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Overview of Vol.5, No.5 - Case Studies of Terrestrial Decontamination

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As U.S. human populations increase, urbanized areas expand to the edges of landscapes contaminated by human industry and natural resource processing. Contaminants left behind by these activities that previously were not sources of immediate concern become environmental problems that pose threats to human health, making swift decontamination necessary. The variability in site conditions, problems posed by contamination, and time constraints of restorations make it difficult to generalize about strategies for decontamination.

In this section of Volume 5 of Restoration and Reclamation Review, terrestrial decontamination is examined in four case studies of remediation efforts. The case studies presented address two decontamination problems: 1) the revegetation and remediation of contaminated soil, and 2) the joint remediation of groundwater and soil contamination. An example of the revegetation and remediation of contaminated soil is provided by David Felleson, who discusses the reclamation of open pit mines and spoils banks resulting from iron ore and taconite mining in northeastern Minnesota. Dana Gardner presents another example of remediating and revegetating contaminated soil in her case study of the reclamation of a zinc, lead and cadmium-laced soil on a zinc smelting site in northeastern Pennsylvania. Matthew Swenson, who summarizes the cleanup of an agricultural pesticide, ethylene dibromide (EDB) discusses the joint remediation of the groundwater and soil contamination at Brookhaven National Laboratory that threatens Long Island's sole source aquifer. Anthony Randazzo presents another example of this kind in his discussion of petroleum-contaminated soil and groundwater resulting from leaking underground storage tanks at the Soo Line Railyard in Minneapolis, Minnesota. Several key issues in restoration planning and implementation success are addressed by these case studies.

Often reviews of contaminant remediation focus on the science and process of those techniques. Case studies address these issues, but also provide the unique opportunity to illuminate the economic and social pressures that may affect remediation techniques chosen and how closely a restoration site is returned to its historical condition. Randazzo points out that as long as economic growth is valued over full remediation, the degree to which a sited is restored will remain limited by economic constraints. Felleson states that recreation and tourism are economic pressures that identify reclamation of abandoned open pit mines as essential, making the main goals of reclamation the re-contouring and rapid stabilization of slopes, not the restoration of a native vegetative community. Partial restoration that emphasizes economic feasibility is the resulting compromise that allows for some limited environmental recovery in these instances.

The case studies in this volume also demonstrate the time pressures and the urgency of remediation when human safety is at stake. In the case of EDB contamination at Brookhaven National Laboratory, Swenson mentions that residents' fear of drinking water contamination and a call from local legislators to have the laboratory shut down fueled a rapid remediation effort. Randazzo notes that the areas designated by Environmental Protection Agency (EPA) as Superfund sites are not necessarily identified by degree of contamination, but are often in locations where development of need jobs and housing is limited by the health threats posed by

the contamination of a site. Felleson lists re-contouring steep slopes that pose serious hazards to residents as the first step of open pit and spoils banks reclamation. In many restoration efforts, maximum environmental improvement in a site is exchanged for faster reduction in threats posed by the site to humans.

Geology and soil characteristics are site factors constrain the feasibility of techniques used and extent of remediation, and can work in favor of, or against speedy successful remediation. At the zinc smelting site discussed by Gardner, steep rocky slopes and downed trees made the site inaccessible to vehicles, making it necessary to blow seeds (mixed with fly ash and sludge) onto the mountainside with an Estes Aerospreader, rather than more traditional seeding methods. One of the factors that contributed to the successful bioremediation of the Soo Line Railyard site addressed by Randazzo is the homogeneity of the subsurface geology and the accessible and uniform plume pattern of the contaminated groundwater—the restoration would have been more complicated and expensive had the plume been dispersed and inaccessible. Site constraints can drastically alter the price of a restoration, which can in turn determine the degree to which a site is restored.

Undeniably, a thorough knowledge of geology and soil characteristics at a restoration site is imperative to restoration planning. Trial and error to determine the efficiency of restoration techniques is inappropriate when money and human health are at stake. But collecting data on site characteristics can be time consuming, and it is difficult to determine how thorough an investigation of site conditions is necessary. Randazzo attributes the successful use of bioreactor technology at Soo Line Railyard to the extensive knowledge of site characteristics, which was obtained over a two-year environmental assessment. Felleson points out that a soils study revealed that reverse stratification of soils had occurred as topsoil was excavated and stockpiled, causing low fertility on spoils banks that presented a primary concern during revegetation. Identification of these conditions can provide essential information for restoration planning purposes that can save time and money.

In addition to collecting data regarding site characteristics, experimentation can often provide essential information to the planning of a restoration project. Gardner lists two studies as essential to determining the best revegetation strategy for the zinc smelter contamination site. A greenhouse study determined that fly ash and sludge were most effective as a growing medium when combined with lime and potash, and another determined that the highest vegetative cover could be achieved with a mixture of orchardgrass (*Dactylis sp.*), tall fescue (*Festuca arundinacea*) and crownvetch (*Coronilla sp.*). Felleson describes an experiment performed by a cooperative research team consisting of the U.S. Bureau of Mines and several mining companies. Their study examined the use of organic amedments to improve revegetation on coarse mine tailings, and determined that less organic amendment than thought necessary was sufficient to re-establish vegetation. Effective pre-restoration experiments require foresight and experience not available to all projects or situations, but significantly increase chances of success.

Although phytoremediation is an attractive, sometimes lower cost and lower maintenance alternative to other remediation techniques, the slow uptake of toxins into plant tissues and the pressures of cleaning up quickly often make phytoremediation infeasible. Two case studies in this volume list two other possible scenarios in which phytoremediation was not an appropriate

remediation technique. In the case of the zinc smelting site, Gardner explains that the potential remediation species were small annuals which did not provide cover for wildlife, an important goal of this restoration. At the Brookhaven National Laboratory site, phytoremediation was infeasible because plants that absorbed EDB became hazardous themselves, posing a threat to organisms that feed on EDB-contaminated plants and the rest of the food chain associated with those organisms.

Because of the economic, social, and individual physical site constraints mentioned above, there is no cook-book recipe for a successful restoration, but creative, cost-effective solutions are necessary. For instance, Gardner describes a case in which a soil amendment was acquired to revegetate Blue Mountain. Fly ash was obtained from a nearby coal-fired electric generating plant, significantly reducing transportation costs, and the city of Allentown, Pennsylvania provided the project with sewage sludge at no cost, since donating the sludge was cheaper than paying to have it landfilled.

A fundamental issue in each of the case studies presented in this volume is the need for a remediation strategy that accounts for the individual needs and constraints of each reclamation site. The consensus is that different strategies are necessary for different situations, and a full knowledge of environmental and social constraints surrounding the project is the key for planning and carrying out a successful restoration.