Frequently Asked Questions About Ecological Revitalization of Superfund Sites

Ecological revitalization provides habitat for wildlife and is not considered beautification or enhancement; therefore it can be incorporated into site remediation plans.

Fact Sheets on Ecological Revitalization

- This fact sheet is the first in a series of fact sheets on ecological revitalization.
- The second fact sheet "Revegetation of landfills and waste containment areas", EPA 542-F-06-001, can be found at http://cluin.org/ecorevitalization.
- Look for our third fact sheet "Ecological Revitalization and Attractive Nuisance Issues", EPA 542-F-06-003.

Introduction

Damaged land does not have to be abandoned land. Ecological revitalization can return damaged land to a state of health, vitality, and diversity. This fact sheet, the first in a series on ecological revitalization, addresses many frequently asked questions about ecological revitalization and revegetation of Superfund sites.

Through the Superfund, Brownfields, and Federal Facilities programs, the U.S. Environmental Protection Agency (EPA), states, tribes, or potentially responsible parties (PRP) clean up sites that pose real or potential threats to human health or the environment. Part of the cleanup process may include ecological revitalization – a cost-effective way to either create habitat or incorporate it as a natural remediation technology for Superfund sites while increasing the ecological value of the land. As those responsible for site cleanups learn more about ecological revitalization, its use at Superfund sites increases. In fact, EPA is helping communities reuse cleaned up sites through the Superfund Redevelopment Initiative (http://www.epa.gov/superfund/programs/recycle/), and several of those Superfund sites have a planned recreational end use that will incorporate ecological revitalization.

The information in this fact sheet is intended for EPA site managers, state agency site managers, consultants, and others interested in restoring disturbed sites. Various information sources used to prepare this fact sheet are listed at the end.

What is ecological revitalization?

Ecological revitalization of a Superfund site is the process of returning a site to a functioning and sustainable use. Ecological revitalization re-establishes a site to a natural state, thus increasing or improving habitat for plants and animals without impairing the remediation activities that ensure the protection of human health and the environment. Although ecological revitalization can be used to create habitat as a specific goal, it also can be used to complement or enhance a traditional cleanup method; as a green remediation technology to remove or stabilize contaminants; or reduce erosion while providing valuable wildlife habitat. Ecological revitalization also can be used adjacent to areas redeveloped for commercial use, such as for riparian zones, and in conjunction with recreational features such as hiking and biking trails or bird-watching lookout stations.

134339

Selected Benefits of Ecological Revitalization

- Removes stigma associated with prior waste sites
- Repairs damaged land
- Enhances property values
- Provides recreational uses for local residents
- Improves soil health and supports diverse vegetation
- Creates wildlife habitat
- Contributes to a green corridor
- Can reduce erosion, sequester carbon, and control landfill leachate
- Protects surface and groundwater from potential contamination

Why should I consider ecological revitalization? What are the benefits?

Ecological revitalization provides a variety of environmental, economic, and public relations benefits. When the end use of a site is considered, those responsible should discuss all future use alternatives with the community, including ecological revitalization. The EPA Environmental Response Team (ERT) can assist in facilitating public outreach.

Environmental Benefits:

- **Biodiversity** In addition to providing areas that are more aesthetically pleasing than mowed grass or pavement, ecological revitalization provides important habitat that attracts and sustains wildlife, such as migratory birds. Areas with a variety of native plant species are less impacted by disease, provide habitat for a variety of wildlife species, and may be vital links to other habitat areas on critical migration routes.
- **Contaminant remediation** Ecological revitalization can include natural remediation technologies that can help biodegrade environmental contaminants, sequester carbon to make it unavailable as a greenhouse gas, improve groundwater recharge, and control landfill leachate.
- **Soil stability** Ecological revitalization provides rooted vegetation to stabilize the soil and can reduce the need to excavate or import soil. This in turn can limit dust, reduce erosion, and slow down and filter storm water runoff.
- **Education** Ecological revitalization provides educational, interpretive, and stewardship opportunities for students and the local community.

