

Iowa Army Ammunition Plant
EPA Region 7
Middletown, Iowa

**Addendum to the Final Fourth Five-Year Review Report
for the Iowa Army Ammunition Plant (Dated March 2021)
May 2025**

The fourth Five-Year Review (FYR) report for the Iowa Army Ammunition Plant (IAAAP) in Middletown, Iowa, was signed by Eric Schilling, Commander, on March 1, 2021, and Mary Peterson, Director of the Superfund and Emergency Management Division of EPA, on March 10, 2021 (USACE and Dawson Solutions, 2021). This addendum provides progress since the FYR and protectiveness determinations for those remedies whose statements were deferred in the March 2021 fourth FYR.

This addendum addresses deferred protectiveness statements for the Soils Operable Unit (OU-1) at the IAAAP.

The fourth FYR report for IAAAP (USACE and Dawson Solutions, 2021) identified two issues for OU-1:

- **Issue 1:** "Historical site operations may have resulted in the release of PFAS [per- and polyfluoroalkyl substances] to the environment at the Fire Training Area at OU-1." The FYR report provided the following recommendation: "Complete the Site Inspection that is currently underway to evaluate PFOA [perfluorooctanoic acid], PFBS [perfluorobutanesulfonic acid], and PFOS [perfluorooctanesulfonic acid] and potential exposure pathways at the Fire Training Pit."
- **Issue 2:** "The soil remediation goals for antimony, cadmium, hexavalent chromium, thallium, and mercury are no longer protective." It provided the following recommendation: "[...] OU-1 remediation goals (RGs) should be evaluated and revised to incorporate current toxicity, exposure assumptions, and cumulative risk and ensure they are protective of human health and the environment. A post-Record of Decision (ROD) change document will be required to document any changes to the RGs."

This FYR addendum provides an update on what the Army has done to address these issues, and a timeframe for when the information will be obtained and when a protectiveness statement can be made.

OU-1 Site Description

The primary sources of contamination at OU-1 are due to past operating practices and explosives-contaminated wastewaters and sludges that were discharged to uncontrolled lagoons and impoundments. Additional sources of contamination include open burning of explosives materials and munitions and landfilling of waste material.

OU-1 addresses soil on the IAAAP, excluding soil contaminated by current use or testing of military munitions or by radiological chemicals (Figure 1). The OU-1 remedy, as defined in the 1997 Interim ROD (U.S. Army Environmental Center, 1997) and ROD (USACE, 1998) included excavation of soils contaminated above RGs, segregation and staging of excavated soil based on type and level of contamination, and on- and offsite treatment and disposal of contaminated soil. The OU-1 RODs have been modified by five Explanations of Significant Differences (ESDs): a 2003 ESD (USACE, 2003), 2006 ESD (USACE, 2006), 2008 ESD (USACE, 2008), 2009 ESD (USACE, 2009), 2011 ESD (USACE, 2011), and 2018 ESD (USACE, 2018). The 2018 ESD established Land Use Controls. OU-1 addresses contaminants found in soils located at the areas identified in the following table:

Area Name	HQAES ID	AEDB-R ID
Line 1	19105.1001	IAAP-001
Line 2	19105.1002	IAAP-002
Line 3	19105.1004	IAAP-003
Line 3A	19105.1006	IAAP-004
Lines 4A and 4B	19105.1008	IAAP-005
Lines 5A and 5B	19105.1008	IAAP-006
Line 6	19105.1010	IAAP-007
Line 8	19105.1012	IAAP-009
Line 9	19105.1013	IAAP-010
Line 800	—	IAAP-011
East Burn Pads	19105.1016	IAAP-012
Demolition Area and Deactivation Furnace	19105.1027	IAAP-021
Burn Cages, Burn Cage Landfill, West Burn Pads, West Burn Pads Landfill	19105.1037	IAAP-032
North Burn Pads	19105.1039	IAAP-036
North Burn Pads Landfill	19105.1040	IAAP-037
Roundhouse Transformer Storage Area	19105.1044	IAAP-040
Incendiary Disposal Area	19105.1018	IAAP-013
Possible Demolition Site	19105.1023	IAAP-018
Central Test Area	19105.1052	IAAP-047
Fire Training Pit	19105.1042	IAAP-039

