231	1.000E+00	5.461E-06	1.628E-05	3.743E-05	1.066E-04	2.672E-04	5.251E-04	3.584E-04	0.000E+00
U-235+D	Ac-227+D	1.000E+00	1.457E-07	1.001E-06	5.077E-06	3.925E-05	2.232E-04	7.656E-04	6.254E-04	0.000E+00
U-235+D	ΣDSR(j)		1.869E-01	1.856E-01	1.829E-01	1.738E-01	1.503E-01	9.068E-02	2.143E-02	0.000E+00
0U-238	U-238	5.400E-05	8.060E-07	8.001E-07	7.884E-07	7.487E-07	6.460E-07	3.855E-07	8.818E-08	0.000E+00
0U-238+D	U-238+D	9.999E-01	4.962E-02	4.926E-02	4.854E-02	4.610E-02	3.977E-02	2.373E-02	5.428E-03	0.000E+00
U-238+D	U-234	9.999E-01	2.360E-08	7.035E-08	1.618E-07	4.610E-07	1.155E-06	2.271E-06	1.553E-06	0.000E+00
U-238+D	Th-230	9.999E-01	1.498E-13	1.044E-12	5.465E-12	4.725E-11	3.615E-10	2.821E-09	1.074E-08	0.000E+00
U-238+D	Ra-226+D	9.999E-01	1.181E-15	1.763E-14	2.037E-13	5.213E-12	1.152E-10	2.905E-09	3.022E-08	0.000E+00
U-238+D	Pb-210+D	9.999E-01	8.325E-19	2.556E-17	6.307E-16	4.571E-14	2.624E-12	1.571E-10	2.604E-09	0.000E+00
U-238+D	ΣDSR(j)		4.962E-02	4.926E-02	4.854E-02	4.610E-02	3.977E-02	2.374E-02	5.430E-03	0.000E+00

The DSR includes contributions from associated (half-life ≤ 180 days) daughters.
0

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 2.500E+01 mrem/yr

0Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
U-234	1.499E+03	1.511E+03	1.533E+03	1.614E+03	1.869E+03	3.113E+03	1.243E+04	*6.247E+09
U-235	1.338E+02	1.347E+02	1.367E+02	1.439E+02	1.663E+02	2.757E+02	1.167E+03	*2.161E+06
U-238	5.038E+02	5.075E+02	5.151E+02	5.423E+02	6.285E+02	1.053E+03	4.604E+03	*3.361E+05

*At specific activity limit
0

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

0Nuclide (i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
U-234	1.000E+00	0.000E+00	1.667E-02	1.499E+03	1.667E-02	1.499E+03
U-235	1.000E+00	0.000E+00	1.869E-01	1.338E+02	1.869E-01	1.338E+02
U-238	1.000E+00	0.000E+00	4.962E-02	5.038E+02	4.962E-02	5.038E+02

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Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

0Nuclide (j)	Parent (i)	THF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
U-234	U-234	1.000E+00	1.667E-02	1.655E-02	1.631E-02	1.549E-02	1.336E-02	7.972E-03	1.822E-03	0.000E+00
U-234	U-238	9.999E-01	2.360E-08	7.035E-08	1.618E-07	4.610E-07	1.155E-06	2.271E-06	1.553E-06	0.000E+00
U-234	ΣDOSE(j)		1.667E-02	1.655E-02	1.631E-02	1.549E-02	1.336E-02	7.974E-03	1.824E-03	0.000E+00
0Th-230	U-234	1.000E+00	1.587E-07	4.745E-07	1.099E-06	3.214E-06	8.687E-06	2.256E-05	3.830E-05	0.000E+00
Th-230	U-238	9.999E-01	1.498E-13	1.044E-12	5.465E-12	4.725E-11	3.615E-10	2.821E-09	1.074E-08	0.000E+00
Th-230	ΣDOSE(j)		1.587E-07	4.745E-07	1.099E-06	3.214E-06	8.687E-06	2.256E-05	3.831E-05	0.000E+00
0Ra-226	U-234	1.000E+00	1.667E-09	1.163E-08	6.094E-08	5.289E-07	4.091E-06	3.310E-05	1.372E-04	0.000E+00
Ra-226	U-238	9.999E-01	1.181E-15	1.763E-14	2.037E-13	5.213E-12	1.152E-10	2.905E-09	3.022E-08	0.000E+00
Ra-226	ΣDOSE(j)		1.667E-09	1.163E-08	6.094E-08	5.289E-07	4.091E-06	3.310E-05	1.372E-04	0.000E+00
0Pb-210	U-234	1.000E+00	1.468E-12	2.179E-11	2.485E-10	6.075E-09	1.186E-07	2.112E-06	1.264E-05	0.000E+00
Pb-210	U-238	9.999E-01	8.325E-19	2.556E-17	6.307E-16	4.571E-14	2.624E-12	1.571E-10	2.604E-09	0.000E+00
Pb-210	ΣDOSE(j)		1.468E-12	2.179E-11	2.485E-10	6.075E-09	1.186E-07	2.112E-06	1.264E-05	0.000E+00
0U-235	U-235	1.000E+00	1.869E-01	1.855E-01	1.828E-01	1.736E-01	1.498E-01	8.939E-02	2.045E-02	0.000E+00
0Pa-231	U-235	1.000E+00	5.461E-06	1.628E-05	3.743E-05	1.066E-04	2.672E-04	5.251E-04	3.584E-04	0.000E+00
0Ac-227	U-235	1.000E+00	1.457E-07	1.001E-06	5.077E-06	3.925E-05	2.232E-04	7.656E-04	6.254E-04	0.000E+00
0U-238	U-238	5.400E-05	8.060E-07	8.001E-07	7.884E-07	7.487E-07	6.460E-07	3.855E-07	8.818E-08	0.000E+00
U-238	U-238	9.999E-01	4.962E-02	4.926E-02	4.854E-02	4.610E-02	3.977E-02	2.373E-02	5.428E-03	0.000E+00
U-238	ΣDOSE(j)		4.962E-02	4.926E-02	4.854E-02	4.610E-02	3.977E-02	2.373E-02	5.428E-03	0.000E+00

THF(i) is the thread fraction of the parent nuclide.

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Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

0Nuclide (j)	Parent (i)	THF(i)	S(j,t), pCi/g t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
U-234	U-234	1.000E+00	1.000E+00	9.926E-01	9.781E-01	9.289E-01	8.014E-01	4.781E-01	1.093E-01	6.244E-04
U-234	U-238	9.999E-01	0.000E+00	2.814E-06	8.318E-06	2.633E-05	6.816E-05	1.356E-04	9.300E-05	1.773E-06
U-234	ΣS(j):		1.000E+00	9.927E-01	9.781E-01	9.289E-01	8.015E-01	4.783E-01	1.094E-01	6.262E-04
0Th-230	U-234	1.000E+00	0.000E+00	8.969E-06	2.671E-05	8.677E-05	2.422E-04	6.361E-04	1.083E-03	1.203E-03
Th-230	U-238	9.999E-01	0.000E+00	1.270E-11	1.132E-10	1.215E-09	9.920E-09	7.921E-08	3.035E-07	4.613E-07
Th-230	ΣS(j):		0.000E+00	8.969E-06	2.671E-05	8.677E-05	2.422E-04	6.362E-04	1.084E-03	1.204E-03
0Ra-226	U-234	1.000E+00	0.000E+00	1.941E-09	1.732E-08	1.867E-07	1.541E-06	1.276E-05	5.328E-05	9.047E-05
Ra-226	U-238	9.999E-01	0.000E+00	1.833E-15	4.899E-14	1.751E-12	4.270E-11	1.115E-09	1.172E-08	3.395E-08
Ra-226	ΣS(j):		0.000E+00	1.941E-09	1.732E-08	1.867E-07	1.541E-06	1.276E-05	5.329E-05	9.050E-05
0Pb-210	U-234	1.000E+00	0.000E+00	1.996E-11	5.263E-10	1.796E-08	3.869E-07	7.125E-06	4.301E-05	8.070E-05
Pb-210	U-238	9.999E-01	0.000E+00	1.416E-17	1.122E-15	1.284E-13	8.414E-12	5.274E-10	8.847E-09	3.016E-08
Pb-210	ΣS(j):		0.000E+00	1.996E-11	5.263E-10	1.796E-08	3.869E-07	7.126E-06	4.302E-05	8.073E-05
0U-235	U-235	1.000E+00	1.000E+00	9.927E-01	9.781E-01	9.289E-01	8.015E-01	4.783E-01	1.094E-01	6.262E-04
0Pa-231	U-235	1.000E+00	0.000E+00	2.100E-05	6.208E-05	1.965E-04	5.086E-04	1.011E-03	6.922E-04	1.311E-05
0Ac-227	U-235	1.000E+00	0.000E+00	3.296E-07	2.842E-06	2.726E-05	1.653E-04	5.789E-04	4.751E-04	9.530E-06
0U-238	U-238	5.400E-05	5.400E-05	5.360E-05	5.282E-05	5.016E-05	4.328E-05	2.583E-05	5.908E-06	3.381E-08
U-238	U-238	9.999E-01	9.999E-01	9.926E-01	9.781E-01	9.288E-01	8.015E-01	4.782E-01	1.094E-01	6.262E-04
U-238	ΣS(j):		1.000E+00	9.927E-01	9.781E-01	9.289E-01	8.015E-01	4.783E-01	1.094E-01	6.262E-04

THF(i) is the thread fraction of the parent nuclide.
0RESCALC.EXE execution time = 2.12 seconds

ATTACHMENT C-2

Site Worker RESRAD Risk Output Report

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Part III: Intake Quantities and Health Risk Factors

Cancer Risk Slope Factors 2
Risk Slope and ETFG for the Ground Pathway 4
Amount of Intake Quantities and Excess Cancer Risks
Time= 0.000E+00 5
Time= 1.000E+00 8
Time= 3.000E+00 11
Time= 1.000E+01 14
Time= 3.000E+01 17
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Cancer Risk Slope Factors Summary Table
Risk Library: FGR 13 Morbidity

0 Menu	Parameter	Current Value	Base Case*	Parameter Name
Sf-1	Ground external radiation slope factors, 1/yr per (pCi/g):			
Sf-1	Ac-227+D	1.47E-06	3.48E-10	SLPF(1,1)
Sf-1	Pa-231	1.39E-07	1.39E-07	SLPF(2,1)
Sf-1	Pb-210+D	4.21E-09	1.41E-09	SLPF(3,1)
Sf-1	Ra-226+D	8.49E-06	2.29E-08	SLPF(4,1)
Sf-1	Th-230	8.19E-10	8.19E-10	SLPF(5,1)
Sf-1	U-234	2.52E-10	2.52E-10	SLPF(6,1)
Sf-1	U-235+D	5.43E-07	5.18E-07	SLPF(7,1)
Sf-1	U-238	4.99E-11	4.99E-11	SLPF(8,1)
Sf-1	U-238+D	1.14E-07	4.99E-11	SLPF(9,1)
Sf-2	Inhalation, slope factors, 1/(pCi):			
Sf-2	Ac-227+D	2.13E-07	1.49E-07	SLPF(1,2)
Sf-2	Pa-231	7.62E-08	7.62E-08	SLPF(2,2)
Sf-2	Pb-210+D	3.08E-08	1.58E-08	SLPF(3,2)
Sf-2	Ra-226+D	2.83E-08	2.82E-08	SLPF(4,2)
Sf-2	Th-230	3.40E-08	3.40E-08	SLPF(5,2)
Sf-2	U-234	2.78E-08	2.78E-08	SLPF(6,2)
Sf-2	U-235+D	2.50E-08	2.50E-08	SLPF(7,2)
Sf-2	U-238	2.36E-08	2.36E-08	SLPF(8,2)
Sf-2	U-238+D	2.36E-08	2.36E-08	SLPF(9,2)
Sf-3	Food ingestion, slope factors, 1/(pCi):			
Sf-3	Ac-227+D	6.53E-10	2.45E-10	SLPF(1,3)
Sf-3	Pa-231	2.26E-10	2.26E-10	SLPF(2,3)
Sf-3	Pb-210+D	3.44E-09	1.18E-09	SLPF(3,3)
Sf-3	Ra-226+D	5.15E-10	5.14E-10	SLPF(4,3)
Sf-3	Th-230	1.19E-10	1.19E-10	SLPF(5,3)
Sf-3	U-234	9.55E-11	9.55E-11	SLPF(6,3)
Sf-3	U-235+D	9.76E-11	9.44E-11	SLPF(7,3)
Sf-3	U-238	8.66E-11	8.66E-11	SLPF(8,3)
Sf-3	U-238+D	1.21E-10	8.66E-11	SLPF(9,3)
Sf-3	Water ingestion, slope factors, 1/(pCi):			
Sf-3	Ac-227+D	4.86E-10	2.01E-10	SLPF(1,4)
Sf-3	Pa-231	1.73E-10	1.73E-10	SLPF(2,4)
Sf-3	Pb-210+D	2.66E-09	8.81E-10	SLPF(3,4)
Sf-3	Ra-226+D	3.86E-10	3.85E-10	SLPF(4,4)
Sf-3	Th-230	9.10E-11	9.10E-11	SLPF(5,4)
Sf-3	U-234	7.07E-11	7.07E-11	SLPF(6,4)
Sf-3	U-235+D	7.18E-11	6.96E-11	SLPF(7,4)
Sf-3	U-238	6.40E-11	6.40E-11	SLPF(8,4)
Sf-3	U-238+D	8.71E-11	6.40E-11	SLPF(9,4)
Sf-3	Soil ingestion, slope factors, 1/(pCi):			
Sf-3	Ac-227+D	6.53E-10	2.45E-10	SLPF(1,5)
Sf-3	Pa-231	2.26E-10	2.26E-10	SLPF(2,5)
Sf-3	Pb-210+D	3.44E-09	1.18E-09	SLPF(3,5)
Sf-3	Ra-226+D	5.15E-10	5.14E-10	SLPF(4,5)
Sf-3	Th-230	1.19E-10	1.19E-10	SLPF(5,5)

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Cancer Risk Slope Factors Summary Table (continued)
Risk Library: FGR 13 Morbidity

0 Menu	Parameter	Current Value	Base Case*	Parameter Name
Sf-3	U-234	9.55E-11	9.55E-11	SLPF(6,5)
Sf-3	U-235+D	9.76E-11	9.44E-11	SLPF(7,5)
Sf-3	U-238	8.66E-11	8.66E-11	SLPF(8,5)
Sf-3	U-238+D	1.21E-10	8.66E-11	SLPF(9,5)
Sf-Rn	Radon Inhalation slope factors, 1/(pCi):			
Sf-Rn	Rn-222	1.80E-12	1.80E-12	SLPFRN(1,1)
Sf-Rn	Po-218	3.70E-12	3.70E-12	SLPFRN(1,2)
Sf-Rn	Pb-214	6.20E-12	6.20E-12	SLPFRN(1,3)
Sf-Rn	Bi-214	1.50E-11	1.50E-11	SLPFRN(1,4)
Sf-Rn	Radon K factors, (mrem/WLM):			
Sf-Rn	Rn-222 Indoor	7.60E+02	7.60E+02	KFACTR(1,1)
Sf-Rn	Rn-222 Outdoor	5.70E+02	5.70E+02	KFACTR(1,2)

*Base Case means Default.Lib w/o Associate Nuclide contributions.

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Risk Slope and Environmental Transport Factors for the Ground Pathway

0Nuclide (i)	Slope(i)*	ETFG(i,t) At Time in Years (dimensionless)							
	t=	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ac-227	3.480E-10	2.275E-01	2.275E-01	2.275E-01	2.275E-01	2.275E-01	2.275E-01	2.275E-01	0.000E+00
At-218	3.570E-09	2.282E-01	2.282E-01	2.282E-01	2.282E-01	2.282E-01	2.282E-01	2.282E-01	0.000E+00
Bi-210	2.760E-09	2.264E-01	2.264E-01	2.264E-01	2.264E-01	2.264E-01	2.264E-01	2.264E-01	0.000E+00
Bi-211	1.880E-07	2.264E-01	2.264E-01	2.264E-01	2.264E-01	2.264E-01	2.264E-01	2.264E-01	0.000E+00
Bi-214	7.480E-06	2.252E-01	2.252E-01	2.252E-01	2.252E-01	2.252E-01	2.252E-01	2.249E-01	0.000E+00
Fr-223	1.400E-07	2.268E-01	2.268E-01	2.268E-01	2.268E-01	2.268E-01	2.268E-01	2.268E-01	0.000E+00
Pa-231	1.390E-07	2.264E-01	2.264E-01	2.264E-01	2.264E-01	2.264E-01	2.264E-01	2.264E-01	0.000E+00
Pa-234	8.710E-06	2.257E-01	2.257E-01	2.257E-01	2.257E-01	2.257E-01	2.257E-01	2.256E-01	0.000E+00
Pa-234m	6.870E-08	2.256E-01	2.256E-01	2.256E-01	2.256E-01	2.256E-01	2.256E-01	2.256E-01	0.000E+00
Pb-210	1.410E-09	2.283E-01	2.283E-01	2.283E-01	2.283E-01	2.283E-01	2.283E-01	2.283E-01	0.000E+00
Pb-211	2.290E-07	2.258E-01	2.258E-01	2.258E-01	2.258E-01	2.258E-01	2.258E-01	2.257E-01	0.000E+00
Pb-214	9.820E-07	2.266E-01	2.266E-01	2.266E-01	2.266E-01	2.266E-01	2.266E-01	2.266E-01	0.000E+00
Po-210	3.950E-11	2.256E-01	2.256E-01	2.256E-01	2.256E-01	2.256E-01	2.256E-01	2.255E-01	0.000E+00
Po-211	3.580E-08	2.255E-01	2.255E-01	2.255E-01	2.255E-01	2.255E-01	2.255E-01	2.254E-01	0.000E+00
Po-214	3.860E-10	2.255E-01	2.255E-01	2.255E-01	2.255E-01	2.255E-01	2.255E-01	2.254E-01	0.000E+00
Po-215	7.480E-10	2.260E-01	2.260E-01	2.260E-01	2.260E-01	2.260E-01	2.260E-01	2.260E-01	0.000E+00
Po-218	4.260E-11	2.256E-01	2.256E-01	2.256E-01	2.256E-01	2.256E-01	2.256E-01	2.255E-01	0.000E+00
Ra-223	4.340E-07	2.268E-01	2.268E-01	2.268E-01	2.268E-01	2.268E-01	2.268E-01	2.268E-01	0.000E+00
Ra-226	2.290E-08	2.270E-01	2.270E-01	2.270E-01	2.270E-01	2.270E-01	2.270E-01	2.270E-01	0.000E+00
Rn-219	2.250E-07	2.267E-01	2.267E-01	2.267E-01	2.267E-01	2.267E-01	2.267E-01	2.266E-01	0.000E+00
Rn-222	1.740E-09	2.259E-01	2.259E-01	2.259E-01	2.259E-01	2.259E-01	2.259E-01	2.258E-01	0.000E+00
Th-227	3.780E-07	2.269E-01	2.269E-01	2.269E-01	2.269E-01	2.269E-01	2.269E-01	2.269E-01	0.000E+00
Th-230	8.190E-10	2.275E-01	2.275E-01	2.275E-01	2.275E-01	2.275E-01	2.275E-01	2.275E-01	0.000E+00
Th-231	2.450E-08	2.277E-01	2.277E-01	2.277E-01	2.277E-01	2.277E-01	2.277E-01	2.277E-01	0.000E+00
Th-234	1.630E-08	2.278E-01	2.278E-01	2.278E-01	2.278E-01	2.278E-01	2.278E-01	2.278E-01	0.000E+00
Tl-207	1.520E-08	2.259E-01	2.259E-01	2.259E-01	2.259E-01	2.259E-01	2.259E-01	2.258E-01	0.000E+00
Tl-210	0.000E+00	2.283E-01	2.283E-01	2.283E-01	2.283E-01	2.283E-01	2.283E-01	2.283E-01	2.283E-01
U-234	2.520E-10	2.277E-01	2.277E-01	2.277E-01	2.277E-01	2.277E-01	2.277E-01	2.277E-01	0.000E+00
U-235	5.180E-07	2.269E-01	2.269E-01	2.269E-01	2.269E-01	2.269E-01	2.269E-01	2.269E-01	0.000E+00
U-238	4.990E-11	2.283E-01	2.283E-01	2.283E-01	2.283E-01	2.283E-01	2.283E-01	2.283E-01	0.000E+00

* - Units are 1/yr per (pCi/g) at infinite depth and area. Multiplication by ETFG(i,t) converts to site conditions.

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Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 0.000E+00 years

Radio-Nuclide	Water Independent Pathways (Inhalation w/o radon)					Water Dependent Pathways					Total Ingestion*
	Inhalation	Plant	Meat	Milk	Soil	Water	Fish	Plant	Meat	Milk	
Ac-227	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pa-231	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pb-210	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ra-226	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-230	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-234	4.033E-02	0.000E+00	0.000E+00	0.000E+00	4.166E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.166E+00
U-235	4.033E-02	0.000E+00	0.000E+00	0.000E+00	4.166E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.166E+00
U-238	4.033E-02	0.000E+00	0.000E+00	0.000E+00	4.166E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.166E+00

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

0

Amount of Intake Quantities QINT9(irn,i,t) and QINT9W(irn,i,t) for Inhalation of
Radon and its Decay Products as pCi/yr at t= 0.000E+00 years

0

Radon Pathway	Radionuclides							
	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 0.000E+00 years

0

Water Independent Pathways (Inhalation excludes radon)

0

Radio-Nuclide	Ground		Inhalation		Plant		Meat		Milk		Soil	
	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	3.977E-10	0.0001	1.027E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.255E-12	0.0000
Pa-231	1.842E-10	0.0001	1.798E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.510E-12	0.0000
Pb-210	1.497E-15	0.0000	1.942E-15	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.246E-14	0.0000
Ra-226	1.791E-11	0.0000	1.068E-14	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.008E-14	0.0000
Th-230	4.932E-13	0.0000	3.630E-12	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.313E-12	0.0000
U-234	1.310E-09	0.0004	2.560E-08	0.0073	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.084E-09	0.0026
U-235	2.811E-06	0.8033	2.302E-08	0.0066	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.288E-09	0.0027
U-238	5.862E-07	0.1675	2.176E-08	0.0062	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.147E-08	0.0033
Total	3.399E-06	0.9714	7.041E-08	0.0201	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.985E-08	0.0085

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Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 0.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Plant		Meat		Milk		All Pathways**	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.112E-10	0.0001
Pa-231	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.077E-10	0.0001
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.590E-14	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.794E-11	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.436E-12	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.599E-08	0.0103
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.844E-06	0.8125
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.194E-07	0.1770
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.500E-06	1.0000

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways
0

Excess Cancer Risks CNRS9(irn,i,t) and CNRS9W(irn,i,t) for Inhalation of
Radon and its Decay Products at t= 0.000E+00 years
0

Radon	Radionuclides							
Pathway	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent
0

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 0.000E+00 years
0 Water Independent Pathways (Inhalation excludes radon)
0

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
U-234	1.328E-09	0.0004	2.560E-08	0.0073	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.085E-09	0.0026
U-235	2.812E-06	0.8035	2.305E-08	0.0066	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.297E-09	0.0027
U-238	5.862E-07	0.1675	2.176E-08	0.0062	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.147E-08	0.0033
Total	3.399E-06	0.9714	7.041E-08	0.0201	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.985E-08	0.0085

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Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 0.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All pathways	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.601E-08	0.0103
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.844E-06	0.8127
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.194E-07	0.1770
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.500E-06	1.0000

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

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Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 1.000E+00 years

Radio-Nuclide	Water Independent Pathways (Inhalation w/o radon)					Water Dependent Pathways					Total Ingestion*
	Inhalation	Plant	Meat	Milk	Soil	Water	Fish	Plant	Meat	Milk	
Ac-227	1.329E-08	0.000E+00	0.000E+00	0.000E+00	1.373E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.373E-06
Pa-231	8.470E-07	0.000E+00	0.000E+00	0.000E+00	8.751E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.751E-05
Pb-210	8.051E-13	0.000E+00	0.000E+00	0.000E+00	8.317E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.317E-11
Ra-226	7.830E-11	0.000E+00	0.000E+00	0.000E+00	8.089E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.089E-09
Th-230	3.617E-07	0.000E+00	0.000E+00	0.000E+00	3.737E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.737E-05
U-234	4.003E-02	0.000E+00	0.000E+00	0.000E+00	4.136E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.136E+00
U-235	4.003E-02	0.000E+00	0.000E+00	0.000E+00	4.136E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.136E+00
U-238	4.003E-02	0.000E+00	0.000E+00	0.000E+00	4.136E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.136E+00

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

0

Amount of Intake Quantities QINT9(irn,i,t) and QINT9W(irn,i,t) for Inhalation of
Radon and its Decay Products as pCi/yr at t= 1.000E+00 years

0

Radon Pathway	Radionuclides							
	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+00 years

0

Water Independent Pathways (Inhalation excludes radon)

0

Radio-Nuclide	Ground		Inhalation		Plant		Meat		Milk		Soil	
	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	4.409E-10	0.0001	1.139E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.608E-12	0.0000
Pa-231	1.979E-10	0.0001	1.932E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.921E-12	0.0000
Pb-210	1.735E-15	0.0000	2.252E-15	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.605E-14	0.0000
Ra-226	2.008E-11	0.0000	1.197E-14	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.252E-14	0.0000
Th-230	5.314E-13	0.0000	3.911E-12	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.414E-12	0.0000
U-234	1.300E-09	0.0004	2.541E-08	0.0073	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.017E-09	0.0026
U-235	2.791E-06	0.8033	2.285E-08	0.0066	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.219E-09	0.0027
U-238	5.819E-07	0.1675	2.160E-08	0.0062	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.139E-08	0.0033
Total	3.374E-06	0.9714	6.989E-08	0.0201	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.964E-08	0.0085

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Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Plant		Meat		Milk		All Pathways**	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.559E-10	0.0001
Pa-231	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.232E-10	0.0001
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.003E-14	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.011E-11	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.857E-12	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.573E-08	0.0103
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.823E-06	0.8125
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.149E-07	0.1770
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.474E-06	1.0000

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways
0

Excess Cancer Risks CNRS9(irn,i,t) and CNRS9W(irn,i,t) for Inhalation of
Radon and its Decay Products at t= 1.000E+00 years
0

Radon	Radionuclides							
Pathway	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent
0

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+00 years
0 Water Independent Pathways (Inhalation excludes radon)
0

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
U-234	1.321E-09	0.0004	2.541E-08	0.0073	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.019E-09	0.0026
U-235	2.791E-06	0.8035	2.288E-08	0.0066	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.229E-09	0.0027
U-238	5.819E-07	0.1675	2.160E-08	0.0062	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.139E-08	0.0033
Total	3.374E-06	0.9714	6.989E-08	0.0201	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.964E-08	0.0085

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Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All pathways	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.575E-08	0.0103
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.823E-06	0.8127
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.149E-07	0.1770
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.474E-06	1.0000

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

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Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 3.000E+00 years

Radio-Nuclide	Water Independent Pathways (Inhalation w/o radon)					Water Dependent Pathways					Total Ingestion*
	Inhalation	Plant	Meat	Milk	Soil	Water	Fish	Plant	Meat	Milk	
Ac-227	1.146E-07	0.000E+00	0.000E+00	0.000E+00	1.184E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.184E-05
Pa-231	2.504E-06	0.000E+00	0.000E+00	0.000E+00	2.587E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.587E-04
Pb-210	2.123E-11	0.000E+00	0.000E+00	0.000E+00	2.193E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.193E-09
Ra-226	6.985E-10	0.000E+00	0.000E+00	0.000E+00	7.217E-08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.217E-08
Th-230	1.077E-06	0.000E+00	0.000E+00	0.000E+00	1.113E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.113E-04
U-234	3.945E-02	0.000E+00	0.000E+00	0.000E+00	4.075E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.075E+00
U-235	3.945E-02	0.000E+00	0.000E+00	0.000E+00	4.075E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.075E+00
U-238	3.945E-02	0.000E+00	0.000E+00	0.000E+00	4.075E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.075E+00

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

0

Amount of Intake Quantities QINT9(irn,i,t) and QINT9W(irn,i,t) for Inhalation of
Radon and its Decay Products as pCi/yr at t= 3.000E+00 years

0

Radon Pathway	Radionuclides							
	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+00 years

0 Water Independent Pathways (Inhalation excludes radon)

0

Radio-Nuclide	Ground		Inhalation		Plant		Meat		Milk		Soil	
	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	5.342E-10	0.0002	1.380E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.372E-12	0.0000
Pa-231	2.248E-10	0.0001	2.194E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.724E-12	0.0000
Pb-210	2.293E-15	0.0000	2.975E-15	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.441E-14	0.0000
Ra-226	2.488E-11	0.0000	1.484E-14	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.791E-14	0.0000
Th-230	6.068E-13	0.0000	4.466E-12	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.615E-12	0.0000
U-234	1.281E-09	0.0004	2.504E-08	0.0073	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.885E-09	0.0026
U-235	2.750E-06	0.8033	2.252E-08	0.0066	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.084E-09	0.0027
U-238	5.734E-07	0.1675	2.128E-08	0.0062	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.122E-08	0.0033
Total	3.325E-06	0.9713	6.887E-08	0.0201	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.920E-08	0.0085

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Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Plant		Meat		Milk		All Pathways**	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.524E-10	0.0002
Pa-231	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.534E-10	0.0001
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.968E-14	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.493E-11	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.688E-12	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.520E-08	0.0103
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.781E-06	0.8125
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.059E-07	0.1770
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.423E-06	1.0000

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways
0

Excess Cancer Risks CNRS9(irn,i,t) and CNRS9W(irn,i,t) for Inhalation of
Radon and its Decay Products at t= 3.000E+00 years
0

Radon	Radionuclides							
Pathway	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent
0

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+00 years
0 Water Independent Pathways (Inhalation excludes radon)
0

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
U-234	1.307E-09	0.0004	2.504E-08	0.0073	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.887E-09	0.0026
U-235	2.751E-06	0.8035	2.255E-08	0.0066	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.096E-09	0.0027
U-238	5.734E-07	0.1675	2.128E-08	0.0062	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.122E-08	0.0033
Total	3.325E-06	0.9713	6.887E-08	0.0201	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.920E-08	0.0085

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Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All pathways	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.523E-08	0.0103
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.782E-06	0.8127
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.059E-07	0.1770
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.423E-06	1.0000

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

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Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 1.000E+01 years

Radio-Nuclide	Water Independent Pathways (Inhalation w/o radon)					Water Dependent Pathways					Total Ingestion*
	Inhalation	Plant	Meat	Milk	Soil	Water	Fish	Plant	Meat	Milk	
Ac-227	1.099E-06	0.000E+00	0.000E+00	0.000E+00	1.136E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.136E-04
Pa-231	7.925E-06	0.000E+00	0.000E+00	0.000E+00	8.188E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.188E-04
Pb-210	7.241E-10	0.000E+00	0.000E+00	0.000E+00	7.481E-08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.481E-08
Ra-226	7.529E-09	0.000E+00	0.000E+00	0.000E+00	7.778E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.778E-07
Th-230	3.500E-06	0.000E+00	0.000E+00	0.000E+00	3.615E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.615E-04
U-234	3.746E-02	0.000E+00	0.000E+00	0.000E+00	3.870E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.870E+00
U-235	3.746E-02	0.000E+00	0.000E+00	0.000E+00	3.870E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.870E+00
U-238	3.746E-02	0.000E+00	0.000E+00	0.000E+00	3.870E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.870E+00

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

0

Amount of Intake Quantities QINT9(irn,i,t) and QINT9W(irn,i,t) for Inhalation of
Radon and its Decay Products as pCi/yr at t= 1.000E+01 years

0

Radon Pathway	Radionuclides							
	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+01 years

0

0 Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Plant		Meat		Milk		Soil	
	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	9.157E-10	0.0003	2.365E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.494E-12	0.0000
Pa-231	3.123E-10	0.0001	3.049E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.342E-12	0.0000
Pb-210	5.221E-15	0.0000	6.776E-15	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.836E-14	0.0000
Ra-226	4.638E-11	0.0000	2.765E-14	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.202E-14	0.0000
Th-230	8.622E-13	0.0000	6.346E-12	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.295E-12	0.0000
U-234	1.217E-09	0.0004	2.378E-08	0.0073	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.438E-09	0.0026
U-235	2.611E-06	0.8031	2.138E-08	0.0066	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.627E-09	0.0027
U-238	5.445E-07	0.1675	2.021E-08	0.0062	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.066E-08	0.0033
Total	3.158E-06	0.9713	6.543E-08	0.0201	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.774E-08	0.0085

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Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Plant		Meat		Milk		All Pathways**	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.469E-10	0.0003
Pa-231	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.521E-10	0.0001
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.036E-14	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.646E-11	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.503E-12	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.343E-08	0.0103
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.641E-06	0.8123
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.754E-07	0.1770
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.252E-06	1.0000

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways
0

Excess Cancer Risks CNRS9(irn,i,t) and CNRS9W(irn,i,t) for Inhalation of
Radon and its Decay Products at t= 1.000E+01 years
0

Radon	Radionuclides							
Pathway	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent
0

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+01 years
0 Water Independent Pathways (Inhalation excludes radon)
0

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
U-234	1.264E-09	0.0004	2.378E-08	0.0073	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.440E-09	0.0026
U-235	2.613E-06	0.8035	2.144E-08	0.0066	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.644E-09	0.0027
U-238	5.445E-07	0.1675	2.021E-08	0.0062	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.066E-08	0.0033
Total	3.158E-06	0.9713	6.543E-08	0.0201	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.774E-08	0.0085

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Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All pathways	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.349E-08	0.0103
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.643E-06	0.8127
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.754E-07	0.1770
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.252E-06	1.0000

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

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Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 3.000E+01 years

Radio-Nuclide	Water Independent Pathways (Inhalation w/o radon)					Water Dependent Pathways					Total Ingestion*
	Inhalation	Plant	Meat	Milk	Soil	Water	Fish	Plant	Meat	Milk	
Ac-227	6.666E-06	0.000E+00	0.000E+00	0.000E+00	6.887E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.887E-04
Pa-231	2.051E-05	0.000E+00	0.000E+00	0.000E+00	2.119E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.119E-03
Pb-210	1.560E-08	0.000E+00	0.000E+00	0.000E+00	1.612E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.612E-06
Ra-226	6.215E-08	0.000E+00	0.000E+00	0.000E+00	6.421E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.421E-06
Th-230	9.768E-06	0.000E+00	0.000E+00	0.000E+00	1.009E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.009E-03
U-234	3.232E-02	0.000E+00	0.000E+00	0.000E+00	3.339E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.339E+00
U-235	3.232E-02	0.000E+00	0.000E+00	0.000E+00	3.339E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.339E+00
U-238	3.232E-02	0.000E+00	0.000E+00	0.000E+00	3.339E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.339E+00

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

0

Amount of Intake Quantities QINT9(irn,i,t) and QINT9W(irn,i,t) for Inhalation of
Radon and its Decay Products as pCi/yr at t= 3.000E+01 years

0

Radon Pathway	Radionuclides							
	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+01 years

0

Water Independent Pathways (Inhalation excludes radon)

0

Radio-Nuclide	Ground		Inhalation		Plant		Meat		Milk		Soil	
	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	2.181E-09	0.0008	5.633E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.785E-11	0.0000
Pa-231	5.130E-10	0.0002	5.009E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.535E-11	0.0000
Pb-210	2.415E-14	0.0000	3.134E-14	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.624E-13	0.0000
Ra-226	1.428E-10	0.0001	8.516E-14	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.602E-13	0.0000
Th-230	1.523E-12	0.0000	1.121E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.054E-12	0.0000
U-234	1.050E-09	0.0004	2.052E-08	0.0073	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.281E-09	0.0026
U-235	2.253E-06	0.8026	1.845E-08	0.0066	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.444E-09	0.0027
U-238	4.698E-07	0.1673	1.744E-08	0.0062	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.195E-09	0.0033
Total	2.727E-06	0.9713	5.652E-08	0.0201	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.396E-08	0.0085

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Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Plant		Meat		Milk		All Pathways**	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.255E-09	0.0008
Pa-231	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.784E-10	0.0002
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.179E-13	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.431E-10	0.0001
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.679E-11	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.885E-08	0.0103
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.279E-06	0.8118
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.965E-07	0.1768
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.807E-06	1.0000

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways
0

Excess Cancer Risks CNRS9(irn,i,t) and CNRS9W(irn,i,t) for Inhalation of
Radon and its Decay Products at t= 3.000E+01 years
0

