

**FOURTH FIVE-YEAR REVIEW REPORT FOR
ORONOGO-DUENWEG MINING BELT SUPERFUND SITE
JASPER COUNTY, MISSOURI**



Prepared by

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LIST OF ABBREVIATIONS & ACRONYMS

ALC	Aquatic Life Criteria
ARAR	Applicable or Relevant and Appropriate Requirement
ATSDR	Agency for Toxic Substances and Disease Registry
CaCO ₃	Calcium carbonate
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	Contaminant of Concern
DA	Designated Area
DGLS	Department of Geology and Land Survey
EE/CA	Engineering Evaluation/Cost Analysis
EF	Enhanced Fujita
EPA	United States Environmental Protection Agency
FYR	Five-Year Review
IC	Institutional Control
IEUBK	Integrated Exposure Uptake Biokinetic model
JCHD	Jasper County Health Department
MCL	Maximum Contaminant level
MDHSS	Missouri Department of Health and Senior Services
MDNR	Missouri Department of Natural Resources
MDOH	Missouri Department of Health
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
O&M	Operation and Maintenance
OU	Operable Unit
PRP	Potentially Responsible Party
PWSD	Public Water Supply District
RAO	Remedial Action Objective
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RPM	Remedial Project Manager
SDWA	Safe Drinking Water Act
TBC	to be considered
TSMD	Tri-State Mining District
T ₂₀	20 percent Toxicity Threshold
UU/UE	Unlimited use and unrestricted exposure

I. INTRODUCTION

The purpose of a Five-Year Review (FYR) is to evaluate the implementation and performance of a remedy in order to determine whether the remedy is and will continue to be protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in FYR reports such as this one. In addition, FYR reports identify issues found during the review, if any, and document recommendations to address them.

The U.S. Environmental Protection Agency (EPA) is preparing this FYR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121, consistent with the National Contingency Plan (NCP)(40 CFR Section 300.430(f)(4)(ii)), and considering EPA policy.

This is the fourth FYR for the Oronogo-Duenweg Mining Belt Superfund Site. The triggering action for this statutory review is the completion date of the previous FYR. The FYR has been prepared due to the fact that hazardous substances, pollutants, or contaminants remain at the site above levels that allow for unlimited use and unrestricted exposure (UU/UE).

The Site consists of five OUs; four of those OUs will be addressed in this FYR. OU 1 addresses the mill and mine waste. The remedial actions for this OU are ongoing. OUs 2 and 3 addressed lead contamination in residential yards. The remedial actions for those OUs are completed. Any additional response due to site conditions that changed after the May 22, 2011, EF5 tornado will be implemented under OU 1. OU 4 addressed contaminated shallow groundwater. The remedial actions for OU 4 have been completed. OU 5 addresses contaminated surface water and sediments in the Site's perennial streams. The OU that is not addressed in this FYR is OU 5 as it is in the Remedial Investigation/Feasibility Study (RI/FS) stage, and as a result, is not subject to this FYR.

The Oronogo-Duenweg Mining Belt Superfund Site FYR was led by Katy Maynard, Remedial Project Manager. Participants included Brendan Corazzin, Community Involvement Specialist; Mark Doolan, Remedial Project Manager; Jane Kloeckner, Site Attorney; Venessa Madden, Ecological Risk Assessor; Dan Nicoski, Hydrogeologist; Kelly Schumacher, Human Health Risk Assessor; and Don VanDyke, MDNR Project Manager. The review began on 8/21/2016.

Site Background

The Site in Jasper County represents a large part of the Missouri portion of the Tri-State Mining District. The Tri-State District encompasses approximately 2,500 square miles in Oklahoma, Kansas and Missouri, and was formerly one of the richest lead and zinc ore deposits in the world. Mining and smelting activities began as early as 1830, peaked in the years from 1900 through 1950 and continued through the 1970s. The Missouri portion of the district lies within the southwest corner of Jasper County, Missouri. The Site encompasses approximately 250 square miles of the district. Appendix B shows the location and extent of the Site.

Ore production in Jasper County consisted of mining, milling and smelting. Milling included crushing and grinding the rock to standard sizes and separating the ores. At one time, approximately 200 mines were found in and around the Oronogo and Duenweg areas. Extraction and milling of the ore created large piles of mining wastes distributed throughout the county. Approximately 150 million tons of mining and milling wastes contaminated with cadmium, lead and zinc were created during the mining activities. These wastes have been found spread over 11,000 acres, a much larger area than the initial

estimation of 7,000 acres. Approximately 10 million tons of wastes remain on site. These source piles have led to the contamination of surface water, groundwater and surface soils. In addition, smelting operations dispersed airborne contaminants over a large area. Historic smelters have contaminated approximately 2,600 residential yards with unacceptable levels of lead.