AEDB-R ID = Army Environmental Database–Restoration Identification
HQAES ID = Headquarters Army Environmental System Identification

Progress Since the Fourth Five-Year Review Dated March 2021

PFAS Status

A site inspection (SI) report for PFAS at the IAAAP was finalized in December 2022 (Jacobs, 2022a). The SI included only sample analysis for groundwater. At one of the OU-1 sites (Fire Training Pit), nine PFAS were detected above the detection limits, and groundwater concentrations of PFOA, PFOS, and perfluorohexanesulfonic acid (PFHxS) exceeded the project action limits; exceedances of at least one PFAS were identified at all groundwater sample locations. Based on the presence of PFAS in excess of the project action limits, an expanded SI or a remedial investigation (RI) was recommended to delineate the affected areas (Jacobs, 2022a). As a result, planning for an RI for PFAS at the Fire Training Pit, which will include soil sampling, was initiated in 2023.

Reevaluation of Soil Remedial Goals for OU-1

To address the issue identified in the fourth FYR for the IAAAP, an Exposure Assumption and Toxicity Value Assessment was conducted for the five identified chemicals of concern (COCs) (antimony, cadmium,

hexavalent chromium, thallium, and mercury). The assessment evaluated whether the OU-1 RGs for these five COCs are still protective based on 2023 toxicity values and exposure assumptions. Based on the assessment, it was concluded that not all of the existing OU-1 RGs are protective of human health based on exposures to a site worker (indoor worker, outdoor worker, and construction worker). Because activities at the OU-1 sites have changed over the past decades, the site worker may no longer be the only receptor exposed to soil. A comparison of proposed noncarcinogenic and carcinogenic RGs by receptor to the existing OU-1 RGs and soil background values for the IAAAP are presented in Table 1. The background threshold values (BTVs) were established for soil as part of the *Reevaluation of Background Concentrations of Metals in Soil* (Jacobs, 2022b).

The existing RGs for four COCs (antimony, cadmium, hexavalent chromium, and thallium) may not be protective based on current toxicity values and current/future exposure assumptions:

- Current toxicity values for cadmium, hexavalent chromium, and thallium indicate higher toxicity than for previous risk assessments when the existing RGs, which were established in 1996/1997, were used or additional toxicity values were established. There have been no changes to the antimony toxicity values.
- Proposed antimony, cadmium, hexavalent chromium, and thallium RGs for current and future receptors at OU-1 are lower than existing RGs.
- This is consistent with the fourth FYR report, which concluded that the existing RGs for these four COCs may not be protective based on current toxicity values and current/future exposure assumptions.

The existing RG for mercury (as mercuric chloride) remains protective based on current toxicity values and current/future exposure assumptions:

- The proposed mercury RGs for receptors are higher than existing RGs.
- This conclusion is different from the fourth FYR report, since the FYR technical assessment used the Regional Screening Level (RSL) for elemental mercury. Because elemental mercury was not used at the IAAAP, this is not the appropriate form of mercury to evaluate protectiveness at the IAAAP.

The existing OU-1 RGs for the five COCs (antimony, cadmium, hexavalent chromium, thallium, and mercury) were compared to RSLs for a worker spending time both indoors and outdoors (termed a "composite" worker in EPA's RSL table) and an indoor worker. The 2020 RSLs (for a composite worker) are all lower than the existing OU-1 RGs. Note that the 2020 RSLs are being referenced, as these were the values presented in the 2021 FYR, which was the basis for the RG assessment¹. The (2023) calculated RSLs for the indoor worker are also lower than the OU-1 RGs, except for antimony and mercury (as mercuric chloride). This is attributed to the increase in body weight. Based on the comparison of existing RGs to RSLs, not all the RGs are protective of human health based on exposures to a site worker (indoor, outdoor/composite, or construction). Because activities at the OU-1 sites have changed over the past decades, the site worker may no longer be the only receptor exposed to soil. Therefore, the following approach was taken to further evaluate the existing OU-1 RGs for the five COCs (Jacobs, 2023):

