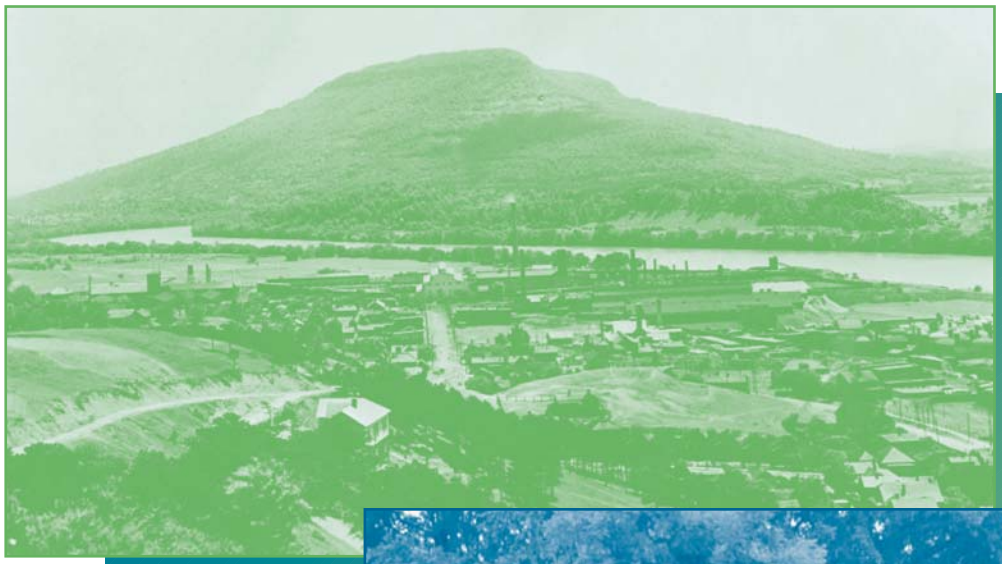
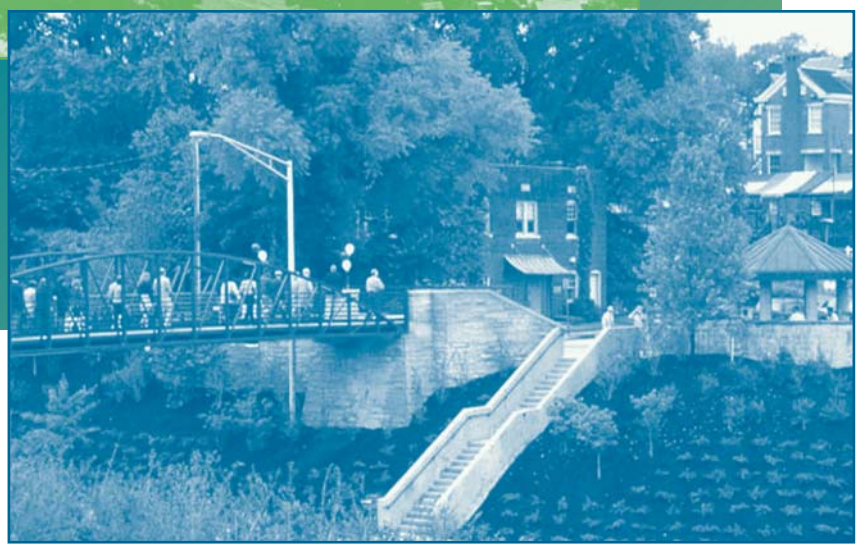
Technical and Regulatory Guidance

Planning and Promoting Ecological Land Reuse of Remediated Sites





July 2006

Prepared by
The Interstate Technology & Regulatory Council
Ecological Land Reuse Team

ABOUT ITRC

Established in 1995, the Interstate Technology & Regulatory Council (ITRC) is a state-led, national coalition of personnel from the environmental regulatory agencies of some 40 states and the District of Columbia, three federal agencies, tribes, and public and industry stakeholders. The organization is devoted to reducing barriers to, and speeding interstate deployment of, better, more cost-effective, innovative environmental techniques. ITRC operates as a committee of the Environmental Research Institute of the States (ERIS), a Section 501(c)(3) public charity that supports the Environmental Council of the States (ECOS) through its educational and research activities aimed at improving the environment in the United States and providing a forum for state environmental policy makers. More information about ITRC and its available products and services can be found on the Internet at www.itrcweb.org**.**

DISCLAIMER

This document is designed to help regulators and others develop a consistent approach to their evaluation, regulatory approval, and deployment of specific technologies at specific sites. Although the information in this document is believed to be reliable and accurate, this document and all material set forth herein are provided without warranties of any kind, either express or implied, including but not limited to warranties of the accuracy or completeness of information contained in the document. The technical implications of any information or guidance contained in this document may vary widely based on the specific facts involved and should not be used as a substitute for consultation with professional and competent advisors. Although this document attempts to address what the authors believe to be all relevant points, it is not intended to be an exhaustive treatise on the subject. Interested readers should do their own research, and a list of references may be provided as a starting point. This document does not necessarily address all applicable heath and safety risks and precautions with respect to particular materials, conditions, or procedures in specific applications of any technology. Consequently, ITRC recommends also consulting applicable standards, laws, regulations, suppliers of materials, and material safety data sheets for information concerning safety and health risks and precautions and compliance with then-applicable laws and regulations. The use of this document and the materials set forth herein is at the user's own risk. ECOS, ERIS, and ITRC shall not be liable for any direct, indirect, incidental, special, consequential, or punitive damages arising out of the use of any information, apparatus, method, or process discussed in this document. This document may be revised or withdrawn at any time without prior notice.

ECOS, ERIS, and ITRC do not endorse the use of, nor do they attempt to determine the merits of, any specific technology or technology provider through publication of this guidance document or any other ITRC document. The type of work described in this document should be performed by trained professionals, and federal, state, and municipal laws should be consulted. ECOS, ERIS, and ITRC shall not be liable in the event of any conflict between this guidance document and such laws, regulations, and/or ordinances. Mention of trade names or commercial products does not constitute endorsement or recommendation of use by ECOS, ERIS, or ITRC.

Planning and Promoting Ecological Land Reuse of Remediated Sites

July 2006

Prepared by
The Interstate Technology & Regulatory Council
Ecological Land Reuse Team

Copyright 2006 Interstate Technology & Regulatory Council

Interstate Technology & Regulatory Council (ITRC). 2006. *Planning and Promoting Ecological Reuse of Remediated Sites*. ECO-2. Washington, D.C.: Ecological Land Reuse Team, Interstate Technology & Regulatory Council, www.itrcweb.org.

ACKNOWLEDGEMENTS

The members of the Interstate Technology & Regulatory Council (ITRC) Ecological Land Reuse Team wish to acknowledge the individuals, organizations, and agencies that contributed to this Technical and Regulatory Guidance Document. The Ecological Land Reuse Team effort, as part of the broader ITRC effort, is funded primarily by the United States Department of Energy. Additional funding and support have been provided by the United States Department of Defense, the United States Environmental Protection Agency (EPA), Exxon-Mobil, and Texaco-Chevron. ITRC operates as a committee of the Environmental Research Institute of the States (ERIS), a Section 501(c)(3) public charity that supports the Environmental Council of the States (ECOS) through its educational and research activities aimed at improving the environment in the United States and providing a forum for state environmental policy makers.

The team also wishes to recognize the efforts of the following individuals and state agencies:

- Charles Johnson, Team Leader, Colorado Department of Public Health and Environment
- Kenneth Beard and Ramesh Belani, Pennsylvania Department of Environmental Protection
- Eleanor Wehner, Texas Commission on Environmental Quality
- Gregory DeCowsky, Delaware Department of Natural Resources and Environmental Control
- Tom Schneider, Ohio Environmental Protection Agency
- David Mosby, Missouri Department of Natural Resources

The team depends on input from all perspectives to give ITRC documents the broadest practical application. The team members have offered that mix of perspectives and skills necessary to further the understanding and incorporate ecological elements into the final land use of remediated sites. The team appreciates the voluntary efforts of the following practitioners who demonstrate the application of ecological elements and do their best to encourage other consultants and businesses to employ this approach: Charles Harman, AMEC Earth and Environmental; Barbara Padlo, Atlantic Richfield; Gregory Fletcher, Suncor Energy; Mark Luce, Chevron; Greg Biddinger, ExxonMobil; Lucinda Jackson, ChevronTexaco; and Joseph Nicolette, Elm Consulting, LLC. Thanks also to a principal partner, The Wildlife Habitat Council, and Leslie Kordello and Raisa Marks (also of The Wildlife Habitat Council) for their practical knowledge of habitat issues and to Letitia O'Connor, Department of Energy, Legacy Management. The team also thanks Mike Fitzpatrick, EPA, for contributing the valuable insight on the value systems and the widespread opinions of EPA on the subject of ecological land reuse.

Foremost, thanks to the community stakeholders John Chambliss and David Jewett for volunteering their time, contributing their community perspective, and helping the team understand the value of the community's knowledge, appreciation, and acceptance of ecological land reuse of remediated sites. Thank you to Chattanooga, Tennessee, not only for being a gracious host to the team, but also for having the insight to rebuild the community, after years of industrial neglect, into a beautiful and thriving cultural community. Thank you for setting the bar high. Finally, thank you Steve Hill (RegTech, Inc.) for keeping the team on track and moving ahead and for reminding members of writing assignments and of their responsibility to the team.

EXECUTIVE SUMMARY

An ecological enhancement is a modification to a site which increases and improves habitat for plants and animals while protecting human health and the environment. Elements of ecological enhancement can include natural or green remediation technologies and/or an end use which restores or otherwise increases the ecological value of the land. Ecological elements may be designed into remediation and closure projects. Considered at the inception of planning a site cleanup, green and natural technologies, in addition to traditional technologies, can cost-effectively cleanup soil and groundwater contamination and restore, create, and/or improve habitat or the ecosystems. Designing an ecological end use as an integrated component of the remediation system can realize more benefits from the remediation process without compromising the selected remediation goals and objectives. Incorporation of ecological enhancements can benefit multiple stakeholders, such as regulatory agencies, the regulated community, local communities, and the general public. The team believes that greater benefits may be gained by integrating ecological land reuse into the initial remediation strategy, but this in no way is meant to preclude incorporation of ecological enhancements into remediation projects which are already underway.

The Interstate Technology and Regulatory Council (ITRC) Ecological Land Reuse Team has developed this guidance document to promote ecological land reuse as an integrated part of site remediation strategies and as an alternative to conventional property development or redevelopment. This reuse may be achieved through a design that considers natural or green technologies or through more traditional cleanup remedies. The decision process presented here helps stakeholders to integrate future land use and stakeholder input into an ecological land end-use-based remediation project. Key to the project success is an understanding of the service capacity (the ability to produce jobs, housing, environmental habitat, mineral resources, agricultural goods, and other societal values) at, near, and surrounding a remediation project. Integrating stakeholders input regarding their desires for community development and needs is critical. This type of an integrated project can gain strong support from the stakeholders and can transform them into strong advocates for projects integrating ecological elements into the future land reuse plans. The ITRC team is experienced in cleanup and ecological and habitat development techniques and in representing various interests (such as community stakeholders, consultants, the regulated community, government regulatory agencies, non-governmental organizations, and other government agencies). The team has incorporated various perspectives into this guidance to improve its applicability, usability, and value.

This document describes key decision points in a flow diagram format and defines the practicality of applying natural or green technologies to traditional remediation processes. Ecological benefits have not traditionally been designed into, nor credited to, the value of the reusable land until successful remediation was completed. Now, natural and green technologies can improve the ecology of the site as long as they support the intent of the land's use and do not jeopardize the elimination or reduction of the human or environmental risk. Consideration of ecological benefits, as well as the end use of an environmentally impacted site, is an integral component of the remediation process.

Ecological land reuse may have multiple advantages, and a single ecological element may have multiple benefits such as environmental, economic, or public. This guidance document categorizes several ecological reuses, without limiting their benefits, in order to offer a presentation of possible advantages. The potential advantages are shown below:

Environmental	Economic	Public
• attracts wildlife • hydraulically controls landfill leachate • biodegrades environmental contaminants • controls dust • reduces sediment transport and controls erosion • stabilizes stream banks • uses atmospheric carbon dioxide • improves groundwater recharge • minimizes human and environmental exposures • provides a harvestable resource • improves aesthetics • provides educational opportunities • provides recreational areas • provides migratory pathways • improves plant diversity	• is cost competitive • provides use for waste material • enables more efficient use of limited resources • provides institutional control • can potentially generate revenue • provides marketing and competitive advantages • increases property value • provides source of recoverable resources • provides potential for environmental offsets • potential for enhanced environmental stewardship • offers tax advantages • reduces natural resources damage liability	• provides recreational and tourism opportunities • provides educational opportunities • improves corporate reputation • improves goodwill through good neighbor • enhances workforce stability through improved morale • improves aesthetics • improves livability • increases natural resources

These benefits are included in a value system used to estimate the cost of cleanup alternatives at a contaminated site. A project team should consider the complete life cycle of the project, from technology selection to final disposition of the property, for an accurate economic picture of the alternatives. A comparison of the relative economic advantages of two alternative approaches, one having moderate initial costs, high O&M (operation and maintenance) costs, and a short duration and the other having low initial costs, moderate O&M/administrative costs and a long duration can be made through a net present value analysis. These cost elements can be broken down into three general categories: quantifiable values, semiquantifiable values, and qualitative values.

Items in each of the three value categories should be considered for every potential alternative in a project to fully evaluate its value in comparison to other alternatives. When properly done, they present a “story”—an objective and subjective description of the outcome that also explains the indirect benefits, which may not have a clear economic value. This process leads to inclusive decision making. Even if a factor is thrown out for lack of impact on the decision, it should still be considered to make sure all projects are evaluated consistently and completely. A comprehensive financial estimate, using as many of the pertinent factors as possible, will provide more sound decisions, thus offering optimal benefits to the site, the company, the community, and the ecology of the area.

Ecological service as a reuse element is still emerging; however additional information or data is necessary to fully realize the broad benefits of ecological land reuse. New research and reporting needs to accomplish the following:

- Explain and document the service capacity offered by a given area and how that capacity can be fulfilled by man-made systems.
- Track ecological land reuses and evaluate how they may positively impact the surrounding and interconnected systems.
- Better explain the methodologies to create ecological end-use projects that will provide the desired service.
- Document the impact ecological land reuse of remediated, reclaimed, or restored sites has on migratory flyways and corridors.
- Document the integration of environmental remediation technologies into a sustainable ecological end use.
- Integrate information from sites, which have restored or created ecological benefits, into a learning center or database which is readily available to all stakeholders.
- Provide the basis to move remediation away from pumps and pipes and toward more nonmechanical systems capable of the same level of environmental and human health protection, while providing a more wildlife- and human-friendly end use.
- Document ecologically based mechanisms that provide sustainable institutional controls.
- Better explain the mechanisms and institutional controls that can be placed on property to manage any residual threats (e.g. deed restrictions, uniform covenant program, or conservation easement).
- Develop a template that states can use, and adjust to their own use, to track and evaluate the environmental effectiveness of land use controls placed on a site, perhaps through a national organization that represents the states (see Section 4.8.2, ITRC ALT-4 2006).
- Document the improved quality of life of the individual and the livability of the community where green space is incorporated into the urban and suburban environment.

A case study from Chattanooga, Tennessee, most effectively demonstrates the successful application of ecological elements to improve the livability of an area while restoring a site. A working partnership between government, industry, and the community transformed an industrial wasteland into a vibrant, upscale downtown community—resulting in improved livability, increased property values, healthy environments, and controlled growth. Certainly not all future land use may be conducive to ecological elements or enhancements; however, in situations where ecological elements or enhancements may be integrated into the remediation process, whether using conventional or green remediation technologies, they can benefit the owners, operators, community, and ecosystem through the ecological elements used to remediate the site.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS I

EXECUTIVE SUMMARY III

1. INTRODUCTION 1

2. OVERVIEW OF ECOLOGICAL LAND REUSE 3

   2.1 Using Natural or Ecological Enhancements as a Cleanup Technology 6
   2.2 Natural or Green Remediation Strategies 7
   2.3 Creating Habitat as a Complement to a Traditional Remedies 9
   2.4 Ecological Enhancements as End-use Goals 10

3. BENEFITS AND CONSTRAINTS 10

   3.1 Environmental Benefits 11
   3.2 Economic Benefits 13
   3.3 Public Benefits 15
   3.4 Constraints 16

4. IDENTIFYING REGULATORY FLEXIBILITY AND CONSTRAINTS 16

   4.1 Regulations and Guidance 18
   4.2 Conventional Requirements versus Performance Requirements 24
   4.3 Example of State Flexibility (Pennsylvania) 25

5. DECISION MAKING 25

   5.1 Service Capacity 27
   5.2 Selection of Green versus Traditional Technologies 36
   5.3 End Use 37
   5.3 End Use Conclusion 41

6. ECOLOGICAL REUSE PLANNING AND TARGET ECOSYSTEMS 42

   6.1 Planning an Ecological Land Reuse Project 43
   6.2 Targeted Ecosystems for Ecological Reuse 48

7. COST AND BENEFIT CONSIDERATIONS 60

   7.1 Net Environmental Benefit Analysis 63
   7.2 Quantifiable Values 66
   7.3 Semiquantifiable Values 68
   7.4 Qualitative Values 70

8. COMMUNITY STAKEHOLDERS 72

   8.1 Urban Revival on a Grand Scale: Chattanooga, Tennessee 74
   8.2 New Beginnings - The Woodlawn Wildlife Area, Port Deposit, Maryland 77
   8.3 Integrating Stakeholders into Problem Solving Teams 79

9. FINDINGS, RECOMMENDATIONS, AND OPPORTUNITIES 81
9.1 Community Partnerships 81
9.2 Ecological Elements 82
9.3 Ecological Risk 82
9.4 Remediation Outcome 83
9.5 Ecological End Uses 83
9.6 Costs 84
9.7 Opportunities 84
10. REFERENCES 85
11. BIBLIOGRAPHY 88

LIST OF TABLES

Table 5-1. Ecosystem services 30
Table 5-2. Traditional versus green technologies 37
Table 5-3. Mixed end uses 41
Table 6-1. Species used in floodplain forest replanting 51
Table 7-1. Additional details of value determination of and ecological land reuse 62
Table 7-2. Traditional horizontal three-phase extraction system versus ecological phytohydraulic barrier system 67
Table 7-3. Pump and treat versus ecological reuse 68
Table 7-4. Traditional horizontal three-phase extraction system versus ecological phytohydraulic barrier system, revised 69
Table 7-5. Comparison of interested party influence, pump and treat versus ecological reuse 70
Table 7-6. Comparison of values, pump and treat versus ecological reuse 71
Table 8-1. New Beginnings facts 78
Table 8-2. New Beginnings – The Woodlawn Wildlife Area team members and roles 79
Table 8-3. Principal project stakeholders 80

LIST OF FIGURES

Figure 1-1. Decision tree 2
Figure 3-1. What was the goal for using ecological land reuse? 11
Figure 5-1. Decision diagram 26
Figure 5-2. Venn diagram of service capacity 27
Figure 5-3. Coolidge Park adjacent to the North Shore Wetlands Park 28
Figure 5-4. Coolidge Park adjacent to the North Shore Wetlands Park 28
Figure 6-1. Site planting 46
Figure 7-1. Influence diagram of quantifiable, semiquantifiable, and qualitative values 62

LIST OF APPENDICES

Appendix A. Acronyms
Appendix B. Glossary
Appendix C. Case Studies
Appendix D. List of NGO and Other Ecological Business Contacts
Appendix E. State Survey
Appendix F. ITRC Team Contacts, Fact Sheet, and Product List

PLANNING AND PROMOTING
ECOLOGICAL LAND REUSE OF REMEDIATED SITES

1. INTRODUCTION

Often ecological considerations are incorporated into remediation and closure projects as an afterthought, or worse, following completion of the remediation project. This approach does not take advantage of a fully integrated ecological end use in the remediation design. In 2003, The Wildlife Habitat Council (WHC) and the ITRC (Interstate Technology & Regulatory Council) worked cooperatively to develop a white paper, *Making the Case for Ecological Enhancements* (ITRC ECO-1 2004). The purpose of this white paper was to present natural or ecologically friendly alternatives to traditional remediation processes, thus allowing the incorporation of ecological enhancements as integral components of both the remediation process and the reuse of environmentally impacted sites. The document defined ecological enhancements as modifications to a site that restore, increase, or improve habitat for plants and animals while protecting human health and the environment.