Approximately 60,000 people live within the Site boundaries. Most of the population is located within the city of Joplin and the surrounding communities of Webb City, Carterville and Duenweg. Several other small communities are scattered throughout the Site. Land use within the Site is mixed from rural to agricultural and urban. Growth in the communities is high. Development in many areas is spreading into mine-scarred lands. Prior to the EPA's groundwater actions, many homes outside corporate city limits relied on the shallow aquifer for drinking water through private water wells.

FOURTH FIVE-YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION		
Site Name: Oronogo-Duenweg Mining Belt Superfund Site		
EPA ID: MOD 980686281		
Region: 7	State: MO	City/County: Jasper County
SITE STATUS		
NPL Status: Final		
Multiple OUs? Yes	Has the site achieved construction completion? No	
REVIEW STATUS		
Lead agency: EPA		
Author name (Federal or State Project Manager): Katy Maynard		
Author affiliation: US EPA Region 7		
Review period: 8/21/2016 - 7/11/2017		
Date of site inspection: Multiple dates		
Type of review: Statutory		
Review number: 4		
Triggering action date: 8/29/2012		
Due date (five years after triggering action date): 8/29/2017		

II. RESPONSE ACTION SUMMARY

Basis for Taking Action

The contaminants of concern (COCs) for soil, groundwater, surface water and sediments are lead, cadmium, and zinc.

In 1991, the Missouri Department of Health (MDOH), now the Missouri Department of Health and Senior Services (MDHSS), funded by the EPA through the Agency for Toxic Substances and Disease Registry (ATSDR), began a large-scale health study to learn how local residents had been and were being affected by mine-related contamination. The results of that study, released in May 1994, found increased blood lead levels due to exposure to contaminated soils in the Jasper County Superfund Site, and recommended that exposure to the lead-contaminated soil in the study area be reduced. The study showed that approximately 14 percent of children younger than seven years of age at the Site had blood lead levels exceeding 10 micrograms per deciliter ($\mu\text{g}/\text{dL}$).

In response to the health study, the EPA developed a lead strategy for the Site in cooperation with other state, local, and federal agencies. This strategy was presented to the public in May 1994, along with the findings of the health study. The priority of the lead strategy was to address the areas with the highest health risks first. These areas include day care centers with play area soil exceeding 500 parts per million (ppm) lead, yard soil exceeding 500 ppm lead at homes where children with elevated blood lead reside, and residential yard soils exceeding 2,500 ppm lead. The second priority was to remediate soil in residential yards exceeding 500 ppm lead at homes where soils exceeded the action level of 800 ppm. The final Site priority was to replace the temporary bottled water program with a public water supply at homes with metals-contaminated, private drinking water wells.

Beyond the human health issues in the area, a significant evaluation of the ecological impacts from mining was undertaken as a part of the RI. A detailed ecological risk assessment was performed by the EPA and the Potentially Responsible Parties (PRPs). The U.S. Fish and Wildlife Service, under an interagency agreement with the EPA, identified a federally listed endangered species and critical species habitat in the Site's streams. The Ecological Risk Assessment (completed in May 1998) identified significant risk to both aquatic and terrestrial life.

Response Actions

OU 1 – Mine and Mill

In August 2002, the EPA signed an Engineering Evaluation/Cost Analysis (EE/CA) for a non-time-critical removal action of mining waste in the Oronogo-Duenweg designated area (DA), located on the east side of the Site, to clean up mining waste in and adjacent to the construction corridor of the Route 249 Highway project. The EE/CA specified using the mine and mill waste as subsurface fill during construction of the roadway as follows:

- Excavation of the mining waste piles with transport into the highway corridor;
- Removal of the top 12 inches of soil beneath the excavated waste piles;
- Incorporation of the mining wastes and underlying soil into the highway construction fill;
- Implementation of storm water run-off controls during excavation and disposal activities;

- Dust suppression during excavation and disposal activities;
- Placement of 12 inches of clean soil cover on mining waste exceeding 1,500 ppm lead in the highway side slopes;
- Revegetation of disturbed areas.

In September 2004, the EPA signed a Record of Decision (ROD) for the cleanup of the remaining mine wastes at the Site under OU 1.

- Removal Action Objectives (RAOs) for the remedy selected
 - Source material: Mitigate risks to terrestrial vermivores from exposure to COCs from mine, mill and smelter wastes within the Site, such that the calculated toxicity quotients or hazard indexes are less than or equal to 1.0.
 - Sediments: Mitigate risks to aquatic biota in Class P streams and their tributaries exceeding federal Aquatic Life Criteria (ALC) for the COCs by controlling the transport of mine, mill and smelter wastes from source areas to waters of the state.
 - Surface water: Mitigate exposure of aquatic biota to COCs released and transported from mine and mill wastes where applicable or relevant and appropriate requirements (ARARs) for surface water are exceeded in Class P streams and tributaries.
 - Surface water: Mitigate exposure of aquatic biota to COCs released and transported from Site mine-related pits and ponds where surface water ARARs are exceeded in Class P streams and in tributaries.
 - Groundwater: Mitigate exposure of aquatic biota to COCs in releases of groundwater from flowing mine shafts at the Site where surface water ARARs are exceeded in Class P streams and in tributaries.
- Remedy components
 - Removal of mine/mill wastes, contaminated soil, and selected stream sediments;
 - Subaqueous disposal of excavated source material in mine subsidence pits;
 - Recontouring and revegetating excavated areas;
 - Plugging of selected mine shafts and surface water diversion from mine openings;
 - A monitoring program for assessing the effect of cleanup on Site streams;
 - Continuation of the Health Education Program established under OUs 2 and 3;
 - Institutional Controls (ICs) to regulate future residential development in contaminated areas and use of the disposal areas.