Economic Benefits:

- **Cost** Not only is ecological revitalization cost-competitive with other remediation technologies, but the reduced maintenance requirements often make it less expensive than many other end uses. Conservation easements, environmental offsets, and an increased tax base can also provide additional economic benefits.
- **Aesthetic value** Ecological revitalization can provide recreational areas that increase local property values or provide revenue. In addition, aesthetically pleasing commercial greenscaping or residential areas attract more customers and can be marketed to create a competitive advantage.

Public Relations Benefits:

- **Improved community image** Ecologically revitalized sites improve the aesthetics of a community and may increase recreational use and tourism.
- **Improved agency image** Site owners and regulatory agencies may gain an enhanced reputation, "green" image, external validation, and sustainable operations.

Additional information on the benefits of ecological revitalization is available through the Interstate Technology and Regulatory Council (ITRC 2004 and 2006). See the information resources listed at the end of this fact sheet.

What types of sites can be ecologically revitalized? Are small or industrial sites eligible?

Ecological revitalization can be implemented to some degree at any site; however, the benefits will be strongly influenced by the surrounding area. Ecological revitalization can most easily be incorporated for a site that is already located within a larger beneficial habitat or ecosystem. Sites that are somewhat isolated, but are along a corridor or riparian or transition zone and linked to more extensive habitat, are also suitable for revitalization. Sites that are completely isolated within industrial or residential development may also be candidates for ecological improvements and community recreational opportunities.

Small or industrial sites within an urban or suburban setting may appear to contribute less to the ecosystem, but they can be important habitats, reservoirs, or sanctuaries, and provide excellent opportunities for public education or recreation. In many cases, these sites provide valuable opportunities for restoring rare or unique habitat types and provide beneficial recreational assets such as soccer fields, golf courses, playgrounds, or parks with a green element. In many situations, ecological revitalization should be considered as part of a "green landscaping" approach to site development. These sites can provide a sense of ownership and opportunities for stewardship among the residents and public.

Should I use native vegetation for ecological revitalization?

Native vegetation should be used for ecological revitalization whenever possible. Executive Order 13148 refers to a presidential memorandum regarding beneficial landscape practices on grounds landscaped with federal dollars (http://www.epa.gov/greenacres/EO13148.pdf). The memorandum requires the use of regional native vegetation in landscaping when possible. Native vegetation prefers native (unfertilized) soils, and does not require soil amendments, such as fertilizer. Appropriate site and soil analyses should be performed during predesign stages of the project. On many Superfund sites, the soil characteristics are different than characteristics of native soil (for example, soil may have a lower pH or higher salt concentration). Soil amendments may be necessary in these cases to remediate contamination, and certain native vegetation may not thrive in the resulting environment. Therefore, it is not always possible to revegetate a site strictly using regional native vegetation. A restoration practitioner should be consulted to aid in proper selection of the vegetation and to increase the chance of planting success. The restoration practitioner can specify analyses that help match appropriate species of vegetation with site and soil conditions. Some minimal care should be incorporated during implementation, and a plan could be developed to cover such items as watering and any need for pest control, including control of invasive plant species. Longer term

Site managers should work with the local community when deciding to include ecological revitalization as a cleanup component for a site. Active participation by the local community enhances the value and acceptance of the final restoration effort. EPS's ERT (http://www.ert.org) can help to foster community partnership by outreach, public meetings, and providing technical information.