> ***Ecological land use, where appropriate, yields both tangible and intangible benefits for remediated sites.***
>
> *"An ecological enhancement modifies a site to increase/improve habitat for plants and animals while protecting human health and the environment. An ecological element can include natural remediation technologies and/or also represent an end-use which restores/increases the ecological value of the land"*
>
> *-From: Making the Case for Ecological Enhancements*

The white paper included several objectives:

- gaining greater regulatory flexibility and support for use of ecological land reuse
- identifying the strategy for obtaining constructive and meaningful stakeholder involvements
- ensuring sound scientific and technical support for ecological land reuse practices
- defining the value of ecological land reuse and communicate those values

As illustrated in the *Making the Case for Ecological Enhancements*, natural or green technologies can effectively contribute to the success of remediation projects; however, ecological reuse is not universally applicable. Site-specific considerations and engineering evaluation of goals and objectives, regulatory constraints, potential technologies, predicted costs, and likely benefits must be objectively studied at each potential site. This new guidance document, *Planning and Promoting Ecological Reuse of Remediated Sites*, describes a decision-making process that provides for an ecological end use through the planning and design process of remediating a site. The design and construction of the ecological end use as an integrated component of the remediation system will result in more pronounced benefits from the remediation process. In order to help remediation planners and stakeholders implement ecological enhancements at the earliest possible stage, this document includes the following:

- benefits, incentives, and limitations for implementing ecological enhancements at environmentally impacted sites
- a team questionnaire which asked states to provide their rationale for incorporating ecological elements or enhancements into a remediation project
- case studies in which the ecological enhancements are incorporated into the remedial design and/or end use
- recommendations for the successful design of ecological enhancements at environmentally impacted properties
- recommendations for improvements to foster greater acceptance and regulatory flexibility for incorporation of ecological enhancements as components of remedial actions and end use
- areas where additional scientific research is needed

Ecological enhancements considered at the start of planning for environmental remediation at Superfund or Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Resource Conservation and Recovery Act (RCRA), and Brownfield sites[1] can be a cost-effective and efficient way to restore, create, and/or improve wildlife habitat or the ecosystems of the site, while meeting established remediation goals and objectives. Incorporation of ecological enhancements can benefit multiple stakeholders such as regulatory agencies, the regulated community (industry), local communities, and the general public. In the National Contingency Plan (NCP), the U.S. Environmental Protection Agency (EPA) determines on a case-by-case basis whether an activity or feature constitutes an enhancement [40 CFR 300.515(f)]. Although enhancements that do not contribute to the remediation of a site cannot be funded by EPA, they can be included in a remedial action if they are consistent with and do not interfere with the protectiveness of the selected remedy.

Figure 1-1. Decision tree

This guidance describes a process to promote ecological land reuse activities considering natural or green technologies instead of, or in conjunction with, traditional technologies and considers natural or ecological end-uses as alternatives to conventional property development or redevelopment. The decision tree shown in Figure 1-1 contains a potential conceptual process for integrating future land use and stakeholder input into an ecological land end-use-based remediation project. Key to the success of these projects is an understanding of the potential future land uses at, near, or around a remediation site. Integrating stakeholder input regarding community development and needs is critical in helping planners to gain strong support from the stakeholders and to become advocates for projects integrating ecological land reuse.

[1] For the purpose of this document, a site is an area subject to remediation and potential ecological land reuse.

Finally, this guidance document also contains a decision diagram (see Section 5) that illustrates the practicality of applying natural or green technologies to the traditional remediation processes. Natural and green technologies, together with natural/ecological end uses, are referred to as "ecological elements" throughout this guidance. Ecological benefits have not routinely been designed into, nor credited to the value of, the reusable land following successful remediation. Natural and green technologies can improve the ecology of the site as long as they are coincident with the intent of the land's use and do not interfere with the remediation of the site. Ecological benefits should be considered as integral components of the remediation process, as well as in the end use of an environmentally impacted site. Without an early evaluation of the ecological enhancement options, adverse impact to the ecology resulting from the remediation is usually never evaluated and could potentially outweigh the benefit of the remediation.

2. OVERVIEW OF ECOLOGICAL LAND REUSE

The purpose of ecological enhancements to a site is to restore the lost or diminished ecological resources, thereby enhancing the site's value to the owners, operators, and the community while maintaining protection for both human health and the environment. To optimize long-term maintenance, an ecological end use is best served by elements and technologies that are permanent and sustain themselves after remediation is complete. Whether or not the final ecological land use is sustainable will depend on the attitudes, resources, and values of both the current and future site owners, as well as the surrounding community.

The reduction or removal of contamination or the reduction of risk through remediation must not be jeopardized or compromised by the inclusion of ecological elements or the designation of an ecological land reuse.

Transforming a degraded habitat into an ecological asset presents a variety of challenges, thus an ecologically-based remediation project can be more challenging than one using conventional remediation technologies. On the other hand, the initiation of ecological remedial activities at a site represents a unique opportunity to leverage limited resources and achieve an improved outcome. Ecological site remediation presents the opportunity to do much more than treat or remove contamination from impacted water, air, and soil—when a remediation project is completed, the sustainable ecological elements will leave a legacy of ecological assets for the community. The Ecological Land Reuse Team's position is that their organizations support the use of ecological elements in remedial projects to support an ecologically-based end use.

Habitat and the sustainable condition of a resource are seldom elements of the typical remedy in RCRA Subtitle C; however, CERCLA has more effectively attempted to capture ecological land reuse in its remedy selection process (see *CERCLA Coordination with Natural Resource Trustees, OSWER Directive # 9200.4-22A*, 1997; *Issuance of Final Guidance: Ecological Risk Assessment and Risk Management Principles for Superfund Sites*, OSWER Directive 9285.7-28 October, 1999; and *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments*, EPA 540-R-97-006, OSWER, 1997). The use of technologies providing ecological elements as all or part of the remedial alternative may not be

familiar to many regulators; however, the use of natural or green technologies, as remediation tools, are gaining greater acceptance. Additionally the likelihood of regulatory acceptance is enhanced by a focused remedial objective, inclusion and leveraging of stakeholder support, and a realistic timeline for achieving a sustainable site end use. States and owners are realizing the value of ecological land reuse and, in some cases, advocating such reuse. This experience indicates that the incorporation of ecological elements into the remedial design will not compromise the effectiveness or acceptability of the cleanup, nor will it necessarily increase the overall cost of the project to the EPA. If costs do increase, however, non-CERCLA funding will be required for the extra cost of the ecological enhancements that do not contribute to the cleanup design (see Section 4).

EPA emphasizes that the ultimate goal of corrective action (cleanup) is to satisfy the "protection of human health and the environment [HH&E]" standard, which can be achieved using engineered and institutional controls. EPA recognizes that, for a number of reasons, establishing remediation goals for ecological receptors is considerably more difficult than establishing goals for the protection of human health. Although the NCP establishes a protective risk range for human health, it provides little guidance regarding developing remediation goals considered to be adequate for protecting ecological receptors. In practice, a variety of organizations have successfully completed elements of ecological land reuse (including habitat restoration) as functional parts of environmental remediation projects. Some of these successes are highlighted in case studies contained in this document and *Making the Case for Ecological Land Reuse* (ITRC ECO-1 2003).

While restoring habitat, objectives target the elimination of threats to HH&E and exposure routes to wildlife to ensure that land remains capable of serving as safe and supporting habitat. The actions to eliminate relevant exposure routes may be designed to be noninvasive while allowing for existing habitat to thrive. Additionally, ecological reuse must not create an exposure pathway; for example burrowing animals would not be reintroduced at a site with residual contamination at depth.

Ecological enhancements can be applied in three ways at impacted properties, as determined by the characteristics of the property and the nature of the impacts:

1. From the outset, strive to create or restore a safe, sustainable wildlife habitat as a final cleanup goal at compromised sites that once served as habitat (such as a contaminated estuary).

2. Use sustainable habitat as a complement to a traditional remedy to enhance cleanup outcomes at sites that did not previously function as significant habitat (such as abandoned industrial land). The technologies and controls used to arrive at the habitat may or may not be green technologies. While this guidance document emphasizes green technologies to support ecological land reuse as part of remediation, the successful use of traditional technologies can achieve the same goals, as depicted in Figure 5-1. Numerous site remediation approaches can be used to ensure that contaminated material left on site is managed and contained in a manner that protects HH&E, while allowing for safe ecological reuse. Some of the more traditional methods include cover systems (ITRC ALT-2 2003), gas

collection and treatment systems (ITRC-ALT-3 2006), groundwater collection and treatment systems, permeable reactive barrier walls (ITRC PRB-3), and diversion walls. Also see the USEPA CLU-IN site (http://www.clu-in.org/) for additional technology descriptions

3. Use natural or green technologies to remove contaminants or secure sites while providing viable wildlife habitat, even though the final use may not be ecological.

A benefits analysis can assist in determining which approach will be most effective. Ultimately, the characteristics of the site itself as well as the characteristics of the surrounding community will influence the outcome and conclusions (see Section 5). Successful internal marketing of ecologically-based remediation projects depends on much more than the economics of a remediation project. Many intangibles influence ecological choices, including community good will, corporate image, shareholder perception, and stakeholder satisfaction. These components of an ecological reuse remediation project will be further discussed in Sections 5 and 7.

Tailoring the cleanup to a specific end use, established early in the process, can avoid unnecessary actions that otherwise increase costs, delay progress, and may not result in remedies that are fully protective of human health and the environment.

As an example of the interaction of traditional remediation and ecological enhancement, consider a site containing persistent bioavailable toxins where the optimal site cleanup was determined to contain elements of habitat applied as a compliment to a traditional excavation-based remedy. Although excavation activities may temporarily reduce the site's ecological function, this action will ultimately enhance the final habitat quality due to the elimination of residual risks associated with the removed toxins. On the other hand, a natural remedy alone may be preferable at a site where the contaminants are less persistent, immobile, or more subject to degradation. In each case, a traditional remedy alone would have brought the restored site to the minimal conventional endpoint necessary to achieve protection of HH&E, but the incorporation of ecological enhancements would greatly enhance the final ecological value, and possibly social and financial assets. A formalized alternatives analysis, known as a Net Environmental Benefits Analysis, or NEBA (Efroymson 2003), may be used to weigh the cost of various remedial options (contaminant removal, engineered controls, or institutional controls) against the environmental costs and benefits of each alternative. An NEBA can result in acceptance of restoring the site to a non-pristine baseline if the benefit from having some habitat value at the site outweighs the potential for adverse effects from contaminants left in place.

Data collected for an eco-risk assessment used to establish cleanup standards applicable to habitat creation can require more complex evaluation than a human health risk assessment. The resulting cleanup goals for ecological protection may or may not be more stringent than for protection of human health alone. Tailoring the cleanup to a specific end use established early in the process can avoid unnecessary actions that otherwise increase costs, delay progress, and may not result in remedies that are fully protective of HH&E. Designing a site restoration project to include long-term sustainable habitat offers the advantage of creating new habitat, protecting habitat found in previously impacted areas, and mitigating the effects of continued urban encroachment, contaminant toxicity, reduced flora and fauna density, stormwater impacts, and reduced aesthetics.

This guidance identifies the flexibility in cleanup authorities where it is demonstrated that preserving existing habitat or creating new habitat is favored by the regulatory program and therefore has an overall benefit to humans and the environment. An overall site cleanup program should consider habitat restoration (creation, enhancement, preservation, etc.) when evaluating marginal risk scenarios where remedial actions may impact the environment or be of questionable effectiveness in managing risk. The program should allow for an approach that balances the management of marginal ecological risk with natural resource benefits from restoration (see NEBA discussion in Section 7.4).

2.1 Using Natural or Ecological Enhancements as a Cleanup Technology

Many remediation projects end with the cleanup of the impacted media. The ultimate goal of a remediation, however, is to reduce or eliminate exposure to releases of chemical substances in a manner that is protective of HH&E, all the while returning land to beneficial use. A well-planned remediation can achieve much more than simply cleaning up the impacted media such as soil, surface water, groundwater, or air. The cleanup remedy must be cost-effective, as discussed later in Section 7, and use durable solutions, which may include conventional or alternative technologies. In certain instances, ecological or naturally occurring elements may be used as all or part of the remedy. To be accepted under most federal or state hazardous waste programs as an alternative technology, ecological elements or enhancements must

- be evaluated in order to demonstrate a level of performance sufficient to meet the goals and requirements of applicable federal or state remediation regulations (in other words, the initial goal of the project is successful remediation of the impacted area);
- include an analysis of the persistence, toxicity, mobility, and bioaccumulative potential of site-related constituents;
- consider short and long-term potential threats to HH&E.

For example, a constructed wetland that offers treatment of relatively immobile and nonbioaccumulative constituents, as well as providing habitat for wildlife, could be a cost-effective, community-friendly, ecologically viable alternative to more costly conventional technologies such as groundwater pump-and-treat. Likewise phytoremediation, where plant species are considered and selected with respect to the potential habitat they offer, can be a cost-effective alternative for soil, source area, and groundwater treatment. In both of these examples, an ecological risk assessment or monitoring program may be necessary to demonstrate that constituents of concern are not accumulating to levels that might be toxic to wildlife attracted by the created or restored habitat. With regards to the need for these programs, two questions remain:

- Is the created or restored habitat and resulting wildlife population or diversity positive for the remediation system, the surrounding ecology, and community?
- If not, can such benefits be efficiently and effectively designed into the system based on cost and resource needs?

Green technologies run into the same regulatory impediments as other technologies when considered for CERCLA, RCRA, Brownfield, Mining, and Voluntary Cleanup sites. For

example, some treated sludge may be listed as hazardous waste. If the listed waste is "managed", as legally defined, then it must be managed in accordance with stringent standards and be treated or disposed of in accordance with RCRA standards. Some regulatory programs consider plowing or even seeding as management or treatment of the waste. Materials that are mixed with or derived from these materials are also listed wastes, so harvesting plant growth may require management the harvested material as a listed hazardous waste. Policies have been developed to address these issues (area of contamination interpretations in RCRA and Superfund, RCRA Corrective Action Management Unit rules, and others). In some instances, however, impediments associated with the regulatory mandates for managing listed wastes have thwarted natural remediation efforts that would have been successful from a risk management perspective.

Sites where material other than RCRA-listed waste is present would be subject to an individual state's requirements. For example, in Pennsylvania a permit is generally required for processing nonhazardous regulated waste. If the process is part of onsite treatment conducted under the state's environmental cleanup law, however, a permit would not be required, even though the substantive technical requirements must be followed to assure protection of HH&E. At these sites, seeding and harvesting can be done as needed without triggering costly management standards. Harvested materials must be characterized for relevant hazardous waste characteristics but generally need not be managed as hazardous waste.

As stewards of natural resources, individuals responsible for addressing environmentally impacted sites have the ability to effect great improvements on stressed ecological communities. While a traditional remedial technology may be required to resolve the potential short- and long-term threats to HH&E, ecological technologies can be used as a good faith effort to promote additional environmental stewardship, improve property value, and increase community good will. They are a cost-effective means of increasing the ability of restored property to support wildlife. In urban settings, where the availability of habitat is limited, islands of habitat on restored lands may prove invaluable in supporting both migratory and permanent resident species, in preparing for its ultimate ecological service, and in providing environmental educational opportunities.

2.2 Natural or Green Remediation Strategies

Ecological/natural remediation strategies may include one or more of the following technologies or techniques, which may constitute an alternative or may also incorporate traditional remediation techniques in the final alternative chosen to remediate a site. Ecological or natural technologies include but are not limited to the following:

- phytotechnologies (http://www.itrcweb.org/gd_Phyto.asp)
- engineered or natural wetlands treatment (http://www.itrcweb.org/gd_CW.asp or http://www.itrcweb.org/gd_MW.asp)
- ET (evapotranspiration) covers and plant hydraulic barriers (http://www.itrcweb.org/gd_ALT.asp)

- remediation by natural attenuation (http://www.itrcweb.org/gd_ISB.asp)
- enhanced in situ bioremediation (http://www.itrcweb.org/gd_ISB.asp)
- biological soil amendments (Sopper, 1993; Brown et al. 2001 and 2005; EPA 2000; and http://www.itrcweb.org/gd_SMART.asp)

Phytoremediation is the use of plants for water and/or soil or groundwater treatment (see *Phytotechnologies*, http://www.itrcweb.org/gd_Phyto.asp). This technology presents a potentially lower cost alternative to excavation, land farming, or shallow air sparging. The plants used for remediation may also be integrated into temporary or permanent green land uses such as water features in parks, landscaping, natural habitat, or preserves. In the case of salt contamination, halophytic plants can be used to preferentially remove salts from soil and soil pore water, and thus may be used to provide both treatment and vegetative cover. The aboveground portions of such plants may need to be periodically harvested to ensure continued removal of salts from the site over time; thus the use of halophytic plants may be more compatible with park, grazing, and landscaping uses than with habitat or conservation uses.

Engineered wetlands are plant/water systems that mimic natural wetland systems and are designed to remove both solid and dissolved contaminants from water. These wetlands are a potentially lower cost alternative to engineered water treatment systems and may reduce the need for injection systems, water transport by pipeline, and/or diffuser discharges to streams and rivers. A large amount of surface area and periodic maintenance may be required for these systems (ITRC Wetlands-2 2003, http://www.itrcweb.org/gd_CW.asp). This technique may not be useful for small sites or in conservation easements or preserves where periodic maintenance would be disruptive to established habitat. Additionally, planners must be cautious not to create an attractive nuisance by enticing, for example, waterfowl into an area when the wetlands are serving a treatment function such as removing metals.

Case Study: Rocky Flats National Wildlife Refuge

Rocky Flats National Wildlife Refuge will be managed by the U.S. Fish and Wildlife Service (Service) when the EPA certifies that cleanup and closure at the Department of Energy's (DOE) Rocky Flats site has been completed and that all response actions are operating properly and successfully. After EPA certification, DOE will transfer much of Rocky Flats to the Department of the Interior and the Service will manage it as a National Wildlife Refuge. DOE will be required to conduct postclosure environmental monitoring and remedy maintenance in accordance with a postclosure, long-term stewardship agreement approved by EPA and Colorado Department of Public Heath and Environment (CDPHE). DOE will also review the cleanup remedy at least every five years with the EPA and CDPHE. The EPA and CDPHE can require DOE to undertake an additional action if post cleanup monitoring indicates the cleanup is not protective of human health and the environment.