Radon	Radionuclides							
Pathway	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent
0

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+01 years
0 Water Independent Pathways (Inhalation excludes radon)
0

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
U-234	1.194E-09	0.0004	2.052E-08	0.0073	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.285E-09	0.0026
U-235	2.256E-06	0.8036	1.856E-08	0.0066	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.477E-09	0.0027
U-238	4.698E-07	0.1673	1.744E-08	0.0062	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.196E-09	0.0033
Total	2.727E-06	0.9713	5.652E-08	0.0201	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.396E-08	0.0085

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Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All pathways	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.900E-08	0.0103
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.282E-06	0.8128
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.965E-07	0.1768
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.807E-06	1.0000

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

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Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 1.000E+02 years

Radio-Nuclide	Water Independent Pathways (Inhalation w/o radon)					Water Dependent Pathways					Total Ingestion*
	Inhalation	Plant	Meat	Milk	Soil	Water	Fish	Plant	Meat	Milk	
Ac-227	2.335E-05	0.000E+00	0.000E+00	0.000E+00	2.412E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.412E-03
Pa-231	4.077E-05	0.000E+00	0.000E+00	0.000E+00	4.212E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.212E-03
Pb-210	2.874E-07	0.000E+00	0.000E+00	0.000E+00	2.969E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.969E-05
Ra-226	5.147E-07	0.000E+00	0.000E+00	0.000E+00	5.317E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.317E-05
Th-230	2.566E-05	0.000E+00	0.000E+00	0.000E+00	2.651E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.651E-03
U-234	1.929E-02	0.000E+00	0.000E+00	0.000E+00	1.993E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.993E+00
U-235	1.929E-02	0.000E+00	0.000E+00	0.000E+00	1.993E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.993E+00
U-238	1.929E-02	0.000E+00	0.000E+00	0.000E+00	1.993E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.993E+00

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

0

Amount of Intake Quantities QINT9(irn,i,t) and QINT9W(irn,i,t) for Inhalation of
Radon and its Decay Products as pCi/yr at t= 1.000E+02 years

0

Radon Pathway	Radionuclides							
	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+02 years

0

0 Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Plant		Meat		Milk		Soil	
	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	5.078E-09	0.0030	1.311E-10	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.156E-11	0.0000
Pa-231	8.143E-10	0.0005	7.951E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.436E-11	0.0000
Pb-210	2.172E-13	0.0000	2.819E-13	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.261E-12	0.0000
Ra-226	7.342E-10	0.0004	4.378E-13	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.235E-13	0.0000
Th-230	3.198E-12	0.0000	2.354E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.512E-12	0.0000
U-234	6.266E-10	0.0004	1.224E-08	0.0073	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.345E-09	0.0026
U-235	1.345E-06	0.8001	1.101E-08	0.0066	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.442E-09	0.0026
U-238	2.803E-07	0.1668	1.041E-08	0.0062	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.487E-09	0.0033
Total	1.632E-06	0.9713	3.389E-08	0.0202	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.435E-08	0.0085

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Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Plant		Meat		Milk		All Pathways**	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.251E-09	0.0031
Pa-231	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.182E-10	0.0005
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.760E-12	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.355E-10	0.0004
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.525E-11	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.721E-08	0.0102
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.360E-06	0.8093
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.962E-07	0.1763
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.680E-06	1.0000

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways
0

Excess Cancer Risks CNRS9(irn,i,t) and CNRS9W(irn,i,t) for Inhalation of
Radon and its Decay Products at t= 1.000E+02 years
0

Radon	Radionuclides							
Pathway	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent
0

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+02 years
0 Water Independent Pathways (Inhalation excludes radon)
0

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
U-234	1.364E-09	0.0008	1.226E-08	0.0073	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.356E-09	0.0026
U-235	1.350E-06	0.8036	1.122E-08	0.0067	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.508E-09	0.0027
U-238	2.803E-07	0.1668	1.041E-08	0.0062	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.488E-09	0.0033
Total	1.632E-06	0.9713	3.389E-08	0.0202	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.435E-08	0.0085

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Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All pathways	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.798E-08	0.0107
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.366E-06	0.8130
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.962E-07	0.1763
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.680E-06	1.0000

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

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Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 3.000E+02 years

Radio-Nuclide	Water Independent Pathways (Inhalation w/o radon)					Water Dependent Pathways					Total Ingestion*
	Inhalation	Plant	Meat	Milk	Soil	Water	Fish	Plant	Meat	Milk	
Ac-227	1.916E-05	0.000E+00	0.000E+00	0.000E+00	1.979E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.979E-03
Pa-231	2.792E-05	0.000E+00	0.000E+00	0.000E+00	2.884E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.884E-03
Pb-210	1.735E-06	0.000E+00	0.000E+00	0.000E+00	1.792E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.792E-04
Ra-226	2.149E-06	0.000E+00	0.000E+00	0.000E+00	2.220E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.220E-04
Th-230	4.370E-05	0.000E+00	0.000E+00	0.000E+00	4.515E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.515E-03
U-234	4.412E-03	0.000E+00	0.000E+00	0.000E+00	4.558E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.558E-01
U-235	4.412E-03	0.000E+00	0.000E+00	0.000E+00	4.558E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.558E-01
U-238	4.412E-03	0.000E+00	0.000E+00	0.000E+00	4.558E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.558E-01

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

0

Amount of Intake Quantities QINT9(irn,i,t) and QINT9W(irn,i,t) for Inhalation of
Radon and its Decay Products as pCi/yr at t= 3.000E+02 years

0

Radon Pathway	Radionuclides							
	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+02 years

0

Water Independent Pathways (Inhalation excludes radon)

0

Radio-Nuclide	Ground		Inhalation		Plant		Meat		Milk		Soil	
	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	3.763E-09	0.0096	9.717E-11	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.080E-11	0.0001
Pa-231	5.174E-10	0.0013	5.052E-11	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.548E-11	0.0000
Pb-210	1.075E-12	0.0000	1.395E-12	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.613E-11	0.0000
Ra-226	2.641E-09	0.0068	1.576E-12	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.965E-12	0.0000
Th-230	5.100E-12	0.0000	3.754E-11	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.357E-11	0.0000
U-234	1.433E-10	0.0004	2.800E-09	0.0072	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.938E-10	0.0025
U-235	3.075E-07	0.7887	2.518E-09	0.0065	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.016E-09	0.0026
U-238	6.411E-08	0.1644	2.380E-09	0.0061	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.255E-09	0.0032
Total	3.787E-07	0.9712	7.887E-09	0.0202	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.344E-09	0.0086

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Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Plant		Meat		Milk		All Pathways**	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.891E-09	0.0100
Pa-231	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.834E-10	0.0015
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.860E-11	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.646E-09	0.0068
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.621E-11	0.0001
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.937E-09	0.0101
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.111E-07	0.7977
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.775E-08	0.1737
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.900E-07	1.0000

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways
0

Excess Cancer Risks CNRS9(irn,i,t) and CNRS9W(irn,i,t) for Inhalation of
Radon and its Decay Products at t= 3.000E+02 years
0

Radon	Radionuclides							
Pathway	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent
0

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+02 years
0 Water Independent Pathways (Inhalation excludes radon)
0

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
U-234	2.790E-09	0.0072	2.838E-09	0.0073	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.026E-09	0.0026
U-235	3.118E-07	0.7996	2.666E-09	0.0068	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.062E-09	0.0027
U-238	6.411E-08	0.1644	2.383E-09	0.0061	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.256E-09	0.0032
Total	3.787E-07	0.9712	7.887E-09	0.0202	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.344E-09	0.0086

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Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All pathways	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.654E-09	0.0171
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.156E-07	0.8092
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.775E-08	0.1737
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.900E-07	1.0000

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

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Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 1.000E+03 years

Radio-Nuclide	Water Independent Pathways (Inhalation w/o radon)					Water Dependent Pathways					Total Ingestion*
	Inhalation	Plant	Meat	Milk	Soil	Water	Fish	Plant	Meat	Milk	
Ac-227	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pa-231	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pb-210	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ra-226	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-230	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-234	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-235	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-238	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

0

Amount of Intake Quantities QINT9(irn,i,t) and QINT9W(irn,i,t) for Inhalation of
Radon and its Decay Products as pCi/yr at t= 1.000E+03 years

0

Radon Pathway	Radionuclides							
	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+03 years

0 Water Independent Pathways (Inhalation excludes radon)

0

Radio-Nuclide	Ground		Inhalation		Plant		Meat		Milk		Soil	
	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pa-231	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+03 years

Water Dependent Pathways

Radio-	Water		Fish		Plant		Meat		Milk		All Pathways**	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pa-231	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways
0

Excess Cancer Risks CNRS9(irn,i,t) and CNRS9W(irn,i,t) for Inhalation of
Radon and its Decay Products at t= 1.000E+03 years
0

Radon	Radionuclides							
Pathway	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent
0

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+03 years
0 Water Independent Pathways (Inhalation excludes radon)
0

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+03 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All pathways	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

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Cancer Risk Slope Factors Summary Table
Risk Library: FGR 13 Morbidity

0 Menu	Parameter	Current Value	Base Case*	Parameter Name
Sf-1	Ground external radiation slope factors, 1/yr per (pCi/g):			
Sf-1	Ac-227+D	1.47E-06	3.48E-10	SLPF(1,1)
Sf-1	Pa-231	1.39E-07	1.39E-07	SLPF(2,1)
Sf-1	Pb-210+D	4.21E-09	1.41E-09	SLPF(3,1)
Sf-1	Ra-226+D	8.49E-06	2.29E-08	SLPF(4,1)
Sf-1	Th-230	8.19E-10	8.19E-10	SLPF(5,1)
Sf-1	U-234	2.52E-10	2.52E-10	SLPF(6,1)
Sf-1	U-235+D	5.43E-07	5.18E-07	SLPF(7,1)
Sf-1	U-238	4.99E-11	4.99E-11	SLPF(8,1)
Sf-1	U-238+D	1.14E-07	4.99E-11	SLPF(9,1)
Sf-2	Inhalation, slope factors, 1/(pCi):			
Sf-2	Ac-227+D	2.13E-07	1.49E-07	SLPF(1,2)
Sf-2	Pa-231	7.62E-08	7.62E-08	SLPF(2,2)
Sf-2	Pb-210+D	3.08E-08	1.58E-08	SLPF(3,2)
Sf-2	Ra-226+D	2.83E-08	2.82E-08	SLPF(4,2)
Sf-2	Th-230	3.40E-08	3.40E-08	SLPF(5,2)
Sf-2	U-234	2.78E-08	2.78E-08	SLPF(6,2)
Sf-2	U-235+D	2.50E-08	2.50E-08	SLPF(7,2)
Sf-2	U-238	2.36E-08	2.36E-08	SLPF(8,2)
Sf-2	U-238+D	2.36E-08	2.36E-08	SLPF(9,2)
Sf-3	Food ingestion, slope factors, 1/(pCi):			
Sf-3	Ac-227+D	6.53E-10	2.45E-10	SLPF(1,3)
Sf-3	Pa-231	2.26E-10	2.26E-10	SLPF(2,3)
Sf-3	Pb-210+D	3.44E-09	1.18E-09	SLPF(3,3)
Sf-3	Ra-226+D	5.15E-10	5.14E-10	SLPF(4,3)
Sf-3	Th-230	1.19E-10	1.19E-10	SLPF(5,3)
Sf-3	U-234	9.55E-11	9.55E-11	SLPF(6,3)
Sf-3	U-235+D	9.76E-11	9.44E-11	SLPF(7,3)
Sf-3	U-238	8.66E-11	8.66E-11	SLPF(8,3)
Sf-3	U-238+D	1.21E-10	8.66E-11	SLPF(9,3)
Sf-3	Water ingestion, slope factors, 1/(pCi):			
Sf-3	Ac-227+D	4.86E-10	2.01E-10	SLPF(1,4)
Sf-3	Pa-231	1.73E-10	1.73E-10	SLPF(2,4)
Sf-3	Pb-210+D	2.66E-09	8.81E-10	SLPF(3,4)
Sf-3	Ra-226+D	3.86E-10	3.85E-10	SLPF(4,4)
Sf-3	Th-230	9.10E-11	9.10E-11	SLPF(5,4)
Sf-3	U-234	7.07E-11	7.07E-11	SLPF(6,4)
Sf-3	U-235+D	7.18E-11	6.96E-11	SLPF(7,4)
Sf-3	U-238	6.40E-11	6.40E-11	SLPF(8,4)
Sf-3	U-238+D	8.71E-11	6.40E-11	SLPF(9,4)
Sf-3	Soil ingestion, slope factors, 1/(pCi):			
Sf-3	Ac-227+D	6.53E-10	2.45E-10	SLPF(1,5)
Sf-3	Pa-231	2.26E-10	2.26E-10	SLPF(2,5)
Sf-3	Pb-210+D	3.44E-09	1.18E-09	SLPF(3,5)
Sf-3	Ra-226+D	5.15E-10	5.14E-10	SLPF(4,5)
Sf-3	Th-230	1.19E-10	1.19E-10	SLPF(5,5)

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Cancer Risk Slope Factors Summary Table (continued)
Risk Library: FGR 13 Morbidity

0 Menu	Parameter	Current Value	Base Case*	Parameter Name
Sf-3	U-234	9.55E-11	9.55E-11	SLPF(6,5)
Sf-3	U-235+D	9.76E-11	9.44E-11	SLPF(7,5)
Sf-3	U-238	8.66E-11	8.66E-11	SLPF(8,5)
Sf-3	U-238+D	1.21E-10	8.66E-11	SLPF(9,5)
Sf-Rn	Radon Inhalation slope factors, 1/(pCi):			
Sf-Rn	Rn-222	1.80E-12	1.80E-12	SLPFRN(1,1)
Sf-Rn	Po-218	3.70E-12	3.70E-12	SLPFRN(1,2)
Sf-Rn	Pb-214	6.20E-12	6.20E-12	SLPFRN(1,3)
Sf-Rn	Bi-214	1.50E-11	1.50E-11	SLPFRN(1,4)
Sf-Rn	Radon K factors, (mrem/WLM):			
Sf-Rn	Rn-222 Indoor	7.60E+02	7.60E+02	KFACTR(1,1)
Sf-Rn	Rn-222 Outdoor	5.70E+02	5.70E+02	KFACTR(1,2)

*Base Case means Default.Lib w/o Associate Nuclide contributions.

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Risk Slope and Environmental Transport Factors for the Ground Pathway

0Nuclide (i)	Slope(i)* t=	ETFG(i,t) At Time in Years (dimensionless) 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ac-227	3.480E-10	2.275E-01	2.275E-01	2.275E-01	2.275E-01	2.275E-01	2.275E-01	2.275E-01	0.000E+00
At-218	3.570E-09	2.282E-01	2.282E-01	2.282E-01	2.282E-01	2.282E-01	2.282E-01	2.282E-01	0.000E+00
Bi-210	2.760E-09	2.264E-01	2.264E-01	2.264E-01	2.264E-01	2.264E-01	2.264E-01	2.264E-01	0.000E+00
Bi-211	1.880E-07	2.264E-01	2.264E-01	2.264E-01	2.264E-01	2.264E-01	2.264E-01	2.264E-01	0.000E+00
Bi-214	7.480E-06	2.252E-01	2.252E-01	2.252E-01	2.252E-01	2.252E-01	2.252E-01	2.249E-01	0.000E+00
Fr-223	1.400E-07	2.268E-01	2.268E-01	2.268E-01	2.268E-01	2.268E-01	2.268E-01	2.268E-01	0.000E+00
Pa-231	1.390E-07	2.264E-01	2.264E-01	2.264E-01	2.264E-01	2.264E-01	2.264E-01	2.264E-01	0.000E+00
Pa-234	8.710E-06	2.257E-01	2.257E-01	2.257E-01	2.257E-01	2.257E-01	2.257E-01	2.256E-01	0.000E+00
Pa-234m	6.870E-08	2.256E-01	2.256E-01	2.256E-01	2.256E-01	2.256E-01	2.256E-01	2.256E-01	0.000E+00
Pb-210	1.410E-09	2.283E-01	2.283E-01	2.283E-01	2.283E-01	2.283E-01	2.283E-01	2.283E-01	0.000E+00
Pb-211	2.290E-07	2.258E-01	2.258E-01	2.258E-01	2.258E-01	2.258E-01	2.258E-01	2.257E-01	0.000E+00
Pb-214	9.820E-07	2.266E-01	2.266E-01	2.266E-01	2.266E-01	2.266E-01	2.266E-01	2.266E-01	0.000E+00
Po-210	3.950E-11	2.256E-01	2.256E-01	2.256E-01	2.256E-01	2.256E-01	2.256E-01	2.255E-01	0.000E+00
Po-211	3.580E-08	2.255E-01	2.255E-01	2.255E-01	2.255E-01	2.255E-01	2.255E-01	2.254E-01	0.000E+00
Po-214	3.860E-10	2.255E-01	2.255E-01	2.255E-01	2.255E-01	2.255E-01	2.255E-01	2.254E-01	0.000E+00
Po-215	7.480E-10	2.260E-01	2.260E-01	2.260E-01	2.260E-01	2.260E-01	2.260E-01	2.260E-01	0.000E+00
Po-218	4.260E-11	2.256E-01	2.256E-01	2.256E-01	2.256E-01	2.256E-01	2.256E-01	2.255E-01	0.000E+00
Ra-223	4.340E-07	2.268E-01	2.268E-01	2.268E-01	2.268E-01	2.268E-01	2.268E-01	2.268E-01	0.000E+00
Ra-226	2.290E-08	2.270E-01	2.270E-01	2.270E-01	2.270E-01	2.270E-01	2.270E-01	2.270E-01	0.000E+00
Rn-219	2.250E-07	2.267E-01	2.267E-01	2.267E-01	2.267E-01	2.267E-01	2.267E-01	2.266E-01	0.000E+00
Rn-222	1.740E-09	2.259E-01	2.259E-01	2.259E-01	2.259E-01	2.259E-01	2.259E-01	2.258E-01	0.000E+00
Th-227	3.780E-07	2.269E-01	2.269E-01	2.269E-01	2.269E-01	2.269E-01	2.269E-01	2.269E-01	0.000E+00
Th-230	8.190E-10	2.275E-01	2.275E-01	2.275E-01	2.275E-01	2.275E-01	2.275E-01	2.275E-01	0.000E+00
Th-231	2.450E-08	2.277E-01	2.277E-01	2.277E-01	2.277E-01	2.277E-01	2.277E-01	2.277E-01	0.000E+00
Th-234	1.630E-08	2.278E-01	2.278E-01	2.278E-01	2.278E-01	2.278E-01	2.278E-01	2.278E-01	0.000E+00
Tl-207	1.520E-08	2.259E-01	2.259E-01	2.259E-01	2.259E-01	2.259E-01	2.259E-01	2.258E-01	0.000E+00
Tl-210	0.000E+00	2.283E-01	2.283E-01	2.283E-01	2.283E-01	2.283E-01	2.283E-01	2.283E-01	2.283E-01
U-234	2.520E-10	2.277E-01	2.277E-01	2.277E-01	2.277E-01	2.277E-01	2.277E-01	2.277E-01	0.000E+00
U-235	5.180E-07	2.269E-01	2.269E-01	2.269E-01	2.269E-01	2.269E-01	2.269E-01	2.269E-01	0.000E+00
U-238	4.990E-11	2.283E-01	2.283E-01	2.283E-01	2.283E-01	2.283E-01	2.283E-01	2.283E-01	0.000E+00

* - Units are 1/yr per (pCi/g) at infinite depth and area. Multiplication by ETFG(i,t) converts to site conditions.

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Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 0.000E+00 years

Radio-Nuclide	Water Independent Pathways (Inhalation w/o radon)					Water Dependent Pathways					Total Ingestion*
	Inhalation	Plant	Meat	Milk	Soil	Water	Fish	Plant	Meat	Milk	
Ac-227	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pa-231	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pb-210	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ra-226	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-230	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-234	4.033E-02	0.000E+00	0.000E+00	0.000E+00	4.000E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.000E+01
U-235	4.033E-02	0.000E+00	0.000E+00	0.000E+00	4.000E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.000E+01
U-238	4.033E-02	0.000E+00	0.000E+00	0.000E+00	4.000E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.000E+01

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

0

Amount of Intake Quantities QINT9(irn,i,t) and QINT9W(irn,i,t) for Inhalation of
Radon and its Decay Products as pCi/yr at t= 0.000E+00 years

0

Radon Pathway	Radionuclides							
	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 0.000E+00 years

0

Water Independent Pathways (Inhalation excludes radon)

0

Radio-Nuclide	Ground		Inhalation		Plant		Meat		Milk		Soil	
	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	3.672E-14	0.0000	9.482E-16	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.885E-15	0.0000
Pa-231	3.314E-13	0.0000	3.235E-14	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.516E-14	0.0000
Pb-210	4.781E-21	0.0000	6.205E-21	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.889E-19	0.0000
Ra-226	1.239E-15	0.0000	7.386E-19	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.334E-17	0.0000
Th-230	8.365E-16	0.0000	6.157E-15	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.137E-14	0.0000
U-234	5.717E-11	0.0003	1.117E-09	0.0068	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.806E-09	0.0232
U-235	1.227E-07	0.7485	1.005E-09	0.0061	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.891E-09	0.0237
U-238	2.558E-08	0.1561	9.495E-10	0.0058	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.806E-09	0.0293
Total	1.483E-07	0.9050	3.071E-09	0.0187	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.250E-08	0.0763

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Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 0.000E+00 years

Water Dependent Pathways

Radio-Nuclide	Water risk	Water fract.	Fish risk	Fish fract.	Plant risk	Plant fract.	Meat risk	Meat fract.	Milk risk	Milk fract.	All Pathways** risk	All Pathways** fract.
Ac-227	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.055E-14	0.0000
Pa-231	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.589E-13	0.0000
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.999E-19	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.253E-15	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.836E-14	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.980E-09	0.0304
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.276E-07	0.7784
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.134E-08	0.1912
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.639E-07	1.0000

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways
0

Excess Cancer Risks CNRS9(irn,i,t) and CNRS9W(irn,i,t) for Inhalation of
Radon and its Decay Products at t= 0.000E+00 years
0

Radon Pathway	Radionuclides Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent
0

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 0.000E+00 years
0 Water Independent Pathways (Inhalation excludes radon)
0

Radio-Nuclide	Ground risk	Ground fract.	Inhalation risk	Inhalation fract.	Radon risk	Radon fract.	Plant risk	Plant fract.	Meat risk	Meat fract.	Milk risk	Milk fract.	Soil risk	Soil fract.
U-234	5.718E-11	0.0003	1.117E-09	0.0068	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.806E-09	0.0232
U-235	1.227E-07	0.7485	1.005E-09	0.0061	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.891E-09	0.0237
U-238	2.558E-08	0.1561	9.495E-10	0.0058	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.806E-09	0.0293
Total	1.483E-07	0.9050	3.071E-09	0.0187	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.250E-08	0.0763

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Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 0.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All pathways	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.980E-09	0.0304
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.276E-07	0.7784
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.134E-08	0.1912
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.639E-07	1.0000

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

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Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 1.000E+00 years

Radio-Nuclide	Water Independent Pathways (Inhalation w/o radon)					Water Dependent Pathways					Total Ingestion*
	Inhalation	Plant	Meat	Milk	Soil	Water	Fish	Plant	Meat	Milk	
Ac-227	1.329E-08	0.000E+00	0.000E+00	0.000E+00	1.318E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.318E-05
Pa-231	8.470E-07	0.000E+00	0.000E+00	0.000E+00	8.401E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.401E-04
Pb-210	8.051E-13	0.000E+00	0.000E+00	0.000E+00	7.985E-10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.985E-10
Ra-226	7.830E-11	0.000E+00	0.000E+00	0.000E+00	7.765E-08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.765E-08
Th-230	3.617E-07	0.000E+00	0.000E+00	0.000E+00	3.587E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.587E-04
U-234	4.003E-02	0.000E+00	0.000E+00	0.000E+00	3.970E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.970E+01
U-235	4.003E-02	0.000E+00	0.000E+00	0.000E+00	3.970E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.970E+01
U-238	4.003E-02	0.000E+00	0.000E+00	0.000E+00	3.970E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.970E+01

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

0

Amount of Intake Quantities QINT9(irn,i,t) and QINT9W(irn,i,t) for Inhalation of
Radon and its Decay Products as pCi/yr at t= 1.000E+00 years

0

Radon Pathway	Radionuclides							
	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+00 years

0

0 Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Plant		Meat		Milk		Soil	
	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	2.523E-13	0.0000	6.516E-15	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.983E-14	0.0000
Pa-231	9.876E-13	0.0000	9.642E-14	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.836E-13	0.0000
Pb-210	7.099E-20	0.0000	9.213E-20	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.023E-17	0.0000
Ra-226	8.640E-15	0.0000	5.151E-18	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.302E-17	0.0000
Th-230	2.501E-15	0.0000	1.841E-14	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.390E-14	0.0000
U-234	5.675E-11	0.0003	1.109E-09	0.0068	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.778E-09	0.0232
U-235	1.218E-07	0.7485	9.972E-10	0.0061	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.862E-09	0.0237
U-238	2.539E-08	0.1561	9.425E-10	0.0058	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.771E-09	0.0293
Total	1.472E-07	0.9050	3.049E-09	0.0187	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.241E-08	0.0763

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Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Plant		Meat		Milk		All Pathways**	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.787E-13	0.0000
Pa-231	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.368E-12	0.0000
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.039E-17	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.739E-15	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.481E-14	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.943E-09	0.0304
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.266E-07	0.7784
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.111E-08	0.1912
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.627E-07	1.0000

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways
0

Excess Cancer Risks CNRS9(irn,i,t) and CNRS9W(irn,i,t) for Inhalation of
Radon and its Decay Products at t= 1.000E+00 years
0

Radon	Radionuclides							
Pathway	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent
0

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+00 years
0 Water Independent Pathways (Inhalation excludes radon)
0

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
U-234	5.676E-11	0.0003	1.109E-09	0.0068	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.778E-09	0.0232
U-235	1.218E-07	0.7485	9.973E-10	0.0061	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.863E-09	0.0237
U-238	2.539E-08	0.1561	9.425E-10	0.0058	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.771E-09	0.0293
Total	1.472E-07	0.9050	3.049E-09	0.0187	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.241E-08	0.0763

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Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All pathways	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.943E-09	0.0304
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.266E-07	0.7784
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.111E-08	0.1912
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.627E-07	1.0000

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

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Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 3.000E+00 years

Radio-Nuclide	Water Independent Pathways (Inhalation w/o radon)					Water Dependent Pathways					Total Ingestion*
	Inhalation	Plant	Meat	Milk	Soil	Water	Fish	Plant	Meat	Milk	
Ac-227	1.146E-07	0.000E+00	0.000E+00	0.000E+00	1.137E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.137E-04
Pa-231	2.504E-06	0.000E+00	0.000E+00	0.000E+00	2.483E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.483E-03
Pb-210	2.123E-11	0.000E+00	0.000E+00	0.000E+00	2.105E-08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.105E-08
Ra-226	6.985E-10	0.000E+00	0.000E+00	0.000E+00	6.928E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.928E-07
Th-230	1.077E-06	0.000E+00	0.000E+00	0.000E+00	1.068E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.068E-03
U-234	3.945E-02	0.000E+00	0.000E+00	0.000E+00	3.912E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.912E+01
U-235	3.945E-02	0.000E+00	0.000E+00	0.000E+00	3.912E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.912E+01
U-238	3.945E-02	0.000E+00	0.000E+00	0.000E+00	3.912E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.912E+01

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

0

Amount of Intake Quantities QINT9(irn,i,t) and QINT9W(irn,i,t) for Inhalation of
Radon and its Decay Products as pCi/yr at t= 3.000E+00 years

0

Radon Pathway	Radionuclides							
	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+00 years

0

0 Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Plant		Meat		Milk		Soil	
	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	1.280E-12	0.0000	3.304E-14	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.005E-13	0.0000
Pa-231	2.271E-12	0.0000	2.217E-13	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.522E-13	0.0000
Pb-210	8.096E-19	0.0000	1.051E-18	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.167E-16	0.0000
Ra-226	4.529E-14	0.0000	2.700E-17	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.875E-16	0.0000
Th-230	5.794E-15	0.0000	4.264E-14	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.480E-13	0.0000
U-234	5.592E-11	0.0003	1.093E-09	0.0068	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.722E-09	0.0232
U-235	1.200E-07	0.7485	9.826E-10	0.0061	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.806E-09	0.0237
U-238	2.502E-08	0.1561	9.287E-10	0.0058	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.701E-09	0.0293
Total	1.451E-07	0.9050	3.004E-09	0.0187	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.223E-08	0.0763

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Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Plant		Meat		Milk		All Pathways**	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.413E-12	0.0000
Pa-231	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.145E-12	0.0000
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.185E-16	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.580E-14	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.965E-13	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.871E-09	0.0304
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.248E-07	0.7784
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.065E-08	0.1912
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.603E-07	1.0000

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways
0

Excess Cancer Risks CNRS9(irn,i,t) and CNRS9W(irn,i,t) for Inhalation of
Radon and its Decay Products at t= 3.000E+00 years
0

Radon	Radionuclides							
Pathway	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent
0

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+00 years
0 Water Independent Pathways (Inhalation excludes radon)
0

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
U-234	5.597E-11	0.0003	1.093E-09	0.0068	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.723E-09	0.0232
U-235	1.200E-07	0.7485	9.829E-10	0.0061	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.807E-09	0.0237
U-238	2.502E-08	0.1561	9.287E-10	0.0058	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.701E-09	0.0293
Total	1.451E-07	0.9050	3.004E-09	0.0187	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.223E-08	0.0763

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Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All pathways	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.871E-09	0.0304
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.248E-07	0.7784
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.065E-08	0.1912
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.603E-07	1.0000

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

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Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 1.000E+01 years

Radio-Nuclide	Water Independent Pathways (Inhalation w/o radon)					Water Dependent Pathways					Total Ingestion*
	Inhalation	Plant	Meat	Milk	Soil	Water	Fish	Plant	Meat	Milk	
Ac-227	1.099E-06	0.000E+00	0.000E+00	0.000E+00	1.090E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.090E-03
Pa-231	7.925E-06	0.000E+00	0.000E+00	0.000E+00	7.860E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.860E-03
Pb-210	7.241E-10	0.000E+00	0.000E+00	0.000E+00	7.182E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.182E-07
Ra-226	7.529E-09	0.000E+00	0.000E+00	0.000E+00	7.467E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.467E-06
Th-230	3.500E-06	0.000E+00	0.000E+00	0.000E+00	3.471E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.471E-03
U-234	3.746E-02	0.000E+00	0.000E+00	0.000E+00	3.715E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.715E+01
U-235	3.746E-02	0.000E+00	0.000E+00	0.000E+00	3.715E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.715E+01
U-238	3.746E-02	0.000E+00	0.000E+00	0.000E+00	3.715E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.715E+01

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

0

Amount of Intake Quantities QINT9(irn,i,t) and QINT9W(irn,i,t) for Inhalation of
Radon and its Decay Products as pCi/yr at t= 1.000E+01 years

0

Radon Pathway	Radionuclides							
	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+01 years

0

Water Independent Pathways (Inhalation excludes radon)

0

Radio-Nuclide	Ground		Inhalation		Plant		Meat		Milk		Soil	
	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	9.893E-12	0.0001	2.555E-13	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.772E-13	0.0000
Pa-231	6.471E-12	0.0000	6.317E-13	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.858E-12	0.0000
Pb-210	1.979E-17	0.0000	2.568E-17	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.852E-15	0.0000
Ra-226	3.930E-13	0.0000	2.343E-16	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.231E-15	0.0000
Th-230	1.694E-14	0.0000	1.247E-13	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.329E-13	0.0000
U-234	5.311E-11	0.0003	1.038E-09	0.0068	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.535E-09	0.0232
U-235	1.140E-07	0.7484	9.332E-10	0.0061	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.614E-09	0.0237
U-238	2.376E-08	0.1561	8.820E-10	0.0058	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.465E-09	0.0293
Total	1.378E-07	0.9050	2.854E-09	0.0187	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.162E-08	0.0763

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Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Plant		Meat		Milk		All Pathways**	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.093E-11	0.0001
Pa-231	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.961E-12	0.0001
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.897E-15	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.975E-13	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.745E-13	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.626E-09	0.0304
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.185E-07	0.7783
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.911E-08	0.1912
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.523E-07	1.0000

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways
0

Excess Cancer Risks CNRS9(irn,i,t) and CNRS9W(irn,i,t) for Inhalation of
Radon and its Decay Products at t= 1.000E+01 years
0

Radon	Radionuclides							
Pathway	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent
0

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+01 years
0 Water Independent Pathways (Inhalation excludes radon)
0

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
U-234	5.352E-11	0.0004	1.038E-09	0.0068	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.536E-09	0.0232
U-235	1.140E-07	0.7486	9.340E-10	0.0061	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.617E-09	0.0238
U-238	2.376E-08	0.1561	8.820E-10	0.0058	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.465E-09	0.0293
Total	1.378E-07	0.9050	2.854E-09	0.0187	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.162E-08	0.0763

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Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All pathways	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.627E-09	0.0304
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.185E-07	0.7784
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.911E-08	0.1912
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.523E-07	1.0000

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

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Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 3.000E+01 years

Radio-Nuclide	Water Independent Pathways (Inhalation w/o radon)					Water Dependent Pathways					Total Ingestion*
	Inhalation	Plant	Meat	Milk	Soil	Water	Fish	Plant	Meat	Milk	
Ac-227	6.666E-06	0.000E+00	0.000E+00	0.000E+00	6.612E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.612E-03
Pa-231	2.051E-05	0.000E+00	0.000E+00	0.000E+00	2.034E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.034E-02
Pb-210	1.560E-08	0.000E+00	0.000E+00	0.000E+00	1.547E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.547E-05
Ra-226	6.215E-08	0.000E+00	0.000E+00	0.000E+00	6.164E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.164E-05
Th-230	9.768E-06	0.000E+00	0.000E+00	0.000E+00	9.688E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.688E-03
U-234	3.232E-02	0.000E+00	0.000E+00	0.000E+00	3.206E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.206E+01
U-235	3.232E-02	0.000E+00	0.000E+00	0.000E+00	3.206E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.206E+01
U-238	3.232E-02	0.000E+00	0.000E+00	0.000E+00	3.206E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.206E+01

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

0

Amount of Intake Quantities QINT9(irn,i,t) and QINT9W(irn,i,t) for Inhalation of
Radon and its Decay Products as pCi/yr at t= 3.000E+01 years

0

Radon Pathway	Radionuclides							
	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+01 years

0

Water Independent Pathways (Inhalation excludes radon)

0

Radio-Nuclide	Ground		Inhalation		Plant		Meat		Milk		Soil	
	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	5.626E-11	0.0004	1.453E-12	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.420E-12	0.0000
Pa-231	1.622E-11	0.0001	1.583E-12	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.657E-12	0.0000
Pb-210	3.865E-16	0.0000	5.016E-16	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.569E-14	0.0000
Ra-226	3.040E-12	0.0000	1.812E-15	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.273E-14	0.0000
Th-230	4.579E-14	0.0000	3.370E-13	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.170E-12	0.0000
U-234	4.582E-11	0.0003	8.953E-10	0.0068	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.050E-09	0.0232
U-235	9.833E-08	0.7480	8.052E-10	0.0061	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.119E-09	0.0237
U-238	2.050E-08	0.1560	7.610E-10	0.0058	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.852E-09	0.0293
Total	1.190E-07	0.9049	2.465E-09	0.0188	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.003E-08	0.0763

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Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+01 years

Water Dependent Pathways

Radio-Nuclide	Water risk	Water fract.	Fish risk	Fish fract.	Plant risk	Plant fract.	Meat risk	Meat fract.	Milk risk	Milk fract.	All Pathways** risk	All Pathways** fract.
Ac-227	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.214E-11	0.0005
Pa-231	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.245E-11	0.0002
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.658E-14	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.075E-12	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.553E-12	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.991E-09	0.0304
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.023E-07	0.7779
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.512E-08	0.1911
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.315E-07	1.0000

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways
0

Excess Cancer Risks CNRS9(irn,i,t) and CNRS9W(irn,i,t) for Inhalation of
Radon and its Decay Products at t= 3.000E+01 years
0

Radon Pathway	Radionuclides Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent
0

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+01 years
0 Water Independent Pathways (Inhalation excludes radon)
0