- Identify current and potential future receptors at each of the OU-1 sites.
- Calculate proposed RGs for a range of receptors and their exposure routes (based on target risk = 10^{-6} , hazard quotient = 1).
- Compare existing RGs to proposed RGs and soil BTVs.

Potential RGs for current and future receptors (Table 2) were developed and will be documented in an ESD. As noted in Table 2, the current and future receptors include indoor workers, outdoor/composite workers,

¹ The most current RSLs will be used in the final submittal of the forthcoming Explanation of Significant Differences for the Records of Decision Soils Operable Unit 1 (OU-1) Revisions to the Remedial Goals for Iowa Army Ammunition Plant, Middletown, Iowa.

and/or construction workers. Current and potential receptors at individual OU-1 sites are provided in the final *Reevaluation of Soil Remedial Goals for Operable Unit 1 in Support of a Five-Year Review Amendment, Iowa Army Ammunition Plant, Middletown, Iowa* (Jacobs, 2023).

A preliminary human health risk assessment (HHRA) was conducted to evaluate whether existing soil concentrations of four COCs (antimony, cadmium, hexavalent chromium, and thallium) at the OU-1 sites could pose unacceptable risk based on the proposed RGs calculated using current toxicity and receptor-specific exposure parameters. For 20 of the OU-1 sites, soil data for the four COCs (antimony, cadmium, hexavalent chromium, and thallium) collected between 1981 and 2007 were used in HHRA calculations. Maximum detected concentrations were compared to the potential OU-1 RGs; if any of the maximum detected concentrations of the COCs exceeded the potential RG, then an exposure point concentration and risk ratios were calculated for that COC. Based on the preliminary HHRA calculations, additional sampling and risk assessment are recommended for antimony, thallium, and hexavalent chromium in soil at the North Burn Pads site to further assess protectiveness. If new speciated chromium data are collected in the future, then the background values for hexavalent chromium may be adjusted to reflect the current hexavalent/total chromium ratio. Cadmium concentrations are below preliminary RGs and do not require further consideration at the North Burn Pads site. No additional HHRA is warranted at any of the other OU-1 sites.

Issues and Recommendations				
Issues and Recommendations Identified in the Fourth FYR:				
OU(s): OU-1	Issues Category: Remedy Performance			
	Issue: The soil RGs for antimony, cadmium, hexavalent chromium, thallium, and mercury are no longer protective (USACE and Dawson Solutions, 2021).			
	Recommendation: The OU-1 RGs for antimony, cadmium, hexavalent chromium, and thallium have been updated based on toxicity values and current/future exposures as presented in the final <i>Reevaluation of Soil Remedial Goals for Operable Unit 1 in Support of a Five-Year Review Amendment, Iowa Army Ammunition Plant, Middletown, Iowa</i> (Jacobs, 2023). The new RGs will be documented in an ESD for all sites within OU-1 with the exception of the North Burn Pads. Based on the preliminary HHRA calculations, it is recommended that full-scale risk assessment be completed for antimony, thallium, and hexavalent chromium in soil at the North Burn Pads site to further assess protectiveness here. The existing RG for mercury (as mercuric chloride) remains protective based on current toxicity values; therefore, current/future exposure has not been updated.			
Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
No	Yes	Army	EPA/State	
OU(s): OU-1	Issues Category: PFAS Identified			
	Issue: PFAS were identified in the fourth FYR. Site characterization and risk assessment are needed to determine whether the remedy is protective.			
	Recommendation: PFAS were identified in the fourth FYR as an issue. Unacceptable risk has not been determined to date; site characterization and risk assessment are needed to determine whether the remedy is protective. Historical site operations may have resulted in the release of PFAS to the environment at the Fire Training Pit at OU-1. An investigation for PFAS is ongoing as part of the Fire Training Pit RI, and it has not yet been determined whether PFAS poses unacceptable risk that requires remedial action. PFAS are emerging contaminants, data are insufficient to conclude whether it poses unacceptable risks, and no			