The majority of the site has remained undisturbed since its acquisition and provides habitat for many wildlife species, including two species that are federally listed as threatened (bald eagle and Preble's meadow jumping mouse). Establishing the site as a unit of the National Wildlife Refuge System (NWRS) will promote the preservation and enhancement of its natural resources for present and future generations. The Final Comprehensive Conservation Plan (CCP) and Environmental Impact Statement (EIS) for the Rocky Flats National Wildlife Refuge will guide management of Refuge operations, habitat restoration, and visitor services for the next 15 years (208H*http://rockyflats.fws.gov/Documents/FEIS/Chapter_1.pdf*) .

Hydrophilic plants may be successfully used to control water infiltration and seepage. For example, if these plants grow over the top of closed landfills or waste piles they may reduce water seepage more effectively than traditional impermeable cap-and-cover methods. This in turn may reduce water percolation through the waste and reduce water handling and treatment costs (ITRC ALT-2 2003, http://www.itrcweb.org/gd_ALT.asp).

Remediation by natural attenuation (ITRC ISB-3 Reprinted September 1999, http://www.itrcweb.org/gd_ISB.asp) is the reliance on analyzed natural biological systems to metabolize contaminants in soil and ground water. This technique is simultaneously compatible with virtually all ecological land reuses since it neither jeopardizes the use of the surface nor does it disrupt the surface, except for installation and maintenance of monitoring wells. Enhanced in situ bioremediation is similar and normally enhances the existing natural conditions to encourage the remediation or degradation mechanism toward complete mineralization of the contaminants (ITRC ISB-6 1998, http://www.itrcweb.org/gd_ISB.asp).

2.3 Creating Habitat as a Complement to a Traditional Remedies

Carefully designed ecological elements and enhancements may supplement or complement conventional remedial technologies. Remedial technologies typically provide environmental remediation by source control or removal of contaminants. The ability of the media, particularly surface soil, surface water, and sediments, to return to a prerelease functional level has not always been addressed in the remedial process when the remediation process design focuses on human health criteria. Ecological techniques such as improving in stream cover for fish and macroinvertebrates following sediment excavation, installing nesting boxes on a landfill cap, or implementing a woodlot program can cost-effectively return the resource to a productive capacity that would exceed the capacity resulting from conventional remediation techniques. Additionally, these enhanced measures would be expected to receive high marks at sites where local stakeholders are actively involved in selecting the remedial alternatives. This community acceptance is always an important factor in a successful remediation strategy and is one of the nine Superfund criteria used in selecting a remedy.

Ecological elements and enhancements incorporated into site remediation may limit potential environmental liabilities through Natural Resource Damage Assessments (NRDAs).

Ecological elements and enhancements incorporated into site remediation may help manage environmental liabilities under a Natural Resource Damage Assessment (NRDA). Under an NRDA, natural resource trustees have the authority to assess injuries to natural resources and the ecological services associated with the resources that have been diminished or lost as a result of releases of hazardous substances or discharges of oil. Remedial project managers should ensure that natural resource trustees are provided a key stakeholder role throughout the remedial process. Ecological enhancements may arguably offset or mitigate potential claims based upon restoration of habitat function following the remedial process.

2.4 Ecological Enhancements as End-use Goals

One key element of optimized and cost-effective remedial site management is the inclusion of a targeted postremediation or future land use of the property during the development of a remedial action plan. Creation, restoration, protection, or enhancement of habitat define the desired ecological end use, in addition to being complementary to a variety of other end uses of the property. Sites with green end uses can be compatible with a wide variety of ecological/natural remedial options. Many of the ecological enhancement options can be seamlessly incorporated into the land end use itself, especially if incorporated by design as part of the initial remedial selection process. The ecological enhancements then become an integral part of the plant/soil/water habitat system.

Sites with residential end land uses were once considered least compatible with ecological/natural remedial actions, since landowner/seller financial liability considerations often disfavored such uses for remediated sites. Where residential land use could not be avoided (such as in the case of condemnation) the favored remedial actions, such as excavation and refill, were not generally compatible with ecological/natural remedial methods. Recent experience, however, has shown that green land uses, such as parks and greenways, can enhance community and property values and can be an acceptable land reuse, especially in areas where pressures for residential use are high. Ecological enhancements can also be designed into functional elements of residential use such as stormwater routing and retention/detention features. This development, as described in the Woodlawn Case Study, appreciates the added value of intermingled ecological and residential use in the development strategy. Intermingled-use scenarios offer the additional market value of the less crowded open space and recreational value of the ecological enhanced properties.

3. BENEFITS AND CONSTRAINTS

Benefits and constraints provide a rationale for choosing or rejecting remedies with ecological elements or enhancements as an end use. While individual benefits are assigned to specific users for the purposes of this discussion, most benefits help multiple users. Reasons for selecting ecological elements can vary, so the team questionnaire asked respondents to provide their rationale for incorporating ecological elements or enhancements into a remediation project.

Benefits are characterized as environmental, economic, and public; however a benefit should not be restricted to a particular perspective (e.g. industry, regulatory, or public). In many cases the benefit contributes to multiple perspectives: for example, a benefit may directly apply to industry, but indirectly contribute positively to the community and the regulatory agency. Figure 3-1 displays a fairly equitable distribution of why ecological land reuse is targeted for remediation projects. Cost is the most readily quantifiable reason for implementing remedies with ecological elements or enhancements. The majority of the reasons given for implementing ecologically based remediation projects are semiquantifiable (see Section 7 later in this document for a description and examples of quantifiable, semiquantifiable, and qualitative values).

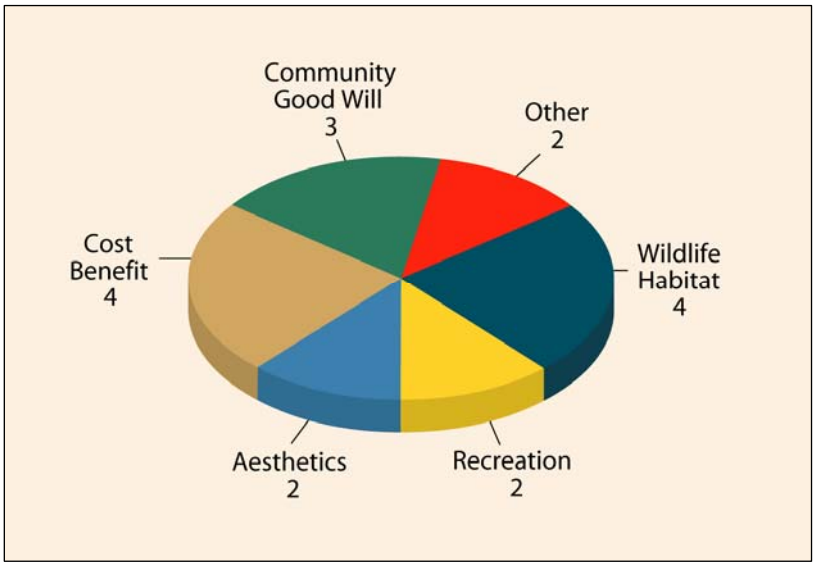


Figure 3-1. What was the goal for selecting ecological land reuse?

3.1 Environmental Benefits

Restoring or creating ecosystems, both during the remedial process and as a final postremediation end use, provides environmental benefits (onsite as well as offsite) to soil, surface water, sediment, and groundwater quality, as well as to human and overall ecological health. These benefits are described below:

- *Attracts wildlife*. Green and natural remediation technologies which include end-use plantings and other habitat elements attract wildlife.

- *Hydraulically controls landfill leachate*. Natural remediation technologies can minimize leachate head buildup in closed landfills, thereby eliminating side or groundwater seepage.

- *Biodegrades environmental contaminants*. Natural biochemical mechanisms can enhance aerobic and anaerobic degradation of various contaminants, including volatile organic compounds, polynuclear aromatics, various other hydrocarbons, and some pesticides.

- *Controls dust*. Both natural remediation technologies and end-use plantings reduce fugitive dust emissions, particularly if the soil is prepared with compost and/or mulch at the time of planting.

- *Reduces sediment transport and soil erosion*. Green and natural remediation technologies and end-use plantings, once established, reduce sediment transport and soil erosion from storm events due to soil stabilization characteristics of plant roots.

- *Stabilizes stream banks*. Plantings can be used along stream banks to prevent erosion and physically filter stormwater runoff, which results in reduced contaminant loading to surface waters.

- *Uses atmospheric carbon dioxide*. Both natural remediation technologies and end-use plantings use atmospheric carbon dioxide and produce oxygen, which directly reduces the greenhouse gases implicated in global warming.

- *Improves ground water recharge*. Both natural remediation technologies and end-use plantings can reduce runoff and improve groundwater recharge

- *Minimizes human and environmental exposures*. In situ natural remediation technologies reduce the need to excavate and haul impacted soil. Excavation and hauling not only use fuel, emit air pollutants, and occupy landfills, but also potentially create additional exposure pathways during the movement of the soil, thereby increasing risk. These traditional methods also provide a risk to heavy equipment operators. For restricted-use sites requiring long-term land use restrictions, ecological and recreational reuse prevents unacceptable human risks to areas of concern.

- *Improves environmental stability*. In situ natural remediation technologies avoid disrupting the soil and associated root structures (as excavation does), thereby improving the stability of the local ecosystem.

- *Provides harvestable resource*. Metals can sometimes be recovered for reuse by harvesting phytoremediation plant biomass. Reusing plant waste provides high organic compost to reduce the dependence on topsoil resources and creates a market for a waste product which can cause environmental problems through uncontrolled use in certain settings.

- *Improves aesthetics*. Both natural remediation technologies and end-use plantings are often more aesthetically pleasing than mowed grass or paved areas.

- *Provides educational opportunity*. Natural remediation technologies, such as plantings, can provide an educational opportunity for students wishing to learn about natural remediation technologies and environmental processes. Where residual contamination or landfills remain, students can learn long-term stewardship of erosion controls, monitoring, and maintenance of engineered remedies.

- *Provides recreational area*. End-use plantings can provide an area for community or employee recreation.

- *Provides migratory pathways*. Both natural remediation technologies and end-use plantings can provide needed landscape ecology for pathways for migratory species and wildlife corridors.

- *Improves plant diversity*. Vegetation may be selected that will enhance the diversity of the existing plant community. In addition, succession planning may be implemented to enhance the plant diversity of future plant communities.

3.2 Economic Benefits

Both natural remediation technologies and end-use plantings can be cost competitive with other traditional remediation technologies and end uses. They also can be an important component of more complex remedies, particularly when addressing final, polishing remedy requirements. Installation, operation, and maintenance costs may be reduced over traditional remedies both for engineered remedies and land management. Specifically, the following economic benefits can be realized:

- *Reuses waste materials*. Composted waste materials (sewage sludge, fly ash, manure, green waste, agriculture waste, food waste, etc.) can be used as a soil amendment for both natural remediation technologies and end-use plantings, thereby reducing the cost of waste disposal.

- *More efficiently use of limited resources*. Limited resources can be better deployed at a greater number of sites if those limited resources can be more cost-effectively deployed by harnessing natural attenuation and biodegradation processes.

- *Enhances institutional controls (ICs)*. When ICs are part of the end use of the site, an ecological component can control the site while providing a beneficial land use (such as a park system which is only open eight hours per day and thus restricts potential exposure to eight hours per day, see inset below). This could be a recreational use, risk-based cleanup outcome with land use or institutional controls (USEPA 2000). The reuse governed by ICs may be viewed as an economic benefit because it has the potential to return the property to productive reuse. ICs can have several other benefits. First, they provide a means of managing property so that it is protective of HH&E without being remediated to unrestricted use concentrations. This saves the owners/operators remediation cost. Second, the property may be placed into economic service that generates revenue for the local or state municipalities. Ecological reuse coupled with institutional controls may be even more financially beneficial since the controls may provide a means of managing areas at parks that are protective of HH&E in ecologically distressed areas. It is precisely this type of reuse that can spark redevelopment of downtown areas. Ecological reuse can also help streamline long-

Case Study: Fernald Closure Project

The projected final land use of the Fernald Closure Project (FCP, a DOE site in Ohio) projects the end use as an undeveloped park with limited public access to the site. Risk evaluations, conducted for each of the site's operable units, used the undeveloped park as the projected final use of the site. A recreational user was the primary receptor used to establish cleanup levels at the site. An environmental assessment (EA) was prepared in 1998 to finalize the land use decision for the Fernald closure plan. The EA proposed that more than 900 acres of the site be restored and dedicated as an undeveloped park. It also proposed a 23-acre portion of the FCP that may be considered for development to support community needs.
(207Hhttp://www.fernald.gov/Future/flu.htm)

term stewardship. An example in which DOE has incorporated ecological end use into the management of legacy sites is included in the Fernald inset and as a case study in Appendix C.

- *May generate revenue*. Ecological end use sites may generate revenue through the provisions of ecological services. Enhanced ecosystems can provide recreational areas for the community and businesses, as well as revenue from commercial or sports fishing, tourism, and other industries.

- *Provides marketing and competitive advantages*. Ecological land reuse can be used as a marketing/competitive advantage to emphasize a company's environmental stewardship, thereby attracting environmentally-conscious clients. Aesthetically pleasing planted areas may provide a competitive edge by attracting more customers.

- *Increases property value*. Ecological elements and enhancements may provide an aesthetic improvement and increase the market value or salability of a property.

- *Provides source of recoverable resources*. Harvested biomass from natural remediation technologies can provide a source of recoverable metals, while harvested biomass from natural remediation technologies and end-use plantings can provide fuel, lumber, or other beneficial end products.

- *Provides potential opportunity to obtain environmental offsets*. Consideration of ecological land reuse may provide an opportunity to allow environmental cleanup cost and requirement offsets when negotiating site cleanup objectives with regulators. If the cleanup objective includes a sustainable ecosystem that will support wildlife resources after remediation, this could be an offset for a pending NRDA claim. If the management of the ecological element coincides with the institutional controls, the overall cost of stewardship can be reduced.

- *Offers tax advantages*. Conservation easements can result in a one-time income tax credit and/or multiyear property tax savings. (see Appendix B in ITRC ECO-1 2003).

These and other economic benefits are analyzed further in Section 7.

3.3 Public Benefits

In many cases, organizations desire to use the ecological enhancements to provide educational opportunities, aesthetic benefits, and natural resources to the local area. Biology, horticulture, ecology, wetland hydrology, plant identification, and environmental remediation are among the topics of educational interest. The natural resources associated with ecological enhancement systems could also serve as seed banks and breeding grounds for species of concern. For site owners and regulatory agencies, these alternatives can provide public relations benefits that may not be available from other strategic options:

- *Improves/increases recreational or tourism opportunities*. Outdoor recreation enhances the livability of a community and thereby the value of the property surrounding or adjacent to it. It provides a desirable landscape and an attractive community.

- *Provides educational opportunities*. During the remediation or redevelopment of environmentally impacted sites, nongovernmental organizations and local community groups such as the Boy Scouts and Girl Scouts, schools, youth programs, bird watchers, nature conservationists, and prairie and wetland enthusiasts may express interest in pursuing reuse alternatives that incorporate ecological elements or enhancements.

- *Improves reputation*. These benefits include enhanced reputation, "green" image, external validation, and sustainable operations. In 1999, the Conference Board, a worldwide business research network, asked consumers what matters most when forming an impression of a company. Most said reputation—it was the number one response. Almost half said they had done business with a company in the preceding 12 months or supported it in some other way if they considered it socially responsible. Half said they had boycotted a company's products in the same period or had urged others to do so when they didn't agree with its actions or policies. Another study by Gregory (2002) showed that business leaders in that year's Fortune top ten most-admired companies ranked consumers as the most important influencers of corporate reputation. Even more than chief executive officer reputation, print media, employees, or analysts, the survey demonstrated the importance of reaching the consumer with strong corporate messages that contribute to market success and business results (ITRC Eco-1 2004, http://www.itrcweb.org/gd_EE.asp).

- *Improves goodwill and good neighbor standing*. Ecological elements and enhancements should be integrated with stakeholder and community planning considerations. These can foster goodwill among facility neighbors immediately adjacent to and throughout the community. Since companies wish to do business with a given community, this goodwill may translate into community acceptance and easier future business development within the community. Ecological reuse can also promote regional cooperative conservation and watershed management.

- *Enhances workforce stability through improved morale*. Long-term employment has a demonstrated benefit for companies.

- *Improves aesthetics*. As mentioned above, improved aesthetics may increase the property value or salability of a parcel.

- *Improves livability*. Ecological enhancements can improve the community image, bring in tourism, and provide recreational usage.

- *Increased natural resources*. The ecological elements or enhancements may convert waste materials into reusable material or generate new salable materials (e.g., harvestable wood as a commodity).

In many cases, nongovernmental organizations (see Appendix D) can provide an impartial assessment of the activities agreed upon by site owners and regulatory agencies and can help the process to move forward with community acceptance. These organizations can also serve to ensure the continued operation and maintenance of these systems, either by monitoring the progress over time (during remediation) or accepting the responsibility directly to manage the end use. In this manner, ecological land reuses lead to sustainable operations and long-term advantages of beneficial public relations.

3.4 Constraints

Even though there are a great many advantages to ecological land reuse, there are also constraints, which over the years have unexpectedly caused public concerns when using some green technologies and ecological enhancements to remediate contaminated sites. These constraints can include the following:

- lack of regulatory acceptance with ecological enhancements
- need for increased creativity
- visual aesthetics
- plant height and density obstructing views
- plant use—could contain noxious or invasive species
- allergies
- attracting undesirable wildlife such as mosquitoes, wasps, snakes, or other perceived nuisance species
- introduction of ecological receptors where none previously existed

Finally, ecological enhancements have the potential to create wildlife imbalances. In some cases, single species plantings such as those often used in phytoremediation can unintentionally encourage ecological imbalances and vulnerabilities to attack by pests or disease. In addition, the natural remediation plantings may have to be protected from wildlife consumption if the plantings will bioaccumulate potential toxins.

4. IDENTIFYING REGULATORY FLEXIBILITY AND CONSTRAINTS

EPA guidance emphasizes that proper closure is essential for a hazardous or solid waste operation or remediation project. EPA’s basic approach to ensuring proper closure and

remediation has been to prescribe criteria for a final remedy that meets the closure regulations specified under RCRA; these criteria are historically affected by human health impacts more than by ecological impacts. This approach is a slow-moving program, but has generally been accepted by the public and regulatory community, regardless of whether it offers the best option for site conditions and end use.

While applicable regulations and guidance are available for reclaiming mining sites, voluntary remediation sites, Brownfield sites, and CERCLA/Superfund sites, a slightly higher incidence of ecological land reuse occurs in voluntary cleanup programs. The increased use of ecological elements and enhancements in voluntary cleanup remediation projects indicates that owners and operators of these sites see a benefit to, and have preference for, remediation strategies that incorporate ecological elements or enhancements. Additionally, current regulatory practices for the other programs may complicate establishing an ecological end use for a remediated site with both traditional technologies and green technologies. This may translate into a real or perceived notion that it may be more complicated to get regulatory approval for ecological elements or enhancements in the remediation plan in programs other than voluntary cleanups. Implicit in all these standards, however, is the goal to return land to productive use. A typical example of regulatory support for this goal is the requirement of stakeholder involvement and economic encouragements in the Brownfield programs (ITRC Brownfields-1 2003, http://www.itrcweb.org/gd_Brnflds.asp). Projects that provide returning value to the region, as an additional objective, move quickly and are highlighted as models for success.

Often, ecological considerations are incorporated into remediation and closure projects as an afterthought or, worse, following the completion of the remediation project.