Radio-Nuclide	Ground risk	Ground fract.	Inhalation risk	Inhalation fract.	Radon risk	Radon fract.	Plant risk	Plant fract.	Meat risk	Meat fract.	Milk risk	Milk fract.	Soil risk	Soil fract.
U-234	4.891E-11	0.0004	8.956E-10	0.0068	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.051E-09	0.0232
U-235	9.840E-08	0.7486	8.082E-10	0.0061	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.128E-09	0.0238
U-238	2.050E-08	0.1560	7.611E-10	0.0058	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.853E-09	0.0293
Total	1.190E-07	0.9049	2.465E-09	0.0188	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.003E-08	0.0763

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Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All pathways	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.996E-09	0.0304
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.023E-07	0.7785
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.512E-08	0.1911
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.315E-07	1.0000

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

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Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 1.000E+02 years

Radio-Nuclide	Water Independent Pathways (Inhalation w/o radon)					Water Dependent Pathways					Total Ingestion*
	Inhalation	Plant	Meat	Milk	Soil	Water	Fish	Plant	Meat	Milk	
Ac-227	2.335E-05	0.000E+00	0.000E+00	0.000E+00	2.316E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.316E-02
Pa-231	4.077E-05	0.000E+00	0.000E+00	0.000E+00	4.043E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.043E-02
Pb-210	2.874E-07	0.000E+00	0.000E+00	0.000E+00	2.850E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.850E-04
Ra-226	5.147E-07	0.000E+00	0.000E+00	0.000E+00	5.104E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.104E-04
Th-230	2.566E-05	0.000E+00	0.000E+00	0.000E+00	2.545E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.545E-02
U-234	1.929E-02	0.000E+00	0.000E+00	0.000E+00	1.913E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.913E+01
U-235	1.929E-02	0.000E+00	0.000E+00	0.000E+00	1.913E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.913E+01
U-238	1.929E-02	0.000E+00	0.000E+00	0.000E+00	1.913E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.913E+01

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

0

Amount of Intake Quantities QINT9(irn,i,t) and QINT9W(irn,i,t) for Inhalation of
Radon and its Decay Products as pCi/yr at t= 1.000E+02 years

0

Radon Pathway	Radionuclides							
	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+02 years

0

0 Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Plant		Meat		Milk		Soil	
	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	1.930E-10	0.0025	4.983E-12	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.516E-11	0.0002
Pa-231	3.186E-11	0.0004	3.111E-12	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.150E-12	0.0001
Pb-210	6.881E-15	0.0000	8.931E-15	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.916E-13	0.0000
Ra-226	2.460E-11	0.0003	1.467E-14	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.648E-13	0.0000
Th-230	1.189E-13	0.0000	8.753E-13	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.038E-12	0.0000
U-234	2.734E-11	0.0003	5.342E-10	0.0068	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.820E-09	0.0231
U-235	5.868E-08	0.7458	4.805E-10	0.0061	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.861E-09	0.0237
U-238	1.223E-08	0.1555	4.541E-10	0.0058	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.299E-09	0.0292
Total	7.119E-08	0.9048	1.478E-09	0.0188	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.009E-09	0.0764

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Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Plant		Meat		Milk		All Pathways**	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.131E-10	0.0027
Pa-231	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.412E-11	0.0006
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.007E-12	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.488E-11	0.0003
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.033E-12	0.0001
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.382E-09	0.0303
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.102E-08	0.7756
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.499E-08	0.1905
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.867E-08	1.0000

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways
0

Excess Cancer Risks CNRS9(irn,i,t) and CNRS9W(irn,i,t) for Inhalation of
Radon and its Decay Products at t= 1.000E+02 years
0

Radon	Radionuclides							
Pathway	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent
0

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+02 years
0 Water Independent Pathways (Inhalation excludes radon)
0

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
U-234	5.206E-11	0.0007	5.350E-10	0.0068	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.824E-09	0.0232
U-235	5.890E-08	0.7487	4.886E-10	0.0062	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.885E-09	0.0240
U-238	1.223E-08	0.1555	4.543E-10	0.0058	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.299E-09	0.0292
Total	7.119E-08	0.9048	1.478E-09	0.0188	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.009E-09	0.0764

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Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All pathways	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.411E-09	0.0306
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.127E-08	0.7788
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.499E-08	0.1905
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.867E-08	1.0000

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

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Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 3.000E+02 years

Radio-Nuclide	Water Independent Pathways (Inhalation w/o radon)					Water Dependent Pathways					Total Ingestion*
	Inhalation	Plant	Meat	Milk	Soil	Water	Fish	Plant	Meat	Milk	
Ac-227	1.916E-05	0.000E+00	0.000E+00	0.000E+00	1.900E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.900E-02
Pa-231	2.792E-05	0.000E+00	0.000E+00	0.000E+00	2.769E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.769E-02
Pb-210	1.735E-06	0.000E+00	0.000E+00	0.000E+00	1.721E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.721E-03
Ra-226	2.149E-06	0.000E+00	0.000E+00	0.000E+00	2.131E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.131E-03
Th-230	4.370E-05	0.000E+00	0.000E+00	0.000E+00	4.334E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.334E-02
U-234	4.412E-03	0.000E+00	0.000E+00	0.000E+00	4.376E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.376E+00
U-235	4.412E-03	0.000E+00	0.000E+00	0.000E+00	4.376E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.376E+00
U-238	4.412E-03	0.000E+00	0.000E+00	0.000E+00	4.376E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.376E+00

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

0

Amount of Intake Quantities QINT9(irn,i,t) and QINT9W(irn,i,t) for Inhalation of
Radon and its Decay Products as pCi/yr at t= 3.000E+02 years

0

Radon Pathway	Radionuclides							
	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+02 years

0

0 Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Plant		Meat		Milk		Soil	
	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	1.576E-10	0.0086	4.070E-12	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.238E-11	0.0007
Pa-231	2.174E-11	0.0012	2.123E-12	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.245E-12	0.0003
Pb-210	4.119E-14	0.0000	5.345E-14	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.935E-12	0.0003
Ra-226	1.020E-10	0.0056	6.085E-14	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.099E-12	0.0001
Th-230	2.020E-13	0.0000	1.487E-12	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.160E-12	0.0003
U-234	6.255E-12	0.0003	1.222E-10	0.0067	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.163E-10	0.0228
U-235	1.342E-08	0.7354	1.099E-10	0.0060	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.257E-10	0.0233
U-238	2.798E-09	0.1533	1.039E-10	0.0057	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.258E-10	0.0288
Total	1.651E-08	0.9045	3.438E-10	0.0188	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.399E-09	0.0766

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Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Plant		Meat		Milk		All Pathways**	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.741E-10	0.0095
Pa-231	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.011E-11	0.0016
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.029E-12	0.0003
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.031E-10	0.0057
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.849E-12	0.0004
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.448E-10	0.0299
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.396E-08	0.7648
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.428E-09	0.1878
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.825E-08	1.0000

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways
0

Excess Cancer Risks CNRS9(irn,i,t) and CNRS9W(irn,i,t) for Inhalation of
Radon and its Decay Products at t= 3.000E+02 years
0

Radon	Radionuclides							
Pathway	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent
0

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+02 years
0 Water Independent Pathways (Inhalation excludes radon)
0

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
U-234	1.084E-10	0.0059	1.237E-10	0.0068	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.282E-10	0.0235
U-235	1.360E-08	0.7453	1.161E-10	0.0064	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.443E-10	0.0243
U-238	2.798E-09	0.1533	1.040E-10	0.0057	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.262E-10	0.0288
Total	1.651E-08	0.9045	3.438E-10	0.0188	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.399E-09	0.0766

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Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All pathways	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.603E-10	0.0362
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.416E-08	0.7760
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.428E-09	0.1878
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.825E-08	1.0000

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

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Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 1.000E+03 years

Radio-Nuclide	Water Independent Pathways (Inhalation w/o radon)					Water Dependent Pathways					Total Ingestion*
	Inhalation	Plant	Meat	Milk	Soil	Water	Fish	Plant	Meat	Milk	
Ac-227	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pa-231	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pb-210	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ra-226	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-230	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-234	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-235	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-238	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

0

Amount of Intake Quantities QINT9(irn,i,t) and QINT9W(irn,i,t) for Inhalation of
Radon and its Decay Products as pCi/yr at t= 1.000E+03 years

0

Radon Pathway	Radionuclides							
	Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+03 years

0

Water Independent Pathways (Inhalation excludes radon)

0

Radio-Nuclide	Ground		Inhalation		Plant		Meat		Milk		Soil	
	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
Ac-227	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pa-231	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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Intrisk : IAAAP Construction Worker
File : C:\RESRAD\IAAAP CONSTRUCTION WORKER.RAD

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+03 years

Water Dependent Pathways

Radio-Nuclide	Water risk	Water fract.	Fish risk	Fish fract.	Plant risk	Plant fract.	Meat risk	Meat fract.	Milk risk	Milk fract.	All Pathways** risk	All Pathways** fract.
Ac-227	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pa-231	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways
0

Excess Cancer Risks CNRS9(irn,i,t) and CNRS9W(irn,i,t) for Inhalation of
Radon and its Decay Products at t= 1.000E+03 years
0

Radon Pathway	Radionuclides Rn-222	Po-218	Pb-214	Bi-214	Rn-220	Po-216	Pb-212	Bi-212
Water-ind.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Water-dep.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Water-ind. == Water-independent Water-dep. == Water-dependent
0

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+03 years
0 Water Independent Pathways (Inhalation excludes radon)
0

Radio-Nuclide	Ground risk	Ground fract.	Inhalation risk	Inhalation fract.	Radon risk	Radon fract.	Plant risk	Plant fract.	Meat risk	Meat fract.	Milk risk	Milk fract.	Soil risk	Soil fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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Intrisk : IAAAP Construction Worker
File : C:\RESRAD\IAAAP CONSTRUCTION WORKER.RAD

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+03 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All pathways	
Nuclide	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.	risk	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

APPENDIX D

RADIOLOGICAL RG DEVELOPMENT FOR STRUCTURES

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DETERMINATION OF DERIVED CONCENTRATION GUIDELINE LEVELS FOR DEPLETED URANIUM IN STRUCTURES AT THE IOWA ARMY AMMUNITION PLANT

INTRODUCTION

This appendix presents the results of DCGL calculations for DU that is present in structures at the IAAAP. In determining the DCGLs presented in this report, several receptor scenarios such as the site worker and construction worker scenarios were evaluated. The purpose of this report is to present DCGLs for structures at the IAAAP FUSRAP areas (Line 1 and the Firing Site Area). The RESRAD-BUILD computer code (version 3.4) was used to determine dose-to-source and risk-to-source ratios for DU. The dose-to-source ratio and risk-to-source ratio were used to calculate individual radionuclide DCGLs that were equivalent to 25 mrem/year or 1E-4 risk (the maximum allowable protective risk in CERCLA).

METHODOLOGY

The principal radiological contaminant in structures at the IAAAP FUSRAP areas is DU. DU is the byproduct remaining after the extraction of U-235 from naturally occurring uranium. DU typically contains about 99.799, 0.200, and 0.001% by weight U-238, U-235, and U-234, respectively, with corresponding activity percentages of 90.14, 1.45, and 8.40. Natural uranium, by comparison, consists of about 99.284, 0.711, and 0.005 weight percent U-238, U-235, and U-234, respectively, with corresponding activity percentages of 48.6, 2.2, and 49.2, respectively, for the stated radioisotopes.

A unit concentration was input into RESRAD-BUILD to determine dose-to-source ratios and risk-to-source ratios for U-234, U-235, and U-238. The dose-to-source ratios and risk-to-source ratios were then used to calculate a DU DCGL based upon DU activity concentrations and the applicable dose-/risk-based limit.

DETERMINATION OF THE DERIVED CONCENTRATION GUIDELINE LEVEL FOR DEPLETED URANIUM

Risk and Dose Assessment Model

RESRAD-BUILD, version 3.4, was used to derive the DCGL for DU. RESRAD-BUILD is a computer code developed at Argonne National Laboratory for DOE to analyze the radiological doses and risks resulting from the remediation and occupancy of buildings contaminated with radioactive material (ANL 2000).

Source Term

DU is the sum of 99.8% of U-238, 0.0007% of U-234, and 0.2% of U-235 with respect to percentages by weight. Because structure survey instruments cannot differentiate between alpha/beta contamination from independent isotopes, the instrument sees decays from all three. Therefore, the DCGL is based on all three isotopes at their assumed activity percentages.

For this assessment, both receptors are assumed to work in the same facility where the entire floor (model default area = 100 m^2) and walls up to a height of 2 m (model default height) are uniformly contaminated with DU. The assumptions regarding room dimensions and contamination represent default model inputs per NUREGs 5512 and 6697 (PNNL 1994; SNL 1999; ANL 2002). The default room size is being used because it represents a room size that is

likely to be smaller than rooms typically found at a large production facility such as the IAAAP. Because in a smaller room, the distances between the walls and receptor located in the center of the room are less than those in a larger room in a production facility, it is assumed that the smaller room results in a higher delivery of radioactive dose to a receptor than a larger room of similar surface concentrations. Therefore, model inputs for the default room are likely to represent a health-conservative exposure scenario.

Receptor Scenarios

Based on the current and future land use, the site worker and construction worker receptors are modeled for this assessment.

Site Worker

The site worker scenario assumes that the critical receptor is a typical site worker who works 250 days/year for 25 years (USEPA 1991b). The individual works in the building structure that is contaminated with surficial radioactive material. The radioactive material can be released into the indoor air by mechanisms such as mechanical removal (decontamination activities) or erosion (removal of surface contamination). The applicable pathways for the site worker include the following:

- External exposure to penetrating radiation from surfaces,
- Inhalation of airborne radioactive particulates, and
- Direct ingestion of surface contamination.

Construction Worker

The construction worker scenario assumes that the critical receptor is a typical construction worker who works 8 hours per day (hr/day) and 250 days/year for 1 year. The individual works in the building structure that is contaminated with surficial radioactive material. The radioactive material can be released into the indoor air by mechanisms such as mechanical removal (decontamination activities) or erosion (removal of surface contamination). The applicable pathways for the construction worker include the following:

- External exposure to penetrating radiation from surfaces,
- Inhalation of airborne radioactive particulates, and
- Secondary ingestion of surface contamination.

NOTE: Because the only difference between the site worker and the construction worker receptors is the number of years each is exposed on-site (i.e., 1 year versus 25 years), both receptors will have the same dose; however, the site worker receptor will be more limiting for risk because risk is additive over the exposure period whereas the dose limit is an annual limit.

The RESRAD-BUILD parameters for both scenarios are listed in Table D-1.

Table D-1. Parameters for RESRAD-BUILD Building Occupancy Scenario (Site Worker/Construction Worker)

Parameter	Description	Value	Justification
Time Parameters			
Exposure Duration	Amount of time that exposure occurs	365 days	NUREG/CR-5512, Volume 1, Section 3.2.1
Indoor Fraction	Fraction of the exposure duration that is spent inside the building	0.23	8 hr/day; 250 days/year
Evaluation Time	Times at which doses are calculated	0 year	RESRAD-BUILD Default
Building Parameters			
Number of Rooms	Number of compartments in the building	1	RESRAD-BUILD Default
Deposition Velocity	Velocity at which airborne particles are deposited onto the floor surfaces	0.01 m/sec	RESRAD-BUILD Default (A sensitivity test resulted in no significant difference between the default value and the minimum and maximum values listed in NUREG/CR-6697)
Re-suspension Rate	Rate at which deposited material is re-suspended into the air	5.0 E-07 sec^{-1}	RESRAD-BUILD Default (approximate midpoint between NUREG/CR-6697 minimum and maximum values)
Building Exchange Rate	Total volume of air going out of the building per unit time divided by the total volume of the building	0.8 hr^{-1}	RESRAD-BUILD Default Consistent with value of 0.75 hr^{-1} for conditioned spaces (cited by American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.)
Room Area	Floor area of the room	100 m^2	NUREG/CR-5512, Volume 1, Section 6.2.1
Room Height	Height of the room	2.5 m	RESRAD-BUILD Default Consistent with NUREG/CR-6697 most likely value of 2.4 m
Room Exchange Rate	Total volume of air going out of the room per unit time divided by the total volume of the room	0.8 hr^{-1}	RESRAD-BUILD Default Same as building exchange rate due to single room
In/Out Flow Rate	Flow rates of air into and out of the room	200 m^3/hr	Room volume (250 m^3) * Room exchange rate (0.8 hr^{-1})
Receptor Parameters			
Number of Receptors		1	RESRAD-BUILD Default
Room # Location	Room in which the receptor is located	1	RESRAD-BUILD Default
Time Fraction	Fraction of time within the building that the exposed individual spends at his receptor location	1	RESRAD-BUILD Default
Breathing Rate	Inhalation rate of airborne material at this location	33.6 m^3/day	NUREG/CR-6697 most likely value (Breathing rate = 1.4 m^3/hr)
Ingestion Rate	Ingestion rate of deposited dust for this location	1 E-04 m^2/hr	RESRAD-BUILD Default (approximate midpoint between NUREG/CR-6697 minimum and maximum values)
Receptor Location	Coordinates of the receptor	5 m, 5 m, 1 m	Located in center of room at height of 1m

Table D-1. Parameters for RESRAD-BUILD Building Occupancy Scenario (Site Worker/Construction Worker) (Continued)

Parameter	Description	Value	Justification
Shielding Parameters			
Thickness	Thickness of the shielding between the contamination source and the receptor location	0	RESRAD-BUILD Default
Density	Density of the shielding material	Not applicable	
Material	Identification of the shielding material	Not applicable	
Source Parameters			
Number of Sources		5	Floor and four walls
Room # location	All sources are located in Room # 1	1	
Source Type		Area	Surface contamination only; volume source is not likely due to historical assessment of the IAAAP buildings. (No processing of materials or activation of building materials)
Direction	Axis perpendicular to the exposed area	Floor (z), Ceiling (z), 4 walls (x,y,x,y)	NUREG/CR-5512, Volume 1, Section 6.2.1
Location	Center point of the source in the x, y, z direction	Floor: 5 m, 5 m, 0 m; Walls: 10 m, 5 m, 1 m 5 m, 10 m, 1 m 0 m, 5 m, 1 m; 5 m, 0 m, 1 m	Entire floor and bottom 2 m of each wall are uniformly contaminated
Geometry: Area	Area of the exposed surface over which the contamination is evenly distributed	100, 20, 20, 20, 20 m^2	
Air Release Fraction	Fraction of the eroded material that is released into the air	0.07	Most likely value. NUREG/CR-6697
Direct Ingestion	Direct ingestion rate of the source by any receptor in the room	0 /hr	RESRAD-BUILD Default
Removable Fraction	Fraction of the source that can be linearly removed between t =0 and lifetime	0.2	Most likely value NUREG/CR-6697
Lifetime	Amount of time in which all of the removable fraction of the source is linearly eroded	10,000 days	Most likely value NUREG/CR-6697
Radionuclides Concentration	Unit concentration is initially run; results are normalized to 25 mrem/year and 1E-4 risk to determine each isotopic DCGL	1 pCi/m^2	

NOTE: The construction worker is exposed for only a single year whereas the site worker is exposed for 25 years.

Development of Derived Concentration Guideline Levels for Structures

DCGLs applicable to structures contaminated by DU have been developed to address the associated contamination.

To derive the surficial contamination DCGL value that would be equivalent to the dose limit of 25 mrem/year, the IAAAP DU COCs(U-238, U-235 and U-234) were entered into the RESRAD-BUILD code (version 3.4) using a source concentration term of 1 pCi/m^2 to determine a dose-to-source ratio and risk-to-source ratio for each of the five surficial exposure sources (i.e., four walls and the floor) assumed for a room in the contaminated structure. The dose-to-source ratio is a derived value based upon the RESRAD-BUILD modeling output that can be used to convert the dose limit to units of surficial contamination (in pCi/m^2). Likewise, the risk-to-source ratio is a derived value based upon the RESRAD-BUILD modeling output that can be used to convert a target cancer risk to units of surficial contamination (in pCi/m^2). The total room dose-to-source ratio and risk-to-source ratio for DU was then calculated by summing the individual surface dose-to-source ratios and the individual risk-to-source ratios, respectively. Table D-2 shows the dose-to-source ratio for DU from all five (four walls and the floor) sources that was based on results obtained from RESRAD-BUILD.

Table D-2. Dose-to-Source Ratio Values

	Dose-to-Source Ratio (mrem/year/pCi/m^2)					
Source	**1**	**2**	**3**	**4**	**5**	**Total**
U-238	1.00E-05	1.97E-06	1.97E-06	1.97E-06	1.97E-06	1.79E-05
U-235	1.17E-05	2.13E-06	2.13E-06	2.13E-06	2.13E-06	2.02E-05
U-234	1.09E-05	2.18E-06	2.18E-06	2.18E-06	2.18E-06	1.96E-05

To determine a DU DCGL, a relative DU dose must first be established by multiplying the dose-to-source ratio by the corresponding DU activity concentration percent. Dividing each relative DU dose by the sum of the relative DU doses results in a percent of DU dose. Multiplying the percent of DU dose by 25 mrem/year results in a dose value for each isotope that, when divided by the dose-to-source ratio and multiplied by a conversion factor, yields the isotope-specific DCGL. The sum of the isotope-specific DCGLs yields a DU DCGL equivalent to 25 mrem/year. Table D-3 shows these calculations. The DU DCGL for dose (25 mrem) is 30,700 dpm/100 cm^2.

Table D-3. Derived Concentration Guideline Level Calculations (Dose-Based)

Isotope	Dose-to-Source Ratio (mrem/year pCi/m^2)	DU Activity Concentration (%)	Relative DU Dose	% DU Dose	Equivalent Dose (mrem/year)	DCGL (dpm/100 cm^2)
U-238	1.79E-05	0.9014	1.61E-05	89%	22.3	27,703
U-235	2.02E-05	0.0145	2.93E-07	2%	0.406	446
U-234	1.96E-05	0.084	1.65E-06	9%	2.28	2582
		Total	1.81E-05		**Total**	**30,731**

Isotopic DCGLs = (Equivalent Dose/dose-to-source ratio) * (2.22 dpm/pCi) * (m^2/100 cm^2).

Table D-4 shows the risk-to-source ratio for DU from all five sources based on results obtained from RESRAD-BUILD.

Table D-4. Risk-to-Source Ratio Values

	Single-Year Risk-to-Source Ratio					
	(risk/pCi/m^2)					
Source	**1**	**2**	**3**	**4**	**5**	**Total**
U-238	2.18E-12	4.06E-13	4.06E-13	4.06E-13	4.06E-13	3.80E-12
U-235	3.18E-12	4.85E-13	4.85E-13	4.85E-13	4.85E-13	5.12E-12
U-234	2.31E-12	4.60E-13	4.60E-13	4.60E-13	4.60E-13	4.15E-12

The risk DU DCGL is calculated in the same way as the dose DU DCGL with the exception that it is divided by a factor of 25 to account for the 25-year CERCLA risk limit versus the single-year risk-to-source ratio. Table D-5 shows these calculations. The DCGL value is 23,000 dpm/100 cm^2 for DU at 1E-4 risk.

Table D-5. Derived Concentration Guideline Level Calculations (Risk-Based)

Isotope	Risk-to-Source Ratio (risk/year pCi/m^2)	DU Activity Concentration (%)	Relative DU Dose	% DU Risk	Equivalent Risk	DCGL (dpm/100 cm^2)
U-238	3.8E-12	0.9014	3.20E-13	90%	9.00E-05	21,009
U-235	5.1E-12	0.0145	7.42E-14	2%	1.80E-06	311
U-234	4.2E-12	0.084	3.74E-12	8%	8.00E-06	1712
		Total	4.13E-12		**Total**	**23,033**

Isotopic DCGLs = (Equivalent Dose/risk-to-source ratio)/25 year) * (2.22 dpm/pCi) * (m^2/100 cm^2).

The risk DCGL value (23,000 dpm/100 cm^2) is more restrictive and has been selected as the DCGL for structural surfaces at Line 1.

RESRAD-BUILD output files are attached as Attachments C-1 and C-2.

ATTACHMENT D-1

RESRAD-BUILD Dose Output File

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** RESRAD-BUILD Dose Program Output, Version 3.4 06/04/09 11:40:14  Page:   1 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
```

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** RESRAD-BUILD Dose Program Output, Version 3.4 06/04/09 11:40:14 Page: 2 **
Title : IAAAP Industrial Worker
Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld

RESRAD-BUILD Input Parameters

Number of Sources : 5
Number of Receptors: 1
Total Time : 3.650000E+02 days
Fraction Inside : 2.300000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	5.000	5.000	1.000	1.000	3.36E+01	1.00E-04

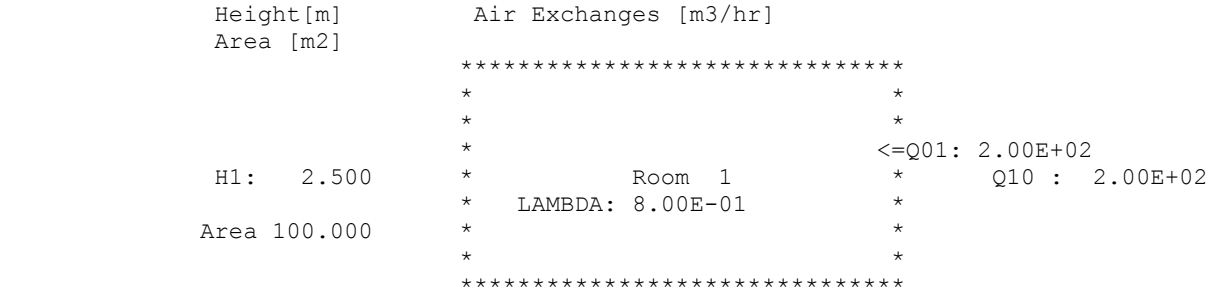
Receptor-Source Shielding Relationship

Receptor	Source	Density [g/cm3]	Thickness [cm]	Material
1	1	2.40E+00	0.00E+00	Concrete
1	2	2.40E+00	0.00E+00	Concrete
1	3	2.40E+00	0.00E+00	Concrete
1	4	2.40E+00	0.00E+00	Concrete
1	5	2.40E+00	0.00E+00	Concrete

```
** RESRAD-BUILD Dose Program Output, Version 3.4 06/04/09 11:40:14  Page:   3 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
```

Building Information

Building Air Exchange Rate: 8.00E-01 1/hr



Deposition velocity: 1.00E-02 [m/s] Resuspension Rate: 5.00E-07 [1/s]

```
** RESRAD-BUILD Dose Program Output, Version 3.4 06/04/09 11:40:14  Page:   4 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld


              ========  Source Information  ========


 Source:  1
        Location::  Room :  1  x:   5.00 y:   5.00  z:   0.00[m]
        Geometry::  Type: Area        Area:1.00E+02 [m2]  Direction: z
        Pathway ::
             Direct Ingestion Rate:    0.000E+00 [1/hr]
             Fraction released to air: 7.000E-02
             Removable fraction:       2.000E-01
             Time to Remove:           1.000E+04 [day]

             Radon Release Fraction:   1.000E-01


   Contamination::
   Nuclide Concentration  Dose Conversion Factor (Library: FGR 13 Morbidity)
   _______ _____________  ____________________________________
                           Ingestion   Inhalation  Submersion
              [pCi/m2]    [mrem/pCi]  [mrem/pCi]  [mrem/yr/
                                                  (pCi/m3)]
    U-238      1.000E+00   2.687E-04   1.180E-01   1.597E-04
    U-235      1.000E+00   2.673E-04   1.230E-01   9.019E-04
    U-234      1.000E+00   2.830E-04   1.320E-01   8.912E-07
    PA-231     0.000E+00   1.060E-02   1.280E+00   2.009E-04
    TH-230     0.000E+00   5.480E-04   3.260E-01   2.032E-06
    AC-227     0.000E+00   1.480E-02   6.724E+00   2.161E-03
    RA-226     0.000E+00   1.321E-03   8.594E-03   1.035E-02
    PB-210     0.000E+00   5.376E-03   1.380E-02   1.043E-05
```

```
** RESRAD-BUILD Dose Program Output, Version 3.4 06/04/09 11:40:14  Page:   5 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld


 Source:  2
        Location::  Room :  1  x:   5.00 y:  10.00  z:   1.00[m]
        Geometry::  Type: Area        Area:2.00E+01 [m2]  Direction: y
        Pathway ::
             Direct Ingestion Rate:    0.000E+00 [1/hr]
             Fraction released to air: 7.000E-02
             Removable fraction:       2.000E-01
             Time to Remove:           1.000E+04 [day]

             Radon Release Fraction:   1.000E-01


    Contamination::
    Nuclide Concentration  Dose Conversion Factor (Library: FGR 13 Morbidity)
    ------- -------------  ------------------------------------------
                            Ingestion   Inhalation  Submersion
                [pCi/m2]    [mrem/pCi]  [mrem/pCi]  [mrem/yr/
                                                    (pCi/m3)]
     U-238      1.000E+00   2.687E-04   1.180E-01   1.597E-04
     U-235      1.000E+00   2.673E-04   1.230E-01   9.019E-04
     U-234      1.000E+00   2.830E-04   1.320E-01   8.912E-07
     PA-231     0.000E+00   1.060E-02   1.280E+00   2.009E-04
     TH-230     0.000E+00   5.480E-04   3.260E-01   2.032E-06
     AC-227     0.000E+00   1.480E-02   6.724E+00   2.161E-03
     RA-226     0.000E+00   1.321E-03   8.594E-03   1.035E-02
     PB-210     0.000E+00   5.376E-03   1.380E-02   1.043E-05

 Source:  3
        Location::  Room :  1  x:  10.00 y:   5.00  z:   1.00[m]
        Geometry::  Type: Area        Area:2.00E+01 [m2]  Direction: x
        Pathway ::
             Direct Ingestion Rate:    0.000E+00 [1/hr]
             Fraction released to air: 7.000E-02
             Removable fraction:       2.000E-01
             Time to Remove:           1.000E+04 [day]

             Radon Release Fraction:   1.000E-01


    Contamination::
    Nuclide Concentration  Dose Conversion Factor (Library: FGR 13 Morbidity)
    ------- -------------  ------------------------------------------
                            Ingestion   Inhalation  Submersion
                [pCi/m2]    [mrem/pCi]  [mrem/pCi]  [mrem/yr/
                                                    (pCi/m3)]
     U-238      1.000E+00   2.687E-04   1.180E-01   1.597E-04
```

```
** RESRAD-BUILD Dose Program Output, Version 3.4 06/04/09 11:40:14  Page:   6 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld


     U-235      1.000E+00   2.673E-04   1.230E-01   9.019E-04
     U-234      1.000E+00   2.830E-04   1.320E-01   8.912E-07
     PA-231     0.000E+00   1.060E-02   1.280E+00   2.009E-04
     TH-230     0.000E+00   5.480E-04   3.260E-01   2.032E-06
     AC-227     0.000E+00   1.480E-02   6.724E+00   2.161E-03
     RA-226     0.000E+00   1.321E-03   8.594E-03   1.035E-02
     PB-210     0.000E+00   5.376E-03   1.380E-02   1.043E-05

 Source:  4
         Location::  Room :  1  x:   0.00 y:   5.00  z:   1.00[m]
         Geometry::  Type: Area        Area:2.00E+01 [m2]  Direction: x
         Pathway ::
              Direct Ingestion Rate:    0.000E+00 [1/hr]
              Fraction released to air: 7.000E-02
              Removable fraction:       2.000E-01
              Time to Remove:           1.000E+04 [day]

              Radon Release Fraction:   1.000E-01


    Contamination::
    Nuclide Concentration  Dose Conversion Factor (Library: FGR 13 Morbidity)
    ------- -------------  ------------------------------------------
                           Ingestion   Inhalation  Submersion
                [pCi/m2]   [mrem/pCi]  [mrem/pCi]  [mrem/yr/
                                                   (pCi/m3)]
     U-238      1.000E+00   2.687E-04   1.180E-01   1.597E-04
     U-235      1.000E+00   2.673E-04   1.230E-01   9.019E-04
     U-234      1.000E+00   2.830E-04   1.320E-01   8.912E-07
     PA-231     0.000E+00   1.060E-02   1.280E+00   2.009E-04
     TH-230     0.000E+00   5.480E-04   3.260E-01   2.032E-06
     AC-227     0.000E+00   1.480E-02   6.724E+00   2.161E-03
     RA-226     0.000E+00   1.321E-03   8.594E-03   1.035E-02
     PB-210     0.000E+00   5.376E-03   1.380E-02   1.043E-05
```

```
** RESRAD-BUILD Dose Program Output, Version 3.4 06/04/09 11:40:14  Page:   7 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld


 Source:  5
        Location::  Room :  1  x:   5.00 y:   0.00  z:   1.00[m]
        Geometry::  Type: Area        Area:2.00E+01 [m2]  Direction: y
        Pathway ::
             Direct Ingestion Rate:    0.000E+00 [1/hr]
             Fraction released to air: 7.000E-02
             Removable fraction:       2.000E-01
             Time to Remove:           1.000E+04 [day]

             Radon Release Fraction:   1.000E-01
```

Contamination::

Nuclide	Concentration	Dose Conversion Factor (Library: FGR 13 Morbidity)		
	[pCi/m2]	Ingestion [mrem/pCi]	Inhalation [mrem/pCi]	Submersion [mrem/yr/ (pCi/m3)]
U-238	1.000E+00	2.687E-04	1.180E-01	1.597E-04
U-235	1.000E+00	2.673E-04	1.230E-01	9.019E-04
U-234	1.000E+00	2.830E-04	1.320E-01	8.912E-07
PA-231	0.000E+00	1.060E-02	1.280E+00	2.009E-04
TH-230	0.000E+00	5.480E-04	3.260E-01	2.032E-06
AC-227	0.000E+00	1.480E-02	6.724E+00	2.161E-03
RA-226	0.000E+00	1.321E-03	8.594E-03	1.035E-02
PB-210	0.000E+00	5.376E-03	1.380E-02	1.043E-05

```
** RESRAD-BUILD Dose Program Output, Version 3.4 06/04/09 11:40:14  Page:   8 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
 Evaluation Time:  0.00000000E+00  years


              ================================================
              ================================================
              ===       Assessment for Time:  1            ===
              ===             Time =0.00E+00 yr            ===
              ================================================
              ================================================


              ========  Source Information  ========


 Source:  1
        Location::  Room :  1  x:   5.00 y:   5.00  z:   0.00 [m]
        Geometry::  Type: Area        Area:1.00E+02 [m2]  Direction: z
        Pathway ::
             Direct Ingestion Rate:    0.000E+00 [1/hr]
             Fraction released to air: 7.000E-02
             Removable fraction:       2.000E-01
             Time to Remove:           1.000E+04 [day]



         Contamination::     Nuclide    Concentration
                                          [pCi/m2]
                             U-238       1.000E+00
                             U-235       1.000E+00
                             U-234       1.000E+00
                             PA-231      0.000E+00
                             TH-230      0.000E+00
                             AC-227      0.000E+00
                             RA-226      0.000E+00
                             PB-210      0.000E+00

 Source:  2
        Location::  Room :  1  x:   5.00 y:  10.00  z:   1.00 [m]
        Geometry::  Type: Area        Area:2.00E+01 [m2]  Direction: y
        Pathway ::
             Direct Ingestion Rate:    0.000E+00 [1/hr]
             Fraction released to air: 7.000E-02
             Removable fraction:       2.000E-01
             Time to Remove:           1.000E+04 [day]



         Contamination::     Nuclide    Concentration
                                          [pCi/m2]
                             U-238       1.000E+00
                             U-235       1.000E+00
                             U-234       1.000E+00
```

```
** RESRAD-BUILD Dose Program Output, Version 3.4 06/04/09 11:40:14  Page:   9 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
 Evaluation Time:  0.00000000E+00  years


                            PA-231      0.000E+00
                            TH-230      0.000E+00
                            AC-227      0.000E+00
                            RA-226      0.000E+00
                            PB-210      0.000E+00

 Source:  3
        Location::  Room :  1  x:  10.00 y:   5.00  z:   1.00 [m]
        Geometry::  Type: Area        Area:2.00E+01 [m2]  Direction: x
        Pathway ::
             Direct Ingestion Rate:    0.000E+00 [1/hr]
             Fraction released to air: 7.000E-02
             Removable fraction:       2.000E-01
             Time to Remove:           1.000E+04 [day]



         Contamination::     Nuclide    Concentration
                                          [pCi/m2]
                            U-238       1.000E+00
                            U-235       1.000E+00
                            U-234       1.000E+00
                            PA-231      0.000E+00
                            TH-230      0.000E+00
                            AC-227      0.000E+00
                            RA-226      0.000E+00
                            PB-210      0.000E+00