In September 2013, the 2004 OU 1 ROD was amended:

- RAOs for the remedy selected
 - No change.
- Remedy components
 - Increase in the volume of on-site wastes and the associated increase in cost;
 - Construction of aboveground repositories;
 - Elimination of the use of biosolids and deep tilling;
 - Increase in the sediment cleanup levels based on site-specific toxicological studies (219 ppm lead, 17 ppm cadmium, 2,949 ppm zinc);
 - Inclusion of contaminated soils in the tornado expedited debris removal (EDR) area in the OU 1 remedy;

- Establishment of a new long-term, above-ground yard soil repository in the former phospho-gypsum waste pile within the Site and closing of the former on-site yard soil repository under OU 2 and OU 3.

Lastly, in 2016, the 2004 OU1 ROD and OU 1 ROD Amendment were modified by an Explanation of Significant Differences as follows:

- Remedy Components
 - Manufactured compost will be utilized to supplement the use of topsoil, which is difficult to obtain in the quantity required, for capping of mining waste repositories;
 - Manufactured compost will be spread in some excavated and remediated areas to promote vegetative growth to help mitigate the severe erosion occurring in these areas. Promotion of better vegetative growth will reduce the amount of operation and maintenance on these eroding areas into the future.

OU 2 – Smelter Zone Residential Yards Soil, and OU 3 – Mine Waste Residential Yard Soil

These OUs both address cleanup of residential yard soil. Response actions were identical and were conducted simultaneously for both OUs. Initial actions conducted for residential yards consisted of a time-critical removal initiated by the EPA in late 1995 on 294 residential yards and six day care centers in the smelter area. Soil removal and replacement was completed at day care centers where soils were greater than 500 ppm lead; at residential yards where soils exceeded 2,500 ppm lead; or where a child in the home had a blood lead level greater than 15 µg/dL. This time critical removal was completed in May 1996.

The EPA signed a ROD for residential yard remediation in August 1996 and began cleanup of yard soil under the remedial program in November 1996.

- RAO for the remedy selected
 - Reduce public exposure, particularly children’s exposure, to residential soils with elevated lead and cadmium concentrations resulting from historic mining and smelting activities.
- Remedy components
 - Excavation and replacement of residential yard soils exceeding 500 ppm lead and 75 ppm cadmium;
 - Construction of an on-site repository for excavated soil;
 - Establishing ICs for new residential and day care center development;
 - Continuation of the ongoing health education programs;
 - Conducting a phosphate stabilization treatability study;
 - Phosphate stabilization of yard soils if treatability study results are positive.

OU 4 – Groundwater

The EPA and the PRPs provided bottled water to those homes where private residential water wells exceeded health-based standards for lead, cadmium and zinc from 1994 to 2002.

The EPA issued a ROD for remedial action for the private water supply wells in July 1998.

- RAO for the remedy selected
 - o Prevent unacceptable human health risk due to ingestion of or exposure to site-related contaminants in groundwater.
- Remedy components
 - o Support to Public Water Supply District 3 (PWSD) in the Oronogo-Duenweg DA;
 - o Extension of existing public water lines in the Oronogo-Duenweg DA;
 - o Extension of existing public water lines in the Irons Gates Extension DA;
 - o Installation of new private deep-aquifer wells to homes not accessible to public water supplies;
 - o ICs to regulate future uses of the contaminated shallow aquifer.

In addition, the OU 4 ROD presented a Technical Impracticability (TI) Waiver for groundwater. This TI Waiver determined that it was not technically feasible to remediate groundwater for heavy metals contamination due to the size of the aquifer.

Table 1: Cleanup Levels Selected

	OU 1		OU 2	OU 3	OU 4
Media	Mine and mill waste	Sediment	Soil	Soil	Ground water
Cleanup Level	400 ppm lead 40 ppm cadmium 6,400 ppm zinc	219 ppm lead 17 ppm cadmium, 2,949 ppm zinc	500 ppm lead	500 ppm lead	0.015 mg/L lead (SDWA) 0.005 mg/L cadmium (MCL)

Status of Implementation

OU 1 – Mine and Mill Waste

The initial remedial action commenced in November 2007. To date, 4,200 acres of what has grown to be over 11,000 acres of mine wastes in OU 1 have been cleaned up, and approximately sixteen million cubic yards of mine wastes and contaminated soil have been excavated, disposed and capped at the Site. Additionally, approximately 13 miles of intermittent stream tributary have been remediated.