A variety of regulations and guidance (CERCLA, RCRA-C, etc.) require that the design of a remediation or closure project must consider site conditions and encourage alternative designs that are innovative and use site-specific information. These alternative designs are accepted as long as they demonstrate a level of performance that is protective of HH&E and adequately meet the intent of the regulatory requirements. Protection of the environment includes ecological reuse, so ecological remediation designs satisfy the intent of the regulations and create the opportunity for alternative closure and remediation designs.

Ecological elements are often incorporated into remediation and closure projects as an afterthought or, worse, following completion of the remediation project. This approach fails to optimize the advantages of a fully integrated ecological land reuse or of early inclusion of potential stakeholder support for ecological elements or enhancements in the remediation design. The design and construction of the ecological end use as an integrated component of the remediation system will realize more pronounced benefits from the remediation process. This section reviews regulations and guidance related to closure and remediation projects that include ecological end use as an integral part of a project. This review provides clear evidence that ecological end uses are not prohibited, but instead are encouraged, when the property owners, communities, and other stakeholders select such land uses while maintaining the protectiveness of the remedy. The regulatory flexibility necessary to promote ecological land reuse into site remedies design is identified in examples that follow.

4.1 Regulations and Guidance

The RCRA and CERCLA programs have issued guidance to tailor remedies to site-specific end uses including ecological enhancements. EPA's document *Guidance on Completion of Corrective Action Activities at RCRA Facilities, (EPA 2003,* http://www.epa.gov/swerffrr/pdf/final_guidance_rcra.pdf) describes how corrective actions can be completed, with contaminants remaining, using controls tailored to protection for a specific end use for the site. On February 18, 2004, EPA issued its new *Guidance for Preparing Superfund Ready for Reuse Determinations at Superfund Sites* as an element of, and tool for, the CERCLA program. This guidance describes how to document the conditions that will allow a Superfund site to be reused.

Superfund's written policy fully embraces a planning process that anticipates future uses. EPA, through the Superfund Redevelopment Program, encourages the beneficial reuse of Superfund sites while working towards EPA's overriding objective for all sites—protection of HH&E. With forethought and effective planning, communities and natural resource trustees (trustees) can return sites to beneficial use without jeopardizing the effectiveness of the remedy put into place to protect HH&E.

EPA has documented over three hundred NPL sites in reuse, a number of which have treatment systems, monitoring wells, contaminated material, or other features remaining on site. About 35 of these sites are reused for primarily ecological purposes. Superfund cleanup sites are being used for wetlands, meadows, streams, and ponds (where they provide habitat for terrestrial and aquatic plants and animals) as well as for low-impact or passive recreation, such as hiking and bird watching. In addition, many sites that were redeveloped primarily for other purposes, such as commercial or recreational facilities, also contain significant ecological resources or green space. The program recognizes that ecosystems are essential to all aspects of life, that it would be difficult to sustain society without them, and that their value in urban, suburban, and rural areas is often not fully recognized when decisions are made about land use.

The Superfund Redevelopment Program maintains an extensive web site that includes EPA directives and information on the reuse of Superfund sites for ecological and other purposes. Some of the key documents to consult for more information include the following:

- OSWER Directive 9355.7-06P Reuse Assessments: A Tool to Implement the Superfund Land Use Directive, 2001
- OSWER Directive 9355.7-04 Land Use: the CERCLA Remedy Selection Process, 1995
- OSWER Directive 9265.0-33, Guidance for Preparing Superfund Ready for Reuse Determinations at Superfund sites, 2004

EPA's Superfund Redevelopment Program has developed a series of reports to inform interested parties at hazardous waste sites about planning and technical issues that may arise during the remediation process when reuse of a site is intended following cleanup. The reports include guidance for sites with onsite containment or treatment facilities or equipment, The reports also address Superfund sites used for commercial facilities, golf courses, and other outdoor recreational areas and include information useful for other types of site uses as well:

- *Reusing Cleaned Up Superfund Sites: Commercial Use Where Waste is Left On-Site*, EPA 540/K-01/008, 2001 (http://www.epa.gov/superfund/programs/recycle/c_reuse.pdf)
- *Recreational Use of Land Above Hazardous Waste Containment Sites*, EPA 540/K-01/002, 2001 (http://www.epa.gov/superfund/programs/recycle/tools/recreuse.pdf)
- *Reuse of CERCLA Landfill and Containment Sites*, EPA 540-F-99-15, 1999 (http://www.epa.gov/superfund/resources/presump/finalpdf/)

Superfund redevelopment efforts can take a variety of forms:

- A pilot program that, since 1999, has provided over seventy local governments with up to $100,000 in funds or facilitation services for reuse assessment and public outreach to help determine their site's future use.
- Partnerships between EPA, states, tribes, other federal agencies, local governments, communities, land owners, lenders, developers, and parties that are potentially responsible for contamination.
- The publication of redevelopment successes through case studies and fact sheets that illustrate reuse options and lessons that have been learned through pilots and other reuse projects.

While current guidance acknowledges reuse as an objective, it implements reuse retrospectively because it asks how sites can be used only after the remedy has been implemented. EPA, on the other hand, encourages planning and coordination toward a land reuse desired by the potentially responsible party (PRP), community and other interested parties. Several legal avenues can introduce this more proactive approach to remediation into the CERCLA program. Under CERCLA, RCRA is the source of potential "applicable or relevant and appropriate requirements" (ARARs) that govern cleanup (Gill et al. 1999) and may still have a critical impact.

Other sources of legislation and regulation may apply to sites in most states. Other sources of remediation authority may be Brownfields, Voluntary Cleanup, Mined Land Reclamation, and other remediation programs. All states have legislation and regulations protecting HH&E; a few states have policies and guidance that address the need to include ecological considerations in cleanup alternatives. Some of these regulations can be viewed at the DOE Office of Environmental Management Laws and Policy site (http://lts.apps.em.doe.gov/center/stewlink0.asp) and at Long Term Stewardship In the Nuclear Weapons Complex (http://ndep.nv.gov/lts/ndaa_lts.htm).

If the goal is to increase ecological enhancements as part of a remedy, an NRDA claim could be offset and

209HNatural Resource Trustees conduct NRDAs to identify and document the extent of injuries, quantify the injuries, and determine the cost of compensation for the injured resources. Compensation for injured natural resources resulting from releases of hazardous substances or discharges of oil can take the form of monetary damages, restoration projects, or a combination of both. Injuries to natural resources are evaluated by identifying the functions or services provided by the resources, determining the baseline level of the services provided by the injured resource(s), and quantifying the reduction in service levels as a result of the contamination. Regulations for assessing NRD have been promulgated under both CERCLA and OPA.
(210Hhttp://www.epa.gov/superfund/programs/nrd/nrda.htm)

provide regulatory incentives to PRPs to align ecological end-uses with resource protection and recovery. Including ecological end use along with strong stakeholder input into remedial decision making may preclude or reduce future NRDA claims. Ecological land reuse could alleviate NRDA whether an NRDA claim is imminent or not. See DOE CERCLA Information Brief, Office of Environmental Guidance, EH-231-017/0693, June 1993 (http://www.eh.doe.gov/oepa/guidance/cercla/nrda.pdf), for information on NRDA assessments in the DOE. While it may be unclear how these ecological reuses may offset future NRDA claims, there appears to be significant technical and regulatory basis for these discussions.

All environmental regulatory rules governing cleanup decisions require that the protectiveness mandates apply so long as land use restrictions are in effect. Remedy protectiveness reviews and institutional or land use controls must be maintained until residual contamination no longer poses a threat to HH&E. The selection of land use controls as a component of ecological reuse go hand-in-hand during remedy selection. For more information please see: *Institutional Controls: A Site Manager's Guide to Identifying, Evaluating and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups, EPA 540-F-00-005, OSWER 9355.0-74FS-P, September 2000.* (http://www.epa.gov/superfund/action/ic/guide/guide.pdf).

4.1.1 Hazardous Waste Disposal Facilities

CFR Title 40 Subchapter I, Parts 260–279 contains regulations governing the management of hazardous waste facilities. At several points the regulations indicate that alternative regulatory requirements may be used to supplant the more specific prescriptive regulations and can be used to support alternative design integrating ecological enhancements. CFR Section 264.110 (below) affords the opportunity to use "alternative requirements," provided they are protective of HH&E:

> ***At several points the regulations indicate that alternative regulatory requirements may be used to supplant the more specific prescriptive regulations and can be used to support alternative design integrating ecological enhancements.***

> § 264.110 Applicability.
> (c) The Regional Administrator may replace all or part of the requirements of this subpart (and the unit-specific standards referenced in § 264.111(c) applying to a regulated unit), with alternative requirements set out in a permit or in an enforceable document (as defined in 40 CFR 270.1(c)(7)), where the Regional Administrator determines that:
>
> > (1) The regulated unit is situated among solid waste management units (or areas of concern), a release has occurred, and both the regulated unit and one or more solid waste management unit(s) (or areas of concern) are likely to have contributed to the release; and
> > (2) It is not necessary to apply the closure requirements of this subpart (and those referenced herein) because the alternative requirements will protect human health and the environment and will satisfy the closure performance standard of § 264.111 (a) and (b) and c. Complies with closure requirements of this subpart including, but not limited to, the requirements of §§264.178, 264.197, 264.228, 264.258, 264.280, 264.310,

> 264.351, 264.601 through 264.603, and 264.1102. (51 FR 16444, May 2, 1986, as amended at 51 FR 25472, July 14, 1986; 57 FR 37264, Aug. 18, 1992; 63 FR 56733, Oct. 22, 1998)

Key to this regulation is the requirement to protect the environment. Integrating ecological end uses via the inclusion of ecological elements or enhancements into remedies is consistent with protection of the environment. Currently the EPA indicates that protecting the environment may include the replacement of habitat that was impacted on a site, local, or region (EPA 2004).

Section 264.110 does not specify prescriptive regulatory requirements but instead focuses on managing the potential risk associated with a hazardous waste or solid waste management units. The alternative requirements that are protective of HH&E are left to negotiations between the facility owner/operator and the regulators. This section also calls out the need to protect not only human health, but also the environment. While Part 264 of the CFR pertains to permitted hazardous waste facilities, similar regulations are found in Part 265, which apply to interim status hazardous waste facilities.

Similarly, Section 265.110(d) is significant because it affords the opportunity for the regional administrator to use "alternative requirements" protective of HH&E. Again, these regulations do not contain specific performance requirements but instead identify the need to be protective or manage the threat associated with a given hazardous waste activity. Therefore, this section of the regulations clearly supports the design, construction, and operation of alternative remedies, including those that are protective of the environment via the inclusion of ecological element or enhancements.

The RCRA regulations clearly establish closure performance standards for hazardous waste disposal facilities. These standards are found in 40 CFR Sections 264.111 and 265.111 for permitted and interim hazardous waste disposal facilities, respectively, and apply to hazardous waste landfills and other RCRA-regulated units. The standards state the following:

> The owner or operator must close the facility in a manner that:
>
> a. Minimizes the need for further maintenance; and
> b. Controls, minimizes, or eliminates, to the extent necessary to protect HH&E, post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated runoff, or hazardous waste decomposition products to the ground or surface waters or to the atmosphere.

The intent of these standards is reiterated along with other previous closure performance criteria: to protect the environment by protecting surface impacts from runoff, surface water, groundwater, and air (in addition to protecting human health). EPA encourages alternative standards that are tailored to protecting HH&E via the inclusion of ecological elements and enhancements into remediation strategies while returning land to a productive end use (see EPA 2003 for further discussion).

Corrective action deals with responding to releases or past disposal events. Section 264.101 of 40 CFR identifies the performance standard related to implementing corrective action. The first portion of the federal corrective action regulations is copied below:

> § 264.101: Corrective action for solid waste management units.
>
> (a) The owner or operator of a facility seeking a permit for the treatment, storage, or disposal of hazardous waste must institute corrective action as necessary to protect HH&E for all releases of hazardous waste or constituents from any solid waste management unit at the facility, regardless of the time at which waste was placed in such unit.

This regulation again identifies the protection of HH&E as a goal. Therefore, at RCRA-regulated facilities with a historical release of solid or hazardous waste, protection of the environment should be considered as part of the final remedy. Similar statutes and regulations pertain to interim status or nonpermitted RCRA regulated facilities. One example is found in Colorado's regulations related to corrective action activities associated with interim status treatment, storage, and disposal facilities:

> Section: 265.5 Interim status corrective action orders.
>
> (a) Facilities that are or were subject to the requirements of Part 265 shall not have releases of hazardous waste or hazardous constituents into the environment which may be or are harmful to human health and the environment. Whenever on the basis of any information, the Department determines that there is or has been a release of hazardous waste or hazardous constituents into the environment from an interim status facility, the Department may issue an order under authority of Section 25-15-308(2), C.R.S. requiring corrective action or such other response measure as it deems necessary to protect human health or the environment. Any order issued under this section may include a suspension or revocation of interim status authorization to operate if the Department has reasonable grounds to believe and finds that the owner and operator has been guilty of a deliberate and willful violation resulting in such releases, or that the public health, safety or environment imperatively requires emergency action. Any order issued under this section shall state with reasonable specificity the nature of the required corrective action or other response measure and shall specify a time for compliance. Any order issued under this section may designate or establish corrective action management units or temporary units in accordance with 264.552 and 264.553.

The Federal Code of Regulations and many of the states' regulations related to the RCRA Program require the protection of the environment in addition to the protection of human health. Protection of the environment may and should include the implementation of ecological elements and enhancements. These requirements are far reaching in that they not only pertain to the RCRA Subtitle C regulatory program, but may also serve as ARARs for the CERCLA program.

4.1.2 Flexibility in Brownfield Legislation

On January 11, 2002, President Bush signed the Small Business Liability Relief and Brownfields Revitalization Act (Pub .L. No. 107-118, 115 stat. 2356, "the Brownfields Law"). The Brownfields Law amended CERCLA by providing funds to assess and clean up Brownfields, clarified CERCLA liability protections, and provided funds to enhance state and tribal response programs. Other related laws and regulations impact Brownfields cleanup and reuse through financial incentives and regulatory requirements. Brownfields legislation also emphasizes protection of the environment:

> ***Title II--Brownfields Revitalization and Environmental Restoration***
>
> Sec. 211. Brownfields Revitalization Funding
>
> (C) Site-By-Site Determinations- Notwithstanding subparagraph (B) and on a site-by-site basis, the President may authorize financial assistance under section 104(k) to an eligible entity at a site included in clause (i), (iv), (v), (vi), (viii), or (ix) of subparagraph (B) if the President finds that financial assistance will protect human health and the environment, and either promote economic development or enable the creation of, preservation of, or addition to parks, greenways, undeveloped property, other recreational property, or other property used for nonprofit purposes.

4.1.3 Flexibility in State Solid Waste Regulations

The federal regulations pertaining to municipal solid waste facilities include provisions for the use of alternative requirements as part of the closure process as identified below:

> (3) The Director of an approved State may establish alternative requirements for the infiltration barrier in a paragraph (b)(1) of this section, after public review and comment, for any owners or operators of MSWLFs that dispose of 20 tons of municipal solid waste per day or less, based on an annual average. Any alternative requirements established under this paragraph must:
> (i) Consider the unique characteristics of small communities;
> (ii) Take into account climatic and hydrogeologic conditions; and
> (iii) Be protective of human health and the environment.

In addition to ecological elements or enhancements being incorporated into the closure process, they should also be considered as part of the corrective action process as identified below in the Federal Solid Waste Regulations.

> Part 258—Criteria For Municipal Solid Waste Landfills Subpart E—Ground-Water Monitoring and Corrective Action
>
> Section: 258.58 Implementation of the corrective action program.

(a) Based on the schedule established under §258.57(d) for initiation and completion of remedial activities the owner/operator must:

(1) Establish and implement a corrective action ground-water monitoring program that:

(i) At a minimum, meets the requirements of an assessment monitoring program under §258.55;

(ii) Indicates the effectiveness of the corrective action remedy; and

(iii) Demonstrates compliance with ground-water protection standard pursuant to paragraph (e) of this section.

(2) Implement the corrective action remedy selected under §258.57; and

(3) Take any interim measures necessary to ensure the protection of human health and the environment. Interim measures should, to the greatest extent practicable, be consistent with the objectives of and contribute to the performance of any remedy that may be required pursuant to CFR40 §258.57. The following factors must be considered by an owner or operator in determining whether interim measures are necessary:

(i) time required to develop and implement a final remedy;

(ii) actual or potential exposure of nearby populations or environmental receptors to hazardous constituents;

(iii) actual or potential contamination of drinking water supplies or sensitive ecosystems;

(iv) further degradation of the ground-water that may occur if remedial action is not initiated expeditiously;

(v) weather conditions that may cause hazardous constituents to migrate or be released;

(vi) risks of fire or explosion, or potential for exposure to hazardous constituents as a result of an accident or failure of a container or handling system; and

(vii) other situations that may pose threats to human health and the environment.

As with regulations pertaining to hazardous waste facilities, remediation planners can take advantage of this opportunity to implement ecologically-based closures in accordance with the provision to protect the environment. Again, the closure process for solid waste facilities should incorporate protection of the environment and not human health alone. Protection of the environment may be most readily achieved by the inclusion of ecological elements or enhancements into the closure and remediation processes.

4.2 Conventional Requirements versus Performance Requirements

The regulatory and guidance citations above identify requirements that have long dictated the protection of HH&E. This may be accomplished by direct implementation of the regulations or by taking advantage of and using "alternative requirements." More recently, however, EPA has adopted policies that are meant to speed remediation and encourage the use of innovative designs (Gill et al 1999). The use of innovative technologies, including ecological elements or

enhancements, is consistent with EPA's desire to move remediation projects through the regulatory process and achieve stable sites with final remedies in place that are protective of HH&E.

In addition, the use of risk-based criteria to evaluate the threat to HH&E is being used more frequently to make closure and remediation decisions. Risk-based criteria allow facilities and regulators to evaluate the current and potential future stressors and resulting threats associated with a particular site, facility, unit, or impacted area. The stressors may represent the risk or threat associated with a specific impacted area of contamination or waste management facility. The stressors are then converted to failure modes for closure or remediation projects. The stressors help planners understand how contamination may be released from an area, what media may be impacted, and who or what could then be exposed to the contamination. Alternative requirements may then be used to protect the environment by integrating ecological elements or enhancements into a postremediation end use as an integral part of the final remedy. This flexibility allows for innovation and alternative designs—designs that are geared toward performance-based instead of criteria-based remedies. These remedies incorporate ecological land reuse via the implementation of ecological elements or enhancements and are protective of human health and the environment.

4.3 Example of State Flexibility (Pennsylvania)

Pennsylvania's Land Recycling Program allows a flexible approach to site remedy selection that could readily accommodate the application of ecological elements or enhancements. The owner/operator of a site can choose one or a combination of three risk-based cleanup standards as an attainment endpoint for the remedial efforts. The final site condition can be selected to accommodate the expected end uses for the site. These regulatory standards are performance based and allow the cleanup to be conducted via a nonprescriptive approach, with the final standard attainment being the basic measure of success. Thus, the means by which the site is cleaned up is at the owner/operator's discretion, as is the final site restoration.

5. DECISION MAKING

Decision making is often driven by the need to address immediate threats or by procedures in a regulatory framework. While these are necessary, successful efforts also take a future view and define a clear vision of the desired end use of the site. To accomplish this, designers must consider the site's relationship to the surrounding environment, the needs of the local community, and the feasible solutions to the limitations created from the site contamination. This requires an immediate, yet step-wise process to effectively evaluate the site, the danger, and the goal. More specifically, the three initial steps in this process are: (1) establish the site service capacity, (2) mitigate immediate threats, and (3) assure that established cleanup goals protect HH&E. Figure 5-1 below details this process.