 Source:  4
        Location::  Room :  1  x:   0.00 y:   5.00  z:   1.00 [m]
        Geometry::  Type: Area        Area:2.00E+01 [m2]  Direction: x
        Pathway ::
             Direct Ingestion Rate:    0.000E+00 [1/hr]
             Fraction released to air: 7.000E-02
             Removable fraction:       2.000E-01
             Time to Remove:           1.000E+04 [day]



         Contamination::     Nuclide    Concentration
                                          [pCi/m2]
                            U-238       1.000E+00
                            U-235       1.000E+00
                            U-234       1.000E+00
                            PA-231      0.000E+00
                            TH-230      0.000E+00
                            AC-227      0.000E+00
                            RA-226      0.000E+00
                            PB-210      0.000E+00
```

```
** RESRAD-BUILD Dose Program Output, Version 3.4 06/04/09 11:40:14  Page:  10 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
 Evaluation Time:  0.00000000E+00  years


 Source:  5
        Location::  Room :  1  x:   5.00 y:   0.00  z:   1.00 [m]
        Geometry::  Type: Area        Area:2.00E+01 [m2]  Direction: y
        Pathway ::
             Direct Ingestion Rate:    0.000E+00 [1/hr]
             Fraction released to air: 7.000E-02
             Removable fraction:       2.000E-01
             Time to Remove:           1.000E+04 [day]



          Contamination::     Nuclide    Concentration
                                           [pCi/m2]
                              U-238       1.000E+00
                              U-235       1.000E+00
                              U-234       1.000E+00
                              PA-231      0.000E+00
                              TH-230      0.000E+00
                              AC-227      0.000E+00
                              RA-226      0.000E+00
                              PB-210      0.000E+00
```

```
** RESRAD-BUILD Dose Program Output, Version 3.4 06/04/09 11:40:14  Page:  11 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
 Evaluation Time:  0.00000000E+00  years
```

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses

[mrem]

	Source 1	Source 2	Source 3	Source 4	Source 5	Total
Receptor 1	3.27E-05	6.28E-06	6.28E-06	6.28E-06	6.28E-06	5.78E-05
Total	3.27E-05	6.28E-06	6.28E-06	6.28E-06	6.28E-06	5.78E-05

```
** RESRAD-BUILD Dose Program Output, Version 3.4 06/04/09 11:40:14  Page:  12 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
 Evaluation Time:  0.00000000E+00  years
```

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.86E-06	1.09E-09	7.14E-12	3.07E-05	9.35E-16	9.63E-08
Total	1.86E-06	1.09E-09	7.14E-12	3.07E-05	9.35E-16	9.63E-08

Source: 2

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.19E-07	2.18E-10	1.43E-12	6.14E-06	1.87E-16	1.93E-08
Total	1.19E-07	2.18E-10	1.43E-12	6.14E-06	1.87E-16	1.93E-08

Source: 3

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.19E-07	2.18E-10	1.43E-12	6.14E-06	1.87E-16	1.93E-08
Total	1.19E-07	2.18E-10	1.43E-12	6.14E-06	1.87E-16	1.93E-08

Source: 4

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.19E-07	2.18E-10	1.43E-12	6.14E-06	1.87E-16	1.93E-08
Total	1.19E-07	2.18E-10	1.43E-12	6.14E-06	1.87E-16	1.93E-08

Source: 5

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.19E-07	2.18E-10	1.43E-12	6.14E-06	1.87E-16	1.93E-08
Total	1.19E-07	2.18E-10	1.43E-12	6.14E-06	1.87E-16	1.93E-08

** RESRAD-BUILD Dose Program Output, Version 3.4 06/04/09 11:40:14 Page: 13 **
Title : IAAAP Industrial Worker
Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
Evaluation Time: 0.00000000E+00 years

Nuclide Detail of Doses

[mrem]

Source: 1

Nuclide	Receptor 1	Total
U-238	1.00E-05	1.00E-05
U-234	1.54E-11	1.54E-11
TH-230	1.14E-16	1.14E-16
RA-226	7.76E-21	7.76E-21
PB-210	5.00E-24	5.00E-24
U-235	1.17E-05	1.17E-05
PA-231	1.13E-09	1.13E-09
AC-227	5.98E-11	5.98E-11
U-234	1.09E-05	1.09E-05
TH-230	1.21E-10	1.21E-10
RA-226	1.10E-14	1.10E-14
PB-210	8.81E-18	8.81E-18

Source: 2

Nuclide	Receptor 1	Total
U-238	1.97E-06	1.97E-06
U-234	3.08E-12	3.08E-12
TH-230	2.28E-17	2.28E-17
RA-226	6.47E-22	6.47E-22
PB-210	9.78E-25	9.78E-25
U-235	2.13E-06	2.13E-06
PA-231	2.25E-10	2.25E-10
AC-227	1.19E-11	1.19E-11
U-234	2.18E-06	2.18E-06
TH-230	2.42E-11	2.42E-11
RA-226	9.15E-16	9.15E-16
PB-210	1.72E-18	1.72E-18

** RESRAD-BUILD Dose Program Output, Version 3.4 06/04/09 11:40:14 Page: 14 **
Title : IAAAP Industrial Worker
Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
Evaluation Time: 0.00000000E+00 years

Source: 3

Nuclide	Receptor 1	Total
U-238	1.97E-06	1.97E-06
U-234	3.08E-12	3.08E-12
TH-230	2.28E-17	2.28E-17
RA-226	6.47E-22	6.47E-22
PB-210	9.78E-25	9.78E-25
U-235	2.13E-06	2.13E-06
PA-231	2.25E-10	2.25E-10
AC-227	1.19E-11	1.19E-11
U-234	2.18E-06	2.18E-06
TH-230	2.42E-11	2.42E-11
RA-226	9.15E-16	9.15E-16
PB-210	1.72E-18	1.72E-18

Source: 4

Nuclide	Receptor 1	Total
U-238	1.97E-06	1.97E-06
U-234	3.08E-12	3.08E-12
TH-230	2.28E-17	2.28E-17
RA-226	6.47E-22	6.47E-22
PB-210	9.78E-25	9.78E-25
U-235	2.13E-06	2.13E-06
PA-231	2.25E-10	2.25E-10
AC-227	1.19E-11	1.19E-11
U-234	2.18E-06	2.18E-06
TH-230	2.42E-11	2.42E-11
RA-226	9.15E-16	9.15E-16
PB-210	1.72E-18	1.72E-18

Source: 5

Nuclide	Receptor 1	Total
U-238	1.97E-06	1.97E-06
U-234	3.08E-12	3.08E-12
TH-230	2.28E-17	2.28E-17
RA-226	6.47E-22	6.47E-22

```
** RESRAD-BUILD Dose Program Output, Version 3.4 06/04/09 11:40:14  Page:  15 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
 Evaluation Time:  0.00000000E+00  years


  PB-210   9.78E-25  9.78E-25
  U-235    2.13E-06  2.13E-06
  PA-231   2.25E-10  2.25E-10
  AC-227   1.19E-11  1.19E-11
  U-234    2.18E-06  2.18E-06
  TH-230   2.42E-11  2.42E-11
  RA-226   9.15E-16  9.15E-16
  PB-210   1.72E-18  1.72E-18
```

```
** RESRAD-BUILD Dose Program Output, Version 3.4 06/04/09 11:40:14  Page:  16 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
 Evaluation Time:  1.00000000  years


              ================================================
              ================================================
              ===       Assessment for Time:  2            ===
              ===             Time =1.00E+00 yr            ===
              ================================================
              ================================================


              ========  Source Information  ========


 Source:  1
         Location::  Room :  1  x:   5.00 y:   5.00  z:   0.00 [m]
         Geometry::  Type: Area        Area:1.00E+02 [m2]  Direction: z
         Pathway ::
              Direct Ingestion Rate:    0.000E+00 [1/hr]
              Fraction released to air: 7.000E-02
              Removable fraction:       1.941E-01
              Time to Remove:           1.000E+04 [day]



          Contamination::     Nuclide    Concentration
                                           [pCi/m2]
                              U-238       9.927E-01
                              U-235       9.927E-01
                              U-234       9.927E-01
                              PA-231      2.098E-05
                              TH-230      8.936E-06
                              AC-227      3.300E-07
                              RA-226      1.935E-09
                              PB-210      1.990E-11

 Source:  2
         Location::  Room :  1  x:   5.00 y:  10.00  z:   1.00 [m]
         Geometry::  Type: Area        Area:2.00E+01 [m2]  Direction: y
         Pathway ::
              Direct Ingestion Rate:    0.000E+00 [1/hr]
              Fraction released to air: 7.000E-02
              Removable fraction:       1.941E-01
              Time to Remove:           1.000E+04 [day]



          Contamination::     Nuclide    Concentration
                                           [pCi/m2]
                              U-238       9.927E-01
                              U-235       9.927E-01
                              U-234       9.927E-01
```

```
** RESRAD-BUILD Dose Program Output, Version 3.4 06/04/09 11:40:14  Page:  17 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
 Evaluation Time:  1.00000000  years


                            PA-231      2.098E-05
                            TH-230      8.936E-06
                            AC-227      3.300E-07
                            RA-226      1.935E-09
                            PB-210      1.990E-11

 Source:  3
        Location::  Room :  1  x:  10.00 y:   5.00  z:   1.00 [m]
        Geometry::  Type: Area        Area:2.00E+01 [m2]  Direction: x
        Pathway ::
             Direct Ingestion Rate:    0.000E+00 [1/hr]
             Fraction released to air: 7.000E-02
             Removable fraction:       1.941E-01
             Time to Remove:           1.000E+04 [day]



         Contamination::     Nuclide    Concentration
                                          [pCi/m2]
                            U-238       9.927E-01
                            U-235       9.927E-01
                            U-234       9.927E-01
                            PA-231      2.098E-05
                            TH-230      8.936E-06
                            AC-227      3.300E-07
                            RA-226      1.935E-09
                            PB-210      1.990E-11

 Source:  4
        Location::  Room :  1  x:   0.00 y:   5.00  z:   1.00 [m]
        Geometry::  Type: Area        Area:2.00E+01 [m2]  Direction: x
        Pathway ::
             Direct Ingestion Rate:    0.000E+00 [1/hr]
             Fraction released to air: 7.000E-02
             Removable fraction:       1.941E-01
             Time to Remove:           1.000E+04 [day]



         Contamination::     Nuclide    Concentration
                                          [pCi/m2]
                            U-238       9.927E-01
                            U-235       9.927E-01
                            U-234       9.927E-01
                            PA-231      2.098E-05
                            TH-230      8.936E-06
                            AC-227      3.300E-07
                            RA-226      1.935E-09
                            PB-210      1.990E-11
```

```
** RESRAD-BUILD Dose Program Output, Version 3.4 06/04/09 11:40:14  Page:  18 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
 Evaluation Time:  1.00000000  years


 Source:  5
        Location::  Room :  1  x:   5.00 y:   0.00  z:   1.00 [m]
        Geometry::  Type: Area        Area:2.00E+01 [m2]  Direction: y
        Pathway ::
             Direct Ingestion Rate:    0.000E+00 [1/hr]
             Fraction released to air: 7.000E-02
             Removable fraction:       1.941E-01
             Time to Remove:           1.000E+04 [day]



          Contamination::     Nuclide    Concentration
                                           [pCi/m2]
                              U-238       9.927E-01
                              U-235       9.927E-01
                              U-234       9.927E-01
                              PA-231      2.098E-05
                              TH-230      8.936E-06
                              AC-227      3.300E-07
                              RA-226      1.935E-09
                              PB-210      1.990E-11
```

```
** RESRAD-BUILD Dose Program Output, Version 3.4 06/04/09 11:40:14  Page:  19 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
 Evaluation Time:  1.00000000  years
```

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses

[mrem]

	Source 1	Source 2	Source 3	Source 4	Source 5	Total
Receptor 1	3.26E-05	6.28E-06	6.28E-06	6.28E-06	6.28E-06	5.77E-05
Total	3.26E-05	6.28E-06	6.28E-06	6.28E-06	6.28E-06	5.77E-05

```
** RESRAD-BUILD Dose Program Output, Version 3.4 06/04/09 11:40:14  Page:  20 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
 Evaluation Time:  1.00000000  years
```

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.85E-06	1.09E-09	7.14E-12	3.07E-05	6.51E-15	9.63E-08
Total	1.85E-06	1.09E-09	7.14E-12	3.07E-05	6.51E-15	9.63E-08

Source: 2

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.19E-07	2.18E-10	1.43E-12	6.14E-06	1.30E-15	1.93E-08
Total	1.19E-07	2.18E-10	1.43E-12	6.14E-06	1.30E-15	1.93E-08

Source: 3

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.19E-07	2.18E-10	1.43E-12	6.14E-06	1.30E-15	1.93E-08
Total	1.19E-07	2.18E-10	1.43E-12	6.14E-06	1.30E-15	1.93E-08

Source: 4

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.19E-07	2.18E-10	1.43E-12	6.14E-06	1.30E-15	1.93E-08
Total	1.19E-07	2.18E-10	1.43E-12	6.14E-06	1.30E-15	1.93E-08

Source: 5

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.19E-07	2.18E-10	1.43E-12	6.14E-06	1.30E-15	1.93E-08
Total	1.19E-07	2.18E-10	1.43E-12	6.14E-06	1.30E-15	1.93E-08

** RESRAD-BUILD Dose Program Output, Version 3.4 06/04/09 11:40:14 Page: 21 **
Title : IAAAP Industrial Worker
Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
Evaluation Time: 1.00000000 years

Nuclide Detail of Doses

[mrem]

Source: 1

Nuclide	Receptor 1	Total
U-238	1.00E-05	1.00E-05
U-234	4.63E-11	4.63E-11
TH-230	7.99E-16	7.99E-16
RA-226	1.16E-19	1.16E-19
PB-210	1.54E-22	1.54E-22
U-235	1.17E-05	1.17E-05
PA-231	3.39E-09	3.39E-09
AC-227	4.15E-10	4.15E-10
U-234	1.09E-05	1.09E-05
TH-230	3.63E-10	3.63E-10
RA-226	7.65E-14	7.65E-14
PB-210	1.31E-16	1.31E-16

Source: 2

Nuclide	Receptor 1	Total
U-238	1.97E-06	1.97E-06
U-234	9.24E-12	9.24E-12
TH-230	1.60E-16	1.60E-16
RA-226	9.66E-21	9.66E-21
PB-210	3.01E-23	3.01E-23
U-235	2.13E-06	2.13E-06
PA-231	6.76E-10	6.76E-10
AC-227	8.27E-11	8.27E-11
U-234	2.18E-06	2.18E-06
TH-230	7.26E-11	7.26E-11
RA-226	6.38E-15	6.38E-15
PB-210	2.57E-17	2.57E-17

```
** RESRAD-BUILD Dose Program Output, Version 3.4 06/04/09 11:40:14  Page:  22 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
 Evaluation Time:  1.00000000  years


Source:  3

  Nuclide  Receptor   Total
              1
  U-238    1.97E-06  1.97E-06
  U-234    9.24E-12  9.24E-12
  TH-230   1.60E-16  1.60E-16
  RA-226   9.66E-21  9.66E-21
  PB-210   3.01E-23  3.01E-23
  U-235    2.13E-06  2.13E-06
  PA-231   6.76E-10  6.76E-10
  AC-227   8.27E-11  8.27E-11
  U-234    2.18E-06  2.18E-06
  TH-230   7.26E-11  7.26E-11
  RA-226   6.38E-15  6.38E-15
  PB-210   2.57E-17  2.57E-17



Source:  4

  Nuclide  Receptor   Total
              1
  U-238    1.97E-06  1.97E-06
  U-234    9.24E-12  9.24E-12
  TH-230   1.60E-16  1.60E-16
  RA-226   9.66E-21  9.66E-21
  PB-210   3.01E-23  3.01E-23
  U-235    2.13E-06  2.13E-06
  PA-231   6.76E-10  6.76E-10
  AC-227   8.27E-11  8.27E-11
  U-234    2.18E-06  2.18E-06
  TH-230   7.26E-11  7.26E-11
  RA-226   6.38E-15  6.38E-15
  PB-210   2.57E-17  2.57E-17



Source:  5

  Nuclide  Receptor   Total
              1
  U-238    1.97E-06  1.97E-06
  U-234    9.24E-12  9.24E-12
  TH-230   1.60E-16  1.60E-16
  RA-226   9.66E-21  9.66E-21
```

```
** RESRAD-BUILD Dose Program Output, Version 3.4 06/04/09 11:40:14  Page:  23 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
 Evaluation Time:  1.00000000  years


  PB-210   3.01E-23  3.01E-23
  U-235    2.13E-06  2.13E-06
  PA-231   6.76E-10  6.76E-10
  AC-227   8.27E-11  8.27E-11
  U-234    2.18E-06  2.18E-06
  TH-230   7.26E-11  7.26E-11
  RA-226   6.38E-15  6.38E-15
  PB-210   2.57E-17  2.57E-17
```

```
** RESRAD-BUILD Dose Program Output, Version 3.4 06/04/09 11:40:14  Page:  24 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
 Full Summary
```

RESRAD-BUILD Dose (Time) Tables

Receptor Dose Received for the Exposure Duration

(mrem)

	Evaluation Time [yr]	
	0.00E+00	1.00E+00
1	5.78E-05	5.77E-05

Receptor Dose/Yr Averaged Over Exposure Duration

(mrem/yr)

	Evaluation Time [yr]	
	0.00E+00	1.00E+00
1	5.78E-05	5.78E-05

ATTACHMENT D-2

RESRAD-BUILD Risk Output File

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```
** RESRAD-BUILD Risk Program Output, Version 3.4 06/04/09 11:40:14  Page:   1 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
```

RESRAD-BUILD Table of Contents

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** RESRAD-BUILD Risk Program Output, Version 3.4 06/04/09 11:40:14 Page: 2 **
Title : IAAAP Industrial Worker
Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld

RESRAD-BUILD Input Parameters

Number of Sources : 5
Number of Receptors: 1
Total Time : 3.650000E+02 days
Fraction Inside : 2.300000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	5.000	5.000	1.000	1.000	3.36E+01	1.00E-04

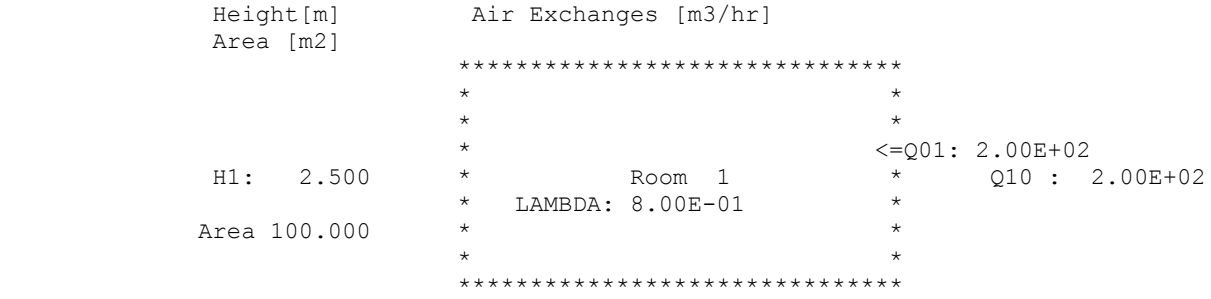
Receptor-Source Shielding Relationship

Receptor	Source	Density [g/cm3]	Thickness [cm]	Material
1	1	2.40E+00	0.00E+00	Concrete
1	2	2.40E+00	0.00E+00	Concrete
1	3	2.40E+00	0.00E+00	Concrete
1	4	2.40E+00	0.00E+00	Concrete
1	5	2.40E+00	0.00E+00	Concrete

```
** RESRAD-BUILD Risk Program Output, Version 3.4 06/04/09 11:40:14  Page:   3 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
```

======== Building Information ========

Building Air Exchange Rate: 8.00E-01 1/hr



Deposition velocity: 1.00E-02 [m/s] Resuspension Rate: 5.00E-07 [1/s]

```
** RESRAD-BUILD Risk Program Output, Version 3.4 06/04/09 11:40:14  Page:   4 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld


             ========  Source Information  ========


 Source:  1
        Location::  Room :  1  x:   5.00 y:   5.00  z:   0.00[m]
        Geometry::  Type: Area        Area:1.00E+02 [m2]  Direction: z
        Pathway ::
             Direct Ingestion Rate:    0.000E+00 [1/hr]
             Fraction released to air: 7.000E-02
             Removable fraction:       2.000E-01
             Time to Remove:           1.000E+04 [day]

             Radon Release Fraction:   1.000E-01
```

Contamination::

Nuclide	Concentration	Slope Factor	
		Ingestion	Inhalation
	[pCi/m2]	[Risk/pCi]	[Risk/pCi]
U-238	1.000E+00	1.206E-10	2.363E-08
U-235	1.000E+00	9.764E-11	2.500E-08
U-234	1.000E+00	9.550E-11	2.780E-08
PA-231	0.000E+00	2.260E-10	7.620E-08
TH-230	0.000E+00	1.190E-10	3.400E-08
AC-227	0.000E+00	6.530E-10	2.129E-07
RA-226	0.000E+00	5.147E-10	2.827E-08
PB-210	0.000E+00	1.193E-09	1.625E-08

```
** RESRAD-BUILD Risk Program Output, Version 3.4 06/04/09 11:40:14  Page:   5 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld


 Source:  2
        Location::  Room :  1  x:   5.00 y:  10.00  z:   1.00[m]
        Geometry::  Type: Area        Area:2.00E+01 [m2]  Direction: y
        Pathway ::
             Direct Ingestion Rate:    0.000E+00 [1/hr]
             Fraction released to air: 7.000E-02
             Removable fraction:       2.000E-01
             Time to Remove:           1.000E+04 [day]

             Radon Release Fraction:   1.000E-01


    Contamination::
     Nuclide Concentration       Slope Factor
    ________ _____________  ____________________________________

                            Ingestion   Inhalation
                [pCi/m2]    [Risk/pCi]  [Risk/pCi]
     U-238      1.000E+00   1.206E-10   2.363E-08
     U-235      1.000E+00   9.764E-11   2.500E-08
     U-234      1.000E+00   9.550E-11   2.780E-08
     PA-231     0.000E+00   2.260E-10   7.620E-08
     TH-230     0.000E+00   1.190E-10   3.400E-08
     AC-227     0.000E+00   6.530E-10   2.129E-07
     RA-226     0.000E+00   5.147E-10   2.827E-08
     PB-210     0.000E+00   1.193E-09   1.625E-08

 Source:  3
        Location::  Room :  1  x:  10.00 y:   5.00  z:   1.00[m]
        Geometry::  Type: Area        Area:2.00E+01 [m2]  Direction: x
        Pathway ::
             Direct Ingestion Rate:    0.000E+00 [1/hr]
             Fraction released to air: 7.000E-02
             Removable fraction:       2.000E-01
             Time to Remove:           1.000E+04 [day]

             Radon Release Fraction:   1.000E-01


    Contamination::
     Nuclide Concentration       Slope Factor
    ________ _____________  ____________________________________

                            Ingestion   Inhalation
                [pCi/m2]    [Risk/pCi]  [Risk/pCi]
     U-238      1.000E+00   1.206E-10   2.363E-08
```

Title : IAAAP Industrial Worker
Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld

U-235	1.000E+00	9.764E-11	2.500E-08
U-234	1.000E+00	9.550E-11	2.780E-08
PA-231	0.000E+00	2.260E-10	7.620E-08
TH-230	0.000E+00	1.190E-10	3.400E-08
AC-227	0.000E+00	6.530E-10	2.129E-07
RA-226	0.000E+00	5.147E-10	2.827E-08
PB-210	0.000E+00	1.193E-09	1.625E-08

Source: 4
Location:: Room : 1 x: 0.00 y: 5.00 z: 1.00[m]
Geometry:: Type: Area Area:2.00E+01 [m2] Direction: x
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 7.000E-02
Removable fraction: 2.000E-01
Time to Remove: 1.000E+04 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration	Slope Factor	
		Ingestion	Inhalation
	[pCi/m2]	[Risk/pCi]	[Risk/pCi]
U-238	1.000E+00	1.206E-10	2.363E-08
U-235	1.000E+00	9.764E-11	2.500E-08
U-234	1.000E+00	9.550E-11	2.780E-08
PA-231	0.000E+00	2.260E-10	7.620E-08
TH-230	0.000E+00	1.190E-10	3.400E-08
AC-227	0.000E+00	6.530E-10	2.129E-07
RA-226	0.000E+00	5.147E-10	2.827E-08
PB-210	0.000E+00	1.193E-09	1.625E-08

```
** RESRAD-BUILD Risk Program Output, Version 3.4 06/04/09 11:40:14  Page:   7 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld


 Source:  5
        Location::  Room :  1  x:   5.00 y:   0.00  z:   1.00[m]
        Geometry::  Type: Area        Area:2.00E+01 [m2]  Direction: y
        Pathway ::
             Direct Ingestion Rate:    0.000E+00 [1/hr]
             Fraction released to air: 7.000E-02
             Removable fraction:       2.000E-01
             Time to Remove:           1.000E+04 [day]

             Radon Release Fraction:   1.000E-01
```

Contamination::

Nuclide	Concentration	Slope Factor	
		Ingestion	Inhalation
	[pCi/m2]	[Risk/pCi]	[Risk/pCi]
U-238	1.000E+00	1.206E-10	2.363E-08
U-235	1.000E+00	9.764E-11	2.500E-08
U-234	1.000E+00	9.550E-11	2.780E-08
PA-231	0.000E+00	2.260E-10	7.620E-08
TH-230	0.000E+00	1.190E-10	3.400E-08
AC-227	0.000E+00	6.530E-10	2.129E-07
RA-226	0.000E+00	5.147E-10	2.827E-08
PB-210	0.000E+00	1.193E-09	1.625E-08

```
** RESRAD-BUILD Risk Program Output, Version 3.4 06/04/09 11:40:14  Page:   8 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
 Evaluation Time:  0.00000000E+00  years


              ==================================================
              ==================================================
              ===       Assessment for Time:  1            ===
              ===             Time =0.00E+00 yr            ===
              ==================================================
              ==================================================


              ========  Source Information  ========


 Source:  1
        Location::  Room :  1  x:   5.00 y:   5.00  z:   0.00 [m]
        Geometry::  Type: Area        Area:1.00E+02 [m2]  Direction: z
        Pathway ::
             Direct Ingestion Rate:    0.000E+00 [1/hr]
             Fraction released to air: 7.000E-02
             Removable fraction:       2.000E-01
             Time to Remove:           1.000E+04 [day]



         Contamination::     Nuclide    Concentration
                                          [pCi/m2]
                             U-238       1.000E+00
                             U-235       1.000E+00
                             U-234       1.000E+00
                             PA-231      0.000E+00
                             TH-230      0.000E+00
                             AC-227      0.000E+00
                             RA-226      0.000E+00
                             PB-210      0.000E+00

 Source:  2
        Location::  Room :  1  x:   5.00 y:  10.00  z:   1.00 [m]
        Geometry::  Type: Area        Area:2.00E+01 [m2]  Direction: y
        Pathway ::
             Direct Ingestion Rate:    0.000E+00 [1/hr]
             Fraction released to air: 7.000E-02
             Removable fraction:       2.000E-01
             Time to Remove:           1.000E+04 [day]



         Contamination::     Nuclide    Concentration
                                          [pCi/m2]
                             U-238       1.000E+00
                             U-235       1.000E+00
                             U-234       1.000E+00
```

```
** RESRAD-BUILD Risk Program Output, Version 3.4 06/04/09 11:40:14  Page:   9 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
 Evaluation Time:  0.00000000E+00  years


                            PA-231      0.000E+00
                            TH-230      0.000E+00
                            AC-227      0.000E+00
                            RA-226      0.000E+00
                            PB-210      0.000E+00

 Source:  3
        Location::  Room :  1  x:  10.00 y:   5.00  z:   1.00 [m]
        Geometry::  Type: Area        Area:2.00E+01 [m2]  Direction: x
        Pathway ::
             Direct Ingestion Rate:    0.000E+00 [1/hr]
             Fraction released to air: 7.000E-02
             Removable fraction:       2.000E-01
             Time to Remove:           1.000E+04 [day]



         Contamination::     Nuclide    Concentration
                                          [pCi/m2]
                            U-238       1.000E+00
                            U-235       1.000E+00
                            U-234       1.000E+00
                            PA-231      0.000E+00
                            TH-230      0.000E+00
                            AC-227      0.000E+00
                            RA-226      0.000E+00
                            PB-210      0.000E+00

 Source:  4
        Location::  Room :  1  x:   0.00 y:   5.00  z:   1.00 [m]
        Geometry::  Type: Area        Area:2.00E+01 [m2]  Direction: x
        Pathway ::
             Direct Ingestion Rate:    0.000E+00 [1/hr]
             Fraction released to air: 7.000E-02
             Removable fraction:       2.000E-01
             Time to Remove:           1.000E+04 [day]



         Contamination::     Nuclide    Concentration
                                          [pCi/m2]
                            U-238       1.000E+00
                            U-235       1.000E+00
                            U-234       1.000E+00
                            PA-231      0.000E+00
                            TH-230      0.000E+00
                            AC-227      0.000E+00
                            RA-226      0.000E+00
                            PB-210      0.000E+00
```

```
** RESRAD-BUILD Risk Program Output, Version 3.4 06/04/09 11:40:14  Page:  10 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
 Evaluation Time:  0.00000000E+00  years


 Source:  5
        Location::  Room :  1  x:   5.00 y:   0.00  z:   1.00 [m]
        Geometry::  Type: Area        Area:2.00E+01 [m2]  Direction: y
        Pathway ::
             Direct Ingestion Rate:    0.000E+00 [1/hr]
             Fraction released to air: 7.000E-02
             Removable fraction:       2.000E-01
             Time to Remove:           1.000E+04 [day]



          Contamination::     Nuclide    Concentration
                                           [pCi/m2]
                              U-238       1.000E+00
                              U-235       1.000E+00
                              U-234       1.000E+00
                              PA-231      0.000E+00
                              TH-230      0.000E+00
                              AC-227      0.000E+00
                              RA-226      0.000E+00
                              PB-210      0.000E+00
```

```
** RESRAD-BUILD Risk Program Output, Version 3.4 06/04/09 11:40:14  Page:  11 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
 Evaluation Time:  0.00000000E+00  years
```

RESRAD-BUILD Risk Tables

Source Contributions to Receptor Risks

[Risk]

	Source 1	Source 2	Source 3	Source 4	Source 5	Total
Receptor 1	7.67E-12	1.35E-12	1.35E-12	1.35E-12	1.35E-12	1.31E-11
Total	7.67E-12	1.35E-12	1.35E-12	1.35E-12	1.35E-12	1.31E-11

```
** RESRAD-BUILD Risk Program Output, Version 3.4 06/04/09 11:40:14  Page:  12 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
 Evaluation Time:  0.00000000E+00  years
```

Pathway Detail of Risks

[Risk]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.34E-12	7.86E-16	5.15E-18	6.29E-12	2.07E-21	3.69E-14
Total	1.34E-12	7.86E-16	5.15E-18	6.29E-12	2.07E-21	3.69E-14

Source: 2

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	8.61E-14	1.57E-16	1.03E-18	1.26E-12	4.15E-22	7.38E-15
Total	8.61E-14	1.57E-16	1.03E-18	1.26E-12	4.15E-22	7.38E-15

Source: 3

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	8.61E-14	1.57E-16	1.03E-18	1.26E-12	4.15E-22	7.38E-15
Total	8.61E-14	1.57E-16	1.03E-18	1.26E-12	4.15E-22	7.38E-15

Source: 4

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	8.61E-14	1.57E-16	1.03E-18	1.26E-12	4.15E-22	7.38E-15
Total	8.61E-14	1.57E-16	1.03E-18	1.26E-12	4.15E-22	7.38E-15

Source: 5

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	8.61E-14	1.57E-16	1.03E-18	1.26E-12	4.15E-22	7.38E-15
Total	8.61E-14	1.57E-16	1.03E-18	1.26E-12	4.15E-22	7.38E-15

** RESRAD-BUILD Risk Program Output, Version 3.4 06/04/09 11:40:14 Page: 13 **
Title : IAAAP Industrial Worker
Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
Evaluation Time: 0.00000000E+00 years

Nuclide Detail of Risks

[Risk]

Source: 1

Nuclide	Receptor 1	Total
U-238	2.18E-12	2.18E-12
U-234	3.26E-18	3.26E-18
TH-230	1.19E-23	1.19E-23
RA-226	7.65E-27	7.65E-27
PB-210	4.16E-30	4.16E-30
U-235	3.18E-12	3.18E-12
PA-231	6.97E-17	6.97E-17
AC-227	2.17E-18	2.17E-18
U-234	2.31E-12	2.31E-12
TH-230	1.27E-17	1.27E-17
RA-226	1.08E-20	1.08E-20
PB-210	7.33E-24	7.33E-24

Source: 2

Nuclide	Receptor 1	Total
U-238	4.06E-13	4.06E-13
U-234	6.50E-19	6.50E-19
TH-230	2.38E-24	2.38E-24
RA-226	8.42E-28	8.42E-28
PB-210	0.00E+00	0.00E+00
U-235	4.85E-13	4.85E-13
PA-231	1.35E-17	1.35E-17
AC-227	3.95E-19	3.95E-19
U-234	4.60E-13	4.60E-13
TH-230	2.53E-18	2.53E-18
RA-226	1.19E-21	1.19E-21
PB-210	1.44E-24	1.44E-24

```
** RESRAD-BUILD Risk Program Output, Version 3.4 06/04/09 11:40:14  Page:  14 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
 Evaluation Time:  0.00000000E+00  years


Source:  3

  Nuclide  Receptor   Total
              1
  U-238    4.06E-13  4.06E-13
  U-234    6.50E-19  6.50E-19
  TH-230   2.38E-24  2.38E-24
  RA-226   8.42E-28  8.42E-28
  PB-210   0.00E+00  0.00E+00
  U-235    4.85E-13  4.85E-13
  PA-231   1.35E-17  1.35E-17
  AC-227   3.95E-19  3.95E-19
  U-234    4.60E-13  4.60E-13
  TH-230   2.53E-18  2.53E-18
  RA-226   1.19E-21  1.19E-21
  PB-210   1.44E-24  1.44E-24


Source:  4

  Nuclide  Receptor   Total
              1
  U-238    4.06E-13  4.06E-13
  U-234    6.50E-19  6.50E-19
  TH-230   2.38E-24  2.38E-24
  RA-226   8.42E-28  8.42E-28
  PB-210   0.00E+00  0.00E+00
  U-235    4.85E-13  4.85E-13
  PA-231   1.35E-17  1.35E-17
  AC-227   3.95E-19  3.95E-19
  U-234    4.60E-13  4.60E-13
  TH-230   2.53E-18  2.53E-18
  RA-226   1.19E-21  1.19E-21
  PB-210   1.44E-24  1.44E-24


Source:  5

  Nuclide  Receptor   Total
              1
  U-238    4.06E-13  4.06E-13
  U-234    6.50E-19  6.50E-19
  TH-230   2.38E-24  2.38E-24
  RA-226   8.42E-28  8.42E-28
```

```
** RESRAD-BUILD Risk Program Output, Version 3.4 06/04/09 11:40:14  Page:  15 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
 Evaluation Time:  0.00000000E+00  years


  PB-210   0.00E+00  0.00E+00
  U-235    4.85E-13  4.85E-13
  PA-231   1.35E-17  1.35E-17
  AC-227   3.95E-19  3.95E-19
  U-234    4.60E-13  4.60E-13
  TH-230   2.53E-18  2.53E-18
  RA-226   1.19E-21  1.19E-21
  PB-210   1.44E-24  1.44E-24
```

```
** RESRAD-BUILD Risk Program Output, Version 3.4 06/04/09 11:40:14  Page:  16 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
 Evaluation Time:  1.00000000  years


              ================================================
              ================================================
              ===       Assessment for Time:  2            ===
              ===             Time =1.00E+00 yr            ===
              ================================================
              ================================================


              ========  Source Information  ========


 Source:  1
         Location::  Room :  1  x:   5.00 y:   5.00  z:   0.00 [m]
         Geometry::  Type: Area        Area:1.00E+02 [m2]  Direction: z
         Pathway ::
              Direct Ingestion Rate:    0.000E+00 [1/hr]
              Fraction released to air: 7.000E-02
              Removable fraction:       1.941E-01
              Time to Remove:           1.000E+04 [day]



          Contamination::     Nuclide    Concentration
                                           [pCi/m2]
                              U-238       9.927E-01
                              U-235       9.927E-01
                              U-234       9.927E-01
                              PA-231      2.098E-05
                              TH-230      8.936E-06
                              AC-227      3.300E-07
                              RA-226      1.935E-09
                              PB-210      1.990E-11

 Source:  2
         Location::  Room :  1  x:   5.00 y:  10.00  z:   1.00 [m]
         Geometry::  Type: Area        Area:2.00E+01 [m2]  Direction: y
         Pathway ::
              Direct Ingestion Rate:    0.000E+00 [1/hr]
              Fraction released to air: 7.000E-02
              Removable fraction:       1.941E-01
              Time to Remove:           1.000E+04 [day]



          Contamination::     Nuclide    Concentration
                                           [pCi/m2]
                              U-238       9.927E-01
                              U-235       9.927E-01
                              U-234       9.927E-01
```

```
** RESRAD-BUILD Risk Program Output, Version 3.4 06/04/09 11:40:14  Page:  17 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
 Evaluation Time:  1.00000000  years


                            PA-231      2.098E-05
                            TH-230      8.936E-06
                            AC-227      3.300E-07
                            RA-226      1.935E-09
                            PB-210      1.990E-11

 Source:  3
        Location::  Room :  1  x:  10.00 y:   5.00  z:   1.00 [m]
        Geometry::  Type: Area        Area:2.00E+01 [m2]  Direction: x
        Pathway ::
             Direct Ingestion Rate:    0.000E+00 [1/hr]
             Fraction released to air: 7.000E-02
             Removable fraction:       1.941E-01
             Time to Remove:           1.000E+04 [day]



         Contamination::     Nuclide    Concentration
                                          [pCi/m2]
                            U-238       9.927E-01
                            U-235       9.927E-01
                            U-234       9.927E-01
                            PA-231      2.098E-05
                            TH-230      8.936E-06
                            AC-227      3.300E-07
                            RA-226      1.935E-09
                            PB-210      1.990E-11

 Source:  4
        Location::  Room :  1  x:   0.00 y:   5.00  z:   1.00 [m]
        Geometry::  Type: Area        Area:2.00E+01 [m2]  Direction: x
        Pathway ::
             Direct Ingestion Rate:    0.000E+00 [1/hr]
             Fraction released to air: 7.000E-02
             Removable fraction:       1.941E-01
             Time to Remove:           1.000E+04 [day]



         Contamination::     Nuclide    Concentration
                                          [pCi/m2]
                            U-238       9.927E-01
                            U-235       9.927E-01
                            U-234       9.927E-01
                            PA-231      2.098E-05
                            TH-230      8.936E-06
                            AC-227      3.300E-07
                            RA-226      1.935E-09
                            PB-210      1.990E-11
```

```
** RESRAD-BUILD Risk Program Output, Version 3.4 06/04/09 11:40:14  Page:  18 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
 Evaluation Time:  1.00000000  years


 Source:  5
        Location::  Room :  1  x:   5.00 y:   0.00  z:   1.00 [m]
        Geometry::  Type: Area        Area:2.00E+01 [m2]  Direction: y
        Pathway ::
             Direct Ingestion Rate:    0.000E+00 [1/hr]
             Fraction released to air: 7.000E-02
             Removable fraction:       1.941E-01
             Time to Remove:           1.000E+04 [day]



          Contamination::     Nuclide    Concentration
                                           [pCi/m2]
                              U-238       9.927E-01
                              U-235       9.927E-01
                              U-234       9.927E-01
                              PA-231      2.098E-05
                              TH-230      8.936E-06
                              AC-227      3.300E-07
                              RA-226      1.935E-09
                              PB-210      1.990E-11
```

```
** RESRAD-BUILD Risk Program Output, Version 3.4 06/04/09 11:40:14  Page:  19 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
 Evaluation Time:  1.00000000  years
```