OU 2 – Smelter Zone Residential Yards Soil and OU 3 – Mine Waste Residential Yard Soil

The EPA completed soil removal and replacement actions at 2,192 residential yards by September 2001. Except for approximately 30 owner-occupied homes where access for cleanup was denied by the owners, the EPA replaced the smelter- and mining-related contaminated soil exceeding 500 ppm lead in the residential yards where the trigger level of 800 ppm lead was met. MDNR conducted the cleanup actions where owners denied access to the EPA and completed those actions in August 2010. In accordance with the State Superfund Contract, these in-kind cleanup actions reduced the state match amount.

OU 4 – Groundwater

Installation of the public water supply systems began in June 2001. The EPA funded PWSD 3, PWSD 1, the cities of Webb City and Duenweg, and Missouri American Water Company to install the new water supply systems to the areas of groundwater contamination, which cover approximately 25 square miles. During the design phase, the EPA was able to expand the extent of public water supply to include all but two of the homes which are specified in the ROD to receive a whole-house treatment unit. For these two homes, MDNR installed new drinking water wells into the deep aquifer to eliminate the maintenance requirements of treatment units. This in-kind service completed by MDNR also reduced the state match amount. The planned water systems were completed in 2007.

IC Summary Table

Table 2: Summary of Implemented ICs

Media, engineered controls, and areas that do not support UU/UE based on current conditions	ICs Needed	ICs Called for in the Decision Documents	Impacted Parcel(s)	IC Objective	Title of IC Instrument Implemented and Date (or planned)
Soil	Yes	Yes	Entire site	Require soil testing at properties where new residential development occurs in mining- or smelting-affected areas of the county	County Health Ordinance
Soil	Yes	Yes	Entire site	Conduct health education activities including blood lead monitoring	Cooperative Agreement with MDHSS
Above ground repository caps	Yes	Yes	Entire site	Prevent development on and disturbance of the cap, thereby protecting the wastes	County Health Ordinance, Deed Restriction, or Missouri Environmental Covenant
Groundwater	Yes	Yes	Entire site	Restrict installation of groundwater wells and groundwater use	State Regulation

OU 1, OU 2, and OU 3

The ROD for the smelter-affected and mining-affected residential yard soils in Jasper County prescribes ICs to reduce future exposure of children to unacceptable concentrations of lead in soils in new residential construction in the undeveloped contaminated areas. Those ICs were envisioned to consist of a site-wide zoning ordinance that will control new development in mine-affected areas, building codes or health ordinances that will require remediation of soils exceeding the risk-based cleanup standards in new residential construction, and deed restrictions or Missouri Environmental Covenants on excavated yard soil repository sites to protect them from human disturbance. In addition, the OU 1 ROD and ROD Amendment prescribe ICs for repository caps where mining waste has been contained in mine voids and above ground repositories.

In 2005 the Jasper County Commission promulgated a health ordinance requiring soil testing at properties where new residential development occurs in mining- or smelting-affected areas of the county. This ordinance prevents the construction of new residences on contaminated soil by requiring both testing and cleanup of soil if the test results exceed 400 ppm lead.

During the remedial action for OUs 2 and 3, the EPA and Jasper County Health Department (JCHD), in conjunction with MDHSS, developed and implemented a health education program. This program, considered by the EPA as an IC, is conducted by the JCHD with funding from the EPA. Health education activities include blood lead monitoring and in-home follow-up of at-risk children, physician education, and general public education activities. The program is functioning well with 2,000 to 2,400 children tested annually.

Additionally, in 2006 at the request of the EPA, the Jasper County Commission promulgated a building ordinance for construction of new residential dwellings in known contaminated areas. The ordinance, also considered an IC, was implemented and is administered by JCHD, and requires heavy metals testing of yard soil at new residential construction. Yard soils that exceed 400 ppm lead or 25 ppm cadmium require remediation under the ordinance, prior to occupancy of the dwelling. Contaminated soils excavated from these residences are disposed at the soil repository discussed above. The program is functioning well with more than 500 properties sampled since it began.

OU 4

The OU 4 ROD specified ICs for the installation of drinking water wells in the contaminated shallow aquifer at the Site. In 2001, MDNR/DGLS promulgated a well-drilling code regulating the installation of drinking water wells in the contaminated portion of the shallow aquifer. This code supplements the EPA's action of installing public water lines and provides protection to future residents at the Site from exposure to metals in the shallow aquifer.

Additionally, MDNR promulgated a wellhead protection program, considered an IC, for Jasper County and Newton County in 2001. This rule requires newly installed wells drilled in the contamination zone to be completed into the deep aquifer and cased and sealed through the shallow aquifer. The program is administered by DGLS and is functioning properly.

Systems Operations/Operation & Maintenance

The O&M activities for each OU are discussed below.