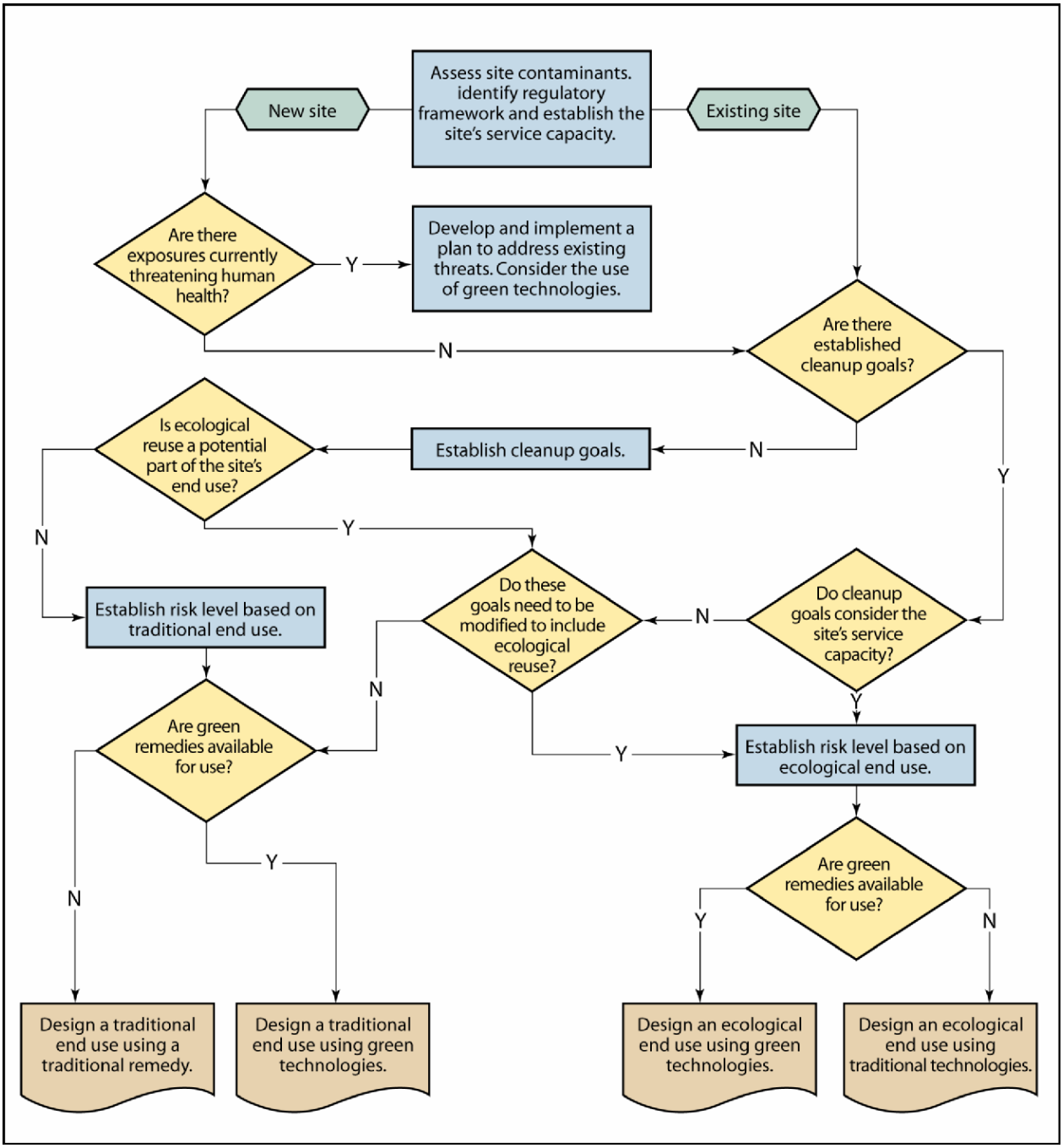


Figure 5-1. Decision making for ecological land reuse at remediated sites

Decision making at a site scheduled for remediation, with an interest in placing the remediated property back into use, requires a clear understanding of the region, expected future conditions of the property, and options to remediate the contamination. This is especially true if the site will include an ecological end use. By integrating ecological elements or enhancements into the cleanup remedy and considering the planned use of the surrounding properties, a natural or created terrain or habitat can intermingle and complement a residential, industrial, and open

space infrastructure. The ability of a remediated property to support the community and surrounding landscape depends on the surrounding capacity. Figure 5-2 displays the general elements used to evaluate the capacity of a site.

Identifying solutions to restore site ecological capacity involves finding the best balance between regional needs, site properties, and the protective actions that will return safe feasible uses to the site. The overlap of site properties and regional needs represents the site's potential ecological service capacity. Not all of the capacities can be restored, however, and remain protective of human health and the environment. One objective is to identify the protective actions needed to restore site capacity and perhaps to mitigate those capacities that can not be restored. Efforts that do not address regional needs represent speculative efforts that may be incongruent with regional needs and future planning.

Figure 5-2. Venn diagram of the general elements used to estimate a site's feasible uses considering the capacity of the surroundings

The Venn diagram depicts three primary and interacting circles: (1) site properties, (2) regional needs, and (3) protective actions. The negative site properties caused by contamination can impact the regional needs by causing a loss of capacity. The protective action can help restore the regional needs through mitigation efforts and thus restore the lost capacity. At the same time, the protective actions may improve the site properties by remediating the contamination through speculative efforts. These can all be driven by the potential or feasible uses of a site based on the impacts from the contamination, potential regional needs, and possible or available protective actions.

5.1 Service Capacity

Service capacity: the ability to produce jobs, housing, environmental habitat, mineral resources, agricultural goods, and other societal values.

Defining the site's service capacity. Every site possesses a unique value to society that is dependent on its properties and its relationship to the surrounding region. The ability of a site to produce jobs, housing, environmental habitat, mineral resources, agricultural goods, and other societal values is the "service capacity". The service capacity of a site is dependent on its regional setting. For example, a one acre lot in downtown New York has a very different service capacity than a one acre lot in rural Napa, California. Contamination will diminish the service capacity of a site and may threaten the capacities of the site, the immediate locale, or surrounding region. For instance, contamination may prevent economic or ecologic use

of a site while also threatening a regional resource. The goal of a site remediation is to eliminate exposure pathways that pose a threat to human health or the environment, to eliminate any threats to regional resources, and to restore the service capacities of the site to the region. As shown in Figure 5-1 above, the first priority is to address existing threats to human health and regional resources, then the actions necessary to restore the site's service capacity are considered. As an example, the Chattanooga site (Figure 5-3, 5-4, and inset on following page) provides a wetland, flooded woodland and a regenerative nursery, as well as greenscapes intermingled with commercial and educational development. A full case study for this site is included in Appendix C.

Figure 5-3 and 5-4. Coolidge Park adjacent to the North Shore Wetlands Park, Chattanooga, Tennessee. See Appendix C for full case study.

Case Study: North Shore Wetlands Park, Chattanooga, Tennessee

North Shore Wetlands Park is located at a 23.5-acre former industrial site on the banks of the Tennessee River in Chattanooga's downtown. The site was agricultural land prior to the mid 1900's and then a manufacturing facility. The site is west of the Market Street Bridge and Coolidge Park, an eight-acre urban park. It now contains the following:

Ecological Features	***Historical Features***	***Educational Features***	***Recreational Features***
Created Wetland *Flooded Forest* *Regenerative Nursery*	*Cherokee Trail* *Meig's Allee* *Bridge Blockhouse* *Underwater Wrecks*	*Outdoor Center* *Amphitheater* *Interpretive Features*	*Canoe Launch* *Riverwalk*

The three-year community planning effort involved hundreds of meetings and thousands of people. The Tennessee Riverpark Master Plan outlined a 25-year development process for the 22-mile riverfront corridor on either side of the Tennessee River. Over 1,600 people turned out to see the Master Plan unveiled at the Convention Center in 1985.

Evaluation and restoration of ecological capacity is an important part of the service capacity consideration. As the site's ecological capacity is not always obvious, it may take an environmental professional to provide input on the ecological needs of the locale and region and the role of the site in meeting those needs. It is helpful to consult with, for example, state conservation and natural resource agencies, land use, planning, and fish and wildlife agencies on the appropriate ecological end-use goals for a specific site. Additionally regional universities, conservation groups, and other stakeholders are useful resources for input into the development of the service capacity of a region.

5.1.1 Factors to Consider When Assessing the Site's Service Capacity

Restoring service capacity restores value to society as an outcome by design.

Site service capacity should be evaluated early in the project (with the help of stakeholder input if possible), and should consider a variety of uses. This evaluation will ultimately be coupled with cost considerations as identified in Section 7. A typical land-use assessment and land-use plan will address capacities such as housing, employment, and recreation, but may overlook environmental capacities such as wildlife habitat or wildlife corridors. Sometimes planners tend to select a single use at the expense of others; a better strategy may be to consider the ecological values and find ways to maintain those values even when the site is used for other purposes (see the Woodlawn case study in Appendix C).

There are several challenges to identifying and restoring ecological capacity. Ecological capacity might consider the variety of species, the population of various species, or the enabling of species to thrive, expand, or migrate. The ecological capacity of an area might improve if barriers to migration routes were removed, overcome, or not established by an engineered

system. Greenways may improve sporadic and isolated plots of habitat by providing connections to other isolated plots of habitat, thus allowing species to migrate, repopulate, and diversify. Creating habitat that has been lost or improving the native habitat can increase the ecological service capacity of an area and improve the survivability of species at or near the site, including endangered species[2]. What may appear to be a useless piece of land ecologically and, therefore, more suitable for sociophysical (the physical environment of human society) development may be a unique habitat to certain species that have adapted to that environment and cannot live elsewhere. If the land is developed, then primary habitat is lost.

Much ecologically rich land is usually in riparian corridors. This is often where people want to farm, where people want to live, and where people want to hunt and fish. Thus, there is pressure to discount ecological values in favor of sociophysical development. It may take extra effort to communicate the ecological importance of a site so that its value to the region can be properly understood and integrated into the remediation project and future use planning. Ecological value goes beyond that which is immediately valuable to human life, and it can be difficult to weigh the value of a system whose value is not obvious until it is gone. Nonetheless, proper weight should be given to the inherent ecological value and considered in the land-use decision making process. This ecological remediation valuation is discussed further in Section 7.

Planning to meet human needs can be done while keeping essential attributes of natural systems intact.

5.1.2 Ecological Factors

Wilson (2004) has identified a number of ecosystem services which are categorized into four functional characteristics. It is difficult to assign a dollar value to the functions of ecosystems and to the elements contributing to the functioning ecosystem. This categorization offers a basis for identifying and evaluating the services an ecosystem can provide and thereby improve the total ecological valuation of the site as remedial design is occurring. Table 5-1 (Wilson 2004) is an illustration of these potential ecosystem functions and the services they perform.

Table 5-1. Ecosystem services (modified from Table 1, Ecosystem Services, Wilson 2004)

Ecosystem Functions	Ecosystem Service Examples
Regulating Ecosystems regulate essential ecological processes and life support system through bio-geochemical cycles and other biospheric processes. These include things like climate regulation, disturbance moderation, and waste treatment.	Climate & Atmospheric Regulation • Carbon Dioxide Sinks • Oxygen production • Ambient VOC Uptake
	Disturbance Moderation • Storm protection • Flood protection • Regulation of runoff • Fire Protection
	Freshwater Regulation • Water catchments

[2] For more information on the endangered species act, go to http://www.epa.gov/region5/defs/html/esa.htm

Ecosystem Functions	Ecosystem Service Examples
	• Groundwater recharge • Drainage and natural irrigation
	Waste Treatment • Pollution control & detoxification • Filtering dust compounds • Abatement of noise pollution
	Biological control • Control of pests and disease • Reduction of herbivory (crop damage)
	Habitat Refuge • Nursery, feeding, and breeding ground for harvested species • Maintenance of biodiversity and genetic resources • Habitat for resident and migratory species
Supporting Ecosystems also provide a range of services that are necessary for the production of the other three services categories. These include nutrient recycling, soil formation, and soil retention.	Nutrient regulation • Nutrient filter • Remineralization of organic and inorganic matter • Trapping sediments and pollutants
	Soil formation and retention • Maintenance of productive soils • Prevention of damage from erosion and siltation • Maintenance of arable land
Provisioning The provisioning function of ecosystems supplies a large variety of ecosystem goods and other services for human consumption, ranging from food and raw materials to energy resources and genetic material.	Food and raw materials • Edible shellfish • Fuel wood • Marketable animal, plant, and fish species
	Water supply • Provision of water for irrigation • Drinking water and industrial use • Medium for transportation
	Genetic and Medicinal resources • Crop resistance to pathogens and pests • New drugs and pharmaceuticals • Chemical models and tools
	Pollination • Pollination of marketable crops • Maintenance of wild plant species and populations
	Ornamental resources • Resources for fashion, handicrafts, and jewelry • Pets, furs, and feathers • Raw materials for decoration and souvenirs
Cultural Ecosystems provide an essential reference function and contribute to the maintenance of human health and well-being by providing spiritual fulfillment, historic integrity, recreation, and aesthetics.	Recreation and Amenity • Non-consumptive recreation and water sports • Aesthetic quality—proximity of houses to environmental amenities • Recreational hunting and fishing • Enjoyment of scenery
	Inspirational and historic • Cultural heritage sites • Archeological treasures

Ecosystem Functions	Ecosystem Service Examples
	• Spiritual and religious meaning

5.1.3 Regional Factors

Determining the ecological value of a site, by its very nature, requires a review of how the site interacts with the region around it. Proximity to wildlife refuges, streams, rivers, parks, wetlands, and riparian habitats should be evaluated to determine the suitability of the site or portions of the site to add to the ecological value of the property. Planners should consider specific aspects of each site:

- Does the site have the potential to provide habitat for migratory or resident species?

- Is this potential habitat in short supply and needed?

- How does this ecological capacity compete with or compliment other regional needs? For example: Can a partnership be created with surrounding land owners to encourage regional eco best practices like grass banking, a conservation easement like Wyoming's conservation easement program (http://nature.org/wyoming), or Weldon Springs a DOE Superfund cleanup resulting in metropolitan prairie (http://www.lm.doe.gov/documents/sites/mo/weldon/factsheets/history.pdf).

- Does the site contain a parcel of land that currently features or could potentially support some of the habitat components (food, water, cover, space) required by wildlife. These parcels can be large or small.

- Is the site adjacent or close to an established wildlife protection area? Examples include national wildlife refuges, national parks, state parks, state wildlife management units, county parks, and private preserves operated by land trust organizations or conservation groups. Sites located adjacent to or nearby these preserves can work to improve their own habitat values. This serves to effectively increase the overall size of the preserve without expanding preserve boundaries.

- Does the site feature or is it located near key ecosystem services/functions? Examples would include breeding, feeding and stopover areas along major migratory routes for birds (such as raptors, neotropical songbirds), and/or butterflies (such as the monarch or painted lady). Does the site serve as a migration route for terrestrial animals (such as the pronghorn antelope)? Does the site play a role in watershed protection? For example, do tributaries run through or along the site?

- Is the site located near or does it serve as an ecological corridor or greenway that promotes the relatively undisturbed movement of wildlife? As the landscape becomes increasingly fragmented, connectivity (or linkage) of green areas is critical so wildlife can access critical resources (food, water, shelter, space).

- Is the site located near or does it contain wetland areas? Wetlands attract wildlife. Riparian habitats along rivers and lakes provide outstanding habitat for a diversity of species. The complex and lush vegetative communities that often characterize riparian areas provide food and shelter for large numbers of species. This is especially true in the more arid western regions of the United States. Marshes in coastal regions are also important.

- Does or could the site serve as an environmental or ecological research area or promote environmental education or tourism efforts?

- Is the site located in a critical area that could be used as part of a statewide or region-wide conservation plan? Most states and/or counties have such plans. Local conservation efforts tend to have the greatest impact when integrated into part of a larger conservation strategy.

- Is the site in a regional watershed protection priority area where ecologically enhanced land helps control flooding, urban runoff, or migration of contaminated water?

The availability and need for various types of land uses such as agricultural, urban, suburban, recreational, or commercial are important to a region.

5.1.4 Site Factors

Site properties to consider include whether: 1) the property elevations indicate upland or wetland habitat, 2) the acreage available is large enough to provide meaningful habitat, 3) threatened and endangered species are or are not present, and importantly, 4) the type of contamination will impact ecological use. The current or historical uses of the property may also dictate the appropriate actions. If the property is currently in use, then it is possible that the site capacity is not significantly diminished and ecological opportunities may be more to compliment the existing uses. Site factors to consider include but are not limited to the following:

- soils
- hydrology, surface water, and groundwater
- fauna
- flora
- contaminant type and remaining contamination with associated land use controls
- community or human factors (for example, a bike path adjacent to the properties)
- air quality (avoid a point source from a soil vapor extraction, or SVE, system)
- existing infrastructure

The process for collecting data on site contamination is important but to some degree may be dictated by the program regulating the site. Ideally, data collection should be viewed as an iterative process to cost-effectively reduce remedy uncertainty and support the process of restoring the site's service capacity. Data on contaminant type and distribution is needed to help define which end uses are viable, as well as the remedies needed to support those uses. With some idea of the capacities intended to be restored, the data collection can be targeted to clarify actions necessary to restore the site while assuring its use is protective.

5.1.5 Protective Actions

Mitigate immediate principal contamination threat. The first priority for action at a site is to be sure that no exposure pathways immediately threaten human health and that offsite migration is contained. Then efforts turn to restoring the service capacities identified from the assessment of regional needs and site properties. The overlap between regional needs, site limiting properties, and the available technologies and actions that can successfully restore uses, provides a list of feasible uses that can be successfully restored.

Assure there are cleanup goals. Next, clean up goals that are protective of the desired end use must be determined. For example, a wildlife management area may or may not require the same level of cleanup if human access is controlled. On the other hand, if crops are raised on the property, human exposure to the soils, water, and ingested crops may mandate extensive cleanup. Institutional controls and other land use controls are often necessary remedial or corrective action components to the end uses.

Ecological use should be identified as a service capacity of the site to be remediated. The ecological service capacity may be evaluated as not significant, but its service capacity should still be evaluated. Then the question becomes "how can the lost ecological service capacity be returned?" The questions of ecological benefit are often complicated by concurrent ecological loss. For instance, a site that may contribute significantly to waterfowl habitat may still have some detrimental characteristics (e.g. invertebrate toxicity). Thus, a net environmental benefit analysis (NEBA) may be needed to define an acceptable course of action (Efroymson 2003). Joseph P. Nicolette, a co-author on Efroymson 2003, describes NEBA in the inset on the following page.

What is Net Environmental Benefit Analysis (NEBA)?

A NEBA is an approach that allows for a systematic evaluation of changes in natural resource values (ecological and human use) associated with land management alternatives (e.g., remedial alternatives) so that consistent comparisons across alternatives can be conducted to achieve the greatest net environmental benefit at the lowest cost, while maintaining protection of human health and the environment. This approach is described in detail in Section 7.4.

The NEBA framework shares the same theoretical foundation as benefit-cost analysis. An important distinction is that, in NEBA, the ecological and human use effects of an action are considered. The NEBA approach identifies and values the primary environmental services that an area or portfolio of holdings may provide given different land uses and actions (such as managing wildlife, building roads and infrastructure, siting facilities, discharging effluent, restoring stream habitat, etc.). The type, quantity, and quality of environmental services provided by an area or waterway are determined, in part, by the surrounding geographic landscape (i.e., land uses). The NEBA approach uses the recent emphasis (NOAA, DOI, USFWS) in the natural resource sciences to consider environmental services within a landscape context. Proposed actions will affect the quality and quantity of ecological and human use services produced at the site or parcel differently. Some services may be improved, some may not be affected, and some may be harmed. A systematic evaluation of these changes in service capacity is needed to make consistent comparisons across alternatives and to optimize the achievement of environmental objectives at least cost.