RESRAD-BUILD Risk Tables

Source Contributions to Receptor Risks

[Risk]

	Source 1	Source 2	Source 3	Source 4	Source 5	Total
Receptor 1	7.66E-12	1.35E-12	1.35E-12	1.35E-12	1.35E-12	1.31E-11
Total	7.66E-12	1.35E-12	1.35E-12	1.35E-12	1.35E-12	1.31E-11

** RESRAD-BUILD Risk Program Output, Version 3.4 06/04/09 11:40:14 Page: 20 **
Title : IAAAP Industrial Worker
Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
Evaluation Time: 1.00000000 years

Pathway Detail of Risks

[Risk]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.33E-12	7.86E-16	5.15E-18	6.29E-12	1.44E-20	3.69E-14
Total	1.33E-12	7.86E-16	5.15E-18	6.29E-12	1.44E-20	3.69E-14

Source: 2

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	8.55E-14	1.57E-16	1.03E-18	1.26E-12	2.89E-21	7.38E-15
Total	8.55E-14	1.57E-16	1.03E-18	1.26E-12	2.89E-21	7.38E-15

Source: 3

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	8.55E-14	1.57E-16	1.03E-18	1.26E-12	2.89E-21	7.38E-15
Total	8.55E-14	1.57E-16	1.03E-18	1.26E-12	2.89E-21	7.38E-15

Source: 4

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	8.55E-14	1.57E-16	1.03E-18	1.26E-12	2.89E-21	7.38E-15
Total	8.55E-14	1.57E-16	1.03E-18	1.26E-12	2.89E-21	7.38E-15

Source: 5

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	8.55E-14	1.57E-16	1.03E-18	1.26E-12	2.89E-21	7.38E-15
Total	8.55E-14	1.57E-16	1.03E-18	1.26E-12	2.89E-21	7.38E-15

** RESRAD-BUILD Risk Program Output, Version 3.4 06/04/09 11:40:14 Page: 21 **
Title : IAAAP Industrial Worker
Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
Evaluation Time: 1.00000000 years

Nuclide Detail of Risks

[Risk]

Source: 1

Nuclide	Receptor 1	Total
U-238	2.18E-12	2.18E-12
U-234	9.79E-18	9.79E-18
TH-230	8.37E-23	8.37E-23
RA-226	1.14E-25	1.14E-25
PB-210	1.28E-28	1.28E-28
U-235	3.17E-12	3.17E-12
PA-231	2.09E-16	2.09E-16
AC-227	1.50E-17	1.50E-17
U-234	2.31E-12	2.31E-12
TH-230	3.81E-17	3.81E-17
RA-226	7.54E-20	7.54E-20
PB-210	1.09E-22	1.09E-22