Site Types and Case Studies Related to Ecological Revitalization

- **Mining:** Cherokee County Galena Subsite (OU5) (native prairie grassland with potential for grazing or light industry development) - http://www.epa.gov/superfund/programs/recycle/success/casestud/chercsi.htm
- **Foundries:** Abex Corporation (playground in addition to a fire department and police station) - http://www.epa.gov/superfund/programs/recycle/success/briefs
- **Manufacturing facilities:** Industri-Plex (open space and wetlands preserve in addition to expanded roads and retail space) - http://www.epa.gov/superfund/programs/recycle/success/casestud/iplexcsi.htm
- **Avtex Fibers:** (open space in addition to a recreational park and an eco-business park) - http://www.epa.gov/superfund/accomp/success/avtex.htm
- **Refineries:** Alameda Naval Air Station (golf course and marina) - http://www.epa.gov/superfund/programs/recycle/pilot/facts/r9_38.htm
- **Landfills:** Lipari Landfill (open space with nature trail in addition to recreational fields, a parking lot and recreation building) - http://www.epa.gov/superfund/programs/recycle/success/1-pagers/lipari.htm
- **Military Installations:** Pease Air Force Base (wildlife refuge in addition to a public airport)- http://www.epa.gov/superfund/programs/recycle/success/briefs
- **Metal Plating:** Revere Chemical (native wildflower habitat) - http://www.epa.gov/superfund/programs/recycle/success/briefs/pa_brief.htm#pa_14
- **Tannery:** A.C. Lawrence Leather site in New England - contact ERT for more information

For more cases studies, visit the Wildlife Habitat Council website at http://www.wildlifehc.org/brownfield_restoration/case_studies.cfm.

Leadville, CO – Before ecological restoration
(Source: Dr. Sally Brown, University of Washington)

Leadville, CO – After ecological restoration
(Source: Dr. Sally Brown, University of Washington)

maintenance options, if allowed and appropriate, should also be established for the site.

Early in the process, site managers should incorporate funding in the budget for implementing ecological revitalization. While native plant seeds can be expensive and more difficult to sow, the reduced operation and maintenance (O&M) costs make native plants a more economical long-term option than non-native plants. Native plants can be used to establish a self-sustaining ecosystem, usually within 3 to 4 years, if properly selected and planted.

What kind of habitat should be considered for ecological revitalization?

Any site has the potential for ecological restoration, regardless of its size or location. While a variety of habitats can be considered for ecological revitalization, the habitat type in the surrounding area would likely have the greatest chance of success. In any case, site managers should always work with the community to determine the preferred beneficial reuse for the site, and thus habitat type.

Ecological revitalization can be managed for a variety of habitats such as meadow, prairie, riparian buffers and forest, and for wildlife such as nongame species, birds, and migratory butterflies. When planning for a specific habitat type, a restoration practitioner can provide valuable recommendations to maximize a habitat's potential for success. In addition to determining appropriate species and management techniques, the restoration practitioner can provide recommendations for adding nesting boxes, preserving snags, considering pollinators, and adding other habitat features to help attract and sustain wildlife populations.

Can you effectively predict and control the type of vegetation that will develop on a site when applying ecological revitalization?

Various types of Superfund sites, such as mined areas, hazardous waste spills, and landfills may require very different treatment technologies and different approaches to ecological revitalization. Initially, a planting will typically consist of a mixture of seeds or plants, native when possible, used to revitalize the habitat. However, the diversity will change because some plants will be better adapted to the site-specific conditions than others. If the vegetation is not maintained at the same stage as when it was planted, the plant community will naturally progress toward a more mature state or climax community. For example, if a native grass planting is not mowed in some regions, shrubs and trees will eventually take root and grassland will progress toward woodland. It is most

West Page Swamp, Bunker Hill, ID – Before ecological restoration
(Source: Dr. Sally Brown, University of Washington)

West Page Swamp, Bunker Hill, ID – After ecological restoration
(Source: Dr. Sally Brown, University of Washington)

important to maintain native species that are functional based on the surrounding native vegetation.

At any revitalized site, invasive species should be controlled to allow native species to become established. Invasive species can quickly spread and invade disturbed land, especially in areas that contain bare soil. An invasive species management plan should be developed to prescribe methods for effectively controlling invasive species, such as burning, where allowed, or the use of chemical, biological, or hand-pulling techniques.

Will implementing an ecological revitalization project impair site remediation or development?