NEBA is a method comprised of a set of agency approved and litigation tested techniques and tools for quantifying the benefits of alternative land uses or actions (e.g., remedial actions) that affect the environment. The NEBA approach and quantification tools can be used to:

1. *estimate value of environmentally sensitive areas;*
2. *develop and evaluate a suite of alternatives;*
3. *provide a basis for balancing economic, human, and natural resource drivers affecting proposed alternatives;*
4. *support measures to weigh and rank alternatives that meet cost-effective objectives;*
5. *provide a means to expand the range of potentially acceptable alternatives;*
6. *provide documentation that provides a defensible alternative analysis and selection;*
7. *provide a basis for establishing appropriate mitigation measures; and*
8. *provide performance-based measures that can be used to conduct monitoring and adaptive management activities.*

When properly planned and implemented, the NEBA approach provides a systematic, consistent, and defensible process that can significantly enhance stakeholder support for selected environmental and land use planning decisions. This process also promotes the selection of decisions that demonstrate a balanced win for the environment and the stakeholders.

-Taken from: Natural Resource Valuation and Net Environmental Benefit Analysis (valuing ecological and human use services) by Joseph P. Nicolette, currently Vice President, ELM Consulting, LLC.

Some site capacities may have been lost; however, that does not mean the capacity can not be restored to the region. For instance, wetland habitat may have been an historical capacity, but is now replaced with a large landfill that may not be feasible to move. The lost capacity could be returned by creating new habitat in other areas (e.g., offsite mitigation). Other capacities can be treated similarly (payment to housing trust funds in lieu of building housing, replace water source with treated municipal water, etc.). These mitigation measures may be far more beneficial, effective, and timely at returning needed capacity to the region than to attempt to fully restore the site. Remediation, however, is the focus and cannot be jeopardized in lieu of added ecological capacity. Again, a good regional assessment should help identify the offsite or out-of-kind mitigation opportunities that best address the need (such as connecting fragmented habitat, etc.)

Ecological capacity can also be returned during the process of restoration to another use (for example, cleanup to prepare for housing or industrial use). Various green technologies offer temporary ecological capacity while they are in use (see ITRC ALT-2 2003; ITRC Wetlands-1 2003; ITRC Wetlands-2 2005; ITRC Phyto-2 2001).

Off-site wetlands mitigation *should be in the same general vicinity or close to the impacted wetlands site. A mixture of on-site and off-site compensatory wetlands can be considered as well; however, the functional scoring should be the basis for the type and amount of on-site and off-site compensatory mitigation.*

In-kind *wetlands compensation for a wetland loss involves replacement of a wetland area by establishing, restoring, enhancing, or protecting and maintaining a wetland area of the same physical and functional type. In-kind replacement generally is required when the impacted resource is locally important.*

Out-of–kind *compensation for a wetland loss involves replacement of a wetland area by establishing, restoring, enhancing, or protecting and maintaining an aquatic resource of different physical and functional type (ITRC Wetlands-2 2005).*

5.2 Selection of Green versus Traditional Technologies

Even when an ecological end use is not a stand alone cleanup option, so-called "green technologies" can be used to provide years of ecological benefit while the site is undergoing cleanup of principal threat contamination. Green technologies are approaches that use plants to draw water, extract toxics, assist in microbial digestion of toxics, provide cover, or in some way aid in the accomplishment of the remedial objective while also temporarily providing greenspace, open space, a livable environment, and/or habitat. Green technologies are viable remedial components for long-term response actions for residual contamination issues. Examples of these green technologies may include, but are not limited to, constructed wetlands, rain gardens, filter strips, and bioswales as ecological enhancements. Table 5-2 provides a comparison of conventional remedies and ecological remedies.

Table 5-2. Traditional versus green technologies

Target Goal	Traditional Remedies	Ecological Remedies
Dig and haul (Source Zones)	Excavation, source removal, hot spot removal	
Caps and barrier containments	RCRA covers, slurry/sheet pile walls, permeable reactive barriers	Vegetative covers, tree hydraulic barriers,
Soil treatment	Land farming, Bio-piles	Phyto/bioremediation composting
In situ plume treatment	Sparging/soil vapor extraction system	Deep-rooted systems (trees, prairie species)
Groundwater control	Pumping/extraction systems	Tree hydraulic systems
Ex situ treatment systems	Granular activated carbon, advanced oxidation, bioreactors, catalytic/thermal oxidizers	Phytoextraction, photosynthetic oxidation, plant bioreactions, constructed wetlands

5.3 End Use

During the planning phase of a remediation program the performance of the effort should be scaled to what the owner, regulatory oversight agency, and the nearby community expects the forecasted use of the property after completion. This guidance naturally focuses on ecological end uses (see Table 5-3, Section 5.3.2). Ecological end uses may be the ultimate final use of the property or an integrated element of a larger planned use that is agreed upon by the affected community. Regardless of the ultimate disposition of the property, the remediation process may still take advantage of green or natural technologies.

5.3.1 Designing for Ecological End Use Using Traditional Remediation Technologies

There are many instances where ecological reuse or enhancements can be part of the remedial solution; the elements described in Section 5.1.4 still apply. Key stakeholders should be involved in defining how the property will be used. Additionally, the remedy and land use controls should be tailored to efficiently reduce any risk of toxic exposure to future users or impairment of neighboring resources.

Commonly used traditional remedial approaches at hazardous waste sites or RCRA Corrective Action facilities include such actions as excavation, capping, gas collection, and treatment, groundwater pump and treat systems, in situ treatment, solidification and stabilization, and barrier wall installation. These are actions that usually result in a significant impact to ecosystems at the point of remediation, and the resulting loss of vegetative communities and associated wildlife populations. An option to protect or improve the biological conditions at the site, however, can be identified as the preferred end-use option and incorporated into the design of the remedial action. The greatest flexibility with respect to the type of ecological end-use options available or the manner in which they may be implemented will occur if end-use planning and stakeholder input occurs early, often, and as part of the remedial selection and design process. The ultimate goal of the ecological end use is the development of a complex

habitat capable of supporting an assortment of habitats that are sustainable, and, if possible, self sustaining.

Ecological end-use options will vary widely, depending upon the location of the site with respect to future growth demands, geography, topography, elevation, climate, soils, and hydrology. As a result of this variability in sites, it is not possible to dictate specific end-use decisions or activities that are applicable to all sites. Instead, planners at individual sites should consider three general issues in designing and planning an ecological end-use option appropriate for their location. Those general issues include biodiversity, type of contamination, and scope of the ecological end-use project. These issues should be considered regardless of whether the end use is associated with traditional technology or any green or natural technologies.

5.3.1.1 Biodiversity

Biological diversity, or biodiversity, refers to the variety of life in all of its forms and levels or organization (Hunter, 1990). Planners for an ecological end use at a given site should approach their project with the goal of generating a diverse ecosystem. The sustainability of a project will be based on how the ecosystem works, the various interactions that occur between biological components (such as plants and animals), and the abiotic components, such as soil and water.

Harker et al. (1993) establishes a series of principles and guidelines to be applied spatially in the design of an ecological reuse project, as well as to the development of individual communities as part of the project:

Spatial Principles and Guidelines

1. Large areas of natural communities sustain more species than small ones;
2. Many small patches of natural communities in an area will help sustain regional diversity;
3. The shape of a natural community is as important as the size;
4. Fragmentation of habitats, communities, and ecosystems reduces diversity;
5. Isolated patches of natural communities sustain fewer species than closely associated patches;
6. Species diversity in patches of natural communities connected by corridors is greater than disconnected patches;
7. A heterogeneous mosaic of natural community types sustains more species and is more likely to support rare species than a single homogeneous community; and
8. Ecotones between natural communities are natural and support a variety of species from both communities and species specific to the ecotone.

Community Principles and Guidelines

1. Full restoration of native plant communities sustains diverse wildlife populations;

2. An increase in the structural diversity of vegetation increases species diversity;
3. A high diversity of plant species assures a year-round food supply for the greatest diversity of wildlife;
4. Species survival depends on maintaining minimum population levels; and
5. Low intensity land management sustains more species and costs less than high intensity.

5.3.1.2 Type of contamination

Planning for an ecological reuse project must take into consideration the type of contamination at the site, particularly if the contamination is bioaccumulative and if residual contamination is to be left on site. Bioaccumulative constituents include, but are not limited to, organochlorine pesticides, polychlorinated biphenyls, some chlorinated organic compounds, and metals such as mercury. These constituents have the potential to accumulate in the tissues of organisms and, depending upon the type of constituent, have the ability to concentrate at successively higher levels of the food chain (bioaccumulation). Planning for the ecological end-use project must assure plants and wildlife will not be exposed to the constituents of concern at levels that cause them harm through direct contact or bioaccumulation. The ecological risk assessment process in the remedial investigation (RI) or remedial field investigation (RFI) phase of the site investigation will provide input into the type of constituents that are on site and the levels that may produce a toxicological impact.

5.3.1.3. Scope of the ecological end-use project

The ecological end-use project for a given site will depend on a variety of circumstances, not the least of which is the desire of the site manager. The project can include the development of forests, grasslands, butterfly meadows, or low impact recreational activities such as bird watching. The end-use project manager must consider input from local, state, and possibly federal regulatory agencies, as well as resource management agencies in order to identify the specifics of the proposed ecological end-use project. The scope of the project will be defined by a number of site-specific characteristics that are summarized in the USEPA's *Guidance for Preparing Superfund Ready for Reuse Determinations at Superfund Sites* (EPA 2004). Those characteristics include:

- *Size of the site*. The larger the site, the greater the likelihood that a sufficient amount of land exists to support a viable, self-sustaining ecosystem.

- *Existing habitat at the site*. The less disturbance of existing habitat at the site, the greater potential for successful restoration.

- *Proximity to existing undisturbed areas*. Natural areas that exist adjacent to, or in close proximity of the site can effectively increase the habitat area.

- *Surrounding land uses*. The type of land use activities that occur in the property surrounding the site can affect the ability of the onsite ecological reuse project to become fully functioning.
- *Topography*. Sites with extremes in topography are more difficult to restore than sites with level topography.

- *Hydrology*. Sites with a natural water supply have a greater potential to support a water dependent ecological reuse, such as a wetland.

- *Site access*. The control of public access through such devices as institutional controls heightens the potential for a project to achieve expected functions.

5.3.2 Designing for an Ecological End Use Using Green Technologies

When an ecological end use (Table 5-3) is the primary objective, green technologies can be used in the process of remediation to provide years of ecological benefit while the site is undergoing cleanup and preparation for its ultimate ecological service. Green technologies include approaches that use plants to draw water, extract toxics, assist in microbial degradation of compounds, provide cover, or in some way aid in the accomplishment of the remedial objective and can also providing habitat while in use (see ITRC Phyto-1 1999 and Phyto-2 2001). Appendix C includes case studies of successful selection of an ecological end use.

Table 5-3. Mixed end uses

End Use	Ecological Enhancement	Traditional Element
Wildlife preserve	Habitat	
Pocket park	Raised bed garden, small mammal and bird shelter, butterfly garden, waterscape/wetland, vegetative cover	Benches, play sets, parking lot, barbecue pit, hiking trails
Open space	Pocket parks, walking paths, green landscape, wildlife management area	Parking lot
Aquaculture	Ponds	
Recreational	Parks, recreational facilities (walking paths), educational facility (arboretum)	Restricted or prohibited use, grass fields
Water storage/stormwater management	Constructed wetlands, rain gardens, filter strips, and bioswales	Detention/retention, riprap, diversion dams, concrete lined channels
Golf courses	Vegetative cover, water features, constructed wetland	
Urban garden	Raised beds, garden plots	
Residential/urban development, including cluster development	Pathways, shrub barriers, green roof, riparian buffers, vernal pools, vegetative medians, green infrastructure (recycled material)	Residential homes construction, streets, schools, parking lots, side walks, community centers
Industrial development	Green infrastructure Constructed wetlands for waste water stocked with fish, wildlife habitat (nesting, resting, feeding, cover)	Warehouses, manufacturing, storage

5.3 End Use Conclusion

During the planning phase of a remediation program, the effort should be scaled to what the owner, regulatory oversight agency, and the nearby community expects for the forecasted use of the property after completion. Ecological end uses may be the ultimate final use of the property or an integrated element of a larger planned use that is agreed upon by the affected community. Regardless of the ultimate disposition of the property, the remediation process may still take advantage of green or natural technologies. Applicable regulations require and recent EPA guidance encourages protection of the environment. Protection of the environment may be achieved by the implementation of ecological elements or enhancements. These enhancements have the potential of leaving a legacy of ecological benefit and enrichment in a community long after the remediation project is completed.

This section began by introducing the concept of service capacity. The service capacity is linked to the best use option for a given site undergoing remediation. The evaluation of a site's service capacity also includes the early opportunity for stakeholder involvement regarding future land use and planning. The future land use and planning integrates the ecological, regional, and site factors as they may relate to potential protective or remedial decisions and to future land use. Not all future land use may be conducive to ecological elements or enhancements; however, in

specific situations where ecological elements or enhancements may be integrated into the remediation process, whether using conventional or green remediation technologies, the significant potential exists to provide additional benefit to the owners, operators, and community through the very ecological elements used to remediate the site. Again, Table 5-1 provides an abbreviated list of how ecological elements and enhancements, by early identification of end uses, may be integrated into the remediation strategy to provide such value.

6. ECOLOGICAL REUSE PLANNING AND TARGET ECOSYSTEMS

Section 5 dealt mainly with the planning concepts related to the evaluation of service capacity, community needs assessment, resource availability, and the associated regulatory and political facets of the remedy decision or selection process. This section provides information regarding the implementation of ecological elements or enhancements following the initial planning phases as discussed in Section 5 and identified in the final boxes in Figure 5-1. Ecological elements or enhancements may accompany a variety of remediation technologies, whether they are components of a traditional remediation project recovering lost resources or additions to a remediation project specifically designed to enhance the existing or pre-existing ecological setting.

"Ecological trajectory" begins with the disturbed site and ends with the recovery of a system that meets the goals of the restoration project.

The successful use of ecological elements or enhancements entails detailed planning and an understanding of the complexities of ecological restoration coordinated with a thorough understanding of the potential performance of the chosen technology to remediate contamination. The goal is to initiate the project site along a developmental pathway called an "ecological trajectory" that will lead, ultimately, to a sustainable ecosystem. This ecological trajectory begins with the disturbed site and ends with the recovery of a system that meets the goals of the restoration project (Society of Ecological Restoration 2004). A critical aspect of any ecological reuse project is allowing sufficient time for the system to become sustainable and viable. The Society of Ecological Restoration notes that the following nine attributes provide a basis for determining when an ecosystem restoration project is completed:

1. The restored ecosystem contains a characteristic assemblage of species that occur in a reference location or are consistent with predisturbance ecological characteristics and provide appropriate community structure.

2. The restored ecosystem consists of native plant species.

3. All of the functional groups necessary for the continued development and/or stability of the restored ecosystem are represented or have the potential to colonize by natural means.

4. The physical environment of the restored ecosystem is capable of sustaining reproducing populations of the species required for development along a desired trajectory.

5. The restored ecosystem functions normally for its ecological stage of development.

6. The restored ecosystem is suitably integrated into a larger ecological landscape.

7. Potential threats to the health and integrity of the restored ecosystem have been eliminated.

8. The restored ecosystem is sufficiently resilient to endure normal periodic stress events.

9. The restored ecosystem is sustaining and has the potential to persist indefinitely under existing environmental conditions.

6.1 Planning an Ecological Land Reuse Project

For an ecological reuse project to progress along a trajectory to a sustainable state, it must begin with proper planning. The following sections outline the general steps required to implement an ecological reuse project. The development of an ecological reuse project begins with the assembly of a multidisciplinary team to design the project. Especially with any ecological land reuse project (such as a wetland-based project), a wide assortment of experts may be needed, including remediation specialists, biologists, ecologists, horticulturists, engineers, agronomists, geologists, and soil scientists.

6.1.1 Define Goals and Objectives

The first step in developing the ecological reuse project is to clearly state the goals and objectives of the project. The goals are site specific or broader depending on the service capacity evaluation results. Goals can relate to the number and composition of plant species restored, the structure of vegetation, or functions of the plant community and aesthetics (Harker et al., 1993). Generally, the statement of goals for the ecological reuse project identifies the site conditions to be achieved by the project. The objectives are usually more specific measures to achieve those broader goals. The end-use goals may influence the goals of the remediation; however, confirmation of the completeness of the remediation and post closure care of waste or contamination remaining on site is monitored as defined by the applicable regulatory authority. Note that the goal of the cleanup and the goal of the end use may have different monitoring and evaluation parameters. The ITRC Alternative Landfill Technologies team is currently completing a guidance document on post closure care of landfills (due out in 2006). This guidance also describes the importance of establishing the property end use while defining the performance goals of a closed landfill. See the ITRC ALT Guidance Document page at www.itrcweb.org for the publication of this document and other related documents. In addition, DOE has a process for developing Superfund exit strategies (DOE 2000, http://www.eh.doe.gov/oepa/guidance/cercla/exitstrategies.pdf). Both of these guidance documents provide information

Planning an end-use project:

- *Goals and objectives*
- *Site analysis*
- *Site plan*
- *Identification and selection of plants*
- *Site preparation*
- *Control of invasive species*
- *Monitoring and maintenance*

describing how to monitor the site's remedial efforts and determine when cleanup is completed and monitoring can be reduced or eliminated.

6.1.2 Conduct Site-Specific Analysis

In the early stages of planning an ecological reuse project, a detailed ecological characterization of the site should be conducted. The characterization should include an evaluation of existing plant communities, soils, hydrology, and wildlife. In addition to this characterization of the site, for planning purposes it may be beneficial to identify and characterize a reference ecosystem to serve as the model for planning the ecological end-use and to later serve in the evaluation of the project. The reference ecosystem should represent a point along the intended trajectory of the restoration and can serve to substantiate the goals and objectives of the ecological reuse project (Society of Ecological Restoration, 2004).The following sections describe specific applicable evaluations that can be conducted as part of the overall site analysis.

6.1.2.1 Hydrology analysis

The hydrology of the site must be characterized, especially if the ecological end use consists of a water dependent activity such as wetlands development. The development of an ecological end use in upland setting requires an understanding of the amount of precipitation as opposed to a detailed hydrologic study. The hydrologic state of a wetland site can be represented by a hydrologic budget, which is essentially the difference in the volume of water moving into the wetland site and the volume of water moving out. Water budgets are influenced by the balance between inflows and outflows of water, surface contours of the landscape, subsurface soil, geology, and groundwater condition (Mitsch and Gosselink 1993; ITRC Wetlands-1, 2003, http://www.itrcweb.org/gd_CW.asp; and ITRC Wetlands-2 2005, http://www.itrcweb.org/gd_MW.asp).

Characterization of the water budget for any wetland can be estimated through modeling and the collection of desktop information from sources such as the National Climatic Center and U. S. Geological Survey. Quantitative data regarding subsurface water conditions can be collected through the use of piezometers or monitoring wells. Sprecher (2000) provides a detailed description of the construction of monitoring wells in wetlands as well as recommendations on categorizing wetlands water budgets.