Source: 2

Nuclide	Receptor 1	Total
U-238	4.06E-13	4.06E-13
U-234	1.95E-18	1.95E-18
TH-230	1.67E-23	1.67E-23
RA-226	1.26E-26	1.26E-26
PB-210	2.52E-29	2.52E-29
U-235	4.85E-13	4.85E-13
PA-231	4.05E-17	4.05E-17
AC-227	2.74E-18	2.74E-18
U-234	4.60E-13	4.60E-13
TH-230	7.60E-18	7.60E-18
RA-226	8.31E-21	8.31E-21
PB-210	2.15E-23	2.15E-23

```
** RESRAD-BUILD Risk Program Output, Version 3.4 06/04/09 11:40:14  Page:  22 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
 Evaluation Time:  1.00000000  years


Source:  3

  Nuclide  Receptor   Total
              1
  U-238    4.06E-13  4.06E-13
  U-234    1.95E-18  1.95E-18
  TH-230   1.67E-23  1.67E-23
  RA-226   1.26E-26  1.26E-26
  PB-210   2.52E-29  2.52E-29
  U-235    4.85E-13  4.85E-13
  PA-231   4.05E-17  4.05E-17
  AC-227   2.74E-18  2.74E-18
  U-234    4.60E-13  4.60E-13
  TH-230   7.60E-18  7.60E-18
  RA-226   8.31E-21  8.31E-21
  PB-210   2.15E-23  2.15E-23


Source:  4

  Nuclide  Receptor   Total
              1
  U-238    4.06E-13  4.06E-13
  U-234    1.95E-18  1.95E-18
  TH-230   1.67E-23  1.67E-23
  RA-226   1.26E-26  1.26E-26
  PB-210   2.52E-29  2.52E-29
  U-235    4.85E-13  4.85E-13
  PA-231   4.05E-17  4.05E-17
  AC-227   2.74E-18  2.74E-18
  U-234    4.60E-13  4.60E-13
  TH-230   7.60E-18  7.60E-18
  RA-226   8.31E-21  8.31E-21
  PB-210   2.15E-23  2.15E-23


Source:  5

  Nuclide  Receptor   Total
              1
  U-238    4.06E-13  4.06E-13
  U-234    1.95E-18  1.95E-18
  TH-230   1.67E-23  1.67E-23
  RA-226   1.26E-26  1.26E-26
```

```
** RESRAD-BUILD Risk Program Output, Version 3.4 06/04/09 11:40:14  Page:  23 **
 Title : IAAAP Industrial Worker
 Input File : C:\RESRAD_Family\BUILD\IAAAP Industrial Worker.bld
 Evaluation Time:  1.00000000  years


  PB-210   2.52E-29  2.52E-29
  U-235    4.85E-13  4.85E-13
  PA-231   4.05E-17  4.05E-17
  AC-227   2.74E-18  2.74E-18
  U-234    4.60E-13  4.60E-13
  TH-230   7.60E-18  7.60E-18
  RA-226   8.31E-21  8.31E-21
  PB-210   2.15E-23  2.15E-23
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APPENDIX E

DETAILED INFORMATION FOR COST ANALYSIS OF THE REMEDIAL ALTERNATIVES

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DETAILED INFORMATION FOR COST ANALYSIS OF THE REMEDIAL ALTERNATIVES

GENERAL SITE INFORMATION

DU-contamination at the FSA is present in the top 2 ft bgs, with the great majority of the contamination present in the top 0 to 1 ft bgs. There are also two structural components in two buildings at Line 1 (Building 1-11 and Building 1-63-6) that exceed the structural surface RG derived for protection of industrial site workers.

REMEDIAL ACTION ALTERNATIVE DETAILS

Table E-1 presents the soil and structure remediation alternatives evaluated in the FS. Cost estimate summary spreadsheets for each action alternative are presented in the tables that constitute Attachment E-1. Detailed cost estimates for Alternative 3 and Alternative 4, each combined with Alternative S3 are presented in Attachment E-2. Calculation of volume estimates are presented in Attachment E-3.

Table E-1. Summary of Remedial Alternatives for Soil and Line 1 Structural Surfaces

Alternative	Description	Notes
Soil Remediation Alternatives		
1	No Action for Soil	Required by the NCP
2	Land Use Controls for Soil	Limited response action
3	Excavation of Depleted Uranium-Contaminated Soil with Off-Site Disposal	Full response action for DU soil
4	Excavation of Depleted Uranium-Contaminated Soil with Physical Treatment and Off-Site Disposal	Full response action for DU soil with reduced volume for disposal by treatment of DU-contaminated soil
Structures Remediation Alternatives		
S1	No Action for Structures	Required by the NCP
S2	Land use Controls for Structures	Limited response action
S3	Decontamination/Replacement of Structures	Full response action

SOIL REMEDIATION ALTERNATIVES

Alternative 1 – No Action for Soil

This alternative assumes that no further soil investigations and no remedial action would occur at the FUSRAP areas. This alternative would serve as a baseline for comparison of other remedial alternatives. There are no costs associated with this alternative.

Alternative 2 – Land Use Controls for Soil

The cost of implementing land use controls to restrict the use of, or otherwise prevent the disturbance of, soil would be included in this alternative. Existing controls include use restrictions and outgrants administered by the U.S. Army as part of its land management responsibilities. Under this alternative, additional land use controls would be implemented, which would include specific prohibitions against any actions that would disturb the soil at the FSA. Included in the cost estimate are professional hours to assist the U.S Army in implementing these land use controls and the development of five-year reviews (out to 30 years). One document would cover all sites addressed by this FS.

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

This alternative involves the excavation of surface and shallow subsurface DU-contaminated soil from the FSA. Table E-2 presents in detail the areas and volumes for each of these excavations.

Table E-2. Excavation Details

Site	Excavation Area (ft^2)	Estimated Excavation Volume (in-situ/ex-situ CY)	Excavation Process
Firing Site 12 Area	338,000	16,938/ 22,020	In 1-ft lifts, with GWS guidance
Firing Sites 1 and 2	27	1/1.3	One point excavation with GWS guidance
Firing Sites 3, 4, and 5	27	1/1.3	One point excavation with GWS guidance
Firing Sites 6 Area	27	1/1.3	One point excavation with GWS guidance

Prior to excavation at the Firing Site 12 Area, an estimated area of 104,000 ft^2 would require clearing (no grubbing necessary). Excavation of DU at the Firing Site 12 Area would involve an iterative excavation process, starting with excavation of a 1 ft lift of soil within a 100-m radius of the center (ground zero) of the Firing Site 12 Area. Once the first excavation lift is completed, a GWS would be performed to define the lateral extent (or individual pockets) of excavation necessary for the next 1 ft lift in this area. Excavation of limited areas and individual pockets within a ring area beyond the 100-m radius and out to approximately a 175-m radius would also be performed to a depth of 1 ft (see Attachment E-3). Equipment used for excavation within the 100-m radius would be a bulldozer for the first lift and hand excavation plus mini-backhoe for the second lift. A second GWS would be part of the excavation confirmation activities. Excavation of the small DU-contaminated areas (i.e., a single DU fragment identified during radiological surveys) at Firing Sites 1 and 2; Firing Sites 3, 4, and 5; and the Firing Site 6 Area would be performed using a mini-backhoe or hand excavation and would also entail a GWS as part of the confirmation activity.

Disposal of DU-contaminated soil as LLRW would be at a landfill approved to receive LLRW.

Excavation confirmation sampling would be performed at a frequency of three samples (one screening, one systematic, and one biased for elevated areas) per 100 m^2 (1,076 ft^2) except for the small DU-contaminated areas, where a one sample per 100 m^2 would be collected. Excavation confirmation sample results would be compared directly to the human health RGs to assess the need for any over excavation.

A soil staging area would be needed for storing contaminated soil after excavation and prior to loading onto long-haul trucks. This staging area needs to be lined with 60-mil [one thousandth (10^{-3}) of an inch] plastic and have a storm-water collection sump. The staging area should be approximately 200 by 200 ft in size. Water from the sump would need to be filtered, with the spent filters combined with DU-contaminated soil for disposal. Treated water would require sampling for contaminant parameters prior to its release to the nearest storm-water drainage. Once excavation, sampling, soil disposal, and site restoration are complete, no further O&M or monitoring is required for this alternative.

Below-grade building surfaces at the Firing Site 12 Area would become exposed during excavation and may be radiologically contaminated, thus requiring cleaning by high-pressure water washing. An estimated 475 ft^2 of surface area may be radiologically contaminated and may require this cleaning. After cleaning, the surfaces would be radiologically surveyed to assess

whether additional cleaning is necessary. Additional rounds of cleaning would be performed with high pressure washing, followed by grit blasting or scabbling as needed.

Each excavation site would also need to be restored to its original condition. For costing purposes this would involve backfilling each excavation with soil from a borrow location off-site from the IAAAP, placing and compacting the soil, and re-establishing vegetation (assume native grass only). Finally, a construction completion report would be prepared.

No additional land use controls would be implemented, though 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.

Five-year reviews (out to 30 years) would also be required in implementing this alternative and to verify that land use continues to be industrial. One document would cover all sites addressed by this FS.

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

This alternative is similar to Alternative 3 except that the excavated soil would be treated using a physical treatment process (e.g., soil sorting and radiological scanning) to decrease the volume of soil requiring off-site disposal.

Excavation of contaminated soil would proceed in the same manner, with the same volumes, and with the same sampling frequency as described in Alternative 3. Excavation confirmation sample results would be compared directly to the human health RGs to assess the need for any over excavation.

Once stockpiled, the DU-contaminated soil would be run through the physical treatment process (e.g., soil sorting and radiological scanning) to decrease the volume of soil requiring off-site disposal. This system would be initially used as a demonstration pilot test soil refine the design of the system.

A soil staging area would be needed for storing contaminated soil after excavation and prior to treatment and/or loading onto long-haul trucks. This staging area needs to be lined with 60-mil plastic and have a storm-water collection sump. The staging area should be approximately 200 by 200 ft in size. Water from the sump would need to be filtered, with the spent filters combined with DU-contaminated soil for disposal. Treated water would require sampling for contaminant parameters prior to release to the nearest storm-water drainage. Once excavation, sampling, soil disposal, and site restoration are complete, no further O&M or monitoring is required for this alternative.

Below-grade building surfaces at the Firing Site 12 Area would become exposed during excavation and may be radiologically contaminated, thus requiring cleaning by high-pressure water washing. An estimated 475 ft^2 of surface area may be radiologically contaminated and may require this cleaning. After cleaning, the surfaces would be radiologically surveyed to assess whether additional cleaning is necessary. Additional rounds of cleaning would be performed with high pressure washing, followed by grit blasting or scabbling as needed.

Each excavation site would also need to be restored to its original condition. For costing purposes this would involve backfilling each excavation with treated soil or soil from a borrow location off-site from the IAAAP, placing and compacting the soil, and re-establishing vegetation (assume native grass only). Eighty percent of the original soil volume would go for

disposal. Disposal of DU-contaminated soil as LLRW would be at a landfill approved to receive LLRW. Twenty percent of the soil volume would be returned to the site as backfill after the physical treatment process (e.g., soil sorting and radiological scanning) while 80% of the original soil volume would need to be acquired from an off-site borrow source for backfilling. Finally, a construction completion report would be prepared.

No additional land use controls would be implemented, though 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.

Five-year reviews (out to 30 years) would also be required in implementing this alternative and to verify that land use continues to be industrial. One document would cover all sites addressed by this FS.

LINE 1 STRUCTURAL SURFACE REMEDIATION ALTERNATIVES

The specific components with surface radioactivity above RGs and requiring remediation are a steel grate covering a floor sump located at Building 1-11 and the air filters in an air-handling unit at Building 1-36-6. The RG for these structural surfaces is 23,000 dpm/100 cm^2.

Alternative S1 – No Action for Structures

This alternative assumes that no remedial action would be performed for IAAAP structures at the FUSRAP areas. There are no costs associated with this alternative.

Alternative S2 – Land Use Controls for Structures

The cost of establishing no-entry zones or placing land use controls to restrict entry to contaminated structures would constitute the costs for this alternative. Included in the cost estimate are professional hours to assist the U.S Army in implementing and supporting these land use controls and the development of five-year reviews (out to 30 years). One document would cover all sites addressed by this FS.

Alternative S3 – Decontamination/Replacement of Structures

Under this alternative, the contaminated air filters at Line 1 Building 1-63-6 would be removed and replaced. Decontamination of radiologically contaminated components such as air filters is not feasible and, for some components, is not cost effective.

The steel floor grate covering the sump at Line 1 Building 1-11 would be decontaminated and, if methods fail to successfully decontaminate the grate, it would be replaced. The floor grate, covering an area of 46 ft^2, requires decontamination by high-pressure water washing. After each round of cleaning, radiological surveying would be performed to determine if additional cleaning is necessary. Decontamination water generated from the grate cleaning 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.

No additional land use controls would be implemented, though 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.

Five-year reviews (out to 30 years) would also be required in implementing this alternative and to verify that land use continues to be industrial. One document would cover all sites addressed by this FS.

ATTACHMENT E-1

IAAAP FS Cost Estimate Summaries

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Table E-1-1. Iowa Army Ammunition Plant (IAAAP) Feasibility Study
Feasibility Study - Cost Estimate
Summary of Remedial Alternatives

Remedial Action Alternatives		Duration (years)	Total Cost
1	No Action for Soils	-	$0
2	Land Use Controls for Soils	30	$2,332,013
3	Excavation of Depleted Uranium-Contaminated Soil with Off-Site Disposal	30	$50,401,517
4	Excavation of Depleted Uranium-Contaminated Soil with Physical Treatment and Off-Site Disposal	30	$45,172,033

Line 1 Structure Remediation Alternatives		Duration (years)	Total Cost
S1	No Action for Structures	-	$0
S2	Land Use Controls for Structures	30	$285,772
S3	Decontamination/Replacement of Structures	30	$102,961

Table E-1-2. Iowa Army Ammunition Plant (IAAAP) Feasibility Study
Alternative 2 - Land Use Controls for Soils
Cost Estimate

	Description	Quantity	UOM	Direct Cost	JOOH	HOOH	Profit	Bond	Contract Cost	Contingency	Escalation	Project Cost
	Details			$ 1,913,264.00	$ 85,889.44	$ 33,298.68	$ 40,457.89	$ 13,467.02	$ 2,086,377.03	$ 111,046.21	$ 134,590.25	$ 2,332,013.49
32XXX	**PROJ. MANG. & PRE-REMEDIAL ACTION**			$ 1,102,920.00	$ -	$ -	$ -	$ -	$ 1,102,920.00	$ 57,837.13	$ 53,822.50	$ 1,214,579.62
10	Project Management	1	LS	$ 765,720.00	$ -	$ -	$ -	$ -	$ 765,720.00	$ 40,154.36	$ 37,367.14	$ 843,241.49
30	Remedial Design (LUC Plan)	1	LS	$ 187,200.00	$ -	$ -	$ -	$ -	$ 187,200.00	$ 9,816.77	$ 9,135.36	$ 206,152.13
40	Remedial Action Contracting	1	LS	$ 150,000.00	$ -	$ -	$ -	$ -	$ 150,000.00	$ 7,866.00	$ 7,320.00	$ 165,186.00
331XX	**HTRW REMEDIAL ACTION (CONSTRUCT)**			$ 90,344.00	$ 23,489.44	$ 9,106.68	$ 11,064.61	$ 3,683.02	$ 137,687.75	$ 7,668.06	$ 15,682.63	$ 161,038.44
	(Note: Account 33XXX includes HTRW remedial action (construction) work for all programs and includes operation which occurs during construction (remedial action). Account 33XXX excludes project management at all phases and excludes pre construction investigations and remedial design which are all in Account 32XXX. Account 33XXX excludes post construction Operation and Maintenance (O&M) which is in Account 34XXX.)											
01.08	Institutional Controls/LUCs	1	LS	$ 21,344.00	$ 5,549.44	$ 2,151.48	$ 2,614.04	$ 870.12	$ 32,529.08	$ 1,811.60	$ 3,705.06	$ 38,045.74
22	General Requirements											
22.90	Utility Radiological Support	30	visits	$ 69,000.00	$ 17,940.00	$ 6,955.20	$ 8,450.57	$ 2,812.90	$ 105,158.67	$ 5,856.46	$ 11,977.57	$ 122,992.70
34XXX	**POST REMEDIAL ACTION**			$ 720,000.00	$ 62,400.00	$ 24,192.00	$ 29,393.28	$ 9,784.00	$ 845,769.28	$ 45,541.02	$ 65,085.12	$ 956,395.42
20	Operation, Maintenance & Monitoring											
20.02	Monitoring	1	LS	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
20.03	Five Year Reviews	6	EA	$ 240,000.00	$ 62,400.00	$ 24,192.00	$ 29,393.28	$ 9,784.00	$ 365,769.28	$ 20,370.30	$ 41,661.12	$ 427,800.70
20.04	Post Remedial Site Supervision	120	visits	$ 480,000.00	$ -	$ -	$ -	$ -	$ 480,000.00	$ 25,170.72	$ 23,424.00	$ 528,594.72

Table E-1-3. Iowa Army Ammunition Plant (IAAAP) Feasibility Study
Alternative 3 - Excavation of Depleted Uranium Contaminated Soil with Off-Site Disposal
Cost Estimate

	Description	Quantity	UOM	Direct Cost	JOOH	HOOH	Profit	Bond	Contract Cost	Contingency	Escalation	Project Cost
	Bid Items	**1**	**LS**	$ 27,769,335.57	$ 4,785,730.01	$ 2,085,664.78	$ 2,570,686.13	$ 844,996.93	$ 38,056,413.41	$ 10,475,996.29	$ 1,869,107.29	$ 50,401,517.00
	PROJ. MANG. & PREREMEDIAL ACTION	1	LS	$ 4,097,998.41	$ -	$ -	$ -	$ -	$ 4,097,998.41	$ 214,899.03	$ 199,982.32	$ 4,512,879.77
	Project Management	1	LS	$ 945,524.60	$ -	$ -	$ -	$ -	$ 945,524.60	$ 49,583.31	$ 46,141.60	$ 1,041,249.51
	Investigations (PRP)	1	LS	$ 315,900.00	$ -	$ -	$ -	$ -	$ 315,900.00	$ 16,565.80	$ 15,415.92	$ 347,881.72
	Remedial Design	1	LS	$ 2,521,365.61	$ -	$ -	$ -	$ -	$ 2,521,365.61	$ 132,220.42	$ 123,042.64	$ 2,776,628.67
	Remedial Action Contracting	1	LS	$ 315,208.20	$ -	$ -	$ -	$ -	$ 315,208.20	$ 16,529.52	$ 15,382.16	$ 347,119.88
	HTRW REMEDIAL ACTION (CONSTRUCT)	**1**	**LS**	$ 21,285,079.75	$ 4,785,730.01	$ 2,085,664.78	$ 2,570,686.13	$ 844,996.93	$ 31,572,157.59	$ 9,448,465.48	$ 1,540,721.29	$ 42,561,344.36
	Mobilize and Preparatory Work	1	LS	$ 106,779.66	$ 24,008.44	$ 10,463.05	$ 12,896.23	$ 4,239.05	$ 158,386.43	$ 54,999.65	$ 7,729.26	$ 221,115.34
	Monitoring, Sampling, Test &Analysis	1	LS	$ 1,255,120.00	$ 282,202.30	$ 122,985.78	$ 151,586.13	$ 49,827.09	$ 1,861,721.31	$ 550,625.67	$ 90,852.00	$ 2,503,198.98
	Site Work	1	LS	$ 330,177.14	$ 74,237.32	$ 32,353.16	$ 39,876.88	$ 13,107.72	$ 489,752.23	$ 144,849.90	$ 23,899.91	$ 658,502.04
	Surface Water Collect & Control	1	LS	$ 1,027,668.60	$ 231,061.93	$ 100,698.44	$ 124,115.86	$ 40,797.48	$ 1,524,342.32	$ 553,320.53	$ 74,387.91	$ 2,152,050.75
	Solids Collect and Containment	1	LS	$ 389,212.36	$ 87,510.86	$ 38,137.86	$ 47,006.82	$ 15,451.37	$ 577,319.26	$ 170,748.87	$ 28,173.18	$ 776,241.30
	Physical Treatment	1	LS	$ 132,133.40	$ 29,708.99	$ 12,947.39	$ 15,958.31	$ 5,245.58	$ 195,993.67	$ 57,967.40	$ 9,564.49	$ 263,525.56
	Disposal (Commercial)	1	LS	$ 17,886,360.92	$ 4,021,559.03	$ 1,752,633.60	$ 2,160,208.54	$ 710,070.96	$ 26,530,833.05	$ 7,846,801.63	$ 1,294,704.65	$ 35,672,339.33
	Site Restoration	1	LS	$ 21,619.81	$ 4,861.02	$ 2,118.47	$ 2,611.12	$ 858.29	$ 32,068.70	$ 9,484.69	$ 1,564.95	$ 43,118.34
	Demobilization	1	LS	$ 136,007.85	$ 30,580.13	$ 13,327.04	$ 16,426.24	$ 5,399.38	$ 201,740.64	$ 59,667.13	$ 9,844.94	$ 271,252.72
	ENGINEERING DURING CONSTRUCTION	**1**	**LS**	$ 315,208.20	$ -	$ -	$ -	$ -	$ 315,208.20	$ 114,668.44	$ 15,415.92	$ 445,292.56
	Engineering During Construction	1	LS	$ 315,208.20	$ -	$ -	$ -	$ -	$ 315,208.20	$ 114,668.44	$ 15,415.92	$ 445,292.56
	CONSTRUCTION MANAGEMENT (S&A)	**1**	**LS**	$ 1,891,049.21	$ -	$ -	$ -	$ -	$ 1,891,049.21	$ 687,938.04	$ 92,485.76	$ 2,671,473.01
	CONSTRUCTION MANAGEMENT (S&A)	1	LS	$ 1,891,049.21	$ -	$ -	$ -	$ -	$ 1,891,049.21	$ 687,938.04	$ 92,485.76	$ 2,671,473.01
	POST-REMEDIAL ACTION	**1**	**LS**	$ 180,000.00	$ -	$ -	$ -	$ -	$ 180,000.00	$ 10,025.30	$ 20,502.00	$ 210,527.30
	Operation, Maint. & Monitoring	1	LS	$ 180,000.00	$ -	$ -	$ -	$ -	$ 180,000.00	$ 10,025.30	$ 20,502.00	$ 210,527.30

Table E-1-4. Iowa Army Ammunition Plant (IAAAP) Feasibility Study
Alternative 4 - Excavation of Depleted Uranium-Contaminated Soil with Physical Treatment and Off-Site Disposal
Cost Estimate

	Description	Quantity	UOM	Direct Cost	JOOH	HOOH	Profit	Bond	Contract Cost	Contingency	Escalation	Project Cost
	Bid Items			**$ 24,386,669.55**	**$ 4,785,453.75**	**$ 1,867,797.39**	**$ 2,302,153.69**	**$ 756,729.02**	**$ 34,098,803.39**	**$ 9,397,254.06**	**$ 1,675,975.91**	**$ 45,172,033.37**
	PROJ. MANG. & PREREMEDIAL ACTION	**1**	**LS**	**$ 3,669,298.41**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 3,669,298.41**	**$ 192,418.00**	**$ 179,061.76**	**$ 4,040,778.18**
	Project Management	1	LS	$ 846,624.60	$ -	$ -	$ -	$ -	$ 846,624.60	$ 44,397.00	$ 41,315.28	$ 932,336.88
	Investigations (PRP)	1	LS	$ 282,900.00	$ -	$ -	$ -	$ -	$ 282,900.00	$ 14,835.28	$ 13,805.52	$ 311,540.80
	Remedial Design	1	LS	$ 2,257,565.61	$ -	$ -	$ -	$ -	$ 2,257,565.61	$ 118,386.74	$ 110,169.20	$ 2,486,121.55
	Remedial Action Contracting	1	LS	$ 282,208.20	$ -	$ -	$ -	$ -	$ 282,208.20	$ 14,799.00	$ 13,771.76	$ 310,778.96
	HTRW REMEDIAL ACTION (CONSTRUCT)	**1**	**LS**	**$ 18,562,013.73**	**$ 4,785,453.75**	**$ 1,867,797.39**	**$ 2,302,153.69**	**$ 756,729.02**	**$ 28,274,147.57**	**$ 8,476,018.60**	**$ 1,379,778.39**	**$ 38,129,944.56**
	Mobilize and Preparatory Work	1	LS	$ 106,779.66	$ 27,528.76	$ 10,744.67	$ 13,243.35	$ 4,353.15	$ 162,649.59	$ 56,480.03	$ 7,937.30	$ 227,066.93
	Monitoring, Sampling, Test & Analysis	1	LS	$ 1,255,120.00	$ 323,581.20	$ 126,296.10	$ 155,666.25	$ 51,168.25	$ 1,911,831.80	$ 565,446.43	$ 93,297.39	$ 2,570,575.62
	Site Work	1	LS	$ 301,982.73	$ 75,487.21	$ 29,463.20	$ 36,314.88	$ 11,936.89	$ 446,005.01	$ 131,911.16	$ 21,785.04	$ 599,681.20
	Surface Water Collect & Control	1	LS	$ 1,027,668.60	$ 264,942.19	$ 103,408.86	$ 127,456.59	$ 41,895.60	$ 1,565,371.84	$ 568,213.82	$ 76,390.15	$ 2,209,975.81
	Solids Collect and Containment	1	LS	$ 389,212.36	$ 100,342.44	$ 39,164.38	$ 48,272.06	$ 15,867.26	$ 592,858.51	$ 175,344.78	$ 28,931.50	$ 797,134.78
	Physical Treatment	1	LS	$ 1,013,033.40	$ 263,535.76	$ 102,859.92	$ 126,780.00	$ 41,673.20	$ 1,557,062.15	$ 460,519.19	$ 75,984.63	$ 2,093,565.98
	Disposal (Commercial)	1	LS	$ 14,310,589.31	$ 3,689,398.37	$ 1,439,999.01	$ 1,774,870.79	$ 583,408.58	$ 21,798,266.06	$ 6,447,090.05	$ 1,063,755.38	$ 29,309,111.49
	Site Restoration	1	LS	$ 21,619.81	$ 5,573.78	$ 2,175.49	$ 2,681.40	$ 881.39	$ 32,931.86	$ 9,739.98	$ 1,607.07	$ 44,278.92
	Demobilization	1	LS	$ 136,007.85	$ 35,064.04	$ 13,685.75	$ 16,868.37	$ 5,544.72	$ 207,170.74	$ 61,273.15	$ 10,109.93	$ 278,553.81
	ENGINEERING DURING CONSTRUCTION	**1**	**LS**	**$ 282,208.20**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 282,208.20**	**$ 102,689.78**	**$ 13,805.52**	**$ 398,703.50**
	Engineering During Construction	1	LS	$ 282,208.20	$ -	$ -	$ -	$ -	$ 282,208.20	$ 102,689.78	$ 13,805.52	$ 398,703.50
	CONSTRUCTION MANAGEMENT (S&A)	**1**	**LS**	**$ 1,693,149.21**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 1,693,149.21**	**$ 616,102.38**	**$ 82,828.24**	**$ 2,392,079.83**
	CONSTRUCTION MANAGEMENT (S&A)	1	LS	$ 1,693,149.21	$ -	$ -	$ -	$ -	$ 1,693,149.21	$ 616,102.38	$ 82,828.24	$ 2,392,079.83
	POST-REMEDIAL ACTION	**1**	**LS**	**$ 180,000.00**	**$ -**	**$ -**	**$ -**	**$ -**	$ 180,000.00	**$ 10,025.30**	**$ 20,502.00**	**$ 210,527.30**
	Operation, Maint. & Monitoring	1	LS	$ 180,000.00	$ -	$ -	$ -	$ -	$ 180,000.00	$ 10,025.30	$ 20,502.00	$ 210,527.30

Table E-1-5 Iowa Army Ammunition Plant (IAAAP) Feasibility Study
Structure Alternative S2 - Land Use Controls for Structures
Cost Estimate

	Description	Quantity	UOM	Direct Cost	JOOH	HOOH	Profit	Bond	Contract Cost	Contingency	Escalation	Project Cost
	Details			$ 197,080.00	$ 26,234.00	$ 10,170.72	$ 12,357.42	$ 4,113.36	$ 249,955.50	$ 13,607.64	$ 22,208.61	$ 285,771.76
32XXX	**PROJ. MANG. & PRE-REMEDIAL ACTION**			$ 46,680.00	$ -	$ -	$ -	$ -	$ 46,680.00	$ 2,447.90	$ 2,277.98	$ 51,405.88
10	Project Management	1	LS	$ 28,080.00	$ -	$ -	$ -	$ -	$ 28,080.00	$ 1,472.52	$ 1,370.30	$ 30,922.82
30	Remedial Design (LUC Plan)	1	LS	$ 3,600.00	$ -	$ -	$ -	$ -	$ 3,600.00	$ 188.78	$ 175.68	$ 3,964.46
40	Remedial Action Contracting	1	LS	$ 15,000.00	$ -	$ -	$ -	$ -	$ 15,000.00	$ 786.60	$ 732.00	$ 16,518.60
331XX	**HTRW REMEDIAL ACTION (CONSTRUCT)**			$ 40,900.00	$ 10,634.00	$ 4,122.72	$ 5,009.10	$ 1,667.36	$ 62,333.18	$ 3,471.44	$ 7,099.75	$ 72,904.37
	(Note: Account 33XXX includes HTRW remedial action (construction) work for all programs and includes operation which occurs during construction (remedial action). Account 33XXX excludes project management at all phases and excludes pre construction investigations and remedial design which are all in Account 32XXX. Account 33XXX excludes post construction Operation and Maintenance (O&M) which is in Account 34XXX.)											
01.08	Institutional Controls/LUCs	1	LS	$ 6,400.00	$ 1,664.00	$ 645.12	$ 783.82	$ 260.91	$ 9,753.85	$ 543.21	$ 1,110.96	$ 11,408.02
22	General Requirements											
22.90	Utility Radiological Support	15	visits	$ 34,500.00	$ 8,970.00	$ 3,477.60	$ 4,225.28	$ 1,406.45	$ 52,579.33	$ 2,928.23	$ 5,988.79	$ 61,496.35
34XXX	**POST REMEDIAL ACTION**			$ 109,500.00	$ 15,600.00	$ 6,048.00	$ 7,348.32	$ 2,446.00	$ 140,942.32	$ 7,688.31	$ 12,830.88	$ 161,461.51
20	Operation, Maintenance & Monitoring											
20.02	Monitoring	1	LS	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
20.03	Five Year Reviews	6	EA	$ 60,000.00	$ 15,600.00	$ 6,048.00	$ 7,348.32	$ 2,446.00	$ 91,442.32	$ 5,092.58	$ 10,415.28	$ 106,950.18
20.04	Post Remedial Site Supervision	30	visits	$ 49,500.00	$ -	$ -	$ -	$ -	$ 49,500.00	$ 2,595.73	$ 2,415.60	$ 54,511.33

Table E-1-6. Iowa Army Ammunition Plant (IAAAP) Feasibility Study
Structure Alternative S3 - Decontamination/Replacement of Structures
Cost Estimate

	Description	Quantity	UOM	Direct Cost	JOOH	HOOH	Profit	Bond	Contract Cost	Contingency	Escalation	Project Cost
	Details			$ 82,324.06	$ 2,366.65	$ 923.73	$ 1,138.53	$ 374.23	$ 87,127.21	$ 7,912.48	$ 7,921.50	$ 102,961.18
32XXX	**PROJ. MANG. & PRE-REMEDIAL ACTION**			$ 8,301.59	$ -	$ -	$ -	$ -	$ 8,301.59	$ 435.34	$ 405.12	$ 9,142.04
10	Project Management	1	LS	$ 2,075.40	$ -	$ -	$ -	$ -	$ 2,075.40	$ 108.83	$ 101.28	$ 2,285.51
30	Remedial Design	1	LS	$ 5,534.39	$ -	$ -	$ -	$ -	$ 5,534.39	$ 290.22	$ 270.08	$ 6,094.69
40	Remedial Action Contracting	1	LS	$ 691.80	$ -	$ -	$ -	$ -	$ 691.80	$ 36.28	$ 33.76	$ 761.84
331XX	**HTRW REMEDIAL ACTION (CONSTRUCT)**			$ 9,179.88	$ 2,366.65	$ 923.73	$ 1,138.53	$ 374.23	$ 13,983.03	$ 4,135.64	$ 682.38	$ 18,801.05
	(Note: Account 33XXX includes HTRW remedial action (construction) work for all programs and includes operation which occurs during construction (remedial action). Account 33XXX excludes project management at all phases and excludes pre construction investigations and remedial design which are all in Account 32XXX. Account 33XXX excludes post construction Operation and Maintenance (O&M)											
	High Pressure Water Washing	1	LS	$ 7,444.25	$ 1,919.19	$ 749.08	$ 923.27	$ 303.48	$ 11,339.27	$ 3,353.72	$ 553.36	$ 15,246.35
	Remove & Replace Air Filters and Floor Grate	1	LS	$ 935.63	$ 241.21	$ 94.15	$ 116.04	$ 38.14	$ 1,425.18	$ 421.51	$ 69.55	$ 1,916.24
	Transportation & Disposal of Bldg Decon	1	LS	$ 800.00	$ 206.25	$ 80.50	$ 99.22	$ 32.61	$ 1,218.58	$ 360.41	$ 59.47	$ 1,638.46
									$ -	$ -	$ -	$ -
	ENGINEERING DURING CONSTRUCTION			$ 691.80	$ -	$ -	$ -	$ -	$ 691.80			$ 691.80
	CONSTRUCTION MANAGEMENT			$ 4,150.79	$ -	$ -	$ -	$ -	$ 4,150.79			$ 4,150.79
34XXX	**POST REMEDIAL ACTION**			$ 60,000.00	$ -	$ -	$ -	$ -	$ 60,000.00	$ 3,341.50	$ 6,834.00	$ 70,175.50
20	Operation, Maintenance & Monitoring											
20.03	Five Year Reviews	6	EA	$ 60,000.00	$ -	$ -	$ -	$ -	$ 60,000.00	$ 3,341.50	$ 6,834.00	$ 70,175.50

ATTACHMENT E-2

Detailed Cost Estimates

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Middletown Iowa Feasibility Off Site Disposal version 4

Formerly Utilized Sites Remedial Action Program (FUSRAP) Middletown Iowa Feasibiltiy Study, Alternative 3 for Soils and Alternative S3 for Structures

Estimated by	St. Louis District
Designed by	
Prepared by	Gregory Dyn
Preparation Date	2/15/2011
Effective Date of Pricing	2/15/2011
Estimated Construction Time	675 Days

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Description **Page**

Project Notes ..... **i**
Bid Items **1**
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HTRW REMEDIAL ACTION (CONSTRUCT) 1
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PROJECT BREAKDOWN:

This estimate is structured for remedial action construction as follows using a 5 digit number at Level 1 and a 2 digit number at all remaining levels. The numbers for the first 3 title levels are taken from the Standard Interagency HTRW Remedial Action Work Breakdown Structure (RA-WBS). The 2 digit numbers for the remaining title levels are user defined. The detail items are at Level 5.

Level 1 - WBS Level 1 (Account)
Level 2 - WBS Level 2 (System)
Level 3 - WBS Level 3 (Subsystem)
Level 4 - WBS Level 4 (Assembly Category or Other)
Level 5 - Detail
Level 6 - Not Used

PROJECT DESCRIPTION:

The Middletown Iowa site is part of the Formerly Utilized Sites Remedial Action Program (FUSRAP), which is comprised of multiple properties. The Middletown Iowa Site is located in Des Moines County. Specific sites include Firing Sites 1, 2, 3, 4, 5, 6, and 12 and Building FS12.
This estimate only considers Alternative 3 for Soils, Excavation of DU-Contaminated Soil with Off-Site Disposal, and Alternative 3 for Structures, Decontamination/Replacement of Structures, of the Proposed Plan.

PRODUCTIVITY:

Production rates, as a baseline and as taken from the Unit Price Book (UPB) Database, assumes a non-contaminated working environment with no level of protection productivity reduction factors. When required, productivity for appropriate activities will be adjusted for this project as follows:

1. Level of Protection B - Productivity 48%
2. Level of Protection C - Productivity 55%
3. Level of Protection D Modified - Productivity 82%
4. Level of Protection D - Productivity 96%

Notes in the estimate detail will show when each level applies.

The following daily time breakdown was assumed as taken from the Corps of Engineers "Productivity Study for HTRW Remedial Action Projects".

Example: Light Work with ave. temperature >70 but <85 degrees.

	Level B	Level C	Level D Mod	Level D	Normal
Paid Time (minutes)	480	480	480	480	480
- Non-Productive Time (minutes):					
Standard Losses	140	128	76	32	20
Scheduled/Heat Stress Breaks	65	63	47	33	30
Dexterity Losses	69	51	4	5	0
Productive Time (minutes)	206	238	353	410	430

Date	Author	Note

Paige Scott

Productivity: 206/430 238/430 353/430 410/430 430/430 X100% X100% X100% X100% X100%
48% 55% 82% 96% 100%

Example:

Normal Production Rate (CY/HR)	250	250	250	250	250
X Productivity	.48	.55	.82	.96	1.00
=Reduced Production Rate(CY/HR)	120	138	205	240	250

ESCALATION:

Escalation determinations were made using the Composite Civil Works Construction Index from EM 1110-2-1304, Civil Works Construction Cost Index System (CWCCIS) Dated 30 September 2010. Index projections are based on the current annual Office of Management and Budget (OMB) inflation factors.

For this estimate, the effective date of pricing is October 2010. The anticipated project duration is 675 calendar days. The midpoint of remedial action is October 2013. Post remedial action is anticipated to begin immediatly following the completion of the remedial action. The midpoint of post remedial action is April 2017.

Remedial Action Escalation Calculation:
Remedial Action Midpoint (October 2013) Index = 760.77
Effective Date of Pricing (October 2010) Index = 725.38

Escalation % = (761/725)-1 X 100% = 4.88%

Post Remedial Action Escalation Calculation:
Post Remedial Action Midpoint (April 2017) Index = 807.97
Effective Date of Pricing (October 2010) Index = 725.38

Escalation % = (808/725)-1 X 100% = 11.39%

CONTINGENCY:

Contingencies are shown for both Design Contingencies and Construction Contingencies. Contingency rates are variable and are applied at Level 2 of the estimate (HTRW RA-WBS Level 2, System). Design contingencies are based on the EI01D010 reasonable guide table for remedial action projects. Construction contingencies are based on the consensus of a CEMVS PM/ED group analysis.

Description	Quantity	UOM	DirectCost	JOOH	HOOH	Profit	Bond	ContractCost	Contingency	Escalation	ProjectCost
Bid Items			**27,851,659.63**	**4,787,820.40**	**2,086,566.40**	**2,571,797.42**	**845,362.21**	**38,143,206.05**	**10,483,809.82**	**1,877,012.46**	**50,504,028.33**
PROJ. MANG.& PRE-REMEDIAL ACTION	**1**	**LS**	**4,106,300.00**	**0.00**	**0.00**	**0.00**	**0.00**	**4,106,300.00**	**215,334.37**	**200,387.44**	**4,522,021.81**
HTRW REMEDIAL ACTION (CONSTRUCT)	**1**	**LS**	**21,294,259.63**	**4,787,820.40**	**2,086,566.40**	**2,571,797.42**	**845,362.21**	**31,585,806.05**	**9,452,502.17**	**1,541,387.34**	**42,579,695.56**
ENGINEERING DURING CONSTRUCTION	**1**	**LS**	**315,900.00**	**0.00**	**0.00**	**0.00**	**0.00**	**315,900.00**	**114,668.44**	**15,415.92**	**445,984.36**
CONSTRUCTION MANAGEMENT (S&A)	**1**	**LS**	**1,895,200.00**	**0.00**	**0.00**	**0.00**	**0.00**	**1,895,200.00**	**687,938.04**	**92,485.76**	**2,675,623.80**
POST-REMEDIAL ACTION	**1**	**LS**	**240,000.00**	**0.00**	**0.00**	**0.00**	**0.00**	**240,000.00**	**13,366.80**	**27,336.00**	**280,702.80**

Description	Quantity	UOM	DirectCost	JOOH	HOOH	Profit	Bond	ContractCost	Contingency	Escalation	ProjectCost
Summary			27,851,659.63	4,787,820.40	2,086,566.40	2,571,797.42	845,362.21	38,143,206.05	10,483,809.82	1,877,012.46	50,504,028.33
PROJ. MANG.& PRE-REMEDIAL ACTION	1	LS	4,106,300.00	0.00	0.00	0.00	0.00	4,106,300.00	215,334.37	200,387.44	4,522,021.81
Project Management	1	LS	947,600.00	0.00	0.00	0.00	0.00	947,600.00	49,692.14	46,242.88	1,043,535.02
Investigations (PRP)	1	LS	315,900.00	0.00	0.00	0.00	0.00	315,900.00	16,565.80	15,415.92	347,881.72
Remedial Design	1	LS	2,526,900.00	0.00	0.00	0.00	0.00	2,526,900.00	132,510.64	123,312.72	2,782,723.36
Remedial Action Contracting	1	LS	315,900.00	0.00	0.00	0.00	0.00	315,900.00	16,565.80	15,415.92	347,881.72
HTRW REMEDIAL ACTION (CONSTRUCT)	1	LS	21,294,259.63	4,787,820.40	2,086,566.40	2,571,797.42	845,362.21	31,585,806.05	9,452,502.17	1,541,387.34	42,579,695.56
Mobilize and Preparatory Work	1	LS	106,779.66	24,008.44	10,463.05	12,896.23	4,239.05	158,386.43	54,999.65	7,729.26	221,115.34
Monitor'g,Samplng,Test &Analysis	1	LS	1,255,120.00	282,202.30	122,985.78	151,586.13	49,827.09	1,861,721.31	550,625.67	90,852.00	2,503,198.98
Site Work	1	LS	330,177.14	74,237.32	32,353.16	39,876.88	13,107.72	489,752.23	144,849.90	23,899.91	658,502.04
Surface Water Collect & Control	1	LS	1,027,668.60	231,061.93	100,698.44	124,115.86	40,797.48	1,524,342.32	553,320.53	74,387.91	2,152,050.75
Solids Collect and Containment	1	LS	389,212.36	87,510.86	38,137.86	47,006.82	15,451.37	577,319.26	170,748.87	28,173.18	776,241.30
Physical Treatmet	1	LS	140,513.28	31,593.13	13,768.51	16,970.38	5,578.25	208,423.55	61,643.68	10,171.07	280,238.30
Disposal (Commercial)	1	LS	17,887,160.92	4,021,765.28	1,752,714.10	2,160,307.76	710,103.57	26,532,051.63	7,847,162.04	1,294,764.12	35,673,977.79
Site Restoration	1	LS	21,619.81	4,861.02	2,118.47	2,611.12	858.29	32,068.70	9,484.69	1,564.95	43,118.34
Demobilization	1	LS	136,007.85	30,580.13	13,327.04	16,426.24	5,399.38	201,740.64	59,667.13	9,844.94	271,252.72
ENGINEERING DURING CONSTRUCTION	1	LS	315,900.00	0.00	0.00	0.00	0.00	315,900.00	114,668.44	15,415.92	445,984.36
Engineering During Construction	1	LS	315,900.00	0.00	0.00	0.00	0.00	315,900.00	114,668.44	15,415.92	445,984.36
CONSTRUCTION MANAGEMENT (S&A)	1	LS	1,895,200.00	0.00	0.00	0.00	0.00	1,895,200.00	687,938.04	92,485.76	2,675,623.80
CONSTRUCTION MANAGEMENT (S&A)	1	LS	1,895,200.00	0.00	0.00	0.00	0.00	1,895,200.00	687,938.04	92,485.76	2,675,623.80
POST-REMEDIAL ACTION	1	LS	240,000.00	0.00	0.00	0.00	0.00	240,000.00	13,366.80	27,336.00	280,702.80
Operation, Maint. & Monitoring	1	LS	240,000.00	0.00	0.00	0.00	0.00	240,000.00	13,366.80	27,336.00	280,702.80

Description	Quantity	UOM	DirectCost	JOOH	HOOH	Profit	Bond	ContractCost	Contingency	Escalation	ProjectCost
Details			**27,851,659.63**	**4,787,820.40**	**2,086,566.40**	**2,571,797.42**	**845,362.21**	**38,143,206.05**	**10,483,809.82**	**1,877,012.46**	**50,504,028.33**
PROJ. MANG.& PRE-REMEDIAL ACTION	**1**	**LS**	**4,106,300.00**	**0.00**	**0.00**	**0.00**	**0.00**	**4,106,300.00**	**215,334.37**	**200,387.44**	**4,522,021.81**
Project Management	**1**	**LS**	**947,600.00**	**0.00**	**0.00**	**0.00**	**0.00**	**947,600.00**	**49,692.14**	**46,242.88**	**1,043,535.02**
Investigations (PRP)	**1**	**LS**	**315,900.00**	**0.00**	**0.00**	**0.00**	**0.00**	**315,900.00**	**16,565.80**	**15,415.92**	**347,881.72**
Remedial Design	**1**	**LS**	**2,526,900.00**	**0.00**	**0.00**	**0.00**	**0.00**	**2,526,900.00**	**132,510.64**	**123,312.72**	**2,782,723.36**
Remedial Action Contracting	**1**	**LS**	**315,900.00**	**0.00**	**0.00**	**0.00**	**0.00**	**315,900.00**	**16,565.80**	**15,415.92**	**347,881.72**
HTRW REMEDIAL ACTION (CONSTRUCT)	**1**	**LS**	**21,294,259.63**	**4,787,820.40**	**2,086,566.40**	**2,571,797.42**	**845,362.21**	**31,585,806.05**	**9,452,502.17**	**1,541,387.34**	**42,579,695.56**
(Note: Account 33XXX includes HTRW remedial action (construction) work for all programs and includes operation which occurs during construction (remedial action). Account 33XXX excludes project management at all phases and excludes pre construction investigations and remedial design which are all in Account 32XXX. Account 33XXX excludes post construction Operation and Maintenance (O&M) which is in Account 34XXX.)											
Mobilize and Preparatory Work	**1**	**LS**	**106,779.66**	**24,008.44**	**10,463.05**	**12,896.23**	**4,239.05**	**158,386.43**	**54,999.65**	**7,729.26**	**221,115.34**