OU 1, OU 2, and OU 3

O&M associated with this action consists of implementation of the IC program by the JCHD. These include: 1) a Health Ordinance that requires soil testing for any new construction of residential dwellings and cleanup of soil exceeding 400 ppm prior to occupancy of the dwellings; and 2) a Health Education and Blood Lead Monitoring Program. On average, approximately 2,000 children are tested for blood lead each year. Those with elevated levels are assessed and counseled by local health officials to aid in lowering the blood lead concentration of the child.

The soil repository established for OUs 2 and 3 has been incorporated into OU 1 and is being utilized for the disposal of mining wastes. To date, several thousand cubic yards of contaminated soils have been disposed at this repository since the completion of the OU 2 and 3 remedy. This repository will be closing under the OU 1 action. A new repository has been established in the western portion of the Site for disposal of both mining wastes and residential soils. This new repository remains open for use for disposal of metals-contaminated residential soils by local residents, builders and developers constructing new residential dwellings on contaminated soil.

Additionally, the EPA is conducting ongoing stream monitoring to assess sediment quality as part of the OU 5 RI/FS. These data have not been fully analyzed to date, but will be utilized in the near future to develop the remedy for OU 5 and assess the potential need for additional work on OU 1.

OU 4

The public water supplies installed under the remedy for OU 4 were completed in September 2007. These systems are being operated and maintained by the individual entities that installed the systems. These systems are monitored by MDNR on a quarterly basis as required in the SDWA for public water supply systems. Neither the EPA nor MDNR have incurred any costs associated with the O&M of these systems.

III. PROGRESS SINCE THE LAST REVIEW

This section includes the protectiveness determinations and statements from the last FYR, as well as the recommendations from the last FYR and the current status of those recommendations.

Table 3: Protectiveness Determinations/Statements from the 2012 FYR

OU #	Protectiveness Determination	Protectiveness Statement
1	Will be Protective	The remedy at OU 1 is expected to be protective upon completion. In the interim, soil excavation activities completed to date and the ICs program currently in place adequately address the exposure pathways that could result in unacceptable risks in these areas.
2	Protective	The remedy at OU 2 is protective of human health and the environment. The exposure pathways have been addressed through excavation of soils and the implementation of ICs in the form of residential development ordinances.
3	Protective	The remedy at OU 3 is protective of human health and the environment. The exposure pathways have been addressed through excavation of soils and the implementation of ICs in the form of residential development ordinances.
4	Protective	The remedy at OU 4 is protective of human health and the environment. The exposure pathways have been addressed through the installation of the public water supply systems and the implementation of ICs preventing shallow groundwater use.

There were no issues or recommendations in the last five-year review.

IV. FIVE-YEAR REVIEW PROCESS

Community Notification, Involvement & Site Interviews

A public notice was made available by a newspaper posting in The Joplin Globe, on 8/21/2016, stating that there was a five-year review and inviting the public to submit any comments to the EPA. The results of the review and the report will be made available at the Site information repository located at www.epa.gov/superfund/oronogoduenwegmining.

No Site interviews were conducted for the fourth FYR.

Data Review

In general, for activities completed at OUs 1, 2, 3 and 4, O&M activities at these completed remedies include visual inspection and maintenance of soil covers and the enforcement of institutional controls. The public water supply systems are maintained by the PWSD 3, PWSD 1, the cities of Webb City and Duenweg, and Missouri American Water Company.

A significant number of sediment samples have been collected under the OU 5 RI/FS, but have not yet been fully analyzed to assess the current condition of the streams.

No data was evaluated as part of this FYR.

Site Inspection

The repository established in OUs 2 and 3 has been incorporated into OU 1 for disposal of mining wastes. This repository will be closed under OU 1.

Quarterly reports from MDHSS indicate the health education and building ordinance ICs are fully functioning and protective of human health. The most recent quarterly report indicates that over 500 children were tested with approximately 6 percent of them exceeding 5 µg/dL blood lead.

An EPA review of information from representatives of PWS 3, Duenweg, Webb City, and Missouri American Water Company indicates all water systems installed as part of the OU 4 remedial action are functioning properly and supplying water to homes previously at risk from shallow private drinking wells.

An EPA review of information from MDNR/DGLS indicates that the well-drilling IC rule is functioning appropriately and local well-drilling companies are following the requirements in the rule. Therefore, this IC continues to add to the protectiveness of human health by restricting exposure to contaminated groundwater.

V. TECHNICAL ASSESSMENT

QUESTION A: Is the remedy functioning as intended by the decision documents?

Question A Summary:

The completed remedies continue to operate as intended by the decision documents. The remedy for OU 1 is expected to take another three to five years to be completed. The established ICs in place are proving to be effective in continuing to prevent exposure and prioritize yard remediation.