6.1.2.2 Soil analysis

Soils consist of unconsolidated, natural material that supports, or is capable of supporting, plant life. The upper boundary is air, and the lower boundary is either bedrock or the existence of significant biological activity. Soils are generally divided into two different types: mineral and organic. Soils can be further categorized based on the amount of moisture that is present. A soil profile consists of various soil layers described from the surface downward. These layers, called soil horizons, are generally oriented approximately parallel to the ground surface. A soil horizon usually is differentiated from contiguous horizons by characteristics (such as color, structure, texture) that can be seen or measured in the field. Soil horizons can be divided into major classifications, which are called the master horizons. These master horizons are designated with the letters O, A, E, B, C, and R. The depth and content of these horizons varies greatly

depending on the type and location of the soil. Baseline characterization of the soils should include the following:

- soil types and profiles
- soil classification
- soil series
- soil structure
- soil texture
- organic content
- permeability

This information can be developed specifically through field observations or generally through county soil surveys published by the Natural Resource Conservation Service. Additionally, ecological reuse planners should attempt to document the predisturbance characteristics of the site. Such information should be gained by using historical records, maps, or aerial photographs.

6.1.2.3 Flora and fauna analysis

Standard vegetative assessment techniques should be used in conducting either qualitative or quantitative assessments of the vegetative communities, for instance, within the existing wetlands (see ITRC Wetland-2 2005, Section 3.3.1, Figure 6-1). The vegetative parameters that may be considered and evaluated include the following:

- species composition
- description of community stratification (e.g., number of vegetative layers in the community and their percent cover (Figure 3-1, ITRC Wetlands-2 2005)
- relative frequency, dominance, abundance, and/or percent cover of each individual species
- presence of exotic or invasive species

Existing fauna at a site should be noted and recorded to document present and potential wildlife use.

6.1.3 Develop Detailed Site Plan and Implementation Plan

The detailed site plan outlines the procedures to be used in implementing the ecological reuse and specifies how the project will be put into place. The site plan should outline specifications to be used in the construction of the project, as well as schedules and budgets for site preparation, installation of plants, and postinstallation activities. The site plan will clearly outline the boundaries of the project and specify the development of the different communities that may be incorporated into the reuse project. It is important to include well-developed and explicitly-stated performance standards and an exit strategy in the plan.

The use of native plants is recommended when appropriate. These may be slow-growing species that require an annual stabilizing crop during the establishment phase, which will allow native species to later populate the area in as natural a fashion as possible.
Other factors that should be considered and outlined in the planting plan are as follows:

- timing of planting to achieve maximum survival
- methods of planting
- proposed use of mulch (certified inert material straw mulch rather than hay, which may bring in noxious weeds
- potential soil amendment such as organic material or fertilizer
- potential supplemental watering (should only be used for the establishment of the plant community and not as a long-term tool to support the mitigation)
- replanting

Figure 6-1. Site planting (courtesy of Charles Harman, AMEC Earth and Environmental)**.**

As part of the detailed design, a landscape plan must be developed to identify the types, locations, and sizes of the proposed vegetative communities and the individual species that will compose the communities. The landscape plan should be accompanied by a tabulated list of species that identifies the plants by common and scientific name, and the size and available form (e.g., seed, bare root, rhizome, potted) of the plants to be installed and plant benefits. Because of variations in the genetic makeup of a species over a wide geographic area, plant selection should indicate a local source of the plant material to be used in planting and native is preferred. Careful consideration should be given to the selection of the plant species to be used in relationship to the goals and objectives of the project. Spatial and temporal aspects of the plant community as a whole and individual species should also be considered. Figure 6-1 displays plants being staged for planting at a mitigation wetlands site.

6.1.5 Prepare the Site and Implement Plan

Construction of the ecological reuse project requires great attention to detail to ensure that the project is successful. Extremely close attention to these details will ensure that elevations, grades, and planting materials are completed exactly as shown in the mitigation plan and construction details. Some degree of flexibility should be maintained so that field changes can be easily introduced to address site-specific conditions that arise during construction. Field changes, however, should be evaluated with care to ensure that required hydrology, soil, and vegetative parameters are not compromised.

The construction process is an iterative activity that begins with site preparation and finishes with demobilizing staged equipment and allowing for monitoring to occur. Communication with the construction engineer during the design phase to ensures that all aspects and concerns are addressed. Preconstruction and project status meetings at various stages during the process ensure constant familiarity with the design, design changes, and progress of the construction phase of the project. It is also helpful to regularly review the overall goal of the project and to

highlight critical construction details. Continued oversight and periodic meetings ensure that the actual design is being implemented in the field as expected and intended.

Prior to beginning construction, which will result in the disturbance of the existing soils, soil erosion, and sediment, control measures should be constructed in accordance with the appropriate state, county, and/or conservation district standards for soil erosion and sediment control. The objective is to prevent sediment from being washed from excavated areas into undisturbed areas where it can cause sedimentation problems. All soil erosion and sediment control measures should be maintained in good condition and left in place until permanent vegetation cover is established.

While maintenance activities during establishment should be used to control invasive species, some measures can be taken to help minimize the encroachment and establishment of invasive species. Rapid-growing/spreading plants establish more quickly and help preclude the colonization of invasive species; however, the preferred plant community often includes slow-growing/spreading species. In these instances, it is helpful to add a rapid-growing/spreading species in the interim to act as living mulch. (see ITRC Wetlands-2 2005).

6.1.6 Control Invasive and Undesirable Species

Undesirable insects, plants, diseases, or other invasives must be controlled to allow the ecological reuse project to move along its intended trajectory. Invasive species left uncontrolled can alter the functional value of the system and even encroach on adjacent properties. Control of the invasive species can be accomplished through the use of manual or natural controls (see inset) or through the application of herbicides or insecticides. Care should be taken when using nonnative species that they do not encroach on nearby properties and out-compete native or existing species. These can unintentionally become invasive and destructive to a stable ecosystem. Several agencies provide site specific information helpful in natural or artificial control of invasive vegetation. See the links below for more information.

- Invasive.org (http://www.invasive.org/). Invasive.org is a joint project of The Bugwood Network, USDA Forest Service and USDA APHIS PPQ, The University of Georgia - Warnell School of Forest Resources, and College of Agricultural and Environmental Sciences Department of Entomology (http://www.ent.uga.edu/).

- Invasivespecies.gov (http://www.invasivespecies.gov/).
  This site is the gateway to federal efforts concerning invasive species. It describes impacts of invasive species and the federal government's response, includes species profiles and has links to agencies and organizations dealing with invasive species issues. Invasivespecies.gov is also the Web site for the National Invasive Species Council, which coordinates federal responses to the problem.

- The PLANTS Database (http://plants.usda.gov/). The PLANTS Database provides standardized information about the vascular plants, mosses, liverworts, hornworts, and lichens of the U.S. and its territories. It includes names, plant symbols, checklists, distributional data, species abstracts, characteristics, images, plant links, references, crop

information, and automated tools. The PLANTS Database reduces costs by minimizing duplication and making information exchange possible across agencies and disciplines.

Many local agencies and universities can provide the best information on invasive species and preferred native and non native species for particular habitats in their region of responsibility, including compatible soil types for particular species and plant communities.

6.1.7 Monitor and Maintain the Site for the Long Term

As part of the ecological reuse project, a monitoring plan must be included that identifies how the performance standards will be applied to measure the success of the project. The monitoring plan should include a detailed description of how each of these activities will be accomplished. The monitoring plan must begin with a description of the goals and objectives of the monitoring activity, which should be based on the performance standards that have been agreed upon with the appropriate regulatory agencies. The monitoring program should also outline the parametric and the monitoring frequency. This function may fluctuate depending upon the regulatory body for the site.

The manner in which monitoring is conducted varies depending on the circumstances of the site and the performance standards. Data needs for evaluating the performance standards must be balanced with the cost and effort of conducting the monitoring. As an example, the ITRC Wetlands-2 document estimates that "mitigated wetlands should be monitored for 5–10 years (20 years for forested and similar wetlands systems) and mid-course corrections should be required."

Some of the more important aspects of monitoring are the contingencies that are in place to correct deficiencies identified by the monitoring. This effort can be as simple as having supplemental plants on hand for replanting lost stock to ensure that vegetative success ratios are met or means by which invasive species identified in the mitigation site are addressed. Should damage by an herbivore be identified as a significant problem at the project area, actions such as fencing or individual plant guards should be considered. Devices to enhance predator use of the site could also be considered. In the event of failure due to hydrologic deficiencies or excesses, then contingency plans should be in effect for a complete redesign and reconstruction of the project.

6.2 Targeted Ecosystems for Ecological Reuse

Whether a traditional remedial technology or an alternative green technology is implemented at a remediation site, the reuse of the property for ecological means can be either considered as part of the remedy or as a complement to the remedy. In general, the goal of the ecological reuse will be the development of a functioning ecosystem that is consistent with historic ecosystems in the region or current reference areas chosen as the standard for building purposes. The choice of the type of system will depend upon a variety of factors, including location of the site, baseline or reference system, climate, topography, soils, hydrology, and various nontechnical factors such as public and regulatory constraints. The following sections summarize the basic categories of ecosystems that can be selected for a site.

6.2.1 Upland Restoration

Upland sites with xeric or mesic hydrologic conditions would require the incorporation into the ecological reuse plan of communities dominated by woody species such as forests and shrubland, or open communities dominated by herbaceous species such as grasslands and meadows (including prairies and savannahs). These upland resources are discussed in more detail below. Uplands impacted by significant subsidence could create a retrofit opportunity to establish wetland environments. Examples are landfill subsidence whereby the wetted area is redesigned to allow and encourage infiltration into a waste system to initiate and maintain bioreactor degradation. It should be noted, however, that intermittent ponding may not provide adequate hydraulic characteristics to develop the necessary saturated conditions to sustain the development of hydric soils common to a wetland. In this case, long-term maintenance may be required. Sections 6.2.2 and 6.2.3 further discuss restoring or creating a wetland environment.

6.2.1.1 Forest and shrub restoration and end use

Forests or shrublands can be incorporated as ecological end uses either following the implementation of a traditional remedial action, such as excavation, or as a complement to increase the value of resources at a site where either a traditional remedial action or green technology is implemented. At sites where a forest or shrubland is to be reestablished following removal of the resource, restoration techniques to introduce the target system would be employed. Eyre (1980) provides a listing of forest cover types that can be used as a basis for selecting species for a forest restoration project.

Howell (1986), as quoted in Harker et al. (1993) notes that the re-creation of an upland forest can be evaluated in two ways:

> One emphasizes community structure and species composition, and judges the success of a restoration effort by asking how closely the resulting community resembles the natural, or 'model' community with respect to characteristics such as relative abundance, age-class structure, spacing, and distribution of a particular species. An assumption underlying this 'compositional' approach is that if these species groupings are fairly accurately reproduced, then the dynamics and functions of the communities will also resemble those of the model community.
>
> The second way of establishing goals and evaluating the success of restoration projects emphasizes ecosystem functions, often with little or no reference to species composition. From this point of view, for example, the presence or absence of a particular species is less important than the provision of functions and processes such as nutrient cycling, erosion control, or biomass production.

The creation of a canopy layer of the re-created forest community is the most critical part of the targeted ecosystem. Howell also notes that, in the event that complete restoration of the forest resource is chosen as the goal of the ecological end use, one of six approaches to implementing the forest restoration can be used, depending upon goals of the project, intensity of project

management available, and financial considerations. Those approaches include the following described in Harker et.al., 1986:

1. Plant canopy trees in ultimately desired densities or proportions, mulch the ground beneath the canopy specimens, and plant desired mid-story and understory species immediately;
2. Plant and mulch canopy trees as in the above approach, but plant groundcover that grows well in exposed areas with unrestricted sunlight and add woodland understory and mid-story species as the shade develops from the growing canopy;
3. Plant trees in a less than ultimately desired density, with grassland plants in an understory. As shade develops, plant additional canopy specimens, and finally plant desired understory and mid-story specimens;
4. Plant trees in greater than desired densities and allow natural thinning, or implement thinning, as the canopy develops. Add mid-story and understory specimens at a later date;
5. Plant fast growing canopy specimens as a cover crop and under plant with more desired canopy specimens. Upgrade the understory as the canopy progresses; or
6. Do not plant; instead allow natural succession to drive the forest restoration.

In the event that an existing forest or shrubland is located onsite and the desire is to improve the value of the resources in conjunction with the implementation of the remedial action, then some of the forest management alternatives or resource improvement activities that are available include:

- woodlot management, including selected thinning
- removal of invasive/undesirable woody species
- addition of nesting boxes or platforms, and animal feeders
- planting additional species in areas that are cleared
- addition of snags

At one hazardous waste site in New England, a riparian forest was restored to the banks of a river following the removal of contaminated soils. The project approach began with identifying the target community through a review of available literature on regional forests and forest species. Prior to remedial activities, the bank areas to be excavated were cleared of existing vegetation. Where it was possible from an engineering standpoint, existing supercanopy specimens (predominantly eastern cottonwood, *Populus deltoids*, and black willow, *Salix nigra*) that were present in the riparian habitat were allowed to remain. Once soil removal activities and the placement of a nonwoven geotextile mat in the base of the excavation have been completed, actions to restore the habitat structure were initiated. The first activity was the placement of backfill within the excavation areas to restore the banks to their original grade. A six-inch layer of topsoil was then placed over the backfill to serve as the medium for plant establishment and to restore the final grades along the bank. The topsoil that was used was a loam, with a minimum five percent organic content.

In some areas, the vegetative community was reestabished by planting a riparian community based on the New England floodplain forest community. Common New England floodplain forest community species used in the replantings included:

Table 6-1. Species used in floodplain forest replanting

Canopy	Understory/Shrub
Red maple (*Acer rubrum*)	Northern spicebush (*Lindera benzoin*)
Silver maple (*Acer saccharinum*)	Northern arrowwood (*Viburnum recognitum*)
Black willow (*Salix nigra*)	Silky dogwood (*Cornus amomum*)
American elm (*Ulmus americana*)	Red-osier dogwood (*Cornus sericea*)
White ash (*Fraxinus americana*)	Winterberry holly (*Ilex verticillata*)

Red maple, silver maple, and black willow were the dominant species in this community. As such, they accounted for 75% of the replacement canopy trees. American elm and white ash, as associate species, together accounted for 25% of the replacement canopy trees. Planting of the silver maple and black willow was biased towards the adjacent river. Red osier dogwood and winterberry holly plantings were also biased towards the river.

Following restoration of the grade, trees were installed using standard planting practices. All specimens were container grown with obtained species being four feet to six feet tall. Canopy species were planted uniformly with a basic spacing of twelve feet between specimens. The canopy specimens were planted on a random mixed basis so as to ensure a heterogeneous distribution of species in the canopy.

Based on the data from the habitat assessment, the understory species were planted in a patchy manner so that 40% of both banks were covered by understory species. To allow for good structural distribution and juxtaposition of habitats, the understory vegetation was planted (to the extent possible) in oblong patches thirty feet wide by fifty feet long. Silky dogwood, spicebush, and arrowwood were intermixed on a random basis within the oblong patches. The patches were scattered to be at least forty feet apart.

In order to develop dense areas of habitat for future wildlife usage, all understory species were planted on four-foot centers. Each planted shrub was two to three feet in size and was container grown. All plants were delivered and staged onsite prior to planting. Planting pits were dug one-foot larger than the plant container and pit depth was to the depth of the plant container. When the trees and shrubs had been properly set, the pit was thoroughly watered during and after backfilling. Enough topsoil was used to bring the surface, when settled, to the required grade.

Plants were not removed from containers until immediately before planting. Roots were examined to determine if they were pot bound. Roots that were pot bound were separated prior to planting. Plants were placed in the dug pits in such a manner so as to allow further growth without additional constriction of the root ball. After planting and watering, each plant was mulched with wood chips from on-site cleared vegetation or loose straw and was fertilized with a 10-10-10 (phosphorous, potassium, nitrogen or PKN) slow-release fertilizer. The fertilizer was applied at the product recommended application rate.

6.2.1.2 Meadow restoration and end use

Meadows are open expanses of land that are covered mainly by herbaceous species such as grasses, forbs, and legumes. One of the overriding determinants of a grassland ecosystem is the amount of precipitation that an area receives. Grasslands usually do not receive enough rainfall to support the growth of trees (or they experience a disturbance regime, such as fire, grazing, or mowing, that does not allow for the development of a dominant woody community). At locations where attempts to establish a meadow are made and there is sufficient rainfall to support trees, active management steps may be required to ensure that succession does not move the meadow to a shrubland or forest.

Open meadows can be easily incorporated into the design of a remedial action, whether as a restored resource at a site where excavation may have removed the meadow from service or in conjunction with a traditional remedial technology. For example, a grassland or meadow can be incorporated into a traditional or alternative final landfill cover system (see ALT-2 2003, http://www.itrcweb.org/gd_ALT.asp).

Harker notes that the following steps should be followed in restoring a grassland or meadow:

1. Planting should be accomplished through the use of either seeds or greenhouse grown specimens;
2. Many prairie forb seeds require cold treatment after collection to prevent drying and dormancy or scarification for those seeds with hard seed coats;
3. Controlled burning, usually after the third year of growth, is a highly effective management tool to inhibit undesirable plants. At locations where controlled burning is not an acceptable tool, anthropogenic management activities such as mowing may be necessary to manage the meadow; and
4. The planting of legumes may require the inoculation of the seeds with appropriate rhizobia bacteria for nitrogen fixation.

The choice of plants can be made with the goal of attracting a variety of wildlife, including emphasizing the use of wildflowers to attract various butterfly species, or emphasizing the use of seed forming grasses or legumes to attract certain bird species.

6.2.2 Freshwater Systems

Hazardous waste sites are often associated with a freshwater system of some kind. As such, the ecological elements or enhancements of these systems can easily be incorporated into the remedial design. In some instances the restoration would be part of the remedial action, as in sites where dredging of contaminated sediments from a stream channel or lake bed, or excavation of the riparian boundary of a stream would necessitate that actual restoration of the resource. In other instances, the restoration of the aquatic resource could be conducted in conjunction with the implementation of the remedy in other parts of the site.

In general, aquatic systems are considered and evaluated based on their form. Lotic habitats are running water habitats such as rivers and streams. Lentic habits include inland depressions

containing standing water such as lakes and ponds. Lentic habitats can be further divided into several zones, including the littoral zone (the shallow-water zone at the edge of the lake or pond where light reaches the bottom). The limnetic zone is the open water area of a pond and reaches to the depth below light penetration. The profundal zone is the open water area of a pond or lake that begins at the depth of light penetration and extends to the bottom of the water body. The benthic zone is the bottom of the standing water body. The following sections discuss the two general forms, lotic and lentic, in greater detail.

6.2.2.1 Stream corridor restoration and end use

The restoration or enhancement of a stream corridor as the ecological end use of the resource can be accomplished through a variety of instream or riparian activities. Excellent sources of information on restoring and enhancing lotic habitats for stream corridor restoration include: *The WES Stream Investigation and Streambank Stabilization Handbook* (Beidenharn et al. 1997), *Stream Corridor Restoration: Principles, Processes and Practices* (Federal Interagency Stream Restoration Working Group, FISRWG, 1998), and *Integrated Streambank Protection Guidelines* (Washington State Aquatic Habitat Guidelines Program 2002). *Applied River Morphology* (Rosgen 1996) is a reference commonly used in the classification of streams and the development of goals and objectives for various stream categories.

