CASE STUDY

Oronogo-Duenweg Mining Site
Jasper County, Missouri

August 2010

Prepared by
The Interstate Technology & Regulatory Council
Mining Waste Team

ITRC (Interstate Technology & Regulatory Council). 2010. *Oronogo-Duenweg Mining Site, Jasper County, Missouri*. Mine Waste Treatment Technology Selection Web. Washington, D.C.: Interstate Technology & Regulatory Council, Mining Waste Team. www.itrcweb.org.

Acknowledgements

The ITRC Mining Waste Team would like to acknowledge the assistance of Cherri Baysinger from the Missouri Department of Health and Senior Services, who completed the April 2008 Mine Waste Case Study Survey, from which the information in this case study is taken.

TABLE OF CONTENTS

LIST OF FIGURES

ORONOGO-DUENWEG MINING SITE, JASPER COUNTY, MISSOURI

1. SITE INFORMATION

1.1 Contacts

D. Mark Doola
U.S. Environmental Protection Agency
901 N. 5th Street
Kansas City, KS 66101
Telephone: 913-551-7169
Fax: 913-551-8717
E-mail: Doolan.Mark@epamail.epa.gov

1.2 Name, Location, and Description

The Oronogo-Duenweg mining area covers the western 30%-50% of Jasper County in southwest Missouri (Figure 1-1). The towns of Joplin, Webb, and Carterville are included in this area. Mining of lead and zinc ore began in the mid-1800s and included hundreds of mines and 17 smelters. Peak production occurred in 1916, when over 123 million rock tons were processed to yield approximately 304,000 tons of zinc and 41,000 tons of lead concentrate.

Soil, stream sediments, and area groundwater have elevated concentrations of lead and zinc from the mining and smelting operations. Contamination has occurred through air dispersal from the stacks of the smelters, wind dispersal of ore particles from open haul trucks, leachate from tailings and chat piles, and the tailings and chat piles themselves. Approximately 8 million tons of mining, milling, and waste material are left in the area. Much of the waste material has been removed to be used as fill material in roadbeds, aggregate in asphalt, traction control for icy roads, railroad ballast, roofing abrasives, and as fill in children's sandboxes.

2. REMEDIAL ACTION AND TECHNOLOGIES

Residential yards were divided into quadrants and sampled for lead. If the sample results exceeded 800 mg/kg in any quadrant, the yard was slated for removal. The entire yard was excavated to a depth of 12 inches and the contaminated soil disposed of in a repository. If the soil at a depth of 12 inches exceeded 1500 mg/kg lead, a physical barrier (heavy plastic mesh) was placed on the soil prior to backfilling. Yards identified as containing vegetable gardens were excavated to a depth of 18–24 inches or until confirmation results were below 500 mg/kg lead. Backfilled soil was covered with sod or seeded with grass.

This removal action was conducted to address the residential yards only. The rest of the contamination and site issues were addressed through separate actions under the Superfund process.