(Note: Assumptions: Assume 1 contracts for the purpose of mobilization. Equipment is assumed to be mobilized from the Middleton IA area. Use 40hrs per each mobilzation event including setup time. Use 8 hrs/pc of const. equip./ea. mob. event for operating time and 32hrs standby. Use full operating time for all other equipment and labor. Const. Equip. - Operating time = 8 hrs/pc x 1 ea = 8 hrs/ea Standby time = 32 hrs/pc x 1 ea = 32 hrs/ea Mobilization crew - (crew to be used for operating time only) Truck w/Lowboy, Truck Driver Mechanics truck, Mechanic Pickup truck, Operator, Laborer Duration = 8hrs x 1-contracts x 8 pc's of equip. = 64 hrs)											
Mob Construction Equip & Fac	**1**	**LS**	**57,056.78**	**12,828.70**	**5,590.84**	**6,890.99**	**2,265.10**	**84,632.40**	**30,720.69**	**4,130.06**	**119,483.15**
Construction Equipment	**1**	**LS**	**57,056.78**	**12,828.70**	**5,590.84**	**6,890.99**	**2,265.10**	**84,632.40**	**30,720.69**	**4,130.06**	**119,483.15**
Submittals/Implementation Plans	**1**	**LS**	**14,432.89**	**3,245.10**	**1,414.24**	**1,743.12**	**572.97**	**21,408.32**	**7,771.00**	**1,044.73**	**30,224.05**
(Note: Submittal/implementation plans is work incurred during remedial action for obtaining all necessary plans and permits. These include QA/QC plans, work plans, shop drawings, demolition plans, environmental control plans, pollution control plans, site safety and health plans, site security plan, materials handling/transportation/disposal plan and all local, state, and federal permits. Assume one of each plan per contract.)											
			2,238.13					*3,319.82*			*4,686.88*
Environmental Protection Plan	**1**	**EA**	**2,238.13**	**503.22**	**219.31**	**270.31**	**88.85**	**3,319.82**	**1,205.06**	**162.01**	**4,686.88**
			1,857.07					*2,754.60*			*3,888.91*
Sedimintation Control Plan	**1**	**EA**	**1,857.07**	**417.55**	**181.97**	**224.29**	**73.72**	**2,754.60**	**999.89**	**134.42**	**3,888.91**
			4,654.84					*6,904.53*			*9,747.74*
Site Safety and Health Plan	**1**	**EA**	**4,654.84**	**1,046.60**	**456.11**	**562.18**	**184.79**	**6,904.53**	**2,506.27**	**336.94**	**9,747.74**

Description	Quantity	UOM	DirectCost	JOOH	HOOH	Profit	Bond	ContractCost	Contingency	Escalation	ProjectCost
			2,476.10					*3,672.80*			*5,185.21*
General Site Work Plan	**1**	**EA**	**2,476.10**	**556.73**	**242.63**	**299.05**	**98.30**	**3,672.80**	**1,333.19**	**179.23**	**5,185.21**
			2,456.75					*3,644.11*			*5,144.71*
Quality Control Plan	**1**	**EA**	**2,456.75**	**552.38**	**240.73**	**296.71**	**97.53**	**3,644.11**	**1,322.77**	**177.83**	**5,144.71**
			750.00					*1,112.48*			*1,570.58*
Permits	**1**	**EA**	**750.00**	**168.63**	**73.49**	**90.58**	**29.77**	**1,112.48**	**403.82**	**54.29**	**1,570.58**
Setup/Construct Temp Facilities	**1**	**LS**	**8,890.00**	**1,998.84**	**871.11**	**1,073.68**	**352.92**	**13,186.55**	**4,786.58**	**643.50**	**18,616.63**
(Note: Setup/construct temporary facilities during remedial action includes procurement, setup, and construction of office trailers, storage areas, fencing, access roads, decontamination facilities, decontamination staging areas and other temporary facilities.)											
			1,500.00					*2,224.95*			*3,141.16*
Office Trailers (contractor)	**1**	**EA**	**1,500.00**	**337.26**	**146.98**	**181.16**	**59.55**	**2,224.95**	**807.63**	**108.58**	**3,141.16**
(Note: Assume one setup/hookup.)											
			5,000.00					*7,416.51*			*10,470.55*
Storage Facilities	**1**	**EA**	**5,000.00**	**1,124.20**	**489.94**	**603.87**	**198.50**	**7,416.51**	**2,692.12**	**361.93**	**10,470.55**
(Note: Assume that a staging area will be set up for a an office trailer, tool trailer and any other equipment or materials to be left onsite This item is considered a one time cost.)											
			100.00					*148.33*			*209.41*
Toilets	**2**	**EA**	**200.00**	**44.97**	**19.60**	**24.15**	**7.94**	**296.66**	**107.68**	**14.48**	**418.82**
(Note: Assume 2 portable toilets to be delivered. (2 ea))											
Barricades	**1**	**LS**	**1,500.00**	**337.26**	**146.98**	**181.16**	**59.55**	**2,224.95**	**807.63**	**108.58**	**3,141.16**
(Note: Assume a lump sum cost per contract.)											
			345.00					*511.74*			*722.47*
Signs	**2**	**EA**	**690.00**	**155.14**	**67.61**	**83.33**	**27.39**	**1,023.48**	**371.51**	**49.95**	**1,444.94**
(Note: Assume two construction signs per contract.)											
Construct Temporary Utilities	**1**	**LS**	**26,400.00**	**5,935.80**	**2,586.86**	**3,188.44**	**1,048.06**	**39,159.16**	**11,721.38**	**1,910.97**	**52,791.51**
(Note: Temporary utilities are power and lighting, telephone, water and sewerservices that will be in place only during construction or remedial action. It is assumed that all utilities are presently in-place on site and only at emp. hookup fee will be charged for each utility .)											
Power Connection/Distributio n	**1**	**LS**	**500.00**	**112.42**	**48.99**	**60.39**	**19.85**	**741.65**	**269.21**	**36.19**	**1,047.05**
Telephone/Communica tion Dist.	**1**	**LS**	**100.00**	**22.48**	**9.80**	**12.08**	**3.97**	**148.33**	**53.84**	**7.24**	**209.41**

Description	Quantity	UOM	DirectCost	JOOH	HOOH	Profit	Bond	ContractCost	Contingency	Escalation	ProjectCost
Water Connection/Distributio n	1	LS	500.00	112.42	48.99	60.39	19.85	741.65	269.21	36.19	1,047.05
Sewer Connection/Distributio n	1	LS	300.00	67.45	29.40	36.23	11.91	444.99	161.53	21.72	628.23
American Ordnance Services	1	LS	25,000.00	5,621.02	2,449.68	3,019.36	992.48	37,082.54	10,967.59	1,809.63	49,859.75
Monitor'g,Samplng,Test &Analysis	1	LS	1,255,120.00	282,202.30	122,985.78	151,586.13	49,827.09	1,861,721.31	550,625.67	90,852.00	2,503,198.98
Environmental Monitoring	1	LS	1,255,120.00	282,202.30	122,985.78	151,586.13	49,827.09	1,861,721.31	550,625.67	90,852.00	2,503,198.98
Site Work	1	LS	330,177.14	74,237.32	32,353.16	39,876.88	13,107.72	489,752.23	144,849.90	23,899.91	658,502.04
(Note: Construction during remedial action. Includes stripping topsoil, excavation, backfill, compaction, fine grading, hauling spoil, importation of borrow material and topsoil. Excludes any work involving contaminated or hazardous materials. Personal protection is not required for any of the site work. Production rates assume normal productivity for these items.)											
Clearing and Grubbing	1	LS	41,470.83	9,324.34	4,063.61	5,008.61	1,646.35	61,513.75	18,193.40	3,001.87	82,709.02
			13.11					*19.44*			*26.14*
Earthwork	22,024	CY	288,706.31	64,912.98	28,289.54	34,868.28	11,461.37	428,238.48	126,656.50	20,898.04	575,793.02
(Note: Assumptions: The quantity of borrow material required takes into consideration 20% over-excavation and a material swell factor of 25% . Compaction of fill material is assumed to be placed in loose lifts not to exceed 8-inches thick and compacted to at least 95% of the Standard Proctor max. dry density. Factors: Over-Excavation = 20% Swell = 25% Volumes - Excavation (including over-excavation) = 16,943 cy , Backfill = 22,024 cy Borrow Required = 17,620 cy *For quantity details reference notes under 08 Solids Collect and Containment)											
			1.04					*1.54*			*2.07*
Backfill	22,024	CY	22,851.19	5,137.88	2,239.13	2,759.83	907.17	33,895.20	10,024.90	1,654.09	45,574.19
			6.40					*9.50*			*12.77*
Borrow	22,024	CY	140,997.65	31,702.04	13,815.97	17,028.88	5,597.47	209,142.01	61,856.18	10,206.13	281,204.32
(Note: For the basis of borrow costs reference government estimates for the North County Feasibility Study completed in 2003 USE $4.00/cy for borrow material FOB quarry)											
			4.24					*6.29*			*8.45*
Hauling	22,024	CY	93,363.93	20,992.03	9,148.48	11,275.96	3,706.46	138,486.86	40,959.09	6,758.16	186,204.11
			1.43					*2.12*			*2.85*
Compaction	22,024	CY	31,493.54	7,081.04	3,085.97	3,803.61	1,250.26	46,714.41	13,816.33	2,279.66	62,810.40
Surface Water Collect & Control	1	LS	1,027,668.60	231,061.93	100,698.44	124,115.86	40,797.48	1,524,342.32	553,320.53	74,387.91	2,152,050.75
Additional Labor & Services	1	LS	1,027,668.60	231,061.93	100,698.44	124,115.86	40,797.48	1,524,342.32	553,320.53	74,387.91	2,152,050.75

Description	Quantity	UOM	DirectCost	JOOH	HOOH	Profit	Bond	ContractCost	Contingency	Escalation	ProjectCost
Water Management	**1**	**LS**	**351,411.80**	**79,011.74**	**34,433.88**	**42,441.48**	**13,950.72**	**521,249.63**	**189,208.24**	**25,436.98**	**735,894.85**
Water Treatment	**1**	**LS**	**676,256.80**	**152,050.18**	**66,264.56**	**81,674.38**	**26,846.76**	**1,003,092.69**	**364,112.29**	**48,950.92**	**1,416,155.90**
Solids Collect and Containment	**1**	**LS**	**389,212.36**	**87,510.86**	**38,137.86**	**47,006.82**	**15,451.37**	**577,319.26**	**170,748.87**	**28,173.18**	**776,241.30**
(Note: Parameters/Assumptions: Beneficial reuse is considered for this estimate, therefore part of the excavated material is assumed to be disposed offsite. Excavated material will be loaded into trucks, hauled to the Treatment Area, treated, and stockpiled for transportation to a disposal facility. Total Excavated Volume (InSitu) = 16,943 cy (incl. over-excavation) Total Excavated Volume (ExSitu) = 22,020 cy. InSitu Volume used for excavation, ExSitu Volume used for, hauling, loading, spreading & compaction of backfill. Production Rate: Due to ineffeciencies assumed for this type of work, production rates are adjusted by an efficiency factor as well as the HTRW productivity factor. Database production rates for excavation are based on BCY's.(InSiti) Assume level of protection to be Level D, Productivity factor = 55%)											
			22.97					*34.07*			*45.81*
Contaminated Soil Collection	**16,943**	**CY**	**389,212.36**	**87,510.86**	**38,137.86**	**47,006.82**	**15,451.37**	**577,319.26**	**170,748.87**	**28,173.18**	**776,241.30**
(Note: Includes the removal during remedial action of solid contaminated soil HTRW waste by front end loader, backhoe, gradall, clamshell, dragline or othe rmechanical means. Assume bulk excavation to be acomplished using scrapers and dozers (Firing Site 12). All other material will be loaded directly into trucks and hauled to the soil staging area for the Physical Treatment Process. PPE is not considered for hauling.)											
			7.87					*11.67*			*15.69*
Excavation	**16,943**	**CY**	**133,300.60**	**29,971.43**	**13,061.76**	**16,099.28**	**5,291.91**	**197,724.98**	**58,479.46**	**9,648.98**	**265,853.41**
(Note: Production rates: Excavation by Hydraulic Excavator = 162.5 cy/hr x .75 x .55 = 67 cy/hr Excavation by Scraper = 112.5 cy/hr x .75 x .55 = 46 cy/hr Excavation by Dozer = 115 cy/hr x .75 x .55 = 47 cy/hr USE 47 cy/hr for scapers & dozers)											
			2.12					*3.14*			*4.23*
Hauling	**16,943**	**CY**	**35,912.30**	**8,074.55**	**3,518.95**	**4,337.28**	**1,425.68**	**53,268.77**	**15,754.86**	**2,599.52**	**71,623.14**
			7.96					*11.81*			*15.87*
Stockpiling	**16,943**	**CY**	**134,859.45**	**30,321.92**	**13,214.51**	**16,287.54**	**5,353.79**	**200,037.22**	**59,163.33**	**9,761.82**	**268,962.37**
(Note: Costs for Soil Staging of Excavated Soils)											
			90.00					*133.50*			*179.50*
Excavation Confirmation Sampling	**946**	**EA**	**85,140.00**	**19,142.95**	**8,342.64**	**10,282.72**	**3,379.98**	**126,288.28**	**37,351.23**	**6,162.87**	**169,802.38**
Physical Treatmet	**1**	**LS**	**140,513.28**	**31,593.13**	**13,768.51**	**16,970.38**	**5,578.25**	**208,423.55**	**61,643.68**	**10,171.07**	**280,238.30**
High Pressure Water Washing	**1**	**LS**	**7,444.25**	**1,673.77**	**729.44**	**899.07**	**295.53**	**11,042.06**	**3,265.82**	**538.85**	**14,846.73**
Remove and Replace Air Filters and Floor Grate	**1**	**LS**	**935.63**	**210.37**	**91.68**	**113.00**	**37.14**	**1,387.82**	**410.46**	**67.73**	**1,866.01**
Soil Staging of Excavated Soils	**1**	**LS**	**132,133.40**	**29,708.99**	**12,947.39**	**15,958.31**	**5,245.57**	**195,993.66**	**57,967.40**	**9,564.49**	**263,525.55**
Disposal (Commercial)	**1**	**LS**	**17,887,160.92**	**4,021,765.28**	**1,752,714.10**	**2,160,307.76**	**710,103.57**	**26,532,051.63**	**7,847,162.04**	**1,294,764.12**	**35,673,977.79**

Description	Quantity	UOM	DirectCost	JOOH	HOOH	Profit	Bond	ContractCost	Contingency	Escalation	ProjectCost
(Note: Parameters/Assumptions: As sufficient quantities of contaminated material is stockpiled at the treatment site it will be loaded into the trucks and shipped to Energy Solutions Landfill. Truck availability is considered to be unconstrained, all trucks are available as required. Reference 08 Solids Collect. and Containment notes for quantities. Assumptions: Truck Capacity = 20 lcy, Truck liner = $100/ea, Absorbent Material = $20 /truck, Loading = $5.73/cy, Transportation = $150 /cy, Commercial Disposal Fees - Energy Solutions = $650/cy Assume level of protection to be Level C. Disposal Quantities = 22,024 lcy)											
			162.13					*240.49*			*323.35*
Transport to Storage/Disp Facil	**22,024**	**CY**	**3,570,760.92**	**802,853.08**	**349,889.12**	**431,255.84**	**141,755.87**	**5,296,514.83**	**1,566,505.70**	**258,469.92**	**7,121,490.46**
(Note: Transport to storage/disposal facility during remedial action includesequipment, materials, and labor for hauling, loading and unloading of solid wastes.)											
			12.13					*17.99*			*24.19*
Loading of Solids	**22,024**	**CY**	**267,160.92**	**60,068.70**	**26,178.37**	**32,266.15**	**10,606.04**	**396,280.18**	**117,204.46**	**19,338.47**	**532,823.12**
(Note: Assume F.E.Loader to load material into trucks from stockpile pad. The trucks have a capacity of approximately 18 cy's. Assume the trucks will be lined at a cost of $100 per truck ExSitu Quantity to be used for loading into trucks. Total ExSitu Quant. = 17,620 cy Production Rate: Assume that 3 trucks can be loaded in an hour. (site wide average) 3 ea/hr @ 20 cy/ea = 60 cy/hr 22,024 cy / 60 cy/hr = 367 hrs 22,024 cy / 20 cy/truck = 1102 loads Use two F.E.Loaders, one to move the material around and one to load the cars, six laborers (working foreman), four to line the gondolas and two to close up after loading and a Health Physicist Technician for 1/2hr per rail car for inspection.)											
			150.00					*222.50*			*299.16*
Transportation Costs	**22,024**	**CY**	**3,303,600.00**	**742,784.38**	**323,710.75**	**398,989.69**	**131,149.83**	**4,900,234.65**	**1,449,301.24**	**239,131.45**	**6,588,667.34**
			650.00					*964.15*			*1,296.35*
Disposal Fees and Taxes	**22,024**	**CY**	**14,315,600.00**	**3,218,732.32**	**1,402,746.59**	**1,728,955.30**	**568,315.94**	**21,234,350.15**	**6,280,305.38**	**1,036,236.29**	**28,550,891.82**
(Note: Provides for all fees and taxes charged during remedial action for the disposal of wastes. These include fees and taxes charged at third party/commercial facilities.)											
			650.00					*964.15*			*1,296.35*
Landfill/Burial Grounds	**22,024**	**CY**	**14,315,600.00**	**3,218,732.32**	**1,402,746.59**	**1,728,955.30**	**568,315.94**	**21,234,350.15**	**6,280,305.38**	**1,036,236.29**	**28,550,891.82**
Transportation and Disposal of Building Decon	**1**	**LS**	**800.00**	**179.87**	**78.39**	**96.62**	**31.76**	**1,186.64**	**350.96**	**57.91**	**1,595.51**
(Note: Material Costs for building decon is based on historical costs and only considers transportation and disposal of floor grate and air filters.)											
Site Restoration	**1**	**LS**	**21,619.81**	**4,861.02**	**2,118.47**	**2,611.12**	**858.29**	**32,068.70**	**9,484.69**	**1,564.95**	**43,118.34**
(Note: Middleton Iowa Areas - Firing Site 12 = 338,000 SF, Firing Site 6 = 27 SF, Firing Site 1 & 2 = 27 SF, Firing Sites 3, 4, & 5 = 27 sf Total Middleton Iowa = 338,081 SF / 43,560 sf/acre = 8 acres)											
Earthwork	**1**	**LS**	**5,711.67**	**1,284.22**	**559.67**	**689.82**	**226.75**	**8,472.14**	**2,505.73**	**413.44**	**11,391.31**
			713.96					*1,059.02*			*1,423.91*
Grading	**8**	**ACR**	**5,711.67**	**1,284.22**	**559.67**	**689.82**	**226.75**	**8,472.14**	**2,505.73**	**413.44**	**11,391.31**
Revegetation And Planting	**1**	**LS**	**12,719.89**	**2,859.95**	**1,246.39**	**1,536.23**	**504.97**	**18,867.42**	**5,580.26**	**920.73**	**25,368.41**
(Note: Revegetation and planting provides for the complete restoration of areas affected by remedial action construction. This includes fine grading and leveling of topsoil (refer. earthwork), seeding, mulching, fertilizer, sodding, erosion control, shrubs, and trees.)											

Description	Quantity	UOM	DirectCost	JOOH	HOOH	Profit	Bond	ContractCost	Contingency	Escalation	ProjectCost
			1,089.99					*1,616.78*			*2,173.86*
Seeding/Mulch/Fertilizer	**8**	**ACR**	**8,719.89**	**1,960.59**	**854.44**	**1,053.14**	**346.17**	**12,934.22**	**3,825.45**	**631.19**	**17,390.85**
			500.00					*741.65*			*997.20*
Miscelaneous Landscaping	**8**	**ACR**	**4,000.00**	**899.36**	**391.95**	**483.10**	**158.80**	**5,933.21**	**1,754.81**	**289.54**	**7,977.56**
Site Cleanup	**1**	**LS**	**3,188.25**	**716.85**	**312.41**	**385.06**	**126.57**	**4,729.14**	**1,398.70**	**230.78**	**6,358.62**
Demobilization	**1**	**LS**	**136,007.85**	**30,580.13**	**13,327.04**	**16,426.24**	**5,399.38**	**201,740.64**	**59,667.13**	**9,844.94**	**271,252.72**
(Note: The same assumptions and durations considered for Mobilization and Prepatory Work will be used for Demobilzation unless specified otherwise. Time for decon of equipment is considered part of demob. time. Reference notes under 01 Mobilize and Preporatory work for general assumptions.)											
Removal Of Temporary Facilities	**1**	**LS**	**22,650.00**	**5,092.65**	**2,219.41**	**2,735.54**	**899.18**	**33,596.78**	**9,936.64**	**1,639.52**	**45,172.94**
(Note: Removal during remedial action of temporary facilities includesdemobilization and dismantling of office trailers, storage and decontamination facilities, and other temporary facilities.)											
			750.00					*1,112.48*			*1,495.79*
Office Trailers (contr.'s only)	**1**	**EA**	**750.00**	**168.63**	**73.49**	**90.58**	**29.77**	**1,112.48**	**329.03**	**54.29**	**1,495.79**
			5,000.00					*7,416.51*			*9,971.95*
Storage Facilities	**1**	**EA**	**5,000.00**	**1,124.20**	**489.94**	**603.87**	**198.50**	**7,416.51**	**2,193.52**	**361.93**	**9,971.95**
(Note: Assume the staging areas to be removed after the completion of the last contract.)											
Decon. Fac. for Const. Equip.	**1**	**LS**	**15,000.00**	**3,372.61**	**1,469.81**	**1,811.61**	**595.49**	**22,249.52**	**6,580.55**	**1,085.78**	**29,915.85**
(Note: Assume the decon. facility to be removed after the completion of the last contract. Assume 25% of the original estimated cost for removal.)											
			100.00					*148.33*			*199.44*
Toilets	**2**	**EA**	**200.00**	**44.97**	**19.60**	**24.15**	**7.94**	**296.66**	**87.74**	**14.48**	**398.88**
(Note: Assume 2 portable toilets to be removed per each contract. (2 ea))											
Barricades	**1**	**LS**	**1,500.00**	**337.26**	**146.98**	**181.16**	**59.55**	**2,224.95**	**658.06**	**108.58**	**2,991.59**
(Note: Assume a lump sum cost per contract for removal.)											
			100.00					*148.33*			*199.44*
Signs	**2**	**EA**	**200.00**	**44.97**	**19.60**	**24.15**	**7.94**	**296.66**	**87.74**	**14.48**	**398.88**
(Note: Assume a cost per contract for removal.)											
Removal Of Temporary Utilities	**1**	**LS**	**1,354.85**	**304.63**	**132.76**	**163.63**	**53.79**	**2,009.66**	**594.38**	**98.07**	**2,702.11**
(Note: Provides for the dismantling and disconnection of project utilities during remedial action including site power and lighting, telephone/communication service, water, sewer and gas service.)											

Description	Quantity	UOM	DirectCost	JOOH	HOOH	Profit	Bond	ContractCost	Contingency	Escalation	ProjectCost
Power Connection/Distributio n	1	LS	500.00	112.42	48.99	60.39	19.85	741.65	219.35	36.19	997.20
Telephone/Communica tion Dist.	1	LS	54.85	12.33	5.37	6.62	2.18	81.36	24.06	3.97	109.40
Water Connection/Distributio n	1	LS	500.00	112.42	48.99	60.39	19.85	741.65	219.35	36.19	997.20
Sewer Connection/Distributio n	1	LS	300.00	67.45	29.40	36.23	11.91	444.99	131.61	21.72	598.32
Demob of Construction Equip/Facl	1	LS	72,003.00	16,189.22	7,055.38	8,696.11	2,858.45	106,802.15	31,587.97	5,211.94	143,602.07
(Note: Work associated with demobilization of remedial action construction equipment and temporary facilities. Includes transportation, manifests, tolls, permits, escort vehicles, drivers, and equipment operators.)											
Demob. of Construction Equipment	1	LS	57,056.78	12,828.70	5,590.84	6,890.99	2,265.10	84,632.40	25,031.01	4,130.06	113,793.48
Decon. of Construction Equipment	1	LS	14,946.22	3,360.52	1,464.54	1,805.12	593.35	22,169.75	6,556.96	1,081.88	29,808.59
(Note: It is assumed that all equipment will be mobed., decontaminated, and demobed for each contract. Decontaminate 8 pc.'s/contract x 1 contract = 8 pc's of equipment . Decontamination of construction equipment is assumed to be spread over the year duration considered for this study. Use 2 days/pc. of equip. Decon. Crew and Equipment - Mechanics Truck, Operator/Mechanic Compressor, Laborers -2ea Power Washer, Misc. Small Tools)											
Submittals	1	LS	40,000.00	8,993.64	3,919.49	4,830.97	1,587.96	59,332.06	17,548.14	2,895.40	79,775.61
(Note: Submittals are incurred for obtaining all necessary site clean closure documentation. These include all final reports, punch lists, projectacceptance, final QA/QC reports and As-Built Drawings during remedial action . Assume 500 hrs for a construction completion report.)											
			40,000.00					*59,332.06*			*79,775.61*
Project Acceptance	1	EA	40,000.00	8,993.64	3,919.49	4,830.97	1,587.96	59,332.06	17,548.14	2,895.40	79,775.61
(Note: Assume the Construction Completion Report takes 500 hrs to complete at $80 per hour)											
ENGINEERING DURING CONSTRUCTION	1	LS	315,900.00	0.00	0.00	0.00	0.00	315,900.00	114,668.44	15,415.92	445,984.36
Engineering During Construction	1	LS	315,900.00	0.00	0.00	0.00	0.00	315,900.00	114,668.44	15,415.92	445,984.36
CONSTRUCTION MANAGEMENT (S&A)	1	LS	1,895,200.00	0.00	0.00	0.00	0.00	1,895,200.00	687,938.04	92,485.76	2,675,623.80
CONSTRUCTION MANAGEMENT (S&A)	1	LS	1,895,200.00	0.00	0.00	0.00	0.00	1,895,200.00	687,938.04	92,485.76	2,675,623.80

Description	Quantity	UOM	DirectCost	JOOH	HOOH	Profit	Bond	ContractCost	Contingency	Escalation	ProjectCost
POST-REMEDIAL ACTION	**1**	**LS**	**240,000.00**	**0.00**	**0.00**	**0.00**	**0.00**	**240,000.00**	**13,366.80**	**27,336.00**	**280,702.80**
(Note: (Post Remedial Action))											
Operation, Maint. & Monitoring	**1**	**LS**	**240,000.00**	**0.00**	**0.00**	**0.00**	**0.00**	**240,000.00**	**13,366.80**	**27,336.00**	**280,702.80**
Five Year Review	**1**	**LS**	**240,000.00**	**0.00**	**0.00**	**0.00**	**0.00**	**240,000.00**	**13,366.80**	**27,336.00**	**280,702.80**
(Note: The review consists of land use assessment, monitoring, testing andanalysis, evaluation and risk assessment.)											

Middletown Iowa Feasibility version 4
Formerly Utilized Sites Remedial Action Program (FUSRAP) Middletown Iowa Feasibiltiy Study, Alternative 4 for Soils and Alternative S3 for Structures

Estimated by	St. Louis District
Designed by	
Prepared by	Gregory Dyn
Preparation Date	2/15/2011
Effective Date of Pricing	2/15/2011
Estimated Construction Time	675 Days

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Date	Author	Note

Paige Scott

PROJECT BREAKDOWN:

This estimate is structured for remedial action construction as follows using a 5 digit number at Level 1 and a 2 digit number at all remaining levels. The numbers for the first 3 title levels are taken from the Standard Interagency HTRW Remedial Action Work Breakdown Structure (RA-WBS). The 2 digit numbers for the remaining title levels are user defined. The detail items are at Level 5.

Level 1 - WBS Level 1 (Account)
Level 2 - WBS Level 2 (System)
Level 3 - WBS Level 3 (Subsystem)
Level 4 - WBS Level 4 (Assembly Category or Other)
Level 5 - Detail
Level 6 - Not Used

PROJECT DESCRIPTION:

The Middletown Iowa site is part of the Formerly Utilized Sites Remedial Action Program (FUSRAP), which is comprised of multiple properties. The Middletown Iowa Site is located in Des Moines County. Specific sites include Firing Sites 1, 2, 3, 4, 5, 6, and 12 and Building FS12.
This estimate only considers Alternative 6 for Soils, Excavation of DU-Contaminated Soil and Physical Treatment of DU with Off-Site Disposal, and Alternative 3 for Structures, Decontamination/Replacement of Structures, of the Proposed Plan.

PRODUCTIVITY:

Production rates, as a baseline and as taken from the Unit Price Book (UPB) Database, assumes a non-contaminated working environment with no level of protection productivity reduction factors. When required, productivity for appropriate activities will be adjusted for this project as follows:

1. Level of Protection B - Productivity 48%
2. Level of Protection C - Productivity 55%
3. Level of Protection D Modified - Productivity 82%
4. Level of Protection D - Productivity 96%

Notes in the estimate detail will show when each level applies.

The following daily time breakdown was assumed as taken from the Corps of Engineers "Productivity Study for HTRW Remedial Action Projects".

Example: Light Work with ave. temperature >70 but <85 degrees.

	Level B	Level C	Level D Mod	Level D	Normal
Paid Time (minutes)	480	480	480	480	480
- Non-Productive Time (minutes):					
Standard Losses	140	128	76	32	20
Scheduled/Heat Stress Breaks	65	63	47	33	30
Dexterity Losses	69	51	4	5	0
Productive Time (minutes)	206	238	353	410	430

Date	Author	Note

Paige Scott

Productivity: 206/430 238/430 353/430 410/430 430/430 X100% X100% X100% X100% X100%
48% 55% 82% 96% 100%

Example:

Normal Production Rate (CY/HR)	250	250	250	250	250
X Productivity	.48	.55	.82	.96	1.00
=Reduced Production Rate(CY/HR)	120	138	205	240	250

ESCALATION:

Escalation determinations were made using the Composite Civil Works Construction Index from EM 1110-2-1304, Civil Works Construction Cost Index System (CWCCIS) Dated 30 September 2010. Index projections are based on the current annual Office of Management and Budget (OMB) inflation factors.

For this estimate, the effective date of pricing is October 2010. The anticipated project duration is 675 calendar days. The midpoint of remedial action is October 2013. Post remedial action is anticipated to begin immediatly following the completion of the remedial action. The midpoint of post remedial action is April 2017.

Remedial Action Escalation Calculation:
Remedial Action Midpoint (October 2013) Index = 760.77
Effective Date of Pricing (October 2010) Index = 725.38

Escalation % = (761/725)-1 X 100% = 4.88%

Post Remedial Action Escalation Calculation:
Post Remedial Action Midpoint (April 2017) Index = 807.97
Effective Date of Pricing (October 2010) Index = 725.38

Escalation % = (808/725)-1 X 100% = 11.39%

CONTINGENCY:

Contingencies are shown for both Design Contingencies and Construction Contingencies. Contingency rates are variable and are applied at Level 2 of the estimate (HTRW RA-WBS Level 2, System). Design contingencies are based on the EI01D010 reasonable guide table for remedial action projects. Construction contingencies are based on the consensus of a CEMVS PM/ED group analysis.

Description	Quantity	UOM	DirectCost	JOOH	HOOH	Profit	Bond	ContractCost	Contingency	Escalation	ProjectCost
Bid Items			**24,468,993.61**	**4,787,820.40**	**1,868,721.12**	**2,303,292.22**	**757,103.25**	**34,185,930.60**	**9,405,166.55**	**1,683,897.41**	**45,274,994.56**
PROJ. MANG.& PRE-REMEDIAL ACTION	**1**	**LS**	**3,677,600.00**	**0.00**	**0.00**	**0.00**	**0.00**	**3,677,600.00**	**192,853.34**	**179,466.88**	**4,049,920.22**
HTRW REMEDIAL ACTION (CONSTRUCT)	**1**	**LS**	**18,571,193.61**	**4,787,820.40**	**1,868,721.12**	**2,303,292.22**	**757,103.25**	**28,288,130.60**	**8,480,154.24**	**1,380,460.77**	**38,148,745.61**
ENGINEERING DURING CONSTRUCTION	**1**	**LS**	**282,900.00**	**0.00**	**0.00**	**0.00**	**0.00**	**282,900.00**	**102,689.78**	**13,805.52**	**399,395.30**
CONSTRUCTION MANAGEMENT (S&A)	**1**	**LS**	**1,697,300.00**	**0.00**	**0.00**	**0.00**	**0.00**	**1,697,300.00**	**616,102.38**	**82,828.24**	**2,396,230.62**
POST-REMEDIAL ACTION	**1**	**LS**	**240,000.00**	**0.00**	**0.00**	**0.00**	**0.00**	**240,000.00**	**13,366.80**	**27,336.00**	**280,702.80**

Description	Quantity	UOM	DirectCost	JOOH	HOOH	Profit	Bond	ContractCost	Contingency	Escalation	ProjectCost
Summary			**24,468,993.61**	**4,787,820.40**	**1,868,721.12**	**2,303,292.22**	**757,103.25**	**34,185,930.60**	**9,405,166.55**	**1,683,897.41**	**45,274,994.56**
PROJ. MANG.& PRE-REMEDIAL ACTION	**1**	**LS**	**3,677,600.00**	**0.00**	**0.00**	**0.00**	**0.00**	**3,677,600.00**	**192,853.34**	**179,466.88**	**4,049,920.22**
Project Management	**1**	**LS**	**848,700.00**	**0.00**	**0.00**	**0.00**	**0.00**	**848,700.00**	**44,505.83**	**41,416.56**	**934,622.39**
Investigations (PRP)	**1**	**LS**	**282,900.00**	**0.00**	**0.00**	**0.00**	**0.00**	**282,900.00**	**14,835.28**	**13,805.52**	**311,540.80**
Remedial Design	**1**	**LS**	**2,263,100.00**	**0.00**	**0.00**	**0.00**	**0.00**	**2,263,100.00**	**118,676.96**	**110,439.28**	**2,492,216.24**
Remedial Action Contracting	**1**	**LS**	**282,900.00**	**0.00**	**0.00**	**0.00**	**0.00**	**282,900.00**	**14,835.28**	**13,805.52**	**311,540.80**
HTRW REMEDIAL ACTION (CONSTRUCT)	**1**	**LS**	**18,571,193.61**	**4,787,820.40**	**1,868,721.12**	**2,303,292.22**	**757,103.25**	**28,288,130.60**	**8,480,154.24**	**1,380,460.77**	**38,148,745.61**
Mobilize and Preparatory Work	**1**	**LS**	**106,779.66**	**27,528.76**	**10,744.67**	**13,243.35**	**4,353.15**	**162,649.59**	**56,480.03**	**7,937.30**	**227,066.93**
Monitor'g,Samplng,Test &Analysis	**1**	**LS**	**1,255,120.00**	**323,581.20**	**126,296.10**	**155,666.25**	**51,168.25**	**1,911,831.80**	**565,446.43**	**93,297.39**	**2,570,575.62**
Site Work	**1**	**LS**	**301,982.73**	**77,853.86**	**30,386.93**	**37,453.41**	**12,311.12**	**459,988.04**	**136,046.80**	**22,447.42**	**618,482.26**
Surface Water Collect & Control	**1**	**LS**	**1,027,668.60**	**264,942.19**	**103,408.86**	**127,456.59**	**41,895.60**	**1,565,371.84**	**568,213.82**	**76,390.15**	**2,209,975.81**
Solids Collect and Containment	**1**	**LS**	**389,212.36**	**100,342.44**	**39,164.38**	**48,272.06**	**15,867.26**	**592,858.51**	**175,344.78**	**28,931.50**	**797,134.78**
Physical Treatmet	**1**	**LS**	**1,022,213.28**	**263,535.76**	**102,859.92**	**126,780.00**	**41,673.20**	**1,557,062.15**	**460,519.19**	**75,984.63**	**2,093,565.98**
Disposal (Commercial)	**1**	**LS**	**14,310,589.31**	**3,689,398.37**	**1,439,999.01**	**1,774,870.79**	**583,408.58**	**21,798,266.06**	**6,447,090.05**	**1,063,755.38**	**29,309,111.49**
Site Restoration	**1**	**LS**	**21,619.81**	**5,573.78**	**2,175.49**	**2,681.40**	**881.39**	**32,931.86**	**9,739.98**	**1,607.07**	**44,278.92**
Demobilization	**1**	**LS**	**136,007.85**	**35,064.04**	**13,685.75**	**16,868.37**	**5,544.72**	**207,170.74**	**61,273.15**	**10,109.93**	**278,553.81**
ENGINEERING DURING CONSTRUCTION	**1**	**LS**	**282,900.00**	**0.00**	**0.00**	**0.00**	**0.00**	**282,900.00**	**102,689.78**	**13,805.52**	**399,395.30**
Engineering During Construction	**1**	**LS**	**282,900.00**	**0.00**	**0.00**	**0.00**	**0.00**	**282,900.00**	**102,689.78**	**13,805.52**	**399,395.30**
CONSTRUCTION MANAGEMENT (S&A)	**1**	**LS**	**1,697,300.00**	**0.00**	**0.00**	**0.00**	**0.00**	**1,697,300.00**	**616,102.38**	**82,828.24**	**2,396,230.62**
CONSTRUCTION MANAGEMENT (S&A)	**1**	**LS**	**1,697,300.00**	**0.00**	**0.00**	**0.00**	**0.00**	**1,697,300.00**	**616,102.38**	**82,828.24**	**2,396,230.62**
POST-REMEDIAL ACTION	**1**	**LS**	**240,000.00**	**0.00**	**0.00**	**0.00**	**0.00**	**240,000.00**	**13,366.80**	**27,336.00**	**280,702.80**
Operation, Maint. & Monitoring	**1**	**LS**	**240,000.00**	**0.00**	**0.00**	**0.00**	**0.00**	**240,000.00**	**13,366.80**	**27,336.00**	**280,702.80**

Description	Quantity	UOM	DirectCost	JOOH	HOOH	Profit	Bond	ContractCost	Contingency	Escalation	ProjectCost
Details			**24,468,993.61**	**4,787,820.40**	**1,868,721.12**	**2,303,292.22**	**757,103.25**	**34,185,930.60**	**9,405,166.55**	**1,683,897.41**	**45,274,994.56**
PROJ. MANG.& PRE-REMEDIAL ACTION	**1**	**LS**	**3,677,600.00**	**0.00**	**0.00**	**0.00**	**0.00**	**3,677,600.00**	**192,853.34**	**179,466.88**	**4,049,920.22**
Project Management	**1**	**LS**	**848,700.00**	**0.00**	**0.00**	**0.00**	**0.00**	**848,700.00**	**44,505.83**	**41,416.56**	**934,622.39**
Investigations (PRP)	**1**	**LS**	**282,900.00**	**0.00**	**0.00**	**0.00**	**0.00**	**282,900.00**	**14,835.28**	**13,805.52**	**311,540.80**
Remedial Design	**1**	**LS**	**2,263,100.00**	**0.00**	**0.00**	**0.00**	**0.00**	**2,263,100.00**	**118,676.96**	**110,439.28**	**2,492,216.24**
Remedial Action Contracting	**1**	**LS**	**282,900.00**	**0.00**	**0.00**	**0.00**	**0.00**	**282,900.00**	**14,835.28**	**13,805.52**	**311,540.80**
HTRW REMEDIAL ACTION (CONSTRUCT)	**1**	**LS**	**18,571,193.61**	**4,787,820.40**	**1,868,721.12**	**2,303,292.22**	**757,103.25**	**28,288,130.60**	**8,480,154.24**	**1,380,460.77**	**38,148,745.61**
(Note: Account 33XXX includes HTRW remedial action (construction) work for all programs and includes operation which occurs during construction (remedial action). Account 33XXX excludes project management at all phases and excludes pre construction investigations and remedial design which are all in Account 32XXX. Account 33XXX excludes post construction Operation and Maintenance (O&M) which is in Account 34XXX.)											
Mobilize and Preparatory Work	**1**	**LS**	**106,779.66**	**27,528.76**	**10,744.67**	**13,243.35**	**4,353.15**	**162,649.59**	**56,480.03**	**7,937.30**	**227,066.93**
(Note: Assumptions: Assume 1 contracts for the purpose of mobilization. Equipment is assumed to be mobilized from the Middleton IA area. Use 40hrs per each mobilzation event including setup time. Use 8 hrs/pc of const. equip./ea. mob. event for operating time and 32hrs standby. Use full operating time for all other equipment and labor. Const. Equip. - Operating time = 8 hrs/pc x 1 ea = 8 hrs/ea Standby time = 32 hrs/pc x 1 ea = 32 hrs/ea Mobilization crew - (crew to be used for operating time only) Truck w/Lowboy, Truck Driver Mechanics truck, Mechanic Pickup truck, Operator, Laborer Duration = 8hrs x 1-contracts x 8 pc's of equip. = 64 hrs)											
Mob Construction Equip & Fac	**1**	**LS**	**57,056.78**	**14,709.75**	**5,741.32**	**7,076.47**	**2,326.07**	**86,910.39**	**31,547.57**	**4,241.23**	**122,699.18**
Construction Equipment	**1**	**LS**	**57,056.78**	**14,709.75**	**5,741.32**	**7,076.47**	**2,326.07**	**86,910.39**	**31,547.57**	**4,241.23**	**122,699.18**
Submittals/Implementation Plans	**1**	**LS**	**14,432.89**	**3,720.93**	**1,452.31**	**1,790.04**	**588.39**	**21,984.55**	**7,980.17**	**1,072.85**	**31,037.56**
(Note: Submittal/implementation plans is work incurred during remedial action for obtaining all necessary plans and permits. These include QA/QC plans, work plans, shop drawings, demolition plans, environmental control plans, pollution control plans, site safety and health plans, site security plan, materials handling/transportation/disposal plan and all local, state, and federal permits. Assume one of each plan per contract.)											
			2,238.13					*3,409.17*			*4,813.04*
Environmental Protection Plan	**1**	**EA**	**2,238.13**	**577.01**	**225.21**	**277.58**	**91.24**	**3,409.17**	**1,237.50**	**166.37**	**4,813.04**
			1,857.07					*2,828.74*			*3,993.59*
Sedimintation Control Plan	**1**	**EA**	**1,857.07**	**478.77**	**186.87**	**230.32**	**75.71**	**2,828.74**	**1,026.80**	**138.04**	**3,993.59**
			4,654.84					*7,090.37*			*10,010.11*
Site Safety and Health Plan	**1**	**EA**	**4,654.84**	**1,200.06**	**468.39**	**577.32**	**189.77**	**7,090.37**	**2,573.73**	**346.01**	**10,010.11**

Description	Quantity	UOM	DirectCost	JOOH	HOOH	Profit	Bond	ContractCost	Contingency	Escalation	ProjectCost
			2,476.10					*3,771.65*			*5,324.78*
General Site Work Plan	**1**	**EA**	**2,476.10**	**638.36**	**249.16**	**307.10**	**100.94**	**3,771.65**	**1,369.07**	**184.06**	**5,324.78**
			2,456.75					*3,742.19*			*5,283.19*
Quality Control Plan	**1**	**EA**	**2,456.75**	**633.37**	**247.21**	**304.70**	**100.16**	**3,742.19**	**1,358.38**	**182.62**	**5,283.19**
			750.00					*1,142.42*			*1,612.86*
Permits	**1**	**EA**	**750.00**	**193.36**	**75.47**	**93.02**	**30.58**	**1,142.42**	**414.69**	**55.75**	**1,612.86**
Setup/Construct Temp Facilities	**1**	**LS**	**8,890.00**	**2,291.92**	**894.55**	**1,102.58**	**362.42**	**13,541.48**	**4,915.42**	**660.82**	**19,117.72**
(Note: Setup/construct temporary facilities during remedial action includes procurement, setup, and construction of office trailers, storage areas, fencing, access roads, decontamination facilities, decontamination staging areas and other temporary facilities.)											
			1,500.00					*2,284.84*			*3,225.71*
Office Trailers (contractor)	**1**	**EA**	**1,500.00**	**386.71**	**150.94**	**186.04**	**61.15**	**2,284.84**	**829.37**	**111.50**	**3,225.71**
(Note: Assume one setup/hookup.)											
			5,000.00					*7,616.13*			*10,752.38*
Storage Facilities	**1**	**EA**	**5,000.00**	**1,289.04**	**503.12**	**620.12**	**203.84**	**7,616.13**	**2,764.58**	**371.67**	**10,752.38**
(Note: Assume that a staging area will be set up for a an office trailer, tool trailer and any other equipment or materials to be left onsite This item is considered a one time cost.)											
			100.00					*152.32*			*215.05*
Toilets	**2**	**EA**	**200.00**	**51.56**	**20.12**	**24.80**	**8.15**	**304.65**	**110.58**	**14.87**	**430.10**
(Note: Assume 2 portable toilets to be delivered. (2 ea))											
Barricades	**1**	**LS**	**1,500.00**	**386.71**	**150.94**	**186.04**	**61.15**	**2,284.84**	**829.37**	**111.50**	**3,225.71**
(Note: Assume a lump sum cost per contract.)											
			345.00					*525.51*			*741.91*
Signs	**2**	**EA**	**690.00**	**177.89**	**69.43**	**85.58**	**28.13**	**1,051.03**	**381.51**	**51.29**	**1,483.83**
(Note: Assume two construction signs per contract.)											
Construct Temporary Utilities	**1**	**LS**	**26,400.00**	**6,806.16**	**2,656.49**	**3,274.26**	**1,076.27**	**40,213.17**	**12,036.88**	**1,962.40**	**54,212.46**
(Note: Temporary utilities are power and lighting, telephone, water and sewerservices that will be in place only during construction or remedial action. It is assumed that all utilities are presently in-place on site and only at emp. hookup fee will be charged for each utility .)											
Power Connection/Distribution	**1**	**LS**	**500.00**	**128.90**	**50.31**	**62.01**	**20.38**	**761.61**	**276.46**	**37.17**	**1,075.24**
Telephone/Communication Dist.	**1**	**LS**	**100.00**	**25.78**	**10.06**	**12.40**	**4.08**	**152.32**	**55.29**	**7.43**	**215.05**
Water Connection/Distribution	**1**	**LS**	**500.00**	**128.90**	**50.31**	**62.01**	**20.38**	**761.61**	**276.46**	**37.17**	**1,075.24**

Description	Quantity	UOM	DirectCost	JOOH	HOOH	Profit	Bond	ContractCost	Contingency	Escalation	ProjectCost
Sewer Connection/Distribution	1	LS	300.00	77.34	30.19	37.21	12.23	456.97	165.87	22.30	645.14
American Ordnance Services	1	LS	25,000.00	6,445.22	2,515.62	3,100.62	1,019.19	38,080.66	11,262.80	1,858.34	51,201.79