Site remediation activities are protective of human health, and ecological revitalization modifies a site to increase or improve habitat for plants and animals without impairing site remediation or development. Furthermore, an effective revitalization design can (1) reduce or eliminate exposure through the use of amendments for capping and soil cover or (2) reduce the bioavailability of contaminants through the use of organic amendments. Ecological revitalization measures incorporated for beneficial end use need to be planned early to maximize the use of native vegetation or to focus on opportunities for passive recreation and environmental education during site development. In addition, an ecological risk assessment should be completed to ensure that the revitalization and other cleanup components effectively protect the environment, thereby improving the protection of human health as well.

What is the definition of "attractive nuisance"?

For the purposes of the Superfund Program, an attractive nuisance is the potential for wildlife to be harmed from waste left on a site after a remedial action has been completed and a revegetation effort undertaken. One example is an abandoned mining site that is barren and void of life. After lime-treated biosolids are incorporated to complex the metals of concern, the health of the soil (fertility and general suitability to support root growth) is improved to permit revegetation with native plants and promote a self-sustaining ecosystem as habitat for nongame species. Once the plants are established, animal life becomes re-established. Because the metals remain in the soil, they could move through the food chain to adversely affect raptors at the top of the food chain. Thus, because no animals were present on the site prior to its revitalization, a potential attractive nuisance is created.

Jasper County, MO – Before ecological restoration
(Source: Dr. Sally Brown, University of Washington)

Jasper County, MO – After ecological restoration
(Source: Dr. Sally Brown, University of Washington)

Will ecological revitalization at sites where waste remains cause an attractive nuisance?

While ecological revitalization improves habitat for plants and animals, the primary goal of remediation is to protect human health and the environment. Therefore, if the potential for an attractive nuisance exists, an ecological risk assessment could be conducted to demonstrate that contaminants of concern are not present or will not accumulate to levels that might be toxic to wildlife attracted by the revitalized habitat. The risk assessment or a monitoring program would evaluate the potential risks to the environment, and the remediation and ecological revitalization would address any concerns. In addition, when an ecological revitalization project is implemented, the protection of public health may correspondingly improve. The ERT has conducted various evaluations concerning attractive nuisance over the past 6 years and can provide technical support in addressing this issue at a particular site. Additional information is provided in a separate fact sheet on ecological revitalization and attractive nuisance issues.

Can land application of biosolids cause contaminants to enter the food chain and result in harm?

Generally no. Biosolids are applied (with other soil amendments) to sites with disturbed soil as part of an in situ remediation approach or to provide soil nutrients. These are usually sites with metal-contaminated soils, where it is impractical to extract or remove the contaminants. Components within biosolids help to complex certain contaminants, minimizing or reducing their bioavailability. Iron, lignins, and other organic material can bind contaminants of concern, immobilizing them and rendering them biologically unavailable.

Specifically, the issue of attractive nuisance has been a concern at some Superfund remediation sites involving biosolids application. The concern pertained to lead moving through the vermiform pathway (for example, earthworms to shrews to raptors). Various regulatory agencies have requested studies to address the potential for contaminants to move up the food chain through this pathway. The contaminants are still present in the soil and can be extracted with strong acids. The key question is whether the bioavailability has been reduced to the point where harm or risk is acceptable under normal environmental conditions. Different studies have been conducted to answer this question. For example, treated soils have been fed to pigs, and small mammal trapping with follow-on pathology studies have been performed. To date, no evidence suggests that the contaminants are not adequately complexed. This reduction in bioavailability is encouraging, but has not been evaluated over long periods of time. EPA is currently working on a technical performance measures (TPM) paper to address the types of tests that should be applied to monitor and evaluate the efficacy and safety of applying biosolids during remediation efforts.

Some examples of Superfund sites that used biosolids during restoration include Bunker Hill in Idaho; California Gulch in Leadville, Colorado; and the Jasper County Site in Joplin, Missouri.

For additional information on land application of biosolids and compost, go to http://www.epa.gov/compost and http://www.epa.gov/own/mtb/biosolids/.

How does wetland mitigation compare to ecological revitalization?