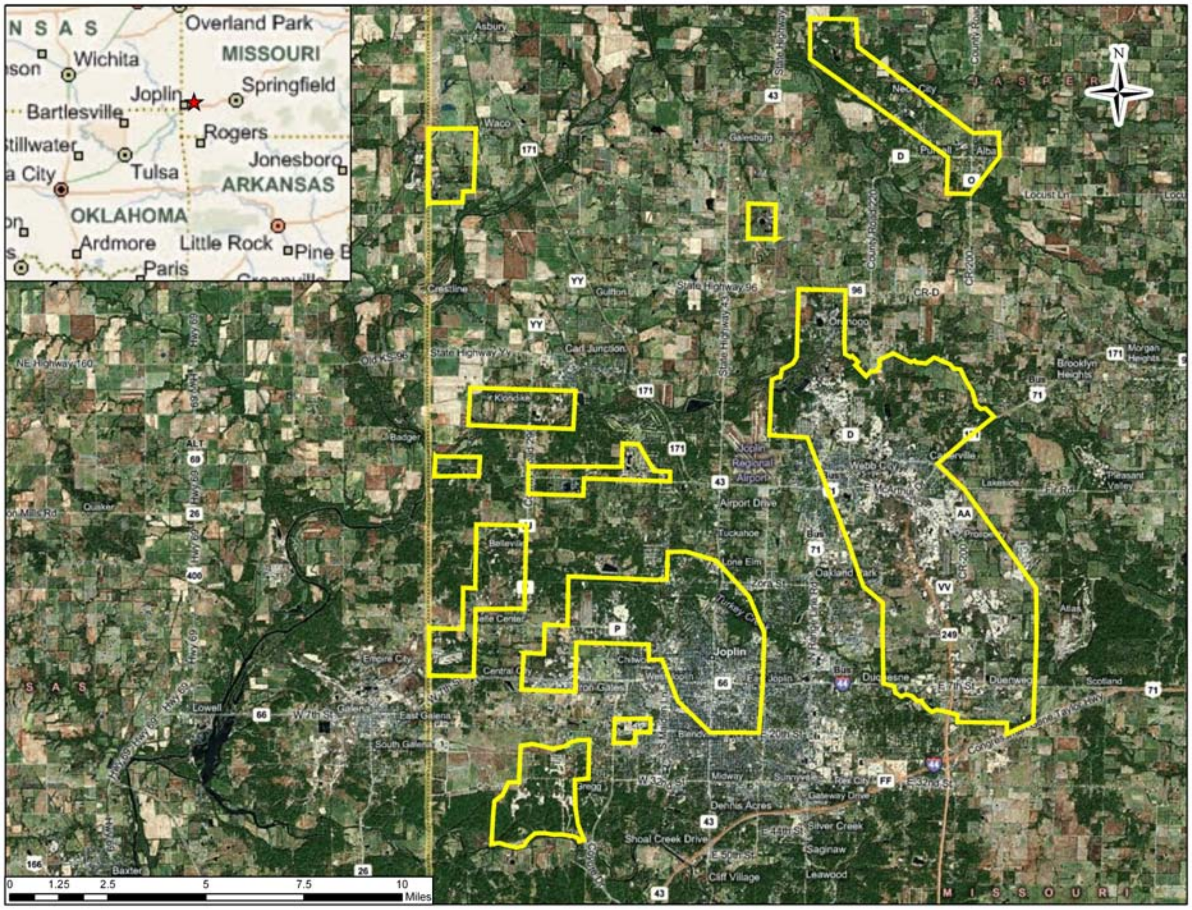

Figure 1-1. Aerial view of Oronogo-Duenweg mining area with location inset.
Map created with ESRI ArcView software using Microsoft Bing maps.

The bioavailability of Jasper County soils was high relative to other sites tested nationwide. In situ phosphate treatment (e.g., phosphoric acid) to reduce bioavailability of lead in residential yards was studied over a period of six years. Results showed reduction in bioavailability of lead (up to 40%) was achieved, but the technology was not implemented since the site goals were met (reduction of blood levels) with soil removal and disposal.

Pilot testing was conducted at the site to evaluate the use of different types and application rates of biosolids (municipal wastewater treatment sludge) to stabilize solid mine wastes and to establish vegetative cover that would reduce exposure risks. Application rates of 40–60 tons per acre (dry weight) of biosolids were applied at selected sites (comprising approximately 200 acres of land) with good short-term success. Additional biosolids were added to select areas at rates up to 150 tons dry weight per acre plus 50 tons per acre of other organic waste (yard waste compost) to successfully establish long-term growth.

3. PERFORMANCE

Site cleanup goals were based on mitigation of risk to human health. Screening values of 800 mg/kg lead and 75 mg/kg cadmium were used for yards to be considered contaminated, which would result in the excavation of the soil. “Clean” soil used to backfill the excavation could not contain lead in concentrations exceeding 240 mg/kg. Cleanup goals were based on IEUBK modeling of blood lead levels in children.

Smelter-contaminated soil and mill waste–contaminated soil (5,000–2,500 mg/kg Pb) was treated with a variety of phosphate amendments (phosphoric acid, potassium chloride, and calcium hydroxide) and subjected to bioavailability testing using immature swine as a model. The conclusion of this study is that the metal chemical bonding formed by phosphate stabilization is stable over time. Heavy application rates were used, with the most effective treatment tested being 1% phosphoric acid, which reduced the bioavailability of lead up to 43%. The reduction in bioavailability was maintained over a 6.5-year period. This study also concluded that phosphate treatment would only be effective for moderately contaminated soils (<1000 mg/kg). The concentration that could be effectively treated is highly dependent on the untreated bioavailability of the lead. Less bioavailable soils could be treated at higher concentrations.

The biosolids sites received an average of 50 tons of biosolids/acre. There was significant success in the establishment and continued growth of vegetation. The vegetative cover had high diversity, and the nutrient runoff at the site was within acceptable limits. An ecological risk evaluation by the U.S. EPA of the site demonstrated that metals no longer present an unacceptable risk at the site. Ten years after treatment some of the areas with highest zinc and lead contamination (>10,000 mg/kg and >2,000 mg/kg, respectively) are poorly vegetated. In areas where 40–50 tons dry weight per acre of biosolids were applied, plants depleted the nutrients relatively rapidly and did not maintain long-term growth. In areas where 200 tons (dry weight) per acre were applied, the plants were observed to maintain long-term growth. The recommendation from this pilot study was that in areas of the highest contamination, higher application rates are needed. The recommendation was for 100 tons/acre of biosolids with 50 tons/acre of additional organic matter to form the appropriate carbon:nitrogen (C:N) ratios. Optimal C:N ratios are approximately 20:1 to reduce the potential for nitrogen runoff. Lime addition may also be necessary to stabilize pH. At the Jasper County site, lime was added at a rate of 10 tons/acre. Any application at this rate would likely require a special permit near any residences due to exceedances of standard nutrient loads. Additionally, the material was not able to be used near residences unless composted due to odors.