OU 1 Remedial Actions

Remedial actions addressing the mining wastes began in November 2007. To date, approximately 16 million cubic yards of wastes have been removed and disposed from 4,200 acres of land at the Site, and cleanup levels were achieved for all source materials (soils, mine waste, and sediments) that have been addressed. The remedy is expected to take another three to five years to complete. ICs in place continue to address and minimize unacceptable residential use of OU 1.

OUs 2 and 3 Remedial Actions

The remedial action is complete for OUs 2 and 3. Soil cleanup levels were achieved at properties addressed during these operable unit cleanups. The original soil repository will be closed and a new above ground repository has been opened; both are functioning properly and continue to receive mine wastes from contaminated yard soils.

OU 4 Remedial Actions

The remedial action was complete in 2007 and the public water supply continues to function as intended.

Sitewide Institutional Controls

The RODs for OU 1, OU 2, and OU 3 specified development of ICs for future residential development within the Site. The Environmental Task Force of Jasper and Newton County developed a health ordinance that requires soil sampling at all new residential properties and the replacement of any soil with lead greater than 400 ppm. The Jasper County Commission and the city of Joplin adopted and implemented the ordinance that became effective on July 1, 2006.

The RODs also specified development of ICs for protection of the repository caps. OU 1, OU 2, and OU 3 ICs protect the yard soil repositories from disturbance. In addition, OU 1 ICs protect the mining waste repositories from disturbance. These ICs consist of land use restrictions and environmental covenants. The EPA and MDNR will continue to establish these repository ICs during implementation of OU 1.

The RODs also specified ongoing health education as part of the remedy. Among a variety of educational activities conducted, the agencies screen the blood lead levels of children and conduct consultations with parents of those children whose levels are elevated. The JCHD reports approximately 2,000-2,400 children are tested per year with approximately 94% having less than 5 µg/dL blood lead, as shown in Table 4. At the conclusion of the OU 1 remedial action, health education will no longer be required at the Site, dependent on future assessment of blood lead data and potential lowering of blood lead standards.

Table 4: Jasper County Health Department Blood Lead Level Results from Screenings Conducted

Level in mg/dL	2012	2013	2014	2015	2016	Total	% of Total
<5	2,198	2,065	2,003	2,003	2,091	10,360	93.90%
5 - 9.99	181	119	97	82	111	590	5.35%
10 - 14.99	16	11	10	6	9	52	0.47%
15 - 19.99	4	3	5	0	1	13	0.12%
>20	5	2	4	4	3	18	0.16%
Total	2404	2200	2119	2095	2215	11033	

MDNR established the ICs for OU 4 as specified in the ROD. Regulations were promulgated to prevent the installation of private drinking water supply wells in the contaminated zone of the shallow aquifer throughout both the Jasper and Newton County Sites.

QUESTION B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Changes in Standards and TBCs

The EPA reviewed the federal and state ARARs and TBCs listed in Tables 4 and 5 of the 2004 OU 1 ROD. The National Ambient Air Quality Primary Standard for lead decreased from 1.5 micrograms per cubic meter (µg/m³) to 0.15 µg/m³ in 2008. The EPA addresses the release of particulates to air during

remediation activities through dust suppression, primarily watering, in the excavation, hauling, and disposal areas.

For groundwater, the federal Maximum Contaminant Levels (MCLs) were considered chemical-specific ARARs. Based on the MCLs at the time, cadmium, lead, manganese, nickel, and zinc were considered COCs in the 1998 OU 4 ROD. As noted during the last FYR, the arsenic MCL dropped from 50 micrograms per liter ($\mu\text{g/L}$) to 10 $\mu\text{g/L}$ in 2006. However, exposure to contaminated groundwater is an incomplete pathway since the remedy called for alternative water supplies and institutional controls governing the drilling of drinking water wells.

Cleanup Levels

The following table outlines cleanup levels at the Site based on protection of ecological resources.

Table 5: Cleanup Levels Based on Protection of Ecological Resources

Media	Cadmium	Lead	Zinc	Reference
Soil (mg/kg)	41	804	6,424	NewFields, 2001
Sediment (mg/kg)	17	219	2,949	MacDonald <i>et al.</i> , 2008
Surface Water ($\mu\text{g/L}$) @ 100 mg/L CaCO_3	0.25	2.5	120	USEPA, 2006

The EPA has updated its national recommended aquatic life water quality criteria for cadmium. The 2016 criteria reflect data for 75 new species and 49 new genera. The 2016 freshwater chronic criterion (0.72 $\mu\text{g/L}$) for dissolved cadmium is slightly higher (less stringent) compared to the 2001 criterion (0.25 $\mu\text{g/L}$) (USEPA, 2016a). Because these changes resulted in less stringent criteria, they do not impact protectiveness of the remedy. However, given the cadmium cleanup levels cited for the terrestrial source material RAO (41 mg/kg), recontamination of surface water due to run-off of contaminated soil is a potential concern at the Site, even with the 2016 updates. Potential run-off contamination to streams is currently being assessed under the OU 5 RI/FS, and adequate protection of the aquatic environment will be addressed under the OU 5 ROD and subsequent remedy actions.