Wetland mitigation involves creating new wetland habitat to compensate for impacts to existing wetlands. Ecological revitalization can be considered part of wetland mitigation depending on the site-specific habitat. However, if the wetland mitigation is part of a contaminant treatment system, it cannot be considered part of ecological revitalization. Such a wetland could be a cost-effective alternative to conventional technology, such as groundwater pump and treat. For example, at the Silver Bow Creek/ Warm Springs Ponds Superfund site in Montana, the PRP decided to fund the revitalization of a copper mining area after cleanup activities were completed; the effort included creating 400 acres of wetlands (http://www.epa.gov/superfund/programs/recycle/success/1-pagers/bowcrk.htm).

For additional information on wetland mitigation requirements, go to http://www.epa.gov/wetlandsmitigation/.

Mitigation ratios vary depending on the type and quality of the wetland that will be lost and the predicted time until functions are revitalized at the mitigation wetland. Even impacts to man-made wetlands can require mitigation because the characteristics and functional value of a wetland – and not the origin – are the primary factors in determining whether mitigation is required. Treatment wetlands constructed to remove contamination from surface water or leachate do not meet mitigation requirements, primarily because of their structure and function. Properly designed treatment wetlands need to be densely planted with an aggressive plant species to minimize exposure to contaminants that may collect in the sediment. These wetlands are not designed to attract wildlife or replicate the habitat and functional values of wetlands.

If plants are introduced for phytoremediation, does that qualify as revitalization?

In some cases, phytoremediation can be a cost-effective alternative for surface soil or water treatment and can help revitalize species diversity through habitat creation or expansion. Phytoremediation encompasses a broad range of designs. Some designs rely on plantation-style grids of non-native species that have negligible ecological value or use mass plantings of hyperaccumulating species that are harvested and disposed of off site; however, these crop systems do not constitute ecological revitalization. Other phytoremediation approaches use a mix of plant species to provide long-term revitalization, reduce bioavailability, and provide valuable habitat. These approaches, when designed to maximize ecological value, would be considered ecological revitalization or revegetation using native species.

Native plantings planned for early in the design process are a cost-effective consideration. However, cost savings realized through phytoremediation are site-specific and depend on the techniques applied. Savings can include the difference between soil removal and disposal versus the cost of the plants and the labor for planting. Savings could be achieved for groundwater contamination by replacing pump-and-treat technology required over many years with deep-rooted plants that extract water and transpire volatile contaminants.

For additional information on phytoremediation, go to http:// www.itrcweb.org/Documents/PHYTO-2ExecSum.pdf or http://www.cluin.org/techfocus and choose phytoremediation.

Do caps or soil covers over residual contamination have to be planted with fescue or is ecological revitalization appropriate?

Ecological revitalization is appropriate at these sites. Many caps and soil covers have been planted with fescue because it is easy to establish. In addition, some site managers are concerned that native plantings are more expensive and that the deeper roots of native species might compromise the cap.

Although caps planted with fescue are easy to establish, they do not provide useful habitat and require routine maintenance, which increases long-term O&M costs. The native seeds and plants themselves are more expensive than lawn grass seed mixes; however, O&M costs over many years are significantly lower for native plantings because of their hardiness to poor conditions, longevity, and self-seeding potential. Ecological revitalization that incorporates mixed native plant species also provides beneficial wildlife habitat.

If a cap is properly designed, roots of native species will not compromise the cap. Root growth depends on the soil characteristics, and the presence of a clay liner or geomembrane influences their growth. Research at the Brookfield Sanitary Landfill in New York showed that roots, including taproots, grow laterally once they reach the clay cap. No significant damage to the clay cap was observed as a result (Robinson and Handel 1995). For additional information, please see the fact sheet on revegetating landfills and waste containment areas (EPA 542-F-06-002, http://www.cluin.org/ecorevitalization) and review the references by Steven Handel listed at the end of this fact sheet.

Ecologically revitalized areas are not necessarily off limits to the public. Recreational uses such as trails, athletic fields, and wildlife mixed use are compatible with ecological revitalization and revegetation using native species. In fact, kiosks and public viewing areas often can be included in ecological revitalization plans.