4. COSTS

The cost for excavation and disposal was approximately $10,000–15,000 per yard. Costs of in situ phosphate treatment of contaminated soils were estimated at $4000 per residential yard. However the cost of this technology has increased due to the decreased availability of phosphoric acid. The current cost of in situ phosphate treatment is high enough to be not cost-effective when compared to conventional excavation and disposal methods. Biosolids application costs are highly variable and driven by local markets, availability of organic matter, and transportation distance.

5. REGULATORY CHALLENGES

No information reported.

6. STAKEHOLDER CHALLENGES

EPA and the Missouri Department of Health and Senior Services conducted extensive public outreach, including the development of written materials and hosting public meetings. The excavation of yards was conducted in conjunction with abandonment of homes and relocation of families. A response summary is included as part of EPA's record of decision.

Phosphate treatment has some limitations in its public acceptance. In situ phosphate treatment results in destruction of vegetation in the yard temporarily and restricted access for a number of days. Residents may not want their yards destroyed despite the status of contamination. However, the alternative is excavation of the yard, which is a more destructive alternative.

Biosolids applications also have some limits in its public acceptance. Biosolids treatment can have serious odor concerns that will definitely limit its use to rural settings. Other potential adverse effects of land application of biosolids are nutrient loading to surface water, and pathogens, additional metals, and other toxic chemicals (e.g., dioxin and PCBs) may be present in the biosolids.

7. OTHER CHALLENGES AND LESSONS LEARNED

Research has shown that phosphate treatment, as an agent to reduce the bioavailability of lead to reduce human health exposure, is effective at only moderate concentrations (<1200 mg/kg). Higher concentrations of lead and other heavy metals could be treated with in situ phosphate if human health protection is not the primary focus (i.e., ecological risk or threats to groundwater). Phosphate treatment is most effective in reducing the mobility and bioavailability of lead.

More implementation is necessary to assess the applicability of in situ treatment. More testing should be conducted on lower application rates (0.75% phosphoric acid, for example) and on other reagents (triple super phosphate) to reduce costs and increase the ease of implementation. In addition, a noninvasive application method such as aqueous application of phosphate amendments in residential settings would increase the cost-effectiveness and the acceptance of this technology. While phosphoric acid–based treatment is the most effective in the long term for stabilizing heavy metals in soil, it can cause short-term leaching of other metals (e.g., Cd and Zn). Therefore, a buffering agent is needed to return soil pH conditions to neutral if other more soluble metals are of concern.

Winter time or cooler weather application is helpful in biosolids treatment. Application in cooler weather reduces the odor and ensuing neighbor complaints. Extensive education is normally necessary for the Clean Water Act (NPDES) permitting authority. Very high application rates are necessary in barren or sparsely vegetated environments: 100–150 tons/acre of biosolids. Where lower rates have been used (25–50 tons/acre) revegetation success has been minimal in five or ten years after application.

8. REFERENCES

EPA (U.S. Environmental Protection Agency). 1996. EPA "Superfund Record of Decision: Oronogo-Duenweg Mining Belt, OU2." www.epa.gov/superfund/sites/rods/fulltext/r0796086.pdf.

EPA. 2004. "EPA Superfund Record of Decision: Oronogo-Duenweg Mining Belt, OU1." www.epa.gov/superfund/sites/rods/fulltext/ r0704656.pdf.

EPA. 2010. "Oronogo-Duenweg Mining Belt, Missouri, EPA ID# MOD980686281." www.epa.gov/region7/cleanup/npl_files/mod980686281.pdf.

Mosby, D. E., S. Casteel, J. Yang, C. J. Gantzer, and R. Blanchar. 2002. *Final Report: Lead Bioavailability Study Phosphate Treatment of Lead-Contaminated Soils, Joplin, Missouri, Jasper County Superfund Site*. For EPA Region VII, Kansas City.

Wood, M., P. Farrelly, and D. Mosby. n.d. "Evaluation and Comparison of Effective Microorganisms for Use in a Lead and Zinc Mine Land Reclamation Project in Jasper County, Missouri, USA." www.envismadrasuniv.org/pdf/Mining%20Reclamation.pdf.