Several species in Jasper and Newton Counties of Missouri have been added to the endangered species list, or are candidate species for the endangered species list.

Table 6: Endangered Species and Candidate Species of Concern at Site

Species	Listed	Habitat
Northern Long-Eared Bat	Threatened, April 2, 2015	Hibernates in caves and mines surrounding wooded areas. Forages in upland forests.
Arkansas Darter	Candidate Species	Rivers
Neosho Mucket	Endangered, September 17, 2013	Critical Habitat designation in the Spring River (April 30, 2015)
Rabbitsfoot Mussel	Threatened, October 17, 2013	Critical Habitat designation in the Spring River (April 30, 2015)

Sediment toxicity values developed by the United States Geological Survey for the TSMD considered sediment toxicity to amphipods (28-day test, *Hyallela azteca*), midge (10-day test, *Chironomus dilutus*), and juvenile mussels (28-day test, *Lampsilis siliquoidea*). Sediment cleanup numbers for the Site were based on the 20% Toxicity Threshold (T₂₀) values for the most sensitive endpoint, amphipod survival. These values are considered protective of native mussel populations, including threatened and endangered species, as they are lower than the T₂₀ values calculated for mussel biomass. With regard to the Arkansas Darter, a fish species was not evaluated in developing sediment cleanup numbers; however, the ambient water quality criteria are based on toxicity to a number of aquatic genera, including fish. Therefore, Site cleanup numbers for water should be protective of fish, including the Arkansas Darter. Finally, terrestrial cleanup levels for soil are based on the most sensitive endpoint, ground-foraging vermivores. Although the terrestrial cleanup levels for soil in Jasper County are higher than the cleanup levels associated with the other sites in the TSMD, these values should be protective of bats, which are aerial foragers, as this foraging strategy reduces exposure to contaminated soil.

OU 1 Soils

The cleanup criteria selected for source materials and contaminated soils in the 2004 ROD were 400 ppm lead, 40 ppm cadmium, and 6,400 ppm zinc. The OU 1 ROD Amendment called for a site-wide building ordinance across Jasper County for all undeveloped areas, requiring builders to sample and clean up soil to <400 ppm lead and <40 ppm cadmium. The OU 1 ROD Amendment also selected tributary sediment cleanup values of 219 ppm lead, 17 ppm cadmium, and 2,949 ppm zinc.

OU 2 and 3 Soils

The action levels established for residential yards in the 1996 ROD were 800 ppm lead and 75 ppm cadmium (25 ppm cadmium in existing gardens). Once an action was triggered by one or more soil samples collected from a single yard, all soil in that yard with >500 ppm lead was excavated to a maximum depth of 12 inches below ground surface. Clean fill was defined as soils <240 ppm lead and <25 ppm cadmium. The OU 1 ROD Amendment stated that cleanup of the residential yards in those areas of the Site exposed during the May 2011 EF5 tornado would be subjected to the Jasper County ordinance levels of 400 ppm lead and 40 ppm cadmium.

Changes in Toxicity and Other Contaminant Characteristics

Changes to the water quality criteria for cadmium are primarily due to the inclusion of new toxicity studies. As in the 2001 criteria, the 2016 freshwater acute criterion was derived to be protective of

aquatic species and was lowered further to protect the commercially and recreationally important rainbow trout. In addition, the duration of the 2016 acute criterion was changed to one hour. Both changes are consistent with the EPA's current aquatic life criteria guidelines. However, these changes do not impact the protectiveness of the remedy.

Changes in Risk Assessment Methods

The action levels established in the 1996 ROD for residential yards (OUs 2 and 3) were 800 ppm lead and 75 ppm cadmium. If a single sample exceeded 800 ppm lead, all soils with lead concentrations >500 ppm were remediated. The 800 ppm action level was based on the IEUBK model modified for ingestion of soil, based on an extensive survey which was part of the 1994 Blood Lead Study of the community conducted by ATSDR and the MDHSS to determine the time children spend outside, and site-specific bioavailability data. Continual blood lead monitoring of over 2,000 children per year by the JCHD indicates that the remedial action has performed in meeting the goals of the 1996 ROD.

The EPA's OLEM Directive 9200.2-167 recommends that Regions should "consider the current scientific conclusions" when implementing OLEM's soil lead policy. The Directive states that the 2013 Integrated Science Assessment for Lead found clear evidence of cognitive function deficits at blood lead levels between 2 and 8 µg/dL, and that the 2012 National Toxicology Program's Monograph on Health Effects of Low-Level Lead found sufficient evidence of effects on cognitive measures and behavior at blood lead levels below 5 µg/dL. Together, both documents found clear evidence of adverse health effects associated with blood lead levels of 5 µg/dL in young children, and newer data suggests health effects are associated with levels as low as 2 µg/dL. As stated in the last FYR for this Site, the EPA's Office of Superfund Remediation and Technology Innovation is in the process of evaluating the best available science in determining a new target blood lead level and implications for Superfund remedial activities. Additionally, many of the parameters used to evaluate potential risks from lead and derive preliminary remediation goals are currently under review. Comparison of the soil lead policy relied upon for the ROD, which identifies 10 µg/dL as the blood lead level of concern, with the latest OLEM Directive, which indicates that adverse health effects are associated with blood lead levels as low as 2 µg/dL, calls into question the protectiveness of the remedy from a risk-based perspective. The EPA is planning an assessment at the Site to determine the current average blood lead concentrations in young children with the current soil concentration cleanup levels. The assessment will determine if any further actions are required at the Site to protect young children.