	baseline risk assessment is available. A site characterization and risk assessment are needed to determine whether the remedy is protective.			
Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
No	Yes	Army	EPA/State	
Other Findings				
Cites the findings/recommendations that were identified during the Fourth FYR but do not affect current and/or future protectiveness:				
No additional findings identified.				

Based on new information developed since the fourth FYR report completion, the protectiveness statements for OU-1 are revised as follows:

Protectiveness Statement(s)	
<i>Operable Unit:</i> OU-1	<i>Protectiveness Determination:</i> Short-Term Protective
<p><i>Protectiveness Statement:</i> The remedy for OU-1 is protective in the short term for the existing OU-1 COCs. Based on the preliminary HHRA calculations (Jacobs, 2023), the remedy at OU-1 currently protects human health and the environment at all OU-1 sites, except for the North Burn Pads site, for the five COCs that were reevaluated (antimony, cadmium, hexavalent chromium, mercury, and thallium). However, as documented in the OU-10 RI report (Jacobs, 2023), the North Burn Pads site is currently inactive with no change in land use anticipated in the near future. Therefore, there are currently no complete exposure pathways. However, for the remedy to be protective in the long term, follow-up actions need to be taken. New OU-1 RGs for antimony, cadmium, hexavalent chromium, and thallium need to be documented in an ESD. Soil sampling is needed at the North Burn Pads site to update the HHRA for this area. Based on the results, a soil removal action may be warranted to achieve protectiveness.</p>	

Next FYR

The fifth FYR report is due by March 11, 2026.

Attachments:

- Table 1 Comparison of Proposed Remediation Goals by Receptor
- Table 2 Potential Remediation Goals for Current and Future Receptors
- Figure 1 OU-1 Site Boundaries

References

Jacobs. 2022a. *Site Inspection Report: Per- and Polyfluoroalkyl Substances (PFAS) Iowa Army Ammunition Plant, Middletown, Iowa*. December.

Jacobs. 2022b. *Reevaluation of Background Concentrations of Soil in Groundwater, Iowa Army Ammunition Plant, Middletown, Iowa*. April.

Jacobs. 2023. *Reevaluation of Soil Remedial Goals for Operable Unit 1 in Support of a Five-Year Review Amendment, Iowa Army Ammunition Plant, Middletown, Iowa*. July.

U.S. Army Environmental Center. 1997. *Interim Action Record of Decision, Soils Operable Unit, Iowa Army Ammunition Plant, Middletown, Iowa*. October.

USACE (U.S. Army Corps of Engineers). 1998. *Record of Decision, Soils Operable Unit, Iowa Army Ammunition Plant, Middletown, Iowa*. September.

USACE (U.S. Army Corps of Engineers). 2003. *Explanation of Significant Difference for the Final Record of Decision (ROD) Soils Operable Unit (OU-1) at Iowa Army Ammunition Plant (IAAAP) Middletown IA*. January.

USACE (U.S. Army Corps of Engineers). 2008. *Explanation of Significant Difference for the Interim Action Record of Decision 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, IA*. Final. June.

USACE (U.S. Army Corps of Engineers). 2009. *Explanation of Significant Difference for the Final Record of Decision (ROD), Soils Operable Unit (OU-1), Change of Primary Treatment Technology from Biological to Alkaline Hydrolysis Chemical Treatment for Iowa Army Ammunition Plant, Middletown, Iowa*. Final. September.

USACE (U.S. Army Corps of Engineers). 2011. *Explanation of Significant Difference for the Records of Decision Soils Operable Unit (OU-1), Addition of Soil Volume, Site-Specific Remedial Goal for Barium, and Offsite Disposal of Contaminated Soil for Iowa Army Ammunition Plant, Middletown, Iowa*. Final. March.