Caps or soil covers that already have established fescue can be converted to native plants. An effective conversion method is to burn the existing fescue, if possible, and follow up with applications of a broad spectrum herbicide registered for the establishment of native warm season grasses and forbs. As the native grasses and forbs are establishing, follow-up herbicide treatments may be necessary to control the fescue. While areas can be converted from fescue to native plants, the conversion must be carefully planned and should be conducted by a restoration practitioner to increase the likelihood of success.

A separate fact sheet on revegetation of landfills and waste containment areas will provide additional information (http://www.cluin.org/ecorevitalization).

What maintenance and repair activities should I expect when supporting ecological revitalization?

All cover-type remedies require some level of maintenance. O&M costs will be lower for ecological revitalization because, while there is some cost for weed control, there is minimal to no cost for mowing.

- **Short-term requirements** When plants are establishing on the site, short-term monitoring and maintenance will consist primarily of weed control and irrigation, when necessary and possible, and reseeding to ensure the health of the native plants. Various methods can be used to control weeds, including mowing, hand pulling, prescribed burning, or use of EPA-registered pesticides; the most appropriate method depends on the final use of the site. An invasive species management plan that specifies short- and long-term activities should be developed early in the process by a restoration practitioner. If necessary in the management plan, guidelines for mowing to control weeds will need to be developed and followed, particularly because forbs and young trees will be eliminated if they are inadvertently mowed.

- **Long-term requirements** Long-term maintenance activities vary depending on the site. Some sites do not require any long-term maintenance because the native plants create a self-sustaining habitat. If the goal is to create a specific setting to attract a particular type of wildlife, such as butterflies, then tree removal and occasional mowing might be necessary. In general, long-term maintenance depends on the long-term objective of the site and should be determined by a restoration practitioner. If the objective requires intervention with the natural progression of the site, then some minimal long-term maintenance would be required.

Considering that native species typically take longer to become fully established (as compared to commercial erosion control seed mixes), how do I provide for appropriate vegetative cover during the establishment period?

Various agencies and organizations, including the Natural Resources Conservation Service (http://www.nrcs.usda.gov/), state native plant societies (such as in California [http://www.cnps.org] and Texas [http://www.npsot.org/]), or local Soil Conservation Service centers (http://offices.sc.egov.usda.gov/locator/app), can identify the best planting time for specific areas and species and can provide additional information to ensure appropriate vegetative cover during the establishment period. Some simple treatment might be required to improve the survival of planted species, such as soil surface cultivation and the use of nurse species (for example, sterile rye grass or non-sterile legumes). A fast-growing sterile nurse species grows quickly and then dies, providing soil protection and increased nutrients. Sterile annual rye grasses that germinate and grow quickly are often added to native seed mixes

For additional information on monitoring and evaluation of a revitalized site, go to http://www.ser.org/content ecological_revitalization_primer.asp#8.

to control erosion. In addition, fast-growing shrubs can be planted to stabilize stream banks, allowing time for slower-growing trees to mature and overtop the shrubs. Small groups of trees can be planted over a remediated area to attract birds and other animals that will naturally disperse seeds and expand the forested area over time.

Ecological revitalization is considered accomplished once a revitalization practitioner is no longer needed to ensure long-term sustainability of the ecosystem (typically after 3 to 5 years). However, long-term management may be required to prevent recurrent degradation of revitalized ecosystems. For trees and shrubs, contracts often require 90 percent survival after the first year of planting. Reseeding of bare spots and poor growth areas is often necessary for grasses and herbaceous plants.

Who is financially responsible for ecological revitalization, and are there any legal requirements?

The financial responsibility and legal requirements associated with ecological revitalization of a Superfund site are site-specific. Although EPA strives to get PRPs to fund the cleanup of a Superfund site, Superfund money can be used for the cleanup if the PRP cannot be found, is not viable, or refuses to cooperate. Whether a site is funded by the PRP or with Superfund money, ecological revitalization activities can be incorporated into the site reuse plan because they are not considered beautification or enhancement. Such activities are considered beneficial reuse and fall within EPA's policies, initiatives, and priorities.