Changes in Exposure Pathways

The EPA is not aware of any new routes of exposure. Vapor intrusion (VI) is not a concern since the contaminants, lead, cadmium, and zinc, are metals and are not volatile. While the ecological-based cleanup levels for the Site are only based on potential risk to mammals (NewFields, 2001), which may not be protective of sensitive bird species such as woodcocks and robins, the Site cleanup levels for cadmium and zinc are based on background concentrations and are being cleaned up to that level.

QUESTION C: Has any other information come to light that could call into question the protectiveness of the remedy?

Changes in Site conditions due to the May 2011 EF5 tornado were addressed in the OU 1 ROD Amendment. Specifically, residential properties in the Expedited Debris Removal Area are subject to the Jasper County ordinance requiring confirmation that lead concentrations in soil are less than 400 ppm

and cadmium concentrations are less than 40 ppm. The EPA is not aware of any additional changes in Site conditions that could affect the protectiveness of the remedy.

VI. ISSUES/RECOMMENDATIONS

Issues/Recommendations	
OU(s) without Issues/Recommendations Identified in the Five-Year Review:	
OU 4	

Issues and Recommendations Identified in the Five-Year Review:				
OU(s): 1	Issue Category: Other Assess potential soil run-off			
	Issue: Potential soil run-off from remediated areas to streams may be contaminating sediments since the terrestrial cleanup levels are higher than the target sediment goals.			
	Recommendation: Assess during development of the OU 5 ROD and remedy			
Affect Current Protectiveness	Affect Future Protectiveness	Party Responsible	Oversight Party	Milestone Date
No	Yes	EPA	EPA	9/30/2019

OU(s): 2 and 3	Issue Category: Other Assess blood lead levels			
	Issue: The cleanup levels selected for residential yards may not protect children to current acceptable blood lead concentrations.			
	Recommendation: Conduct a follow-up blood lead assessment in light of new scientific information			
Affect Current Protectiveness	Affect Future Protectiveness	Party Responsible	Oversight Party	Milestone Date
No	Yes	EPA	EPA	8/29/2022

VII. PROTECTIVENESS STATEMENT

Protectiveness Statement(s)

Operable Unit:1 *Protectiveness Determination:*
Will be Protective

Protectiveness Statement: The remedy at OU 1 is expected to be protective upon completion, once the EPA assesses risks associated with soil cleanup levels and associated target blood lead levels in light of new scientific information. In the interim, soil excavation activities completed to date have removed the contaminated soils, and the ICs program currently in place in the form of residential development ordinances ensures residential properties continue to be evaluated and remediated as warranted.

Protectiveness Statement(s)

Operable Unit:2 *Protectiveness Determination:*
Short-term Protective

Protectiveness Statement: The remedy at OU 2 is protective of human health and the environment in the short-term because the residential yards remediated to date have had the contaminated surface soils removed and backfilled with soils that support residential use. Moreover, the implementation of ICs in the form of residential development ordinances ensures residential properties continue to be evaluated and remediated as warranted. In order to ensure protectiveness in the long-term, the EPA needs to complete an assessment of risks associated with soil cleanup levels established for the Site and associated target blood lead levels, in light of new scientific information.

Protectiveness Statement(s)

Operable Unit:3 *Protectiveness Determination:*
Short-term Protective

Protectiveness Statement: The remedy at OU3 is protective of human health and the environment in the short-term because the residential yards remediated to date have had the contaminated surface soils removed and backfilled with soils that support residential use. Moreover, the implementation of ICs in the form of residential development ordinances ensures residential properties continue to be evaluated and remediated as warranted. In order to ensure protectiveness in the long-term, the EPA needs to complete an assessment of risks associated with soil cleanup levels established for the Site and associated target blood lead levels, in light of new scientific information.

Protectiveness Statement(s)

Operable Unit:4 *Protectiveness Determination:*
Protective

Protectiveness Statement: The remedy at OU 4 is protective of human health and the environment.

VIII. NEXT REVIEW

The next FYR report for the Oronogo-Duenweg Mining Belt Superfund Site is required five years from the completion date of this review.

APPENDIX A
REFERENCE LIST

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APPENDIX B

SITE MAP

Jasper County

Mine Waste Areas and Smelter Zone

