

# APPROPRIATE INDICES TO EVALUATE IN SITU RESTORATION<sup>1</sup>

Sally Brown<sup>2</sup>, Harry Compton, Mark Sprenger, Mike Zimmerman and  
Michael Holmes

**Abstract.** Our work in Leadville, CO as well as in other hard rock and metal contaminated sites in the US involve amendment addition as a means to reduce the hazard associated with elevated soil metals rather than removal and replacement of the contaminated materials. Amendment addition, in this case a mixture of municipal biosolids and limestone, offers the potential to restore large areas in a cost effective manner. The amendment mixture is either applied to the surface of the contaminated materials or incorporated using agricultural equipment. As by-products of different processes, mixtures of residuals can effectively substitute for clean soil at a range of sites. This avoids the potential negative impact associated with harvesting clean soil from sensitive areas. However, with this type of remedial approach, changes in the total concentration of metals in soil will be small. New metrics need to be utilized for evaluation of alternative remedial options.

For these sites we have recommended and implemented a combination of eco-risk and engineering (leach tests) measures with a great deal of success from the regulatory community. At the Leadville site, we utilized a suite of standard engineering measures including the toxic characteristic leaching test (TCLP) and the multiple extraction procedure (MEP) in combination with standard soil extracts and soil functionality measures. We also tested the biosolids and other amendment materials. The in situ amendment was able to meet these standards in addition to the soil functionality measures that were used. This combination of testing protocols was important to gain acceptance of this remedy from within EPA as well as from state and federal agencies, potentially responsible parties and local citizens. A description of the process of appropriate amendment identification and our testing protocol will be described.

**Additional Key Words:** engineering measures, in situ amendment, residuals

---

<sup>1</sup> Paper was presented at the 2006 Billings Land Reclamation Symposium, June 4-8, 2006, Billings MT and jointly published by BLRS and ASMR, R.I. Barnhisel (ed.) 3134 Montavesta Rd., Lexington, KY 40502.

<sup>2</sup> Sally Brown, Research Associate Professor, College of Forest Resources, University of Washington Box 352100 Seattle, WA 98195 (206) 616 1299 E-mail: [slb@u.washington.edu](mailto:slb@u.washington.edu) and Harry Compton, Environmental Engineer and Mark Sprenger, Toxicologist, US EPA Environmental Response Team, 2890 Woodbridge Ave, Edison, NJ 08837 (732) 321 6751 E-mail: [Compton.harry@epa.gov](mailto:Compton.harry@epa.gov) and [Sprenger.mark@epa.gov](mailto:Sprenger.mark@epa.gov) and Mike Zimmerman, On Scene Coordinator and Michael Holmes, Remedial Project Manager US EPA Region 8, Denver, CO (303) 312 6828 E-mail: [Zimmerman.mike@epa.gov](mailto:Zimmerman.mike@epa.gov) and [Holmes.Michael@epa.gov](mailto:Holmes.Michael@epa.gov).