The cost of native seeds can be high, so it is important to decide on the use of native plants early in the process and incorporate the associated costs into the remediation budget. When incorporating beneficial reuse into the site plan and remediation budget, one rule of thumb is to budget 5 to 10 percent of the remediation budget for beneficial reuse. For a removal site, ecological revitalization can be included in the action memorandum; for a remedial site, it can be included in the record of decision. If an ecological revitalization component is included in the selected remedy, completion of the revitalization can be required in a consent decree. If revitalization is not included in the site reuse plan, site managers can work with PRPs to explain the benefits of ecological reuse and encourage voluntary revitalization activities. However, unwilling PRPs cannot be forced to complete revitalization activities if those activities are not included in the site reuse plan.

Additional Information and Resources

Handel, S.N. et al. 1994.
"Biodiversity Resources for Restoration Ecology."
Restoration Ecology.
Volume 2, Number 4. Pages 230 through 241.

Interdisciplinary Training for Ecosystem Restoration.
On-Line Address:
http://www.epa.gov/owow/watershed/wacademy/training/bkley6.html

Internet Seminars on Ecological Restoration.
On-Line Address:
http://www.clu-in.org/studio/seminar.cfm

ITRC. Planning and Promoting Ecological Land Reuse at Remediated Sites. 2006.
On-Line Address:
http://www.itrcweb.org

Plant Conservation Alliance.
On-Line Address:
http://www.nps.gov/plants

Robinson, G.R., and S.N. Handel. 1993.
"Forest Restoration on a Closed Landfill: Rapid Addition of New Species by Bird Dispersal."
Conservation Biology. Volume 7, Number 2.
Pages 271 through 278.

Robinson, G.R., and S.N. Handel. 1995. "Woody Plant Roots Fail to Penetrate a Clay-Lined Landfill: Management Implications." *Environmental Management*. Volume 19, Number 1. Pages 57 through 64.

Society for Ecological Restoration (SER) International: Guidelines for Developing and Managing Ecological Restoration Projects, 2nd Edition. Andre Clewell, John Rieger, and John Munro. December 2005. On-Line Address: http://www.ser.org

U.S. EPA Revegatation of Landfills and Waste Contaminant Areas Fact Sheet" EPA 542 F-06-001. On-Line Address: http://www.cluin.org/ecorevitalization

U.S. EPA. Green Landscaping with Native Plants: Greenacres. On-Line Address: http://www.epa.gov/greenacres/

U.S. EPA Greenscape Program. On-Line Address: http://www.epa.gov/greenscapes/

U.S. EPA. An Introduction and User's Guide to Wetland Restoration, Creation, and Enhancement. On-Line Address: http://www.epa.gov/owow/wetlands/pdf/restdocfinal.pdf

U.S. EPA Land Revitalization Offices and Programs. On-Line Address: http://www.epa.gov/swerrims/landrevitalization/index.htm

U.S. EPA National Association of Remedial Project Managers (NARPM) Training Conference. On-Line Address: http://www.epanarpm.org

U.S. EPA Reusing Cleaned Up Superfund Sites: Golf Facilities Where Waste is Left On Site. On-Line Address: http://www.epa.gov/superfund/programs/recycle/pdfs/golf-103103-c.pdf

U.S. Department of Agriculture, Natural Resource Conservation Service. On-Line Address: http://soils.usda.gov/survey/printed_surveys/

U.S. EPA Superfund Redevelopment Program. On-Line Address: http://www.epa.gov/superfund/programs/recycle/index.htm

Wildlife Habitat Council. On-Line Address: http://wildlifehc/org

Acknowledgment

Photographs used in this fact sheet were reproduced with permission from Dr. Sally Brown, Research Associate Professor, University of Washington.

Contact Us

If you have any questions or comments on this fact sheet, or suggestions for future fact sheets, please contact:

Ellen Rubin
(703) 603-0141
rubin.ellen@epa.gov

Scott Fredricks
(703) 603-8771
fredricks.scott@epa.gov

Office of Superfund Remediation and Technology Innovation (5102P)

EPA 542-F-06-002
December 2006
www.epa.gov