USACE (U.S. Army Corps of Engineers). 2018. *Explanation of Significant Difference for the Records of Decision, Soils Operable Unit 1 (OU-1), Addition of Land Use Controls, Off-Site Disposal of Contaminated Soil, and the Fire Training Pit for Iowa Army Ammunition Plant, Middletown, Iowa*. Final. October.

USACE and Dawson Solutions (U.S. Army Corps of Engineers–Kansas City District and Dawson Solutions). 2021. *Fourth Five-Year Review Report Iowa Army Ammunition Plant Middletown, Iowa*. Final. March.

Tables

Table 1. Comparison of Proposed Remediation Goals by Receptor

OU-1 COC	Units	Existing OU-1 RG	Combined Soil BTV	Indoor Worker ^a		Outdoor/Composite Worker ^b		Construction Worker ^c	
				Noncancer (HQ=1)	Cancer (ELCR=10 ⁻⁶)	Noncancer (HQ=1)	Cancer (ELCR=10 ⁻⁶)	Noncancer (HQ=1)	Cancer (ELCR=10 ⁻⁶)
Antimony	mg/kg	816	19.6	934	—	519	—	134	—
Cadmium	mg/kg	1,000	0.89	233	9,260	550	10,300	62.6	434
Hexavalent chromium	mg/kg	10,000	21 ^d	6,930	12.3	6,470	7.04	1,110	7.8
Mercury (as mercuric chloride)	mg/kg	310	0.49	701	—	3,890	—	773	—
Thallium	mg/kg	143	18.2	23.4	—	51.9	—	13.6	—

^a Protective of inside site worker and occasional site worker; exposure routes: ingestion and inhalation.

^b Protective of maintenance worker and light construction worker; exposure routes: ingestion, dermal, and inhalation.

^c Protective of heavy construction worker; exposure routes: ingestion, dermal, and inhalation.

^d There is no BTV available for hexavalent chromium. The BTV value presented in the table is for total chromium.

-The most current RSLs will be used in the final submittal of the forthcoming Explanation of Significant Differences to the Record of Decision Soils Operable Unit 1 (OU-1) Revisions to the Remedial Goals for Iowa Army Ammunition Plant, Middletown, Iowa

BTV = background threshold value

ELCR = excess lifetime cancer risk

HQ = hazard quotient

mg/kg = milligram(s) per kilogram

RG = remediation goal

Table 2. Potential Remediation Goals for Current and Future Receptors

OU-1 COC	Units	Existing OU-1 RG	Combined Soil BTV	Potential RGs for Current and Potential Future Receptors		
				Indoor Worker	Outdoor/Composite Worker	Construction Worker
Antimony	mg/kg	816 (nc)	19.6	934 (nc)	519 (nc)	134 (nc)
Cadmium	mg/kg	1,000 (nc)	0.89	233 (nc)	550 (nc)	62.6 (nc)
Hexavalent chromium	mg/kg	10,000 (nc)	21 ^a	12.3 (ca)	7.04 (ca)	7.8 (ca)
Thallium	mg/kg	143 (nc)	18.2	23.4 (nc)	51.9 (nc)	13.6 (nc)

Notes:

-Based on target hazard quotient (HQ) =1 and target risk = 10⁻⁶.

-Final proposed RGs would be based on individual site activities and anticipated receptors.

-The most current RSLs will be used in the final submittal of the forthcoming Explanation of Significant Differences to the Record of Decision Soils Operable Unit 1 (OU-1) Revisions to the Remedial Goals for Iowa Army Ammunition Plant, Middletown, Iowa

^a There is no BTV available for hexavalent chromium. The BTV value presented in the table is for total chromium.

ca = cancer

COC = chemical of concern

mg/kg = milligram(s) per kilogram

nc = noncancer

RG = remediation goal

Figure