Monitor'g,Samplng,Test &Analysis	1	LS	1,255,120.00	323,581.20	126,296.10	155,666.25	51,168.25	1,911,831.80	565,446.43	93,297.39	2,570,575.62
Environmental Monitoring	1	LS	1,255,120.00	323,581.20	126,296.10	155,666.25	51,168.25	1,911,831.80	565,446.43	93,297.39	2,570,575.62
Site Work	1	LS	301,982.73	77,853.86	30,386.93	37,453.41	12,311.12	459,988.04	136,046.80	22,447.42	618,482.26
(Note: Construction during remedial action. Includes stripping topsoil, excavation, backfill, compaction, fine grading, hauling spoil, importation of borrow material and topsoil. Excludes any work involving contaminated or hazardous materials. Personal protection is not required for any of the site work. Production rates assume normal productivity for these items.)											
Clearing and Grubbing	1	LS	41,470.83	10,691.55	4,172.99	5,143.42	1,690.67	63,169.46	18,683.10	3,082.67	84,935.23
			11.83					*18.02*			*24.23*
Earthwork	22,024	CY	260,511.90	67,162.31	26,213.94	32,309.99	10,620.45	396,818.58	117,363.70	19,364.75	533,547.02
(Note: Assumptions: The quantity of borrow material required takes into consideration 20% over-excavation and a material swell factor of 25% . Compaction of fill material is assumed to be placed in loose lifts not to exceed 8-inches thick and compacted to at least 95% of the Standard Proctor max. dry density. Factors: Over-Excavation = 20% Swell = 25% Volumes - Excavation (including over-excavation) = 16,943 cy , Backfill = 22,024 cy Borrow Required = 17,620 cy *For quantity details reference notes under 08 Solids Collect and Containment)											
			1.04					*1.58*			*2.12*
Backfill	22,024	CY	22,851.19	5,891.24	2,299.39	2,834.12	931.59	34,807.53	10,294.73	1,698.61	46,800.87
			6.40					*9.75*			*13.11*
Borrow	17,620	CY	112,803.24	29,081.69	11,350.79	13,990.42	4,598.72	171,824.86	50,819.20	8,385.05	231,029.11
(Note: For the basis of borrow costs reference government estimates for the North County Feasibility Study completed in 2003 USE $4.00/cy for borrow material FOB quarry)											
			4.24					*6.46*			*8.68*
Hauling	22,024	CY	93,363.93	24,070.06	9,394.72	11,579.46	3,806.22	142,214.40	42,061.56	6,940.06	191,216.02
			1.43					*2.18*			*2.93*
Compaction	22,024	CY	31,493.54	8,119.32	3,169.03	3,905.99	1,283.92	47,971.79	14,188.21	2,341.02	64,501.02
Surface Water Collect & Control	1	LS	1,027,668.60	264,942.19	103,408.86	127,456.59	41,895.60	1,565,371.84	568,213.82	76,390.15	2,209,975.81
Additional Labor & Services	1	LS	1,027,668.60	264,942.19	103,408.86	127,456.59	41,895.60	1,565,371.84	568,213.82	76,390.15	2,209,975.81
Water Management	1	LS	351,411.80	90,597.12	35,360.71	43,583.85	14,326.22	535,279.70	194,301.01	26,121.65	755,702.35
Water Treatment	1	LS	676,256.80	174,345.07	68,048.15	83,872.75	27,569.38	1,030,092.15	373,912.82	50,268.50	1,454,273.46
Solids Collect and Containment	1	LS	389,212.36	100,342.44	39,164.38	48,272.06	15,867.26	592,858.51	175,344.78	28,931.50	797,134.78

Description	Quantity	UOM	DirectCost	JOOH	HOOH	Profit	Bond	ContractCost	Contingency	Escalation	ProjectCost
(Note: Parameters/Assumptions: Beneficial reuse is considered for this estimate, therefore part of the excavated material is assumed to be disposed offsite. Excavated material will be loaded into trucks, hauled to the Treatment Area, treated, and stockpiled for transportation to a disposal facility. Total Excavated Volume (InSitu) = 16,943 cy (incl. over-excavation) Total Excavated Volume (ExSitu) = 22,020 cy. InSitu Volume used for excavation, ExSitu Volume used for, hauling, loading, spreading & compaction of backfill. Production Rate: Due to ineffeciencies assumed for this type of work, production rates are adjusted by an efficiency factor as well as the HTRW productivity factor. Database production rates for excavation are based on BCY's.(InSiti) Assume level of protection to be Level D, Productivity factor = 55%)											
			22.97					*34.99*			*47.05*
Contaminated Soil Collection	**16,943**	**CY**	**389,212.36**	**100,342.44**	**39,164.38**	**48,272.06**	**15,867.26**	**592,858.51**	**175,344.78**	**28,931.50**	**797,134.78**
(Note: Includes the removal during remedial action of solid contaminated soil HTRW waste by front end loader, backhoe, gradall, clamshell, dragline or othe rmechanical means. Assume bulk excavation to be acomplished using scrapers and dozers (Firing Site 12). All other material will be loaded directly into trucks and hauled to the soil staging area for the Physical Treatment Process. PPE is not considered for hauling.)											
			7.87					*11.98*			*16.11*
Excavation	**16,943**	**CY**	**133,300.60**	**34,366.09**	**13,413.34**	**16,532.61**	**5,434.35**	**203,046.99**	**60,053.50**	**9,908.69**	**273,009.18**
(Note: Production rates: Excavation by Hydraulic Excavator = 162.5 cy/hr x .75 x .55 = 67 cy/hr Excavation by Scraper = 112.5 cy/hr x .75 x .55 = 46 cy/hr Excavation by Dozer = 115 cy/hr x .75 x .55 = 47 cy/hr USE 47 cy/hr for scapers & dozers)											
			2.12					*3.23*			*4.34*
Hauling	**16,943**	**CY**	**35,912.30**	**9,258.51**	**3,613.67**	**4,454.02**	**1,464.06**	**54,702.56**	**16,178.92**	**2,669.49**	**73,550.97**
			7.96					*12.12*			*16.30*
Stockpiling	**16,943**	**CY**	**134,859.45**	**34,767.98**	**13,570.19**	**16,725.94**	**5,497.90**	**205,421.47**	**60,755.78**	**10,024.57**	**276,201.82**
(Note: Costs for Soil Staging of Excavated Soils)											
			90.00					*137.09*			*184.33*
Excavation Confirmation Sampling	**946**	**EA**	**85,140.00**	**21,949.86**	**8,567.19**	**10,559.49**	**3,470.95**	**129,687.49**	**38,356.58**	**6,328.75**	**174,372.82**
Physical Treatmet	**1**	**LS**	**1,022,213.28**	**263,535.76**	**102,859.92**	**126,780.00**	**41,673.20**	**1,557,062.15**	**460,519.19**	**75,984.63**	**2,093,565.98**
			40.04					*60.99*			*82.01*
Soil Sorting	**22,020**	**CY**	**881,700.00**	**227,310.17**	**88,720.81**	**109,352.84**	**35,944.81**	**1,343,028.63**	**397,216.30**	**65,539.80**	**1,805,784.73**
High Pressure Water Washing	**1**	**LS**	**7,444.25**	**1,919.19**	**749.08**	**923.27**	**303.48**	**11,339.27**	**3,353.72**	**553.36**	**15,246.35**
Remove and Replace Air Filters and Floor Grate	**1**	**LS**	**935.63**	**241.21**	**94.15**	**116.04**	**38.14**	**1,425.18**	**421.51**	**69.55**	**1,916.24**
Soil Staging of Excavated Soils	**1**	**LS**	**132,133.40**	**34,065.18**	**13,295.89**	**16,387.84**	**5,386.76**	**201,269.07**	**59,527.66**	**9,821.93**	**270,618.66**
Disposal (Commercial)	**1**	**LS**	**14,310,589.31**	**3,689,398.37**	**1,439,999.01**	**1,774,870.79**	**583,408.58**	**21,798,266.06**	**6,447,090.05**	**1,063,755.38**	**29,309,111.49**
(Note: Parameters/Assumptions: As sufficient quantities of contaminated material is stockpiled at the treatment site it will be loaded into the trucks and shipped to Energy Solutions Landfill. Truck availability is considered to be unconstrained, all trucks are available as required. Reference 08 Solids Collect. and Containment notes for quantities. Assumptions: Truck Capacity = 20 lcy, Truck liner = $100/ea, Absorbent Material = $20 /truck, Loading = $5.73/cy, Transportation = $150 /cy, Commercial Disposal Fees - Energy Solutions = $650/cy Assume level of protection to be Level C. Disposal Quantities = 17,620 lcy)											

Description	Quantity	UOM	DirectCost	JOOH	HOOH	Profit	Bond	ContractCost	Contingency	Escalation	ProjectCost
			162.13					*246.97*			*332.06*
Transport to Storage/Disp Facil	**17,620**	**CY**	**2,856,789.31**	**736,505.93**	**287,463.62**	**354,313.28**	**116,464.48**	**4,351,536.62**	**1,287,017.43**	**212,354.99**	**5,850,909.04**
(Note: Transport to storage/disposal facility during remedial action includesequipment, materials, and labor for hauling, loading and unloading of solid wastes.)											
			12.13					*18.48*			*24.85*
Loading of Solids	**17,620**	**CY**	**213,789.31**	**55,116.80**	**21,512.49**	**26,515.22**	**8,715.68**	**325,649.50**	**96,314.62**	**15,891.70**	**437,855.81**
(Note: Assume F.E.Loader to load material into trucks from stockpile pad. The trucks have a capacity of approximately 18 cy's. Assume the trucks will be lined at a cost of $100 per truck ExSitu Quantity to be used for loading into trucks. Total ExSitu Quant. = 17,620 cy Production Rate: Assume that 3 trucks can be loaded in an hour. (site wide average) 3 ea/hr @ 20 cy/ea = 60 cy/hr 17,620 cy / 60 cy/hr = 294 hrs 17,620 cy / 20 cy/truck = 881 loads Use two F.E.Loaders, one to move the material around and one to load the cars, six laborers (working foreman), four to line the gondolas and two to close up after loading and a Health Physicist Technician for 1/2hr per rail car for inspection.)											
			150.00					*228.48*			*307.21*
Transportation Costs	**17,620**	**CY**	**2,643,000.00**	**681,389.12**	**265,951.13**	**327,798.07**	**107,748.80**	**4,025,887.12**	**1,190,702.82**	**196,463.29**	**5,413,053.23**
			650.00					*990.10*			*1,331.25*
Disposal Fees and Taxes	**17,620**	**CY**	**11,453,000.00**	**2,952,686.20**	**1,152,454.90**	**1,420,458.28**	**466,911.48**	**17,445,510.86**	**5,159,712.20**	**851,340.93**	**23,456,563.99**
(Note: Provides for all fees and taxes charged during remedial action for the disposal of wastes. These include fees and taxes charged at third party/commercial facilities.)											
			650.00					*990.10*			*1,331.25*
Landfill/Burial Grounds	**17,620**	**CY**	**11,453,000.00**	**2,952,686.20**	**1,152,454.90**	**1,420,458.28**	**466,911.48**	**17,445,510.86**	**5,159,712.20**	**851,340.93**	**23,456,563.99**
Transportation and Disposal of Building Decon	**1**	**LS**	**800.00**	**206.25**	**80.50**	**99.22**	**32.61**	**1,218.58**	**360.41**	**59.47**	**1,638.46**
(Note: Material Costs for building decon is based on historical costs and only considers transportation and disposal of floor grate and air filters.)											
Site Restoration	**1**	**LS**	**21,619.81**	**5,573.78**	**2,175.49**	**2,681.40**	**881.39**	**32,931.86**	**9,739.98**	**1,607.07**	**44,278.92**
(Note: Middleton Iowa Areas - Firing Site 12 = 338,000 SF, Firing Site 6 = 27 SF, Firing Site 1 & 2 = 27 SF, Firing Sites 3, 4, & 5 = 27 sf Total Middleton Iowa = 338,081 SF / 43,560 sf/acre = 8 acres)											
Earthwork	**1**	**LS**	**5,711.67**	**1,472.52**	**574.74**	**708.39**	**232.85**	**8,700.17**	**2,573.18**	**424.57**	**11,697.92**
			713.96					*1,087.52*			*1,462.24*
Grading	**8**	**ACR**	**5,711.67**	**1,472.52**	**574.74**	**708.39**	**232.85**	**8,700.17**	**2,573.18**	**424.57**	**11,697.92**
Revegetation And Planting	**1**	**LS**	**12,719.89**	**3,279.30**	**1,279.93**	**1,577.58**	**518.56**	**19,375.26**	**5,730.46**	**945.51**	**26,051.24**
(Note: Revegetation and planting provides for the complete restoration of areas affected by remedial action construction. This includes fine grading and leveling of topsoil (refer. earthwork), seeding, mulching, fertilizer, sodding, erosion control, shrubs, and trees.)											
			1,089.99					*1,660.29*			*2,232.37*
Seeding/Mulch/Fertilizer	**8**	**ACR**	**8,719.89**	**2,248.06**	**877.44**	**1,081.48**	**355.49**	**13,282.36**	**3,928.41**	**648.18**	**17,858.95**
			500.00					*761.61*			*1,024.04*
Miscelaneous Landscaping	**8**	**ACR**	**4,000.00**	**1,031.24**	**402.50**	**496.10**	**163.07**	**6,092.91**	**1,802.05**	**297.33**	**8,192.29**

Description	Quantity	UOM	DirectCost	JOOH	HOOH	Profit	Bond	ContractCost	Contingency	Escalation	ProjectCost
Site Cleanup	**1**	**LS**	**3,188.25**	**821.96**	**320.82**	**395.42**	**129.98**	**4,856.43**	**1,436.34**	**236.99**	**6,529.77**
Demobilization	**1**	**LS**	**136,007.85**	**35,064.04**	**13,685.75**	**16,868.37**	**5,544.72**	**207,170.74**	**61,273.15**	**10,109.93**	**278,553.81**
(Note: The same assumptions and durations considered for Mobilization and Prepatory Work will be used for Demobilzation unless specified otherwise. Time for decon of equipment is considered part of demob. time. Reference notes under 01 Mobilize and Preporatory work for general assumptions.)											
Removal Of Temporary Facilities	**1**	**LS**	**22,650.00**	**5,839.37**	**2,279.15**	**2,809.17**	**923.39**	**34,501.08**	**10,204.09**	**1,683.65**	**46,388.82**
(Note: Removal during remedial action of temporary facilities includesdemobilization and dismantling of office trailers, storage and decontamination facilities, and other temporary facilities.)											
			750.00					*1,142.42*			*1,536.05*
Office Trailers (contr.'s only)	**1**	**EA**	**750.00**	**193.36**	**75.47**	**93.02**	**30.58**	**1,142.42**	**337.88**	**55.75**	**1,536.05**
			5,000.00					*7,616.13*			*10,240.36*
Storage Facilities	**1**	**EA**	**5,000.00**	**1,289.04**	**503.12**	**620.12**	**203.84**	**7,616.13**	**2,252.56**	**371.67**	**10,240.36**
(Note: Assume the staging areas to be removed after the completion of the last contract.)											
Decon. Fac. for Const. Equip.	**1**	**LS**	**15,000.00**	**3,867.13**	**1,509.37**	**1,860.37**	**611.51**	**22,848.39**	**6,757.68**	**1,115.00**	**30,721.07**
(Note: Assume the decon. facility to be removed after the completion of the last contract. Assume 25% of the original estimated cost for removal.)											
			100.00					*152.32*			*204.81*
Toilets	**2**	**EA**	**200.00**	**51.56**	**20.12**	**24.80**	**8.15**	**304.65**	**90.10**	**14.87**	**409.61**
(Note: Assume 2 portable toilets to be removed per each contract. (2 ea))											
Barricades	**1**	**LS**	**1,500.00**	**386.71**	**150.94**	**186.04**	**61.15**	**2,284.84**	**675.77**	**111.50**	**3,072.11**
(Note: Assume a lump sum cost per contract for removal.)											
			100.00					*152.32*			*204.81*
Signs	**2**	**EA**	**200.00**	**51.56**	**20.12**	**24.80**	**8.15**	**304.65**	**90.10**	**14.87**	**409.61**
(Note: Assume a cost per contract for removal.)											
Removal Of Temporary Utilities	**1**	**LS**	**1,354.85**	**349.29**	**136.33**	**168.04**	**55.23**	**2,063.75**	**610.38**	**100.71**	**2,774.84**
(Note: Provides for the dismantling and disconnection of project utilities during remedial action including site power and lighting, telephone/communication service, water, sewer and gas service.)											
Power Connection/Distribution	**1**	**LS**	**500.00**	**128.90**	**50.31**	**62.01**	**20.38**	**761.61**	**225.26**	**37.17**	**1,024.04**
Telephone/Communication Dist.	**1**	**LS**	**54.85**	**14.14**	**5.52**	**6.80**	**2.24**	**83.55**	**24.71**	**4.08**	**112.34**
Water Connection/Distribution	**1**	**LS**	**500.00**	**128.90**	**50.31**	**62.01**	**20.38**	**761.61**	**225.26**	**37.17**	**1,024.04**

Description	Quantity	UOM	DirectCost	JOOH	HOOH	Profit	Bond	ContractCost	Contingency	Escalation	ProjectCost
Sewer Connection/Distribution	1	LS	300.00	77.34	30.19	37.21	12.23	456.97	135.15	22.30	614.42
Demob of Construction Equip/Facl	1	LS	72,003.00	18,563.02	7,245.28	8,930.17	2,935.39	109,676.86	32,438.20	5,352.23	147,467.29
(Note: Work associated with demobilization of remedial action construction equipment and temporary facilities. Includes transportation, manifests, tolls, permits, escort vehicles, drivers, and equipment operators.)											
Demob. of Construction Equipment	1	LS	57,056.78	14,709.75	5,741.32	7,076.47	2,326.07	86,910.39	25,704.75	4,241.23	116,856.37
Decon. of Construction Equipment	1	LS	14,946.22	3,853.27	1,503.96	1,853.70	609.32	22,766.47	6,733.45	1,111.00	30,610.93
(Note: It is assumed that all equipment will be mobed., decontaminated, and demobed for each contract. Decontaminate 8 pc.'s/contract x 1 contract = 8 pc's of equipment . Decontamination of construction equipment is assumed to be spread over the year duration considered for this study. Use 2 days/pc. of equip. Decon. Crew and Equipment - Mechanics Truck, Operator/Mechanic Compressor, Laborers -2ea Power Washer, Misc. Small Tools)											
Submittals	1	LS	40,000.00	10,312.36	4,024.99	4,961.00	1,630.70	60,929.05	18,020.47	2,973.34	81,922.86
(Note: Submittals are incurred for obtaining all necessary site clean closure documentation. These include all final reports, punch lists, projectacceptance, final QA/QC reports and As-Built Drawings during remedial action . Assume 500 hrs for a construction completion report.)											
			40,000.00					*60,929.05*			*81,922.86*
Project Acceptance	1	EA	40,000.00	10,312.36	4,024.99	4,961.00	1,630.70	60,929.05	18,020.47	2,973.34	81,922.86
(Note: Assume the Construction Completion Report takes 500 hrs to complete at $80 per hour)											
ENGINEERING DURING CONSTRUCTION	1	LS	282,900.00	0.00	0.00	0.00	0.00	282,900.00	102,689.78	13,805.52	399,395.30
Engineering During Construction	1	LS	282,900.00	0.00	0.00	0.00	0.00	282,900.00	102,689.78	13,805.52	399,395.30
CONSTRUCTION MANAGEMENT (S&A)	1	LS	1,697,300.00	0.00	0.00	0.00	0.00	1,697,300.00	616,102.38	82,828.24	2,396,230.62
CONSTRUCTION MANAGEMENT (S&A)	1	LS	1,697,300.00	0.00	0.00	0.00	0.00	1,697,300.00	616,102.38	82,828.24	2,396,230.62
POST-REMEDIAL ACTION	1	LS	240,000.00	0.00	0.00	0.00	0.00	240,000.00	13,366.80	27,336.00	280,702.80
(Note: (Post Remedial Action))											
Operation, Maint. & Monitoring	1	LS	240,000.00	0.00	0.00	0.00	0.00	240,000.00	13,366.80	27,336.00	280,702.80
Five Year Review	1	LS	240,000.00	0.00	0.00	0.00	0.00	240,000.00	13,366.80	27,336.00	280,702.80
(Note: The review consists of land use assessment, monitoring, testing andanalysis, evaluation and risk assessment.)											

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ATTACHMENT E-3

Volume Estimates

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Table E-3-1. Soil Volume Estimates

DU at Firing Site 12
All circular areas centered on ground zero
DU detections in soil samples from surface and subsurface soils

Vertical Interval Start (ft bgs)	Vertical Interval End (ft bgs)	Radius of Area (ft)	Raw Area (ft^2)	Percent Excavated	Bank Volume (CY)	Loose Volume (CY)	Comment
0	1	328	337,985	100%	12,518	16,273	based on GWS yellow ring
0	1	574	697,094	5%	1,291	1,678	based on GWS black & red outside yellow
1	2	328	337,985	25%	3,129	4,068	smaller hits expected > 1 ft bgs
2	3	328	337,985	0%	0	0	No DU > RG below 2 ft bgs
				TOTAL	16,938	22,020	

DU at Firing Sites 1 & 2
Circular area defined by Fig 3-1 extent
DU detected only in surface soils.

Vertical Interval Start (ft bgs)	Vertical Interval End (ft bgs)	Radius (ft)	Raw Area (ft^2)		Bank Volume (CY)	Loose Volume (CY)	Comment
0	1	3.0	27		1	1.3	Firing Sites 1 & 2 area, extent by 1 DU detect in gamma walkover survey
				TOTAL	1	1	

DU at Firing Sites 3,4 & 5
DU chunk found during survey, not removed
DU detected only in surface soils.

Vertical Interval Start (ft bgs)	Vertical Interval End (ft bgs)	Radius (ft)	Raw Area (ft^2)		Bank Volume (CY)	Loose Volume (CY)	Comment
0	1	3.0	27		1.0	1.3	Firing Sites 3, 4 & 5 area, extent by 1 DU detect in gamma walkover survey
				TOTAL	1	1	

DU at Firing Sites 6, 7, 8 & 15
DU chunk found during survey, not removed
DU detected only in surface soils.

Vertical Interval Start (ft bgs)	Vertical Interval End (ft bgs)	Radius (ft)	Raw Area (ft^2)		Bank Volume (CY)	Loose Volume (CY)	Comment
0	1	3.0	27		1.0	1.3	Firing Sites-6, 7, 8 & 15 area, extent by 2 DU detects in gamma walkover survey
				TOTAL	1	1	

Factor of 1.3 used in all calculations of loose volume from bank

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APPENDIX F

GROUND-WATER TRANSPORT CALCULATIONS FOR RDX AND TNT AT THE FIRING SITE 6 AREA

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GROUND-WATER TRANSPORT CALCULATIONS FOR RDX AND TNT AT THE FIRING SITE 6 AREA

INTRODUCTION

This appendix describes the ground-water transport calculations performed to assess the potential for RDX and TNT in shallow soil at Firing Site 6 Area to leach into shallow ground water at levels exceeding health-based screening levels. The purpose of conducting this evaluation is to determine if the concentrations of RDX and TNT detected in shallow soil at Firing Site 6 are protective of ground water, or if they would fit the definition of "significant risk" under the provisions of Iowa Administrative Code 567-133.4(3)b(2). This regulation specifies that "in cases of significant risk", cleanup of contaminated soil is necessary to prevent or minimize release to the ground water. Significant risk, as defined in Iowa Administrative Code 567-133.2, means the concentration of a contaminant in ground water has been found to exceed an action level or the concentration present in soils may reasonably be expected to contaminate the ground water to an action level.

The maximum concentration of RDX detected in shallow ground water at the FSA is 0.86 µg/L, which was detected in 2004 in shallow monitoring well JAW-37 (Figure F-1). TNT has not been detected in the FSA monitoring wells. Based on this data, RDX and TNT do not exceed action levels in shallow ground water at the FSA. However, the maximum concentrations of RDX and TNT in soil at Firing Site 6 Area exceed the screening values (1.3 mg/kg RDX and 47.6 mg/kg TNT), suggesting there is a potential for these COCs to impact shallow ground water in the future. The screening values are based on the results of the Summers Model presented in the Final *Record of Decision, Soils Operable Unit #1* (USACE 1998a). The Summers Model was used to develop conservative estimates of the soil concentrations of RDX and TNT that would be protective of ground water at the IAAAP. While the Summers Model is appropriate for this type of initial screening, it does not adequately address many of the processes controlling the migration of contaminants and therefore overestimates the COC concentrations in ground water resulting from leaching at the Firing Site 6 Area. The Summers Model assumes that the soil contamination is instantaneously mixed in a ground-water "mixing zone" directly below the source area. In reality, mixing does not occur instantaneously beneath the source area; during transport, the concentrations are further diluted in ground water due to dispersion, diffusion, and retardation. In addition, natural attenuation processes would act to reduce the RDX and TNT concentrations in soil over time.

In order to include the effects of some of the transport processes not addressed by the Summers Model and to incorporate various site-specific parameters for the Firing Site 6 Area, a number of calculations were performed using simple soil screening equations. The equations estimate the effects of dilution on COCs leaching from soil into the water table and the subsequent effects of transport and degradation of the COCs in the shallow aquifer. Specifically, the equations were used to predict the RDX and TNT concentrations reaching ground water at two locations downgradient of the Firing Site 6 Area: Long Creek and the downgradient boundary of the FSA. The resulting ground-water concentrations were then compared to the appropriate ground-water action levels for RDX and TNT. As was done in the Summers Model, the ground-water action levels were set at the existing EPA health advisory lifetime levels (2 µg/L for both TNT and RDX).

GENERAL APPROACH

Simple screening-level calculations were performed to assess if RDX and TNT concentrations present at the Firing Site 6 Area could contaminate shallow ground water to levels above the RDX and TNT Health Advisory Levels (2 µg/L). The calculations are based on a combination of the soil-water partition equation, simple water and mass balance equations, and Domenico's advection-dispersion equations. Input data requirements for these calculations are not extensive, utilizing a minimum of soil, aquifer, and chemical properties and meteorological values. Output includes the estimated RDX and TNT concentrations in the shallow aquifer at various distances from the Firing Site 6 Area. The calculations were used to evaluate the transport of RDX and TNT vertically through the unsaturated zone to the water table and then within ground water to downgradient locations at Long Creek and the boundary of the FSA.

The first step of the method describes the migration from soil to the shallow aquifer. It simulates the mixing of contaminants into the aquifer due to vertical infiltration from the contaminated soil layers above the water table, resulting in a dilution factor. The second step describes the transport within the saturated zone to a downgradient location, considering sorption, dispersion and degradation processes occurring over this pathway. The result of this step is an attenuation factor that represents the reduction of the concentration due to these processes. Both pathways are then combined to yield a site-specific dilution attenuation factor that represents the overall concentration reduction for the complete pathway. The concentrations reaching a downgradient location are calculated by multiplying the dilution attenuation factor by the concentration in contaminated soil at Firing Site 6 Area.

SITE HYDROGEOLOGY

The Firing Site 6 Area is underlain by deposits of clayey silt (loess) that are generally less than 15 ft thick. Underlying the loess is a thick (typically greater than 30 ft) layer of glacial till (Kellerville Till) composed of silty clay with some discontinuous sandy lenses. The underlying bedrock consists of the cherty limestone of the upper Warsaw Formation. Based on the boring logs for two bedrock wells in the area (JAW-618 and JAW-619), the top of bedrock generally varies in depth from 30 to 55 ft bgs at the FSA.

The aquifer of concern is the shallow aquifer (also known as the Drift Aquifer). The shallow aquifer consists of sandy/silt/silty sand deposits generally at depths between 3 and 30 ft situated within the clay-rich glacial deposits of the Kellerville Till. Horizontal hydraulic conductivities have not been calculated for the shallow aquifer at the Firing Site. Well G-7, located between the Firing Site and the Explosives Disposal Area, had a horizontal permeability of 1×10^{-4} cm/s during slug tests. In general, the shallow aquifer is characterized by low vertical hydraulic conductivities (4.6×10^{-9} cm/s to 5.5×10^{-9} cm/s) (USAEC 1996).

Based on ground-water level data and stream gauging events, shallow ground-water flow is controlled by the presence of Long Creek and the northern tributary. The direction of shallow ground-water flow at the FSA is generally convergent toward the Western and Northern Branches of Long Creek (USAEC 1996). At the northern portion of the FSA, north of Long Creek, shallow flow is semi-radial, ranging from the southwest to the east. At the central and southern portions of the FSA, south of Long Creek, shallow flow is to the northeast.

Eight monitoring wells are present at the Firing Site Area (Figure F-1). Four wells are completed in the glacial till between 15 to 20 feet bgs (JAW-32, JAW-34, JAW-36, and JAW-37), two wells are completed in the glacial till/bedrock interface between 20 to 34 feet bgs (JAW-33 and

JAW-35), and two wells are screened in the deep bedrock aquifer between 53 to 57 ft bgs (JAW-618 and JAW-619). The maximum concentration of RDX detected in ground water at the FSA is 0.86 µg/L, which was detected in 2004 in shallow monitoring well JAW-37.

ASSUMPTIONS AND METHODOLOGY

The methodology used is based on several conservative, simplifying assumptions concerning the release and transport of contaminants in ground water. The following general assumptions were used to assess the potential of shallow ground water to be contaminated as a result of the migration of RDX and TNT contamination from Firing Site 6:

- Steady-state conditions are assumed, where all variables are constant over time.
- Unconfined conditions are conservatively assumed. At the Firing Site 6 Area, the sandy lenses of the shallow aquifer may be relatively confined or semi-confined by overlying clay-rich till deposits that act as a barrier to the flow of contaminants from the overlying soil.
- It is conservatively assumed that no chemical or biological degradation is occurring in the unsaturated zone.
- Only dissolved-phase contamination is present. (i.e., no non-aqueous phase liquids).
- Contamination that may already be present in the shallow aquifer from other sources is not included in the calculations.

Step 1: Vertical Transport from Soil Source to the Water Table

Step 1 addresses transport within the vadose zone and incorporates the effects of mixing of the COCs in the shallow aquifer due to vertical infiltration from soil to the water table. The equations and parameters used in the calculations for Step 1 are presented in Tables F-1 and F-2. Because Step 1 deals only with vertical transport beneath the Firing Site 6 Area, it is identical for both the downgradient locations that were evaluated (Long Creek and the downgradient boundary of the FSA). The following specific assumptions were used in calculating the concentrations of RDX and TNT migrating from soil at Firing Site 6 to the water table:

- The maximum soil concentrations of RDX and TNT in soil at the Firing Site 6 Area were used as conservative estimate of the contaminant concentrations present in the soil at the source (C_{source}).
- The dimensions of the source area are based on the extent of explosives-contaminated soil at the Firing Site 6 Area. Contamination is assumed to be evenly distributed throughout the source area.

The results of the Step 1 calculations, provided in Tables F-1 and F-2, are in the form of dilution factors (DFs) for RDX and TNT.

Step 2: Lateral Transport in Ground Water

Step 2 models the transport of RDX and TNT within the saturated zone to downgradient wells at Long Creek (Table F-1) and the boundary of the FSA (Table F-2). It incorporates the effects of dilution within the aquifer, sorption to soil, dispersion and degradation. The results of the Step 2 calculations are attenuation factors (AFs) for RDX and TNT.

Step 3: Complete Pathway

The two pathways represented in Step 1 and Step 2 are combined by multiplying DF by AF to yield a dilution attenuation factor (DAF) that represents the overall concentration reduction for the complete pathway. The result is then used to estimate concentrations at a downgradient well using the following formula: $C_w = C_{source}$ x DAF.

RESULTS

The estimated concentrations of RDX and TNT in ground water did not exceed their action level (2 µg/L) for either downgradient well location (Tables F-1 and F-2). The concentrations reaching ground water are low primarily due to the following features of the Firing Site 6 Area:

- The extent of the explosives contamination is limited. The explosives-contaminated soil present at the Firing Site 6 Area is confined to the immediate area surrounding the concrete structure at the northern end of the area (an area of approximately 0.09 acres) and is limited to a depth of 2 ft.
- The presence of relatively impermeable (clay-rich) till.
- The average depth of the water table (approximately 8 ft bgs) is below the depth of the soil contamination (approximately 2 ft).

CONCLUSIONS

The potential for RDX and TNT at the Firing Site 6 Area to leach from shallow soil into ground water at levels exceeding their health-based action level is minimal. The results indicate that the projected concentrations at two downgradient locations, Long Creek and the boundary of the FSA, are below the health-based action levels. It is concluded that significant ground-water contamination is not occurring and is not likely to occur in the future as a result of the presence of the limited amount of RDX- and TNT-contaminated soil at the Firing Site 6 Area.

APPENDIX F

FIGURE

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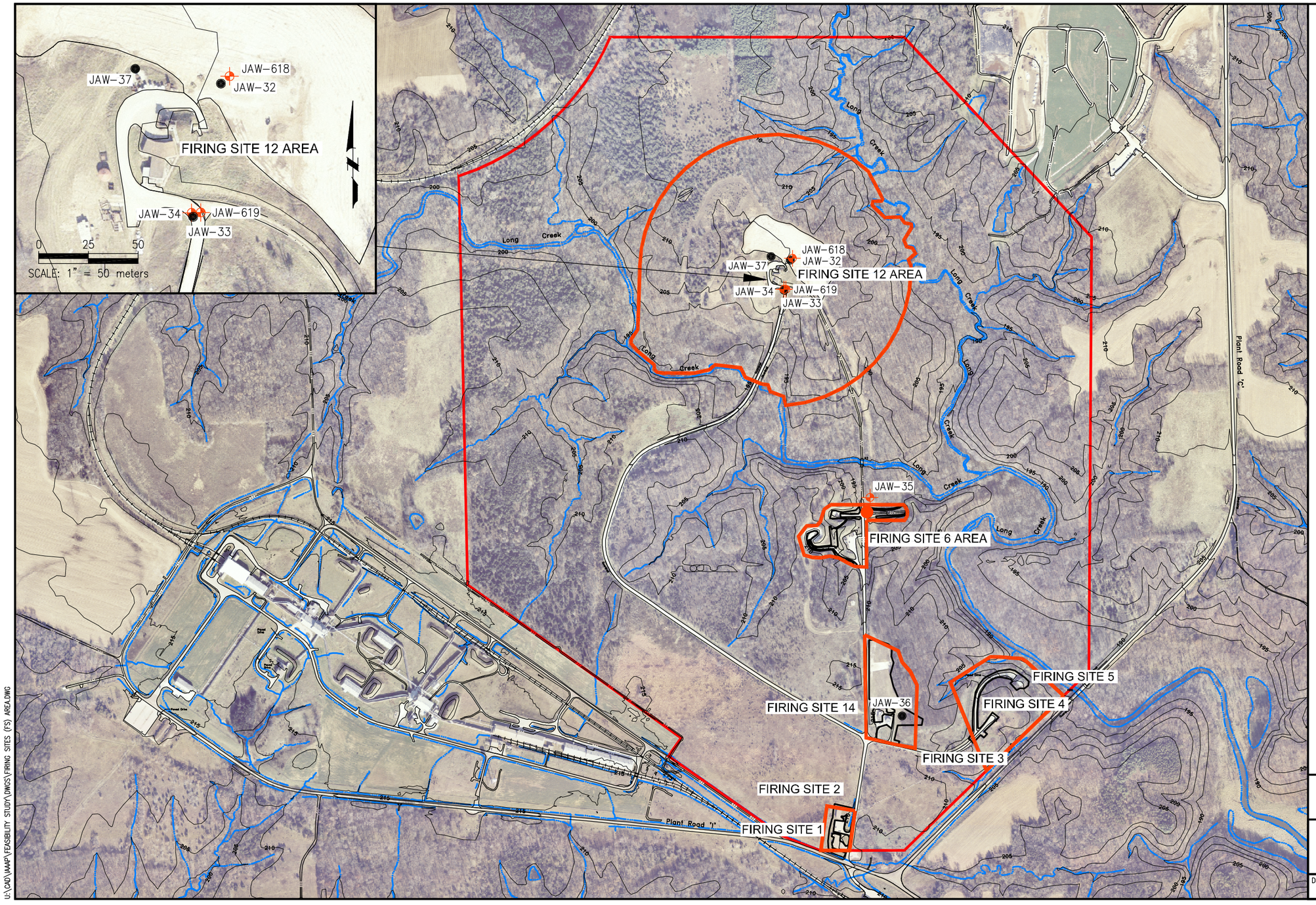

LEGEND:

- RAILROAD
- STREAM
- 200 TOPOGRAPHIC CONTOURS
- APPROXIMATE BOUNDARY OF FIRING SITE AREA (FSA)
- EXPLOSIVES CONTAMINATED AREA
- FIRING SITE AREAS
- SHALLOW GROUND–WATER MONITORING WELL (GLACIAL TILL)
- DEEP GROUND–WATER MONITORING WELL (GLACIAL TILL/BEDROCK INTERFACE)
- DEEP GROUND–WATER MONITORING WELL (BEDROCK)

0 120 240
SCALE: 1" = 240 meters

FUSRAP

Feasibility Study
Iowa Army Ammunition Plant
Middletown, Iowa

DRAWN BY:	REV. NO./DATE:
F. Bauer	02/15/11

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Figure F-1. Ground-water Monitoring Wells at the Firing Sites Area

ATTACHMENT F-1

GROUND-WATER TRANSPORT CALCULATIONS

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Table F-1-1. Ground-Water Transport Calculations to Downgradient Well at Long Creek

Step 1: Vertical Transport from Soil Source to the Water Table

$$\text{Dilution Factor (DF)} = \frac{(\delta_b/(\theta_w + K_d\delta_b + H\theta_a)}{1 + (V_{gw}h/I_fW_s)} \times \frac{L_2}{L_1}$$

Model Parameter	Description	Units	TNT	RDX	Reference
θ_w	Volumetric Water Content of Vadose Zone Soils	cm3-water/cm3-soil	0.26	0.26	Default
δ_b	Soil Bulk Density (kg/l)	kg/L	1.7	1.7	Default
h	Groundwater mixing zone thickness	meters	6.1	6.1	Fence Diagram for FSA (USAEC 1996)
H	Henry's Law Constant	unitless	8.50E-07	8.22E-10	RAIS
P	Annual Precipitation	cm/yr	9.63E+01	9.63E+01	37.9 in/yr
I_f	Net Infiltration rate through soil =0.0009 x P^2	m/day	0.000228	0.000228	Calculated based on silty soil type
K_d	Soil-Water Partition Coefficient	L/kg	11	1.8	Sunahara 2009; Brannon 1999
θ_a	Volumetric Air Content of Vadose Zone Soils	cm3-air/cm3-soil	0.17	0.17	Default
L_1	Thickness of contaminated soil	meters	0.61	0.61	Site Specific -2 ft
L_2	depth to gw table from top of affected soils	meters	2.4	2.4	Site Specific -Used avg wt depth (8 ft)
K	Hydraulic Conductivity	m/day	8.64E-02	8.64E-02	Site Specific - Table 6-1 (MWH 2001)
I	Hydraulic Gradient	unitless	0.02	0.02	Site Specific -Table 6-1 (MWH 2001)
V_{gw}	Darcy Velocity =ki	m/day	1.73E-03	1.73E-03	Calculated
Ws	Width of contaminated area parallel to flow	meters	25	25	Width of Contamination at Firing Site 6 Area

DF	Results of Step 1 Calculation = Dilution Factor	unitless	DF_{TNT}	DF_{RDX}
			3.15E-02	1.80E-01

Table F-1-1. Ground-Water Transport Calculations to Downgradient Well at Long Creek (Continued)

Step 2: Lateral Transport in Ground Water

Attenuation Factor (AF) = A * B * C

$A = \exp[(L_{gw}/2\alpha_x) * (1-SQRT(1+(4D_g\alpha_x/V)))]$

$B = \text{erf}(W/(4* SQRT(\alpha_y L_{gw})))$

$C = \text{erf}(D/(2* SQRT\alpha_z L_{gw}))$

Model Parameter	Description	Units	TNT	RDX	Reference
L_{gw}	Distance from source to well along flow path	meters	170	170	Distance to Long Creek
α_x	Longitudinal Dispersivity = $0.1L_{gw}$	meters	17	17	Default Calculation
α_y	Transverse Dispersivity = $0.33\alpha_x$	meters	5.61	5.61	Default Calculation
α_z	Vertical Dispersivity = $0.05\alpha_x$	meters	0.85	0.85	Default Calculation
v_w	groundwater seepage velocity = V_{gw}/n	m/day	0.006	0.006	Calculated
R_i	Retardation Factor = $1 + (K_d\delta_b/\theta T)$	Unitless	44.49	8.12	Calculated
V	Retarded Velocity = v_w/Ri	m/day	0.00013	0.001	Calculated
D_g	First order decay constant	day-1	0.077	6.42E-05	BWXT Pantex 2007
W	Width of Source	meters	25	25	Area of Contamination at Firing Site 6 Area
D	Depth of Source = depth of mixing zone	meters	6.1	6.1	Fence Diagram for FSA (USAEC 1996)
θ_T	Total Porosity	Unitless	0.43	0.43	Sandy Silt default
n	Effective Porosity	Unitless	0.3	0.3	Default

			AF_{TNT}	AF_{RDX}
AF	**Results of Step 2 Calculation = Attenuation Factor**	**unitless**	0.00E+00	1.46E-05

Step 3: Complete Pathway

Concentration at well (C_w) = C_{source} x DAF

C_{source}	Concentration in contaminated soil at FS-6	mg/kg	2600	160	Maximum concentration at Firing Site 6 Area
DAF	**Dilution attenuation factor (DAF) =DF x AF**	**unitless**	DAF_{TNT}	DAF_{RDX}	
			0.000E+00	2.631E-06	

			$C_{w\text{-}TNT}$	$C_{w\text{-}RDX}$
C_w	**Concentration in downgradient well at Creek**	mg/l	0.00E+00	4.21E-04
		µg/l	0.00E+00	4.21E-01
HAL	Ground-Water Standard (Health Advisory Level)	µg/l	2	2

Table F-1-2. Ground-Water Transport Calculations to the Downgradient Boundary of the FSA

Step 1: Vertical Transport from Soil Source to the Water Table

$$\text{Dilution Factor (DF)} = \frac{(\delta_b/(\theta_w + K_d\delta_b + H\theta_a)}{1 + (V_{gw}h/I_fW_s)} \times \frac{L_2}{L_1}$$

Model Parameter	Description	Units	TNT	RDX	Reference
θ_w	Volumetric Water Content of Vadose Zone Soils	cm3-water/cm3-soil	0.26	0.26	Default
δ_b	Soil Bulk Density (kg/l)	kg/L	1.7	1.7	Default
h	Groundwater mixing zone thickness	meters	6.1	6.1	Fence Diagram for FSA (USAEC 1996)
H	Henry's Law Constant	unitless	8.50E-07	8.22E-10	RAIS
P	Annual Precipitation	cm/yr	9.63E+01	9.63E+01	37.9 in/yr
I_f	Net Infiltration rate through soil =0.0009 x P^2	m/day	0.000228	0.000228	Calculated based on silty soil type
K_d	Soil-Water Partition Coefficient	L/kg	11	1.8	Sunahara 2009; Brannon 1999
θ_a	Volumetric Air Content of Vadose Zone Soils	cm3-air/cm3-soil	0.17	0.17	Default
L_1	Thickness of contaminated soil	meters	0.61	0.61	Site Specific -2 ft
L_2	depth to gw table from top of affected soils	meters	2.4	2.4	Site Specific -Used avg wt depth (8 ft)
K	Hydraulic Conductivity	m/day	8.64E-02	8.64E-02	Site Specific - Table 6-1 (MWH 2001)
I	Hydraulic Gradient	unitless	0.02	0.02	Site Specific -Table 6-1 (MWH 2001)
V_{gw}	Darcy Velocity =ki	m/day	1.73E-03	1.73E-03	Calculated
Ws	Width of contaminated area parallel to flow	meters	25	25	Width of Contamination at Firing Site 6 Area

DF	Results of Pathway 1 Calculation = Dilution Factor	unitless	DF_{TNT}	DF_{RDX}
			3.15E-02	1.80E-01

Table F-1-2. Ground-Water Transport Calculations to the Downgradient Boundary of the FSA (Continued)

Step 2: Lateral Transport in Ground Water

Attenuation Factor (AF) = A * B * C

$A = \exp[(L_{gw}/2\alpha_x) * (1-SQRT(1+(4D_g\alpha_x/V)))]$

$B = erf(W/(4* SQRT(\alpha_y L_{gw})))$

$C = erf(D/(2* SQRT\alpha_z L_{gw}))$

Model Parameter	Description	Units	TNT	RDX	Reference
L_{gw}	Distance from source to well along flow path	meters	470	470	Distance to boundary of FSA
α_x	Longitudinal Dispersivity = $0.1L_{gw}$	meters	47	47	Default Calculation
α_y	Transverse Dispersivity = $0.33\alpha_x$	meters	15.51	15.51	Default Calculation
α_z	Vertical Dispersivity = $0.05\alpha_x$	meters	2.35	2.35	Default Calculation
v_w	groundwater seepage velocity = V_{gw}/n	m/day	0.006	0.006	Calculated
R_i	Retardation Factor = $1 + (K_d\delta_b/\theta T)$	Unitless	44.49	8.12	Calculated
V	Retarded Velocity = v_w/Ri	m/day	0.00013	0.001	Calculated
D_g	First order decay constant	day-1	0.077	6.42E-05	BWXT Pantex 2007
W	Width of Source	meters	25	25	Area of Contamination at Firing Site 6 Area
D	Depth of Source = depth of mixing zone	meters	6.1	6.1	Fence Diagram for FSA (USAEC 1996)
θ_T	Total Porosity	Unitless	0.43	0.43	Sandy Silt default
n	Effective Porosity	Unitless	0.3	0.3	Default

			AF_{TNT}	AF_{RDX}
AF	**Results of Step 2 Calculation = Attenuation Factor**	**unitless**	0.00E+00	7.73E-10

Step 3: Complete Pathway

Concentration at well (C_w) = C_{source} x DAF

C_{source}	Concentration in contaminated soil at FS-6	mg/kg	2600	160	Maximum concentration at Firing Site 6 Area
DAF	**Dilution attenuation factor (DAF) =DF x AF**	**unitless**	DAF_{TNT}	DAF_{RDX}	
			0.000E+00	1.390E-10	

			$C_{w\text{-}TNT}$	$C_{w\text{-}RDX}$
C_w	**Concentration in well at downgradient edge of FSA**	mg/l	0.00E+00	2.22E-08
		µg/l	0.00E+00	2.22E-05
HAL	Ground-Water Standard (Health Advisory Level)	µg/l	2	2