The ultimate goal of a steam restoration project is the development of water quality conditions and habitat circumstances necessary to support a diverse aquatic community. This is generally accomplished by stimulating the development of heterogeneous habitat conditions within and along the stream channel. As with any restoration project, the planning for the project begins with a detailed assessment of current stream conditions. If the restoration is to be incorporated following the removal of contaminated soils or sediment, then a baseline characterization of the form and function of the existing stream and a determination of the objectives (predisturbance conditions) of the stream restoration must be reached. If the restoration is to be conducted in conjunction with a remedial action at another part of the site, then common disturbances must be assessed; these disturbances can include stream channel alteration, water quality impairment, the presence of exotic species, loss or riparian vegetation, and alterations to the streambank.

After the detailed assessment of the stream is completed, planning for an aquatic restoration project will incorporate actions to address three general areas: stream channel restoration, streambank stabilization, and streambank vegetation. Planning for stream channel restoration considers actions to enhance habitat to generate and support a more diverse aquatic community. While the long-term restoration of a stream can best be achieved by relying on natural processes, common engineered habitat structures can be used in the short term to begin the process. FISRWG (1998) notes that the following considerations should be made in the incorporation of habitat structures as part of an instream aquatic restoration:

- The potential adverse impacts from failure of a technique should be assessed before it is used.
- Techniques that change the channel slope or cross-section have a high potential for causing channel instability. These techniques should be carefully analyzed and considered before employment.

- The potential impact of flood elevations should be analyzed before these and other techniques are used.
- Many techniques will not endure on streams subject to general bed degradation.
- Some form of toe protection will be required for many of the instream techniques to endure where scour of the streambank toe is anticipated.
- Regulatory permits and considerations should be taken into account.

Some common instream structures are used to develop habitat (FISRWG 1998):

- *Boulder clusters*. Groups of boulders can be placed in the base flow channel to provide cover, create scour holes, or create areas of reduced velocity.
- *Wiers or sills*. These are log, boulder, or quarry stone structures placed across the channel and anchored to the streambank and/or bed to create pool habitat, control bed erosion, or collect and retain gravel and fines.
- *Fish passages.* These are instream changes which enhance the opportunity for target fish to freely move upstream.
- *Log/brush/rock shelters.* Structures placed in the lower portion of streambanks can enhance fish habitat, prevent erosion, and provide shading.
- *Migration barriers.* Obstacles placed at strategic locations along stream can prevent undesirable species from moving upstream.
- *Wing deflectors.* These are structures that protrude from either streambank that do not extend all the way across the stream and deflect flows, and generate scour holes by accelerating flow.

Streambank stabilization is required for disturbed or reconstructed streambanks to prevent further erosion. While geotextiles or engineered rock gabions can be used ("hard" engineering) the preferred approach, if stream energies allow, is to incorporate natural or "soft" engineering approaches that provide as much natural habitat as possible. Some common streambank treatments to prevent and decelerate erosion and increase habitat include the following (FISRWG 1998):

- *Brush mattresses*. These are combination of rapid-growing live stakes, live facines (i.e., bundles of live stakes), and branch cuttings installed to physically protect streambanks and provide cover.
- *Coconut fiber rolls*. These are biodegradable, linear, yet flexible structure composed of tightly bound coconut husk fibers. They are used to protect gradual slopes from erosion and trap loose sediment encouraging plant growth.
- *Dormant post plantings*. Plantings of certain species embedded vertically into the streambanks can increase channel roughness and reduce stream flow velocities.
- *Vegetated gabions*. These are standard rock gabions with live branch cuttings placed between the rock filled baskets to take root and consolidate the structure and bind it to the toe of the slope.
- *Tree revetments*. A row of interconnected trees secured together and anchored to the toe of the slope can reduce surface water velocities along streambanks, trap sediment, and provide a substrate for plant establishment.

- *Vegetated geogrids.* These are alternating layers of live branch cuttings and compacted soil.

The final action in restoring a stream is in the development of a diverse riparian habitat bordering the stream channel. Plant species in the riparian zone help regulate stream temperature, filter upland runoff to remove sediments and nutrients, stabilize streambanks, provide an outside source of organic material (such as leaf-fall), and provide habitats for terrestrial and aquatic wildlife. See Section 6.2.1 for approaches to restoring forest and grassland habitats located in the riparian zone.

6.2.2.2 Lake and pond restoration

As with lotic habitats, lentic systems (ponds and lakes) can be restored or enhanced as part of an ecological end-use project. The restoration objectives in lentic systems are similar to those for lotic systems: to create a functioning habitat that will support and sustain an aquatic community. The size and complexity of the project will depend, in large part, on the size of the water body and the size of the remedial action in relationship to the water body. Lakeshore stabilization techniques similar to those outlined in the previous section for streams may be necessary for lakes that are of sufficient size to generate windblown waves. In very large lakes with a large fetch that can develop extreme waves, significant measures to protect the bank and stop erosion may be necessary.

In the littoral zone, vegetative plantings incorporating emergent plant species such as those outlined in Section 5.2.3 may be used to establish habitats for fish, amphibians, and aquatic invertebrates, as well as water dependent bird and mammal species. Emergent plants are those species in which at least a portion of the foliage and all of the reproductive structures extend above the surface of any standing water. In the limnetic zone, floating-leaved plants and submerged plants can be used to establish important fish habitat. Floating-leaved plants are characterized by leaves that float on the surface of the water and are attached to the bottom by long stalks. These species are usually found in shallow-water habitats ranging from 12 to 40 inches. Typical of this type of plant are water lilies (*Nymphaea* sp.) and spatterdock (*Nuphar* sp.). Submerged plants are those species in which all foliage is found underwater. This includes eelgrass (*Zostera* spp.) and pondweed (*Potamogeton* spp.). All of these growth strategies also provide a valuable energy source and substrate for aquatic invertebrates that support many higher trophic level organisms. In addition to the use of plant species to generate habitat, brush and rock piles can be placed in restored areas at suitable depths to provide habitat, breeding areas, and refuge for fish.

Fish stocking is also a tool to help restore the aquatic resource. This approach can be used for small water bodies that have been dramatically impacted by remedial actions. Fish stocking is also recommended if the goal of the project is to enhance the species composition or age structure of an existing fishery. The decision as to whether a warm-water or a cold-water fishery will be attempted will depend upon the size and depth of the water body, the site location in relation to elevation and climate, and the intended end use of the water resource. If restocking is used as an approach in a water body, extreme care should be taken in deciding upon the species and feeding strategy of the selected fish species (carnivore, omnivore, and herbivore). Care should be taken to prevent the introduction of voracious herbivores that might remove all plant

material from the water body or voracious carnivores that might entirely remove the prey community and leave a depopulated community over time. Consultation with state fisheries biologists is highly recommended when attempting restocking. State fisheries biologists are a valuable source of information and can alert the project team to common region-specific pitfalls for restocking projects.

6.2.3 Wetland Restoration and End Use

Wetlands are unique and sensitive ecosystems which provide valuable functions in the environment. Wetlands provide necessary feeding, reproductive, and rearing habitat for numerous aquatic and terrestrial organisms; erosion and flood control; groundwater recharge; primary production and nutrient cycling; and contaminant sequestration and transformation. Wetlands can be freshwater, brackish, or marine, are found at various elevations, and occur along coasts as well as inland. They can be found virtually anywhere that hydrologic conditions exist for their development and perpetuation.

The Clean Water Act defines wetlands as “those areas that are inundated or saturated by surface or groundwater at a frequency or duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas” (40 CFR 230.3). “Wetland” can refer to marshes, swamps, bogs, and fens, all of which are characterized by frequent or prolonged presence of water at or near the surface, soils formed under saturated conditions, and habitation by plants adapted to saturated soil conditions.

Wetlands are generally characterized by the presence of three basic parameters: soils, hydrology, and vegetation (ITRC Wetlands-1 2003 and ITRC Wetlands-2 2005). Water is usually present at the surface or within the root zone of wetlands for extended periods of time during the growing season. As a result of the saturated conditions, the soils present in wetlands develop certain unique conditions that are different from upland soils. Where subsidence creates an environment favorable or nearly favorable for the hydrologic needs of a wetland, maintenance may be required for long periods of time to establish the hydric soils of a wetlands and thereby supporting wetlands plant species. Also, in response to the saturated conditions, wetlands support vegetative species that are adapted to living in wet conditions. The following sections more thoroughly describe the parameters used to identify and characterize wetlands.

The most common means of characterizing wetlands is under the system developed for the U.S. Fish and Wildlife Service (Cowardin et al. 1979). As described in Cowardin, wetlands types can be broken into five basic categories: marine, estuarine, riverine, lacustrine, and palustrine. The major categories or systems are based mostly on their position on the landscape. Each of these systems can be further broken down into subsystems, classes, subclasses, and dominance types based on the type of vegetation present and/or the bottom substrate for the wetlands.

Marine wetlands include the open ocean overlying the continental shelf and wetlands occurring along the associated coastline. Estuarine wetlands consist of deepwater tidal flats and adjacent tidal wetlands that are usually mostly enclosed by land and have at least sporadic access to the open ocean. The water associated with these wetlands is at least occasionally diluted by freshwater and generally extends from a point upstream where the salinity level is 5 parts per thousand (ppt) to the seaward limit of wetland emergent species (Cowardin et al. 1979).

Riverine wetlands include all wetlands and deepwater habitats found within a river channel, with the exception of wetlands dominated by trees, shrubs, persistent emergent species, emergent mosses, and lichens. Palustrine wetlands include all nontidal (for the most part they are inland) wetlands dominated by trees, shrubs, persistent emergent species, emergent mosses, or lichens. Palustrine wetlands are bounded by uplands or any other type of wetlands and may be situated shoreward of lakes or river channels or in floodplains. Lacustrine wetlands include wetlands and deepwater habitats found in topographic depressions or dammed river channels, which lack trees, shrubs, emergent species, mosses, or lichen and exceed 20 acres in size. Riverine, palustrine, and lacustrine wetlands are all generally freshwater systems (Cowardin et al. 1979).

In many parts of the country, it is very likely that wetland end uses can be incorporated into the remedial design and final use for hazardous waste sites because wetlands are commonly found at these locations. In a review of sites managed under CERCLA, Hayes (1988) noted that approximately 74% of CERCLA sites in EPA Regions 1, 2, 3, and 4 were associated either directly or indirectly with wetlands. EPA (1989) also found that contamination had been observed in wetlands or was projected to occur in wetlands at 85% of the CERCLA sites evaluated for the 1989 study.

Issues related to wetlands mitigation (compensatory actions in response to permitted injuries to wetlands) are regulated by law and managed by the EPA and U.S. Army Corps of Engineers (USACE), as well as many states. The ITRC Wetlands Mitigation Team is developing a document that describes the various procedures to be used in specific wetlands mitigation activities (ITRC Wetlands-2 2005). In summary, incorporating wetlands as an ecological end use at a hazardous waste site will generally include four different types of actions:

Case Study: Weldon Spring

DOE is returning the Weldon Spring Site to a natural and native ecosystem and is in the process of creating a 150-acre prairie around the disposal cell that extends to the site boundary. When complete, the prairie will be one of the largest plantings of its kind in the metropolitan St. Louis area. The design for the new prairie began in the early 1990s when native grasses were deemed to be the best solution for site restoration. In late spring of 2002, the first permanent planting of prairie grasses and forbs was conducted. Since then, nearly 100 different prairie species have been planted.

In addition, DOE has contributed to the restoration of surrounding ecosystems impacted as a result of project activities. DOE supported funding for the construction of a sixty-acre wetland complex in a nearby state conservation area and implemented an extensive monitoring program to ensure its successful establishment. DOE has also constructed approximately thirty additional acres of wetlands on adjacent conservation lands. All wetlands currently serve as a valuable environmental resource by increasing biodiversity and attracting large migratory waterfowl populations (for more details, see http://www.wssrap.com/transform.htm).

1. restoration of existing degraded wetlands through either reestablishment or rehabilitation
2. enhancement of an existing wetland to improve its physical, chemical, or biological characteristics to heighten, intensify, or improve specific wetland function
3. if the second alternative is impractical, preservation of a wetlands site by removing the threat to, or preventing the decline of, a wetland by an action in or near a wetland
4. under special circumstances, creation of a wetland in an upland or deepwater site where a wetland did not previously exist

The following section discusses wetland end uses as they apply to both freshwater and marine/estuarine environments.

6.2.3.1 Freshwater wetlands

Freshwater wetland reuse can include restoration of a contaminated wetland or creation of a new wetland or enhancement of a degraded wetland. In each instance, the action to restore, create, or enhance the wetland will be based on wetland mitigation practices that are described in ITRC Wetlands-2 (2005). The type of wetland (marsh, scrub/shrub, swamp) to be incorporated into the ecological end use will depend upon the hydrology of the baseline or reference area wetlands used for the mitigation model. The vegetative form of a wetland (such as a marsh) is the physical expression of the wetland hydrology that is present, governed by plant dispersal and establishment.

Marshes are wetlands frequently or continually inundated with water, characterized by emergent, soft-stemmed vegetation. Many different kinds of marshes exist, ranging in form and geologic origin from the prairie potholes to the Everglades, in landscape position from coastal to inland, and in water chemistry from freshwater to saltwater. Marsh hydrology may be driven by surface water, groundwater, or a combination of both. Most nutrients are plentiful, and the pH is usually neutral, leading to an abundance of plant and animal life.

Swamps are wetlands dominated by woody plant species. There are many different kinds of swamps such as the forested red maple wetlands of the Northeast, the widespread and expansive bottomland hardwood forests found along the floodplains of rivers of the Southeast, and cypress swamps. Swamps are characterized by saturated soils and standing water during certain times of the year. Organic soils of swamps form a thick, black, nutrient-rich environment for the growth of water-tolerant trees such as bald cypress (*Taxodium distichum*), Atlantic white cedar (*Chamaecyparis thyoides*), and black gum (*Nyssa sylvatica*). Swamps have two major classes: shrub swamps and forested swamps. Not only do many species of plants and wildlife use swamp habitats, some require large areas of swamp wetlands for successful breeding.

6.2.3.2 Marine and estuarine wetlands

A wetland associated with water from ocean or estuarine sources may be found at a hazardous waste site. Restoration, creation, or enhancement of tidally influenced wetlands has the added challenge of addressing wetlands dominated by plants that require certain salinities to survive, and the logistics of executing a restoration effort in a tidal environment. As with freshwater

wetland systems, tidal wetlands can also be categorized based on the dominant vegetative communities they support. Tidal forests are limited in the U.S. to the mangrove swamps of southern Florida. The most common marine and estuarine wetland systems are the tidal marshes found along coastlines in middle and high latitudes. They are most prevalent in the United States on the eastern coast from Maine to Florida and continuing on to Louisiana and Texas along the Gulf of Mexico. These are generally categorized into two distinct zones, the lower or intertidal marsh, and the upper or high marsh.

As noted in ITRC Wetlands-2, special considerations must be given to addressing wetlands that are saline and tidal in nature. Garbisch (2002) advises that when constructing tidally supported wetlands, the conveyance of water to and from the site must be kept unrestricted to allow for nutrient exchange and salinity moderation. He also notes that mitigation plans should clearly state and show that all vegetated areas are well drained to ensure that ponding, which would lead to high water temperatures and hypersalinization, does not occur unless that is part of the design (e.g., "panes" in salt marshes).

6.2.4 Shoreline Restoration and End Use

Shoreline restoration or enhancement can be selected as part of the ecological end-use project for the site in the appropriate setting. Beach replenishment projects generally consist of dredging sand from offshore deposits and pumping it through pipelines onto the beach. Grading techniques are then used to either distribute the material over the beach or to grade the material to generate sand dunes. Extensive monitoring at every phase of the project is needed to protect aquatic plants, fish, and birds. Sand dune plantings are used to generate critical plant communities required to prevent dune erosion and provide habitat for various species of birds.
In shoreline settings in more urban areas, restoration activities that might be considered include the following:

- development of coastal meadows
- recontour and softening of the shoreline
- development of fish passages
- restoration of historically filled wetlands
- improvement of estuarine circulation
- improvement of tidal flushing
- stabilization of habitats

6.2.5 Wildlife Habitat Measures

In coordination with the habitat establishment activities that are described above, habitat enhancement features can assist in the development of wildlife and aquatic habitat functions. These are simple structures that require little or no maintenance, yet as the planned ecological end-use project develops, they provide increasing habitat quality over time. Examples of enhancement features are as follows:

- woody debris such as logs, stumps, brush piles, and snags
- upland islands in the middle of wetlands, lakes, or ponds

- open-water features such as tidal guts and small pools
- nesting boxes for waterfowl or raptors and roosting structures for other avian species
- bat boxes
- vegetative buffers

7. COST AND BENEFIT CONSIDERATIONS

Remedies incorporating ecological elements or enhancements to support ecological end uses for previously contaminated sites offer protection of HH&E as well as cost savings and income opportunities. Additionally, returning idle land to useful ecological service and optimizing the site's service capacity creates value to the owner and the surrounding community. These opportunities require a thorough understanding of the lifecycle of a project and the costs and cost-saving potential of the site designed with an ecological land reuse in mind. This section describes a holistic approach for evaluating cost considerations in the selection of ecological land reuse using natural and green remedies alongside more traditional remediation approaches. A holistic approach considers numerous cost/benefit variables, rather than simply focusing on the bottom-line economics of the remediation.

Remediation strategies incorporating ecological elements or enhancements may have non-numeric upside potential. This may appear to be intangible at first, but can prove to be very real when integrated into a business development strategy. As pointed out in Section 3.3, one of the major benefits of incorporating ecological elements or enhancements into cleanup remedies is corporate reputation; hence, this begins of the process of integrating the remediation project strategy with the business development strategy. To quantify and demonstrate goodwill a company must do its homework for a specific remediation project, and the community must be involved early in the process to clearly indicate a desire to integrate some ecological elements or enhancements into the remediation strategy.

Ecological elements may not prove to have the best quantifiable costs and benefits in the strict economic analysis; however, the ecologically based remediation project often generates valuable community goodwill. When a company seeks to open additional profit centers in the community, the corporate goodwill generated during the remediation project may translate to improved corporate reputation within the community. The increased goodwill and corporate reputation make it easier for the company to approach the community planning board for its newly proposed business venture. The planning board, with positive support from the community, finds it easier to approve the business development venture. This apparently intangible goodwill, generated by inclusion of the stakeholders in the process and incorporation of the ecological elements in the remediation project, now turns into very real and tangible business development cost savings. The intangible goodwill saves the company the expense of hiring a business consulting/lobbying firm to work with the planning board, public meetings, potentially selecting less desirable business location, opposition by the citizens and possibly the press, or possibly losing out on a business opportunity to a competitor. Cumulatively, these are significant and real cost savings.

This section contains information about cost evaluation, but the semiquantifiable and nonquantifiable asset valuations later in this section may prove to be even more important than the dollars and cents associated with a remediation project. How much is an improved corporate reputation worth? Is it worth putting in a quarterly shareholder report? Could it even be worth a gain of some new investors or an incremental change in the cost of a share?

When valuing an ecological element or enhancement, the project team needs to consider the complete life cycle of the project. From technology selection to final disposition of the property, there are numerous cost elements to be considered. A comparison of the relative economic advantages of two alternative approaches, one having moderate initial costs, high O&M costs, and a short duration and the other having low initial costs, moderate O&M/administrative costs and a long duration can be made through a net present value (NPV) analysis. These cost elements can be broken down into three general categories:

- quantifiable values
- semiquantifiable values
- nonquantifiable values

Elements in the following text and figures (Figure 7-1 and Table 7-1) should be considered for every potential alternative in a project to fully evaluate its value in comparison to other alternatives.

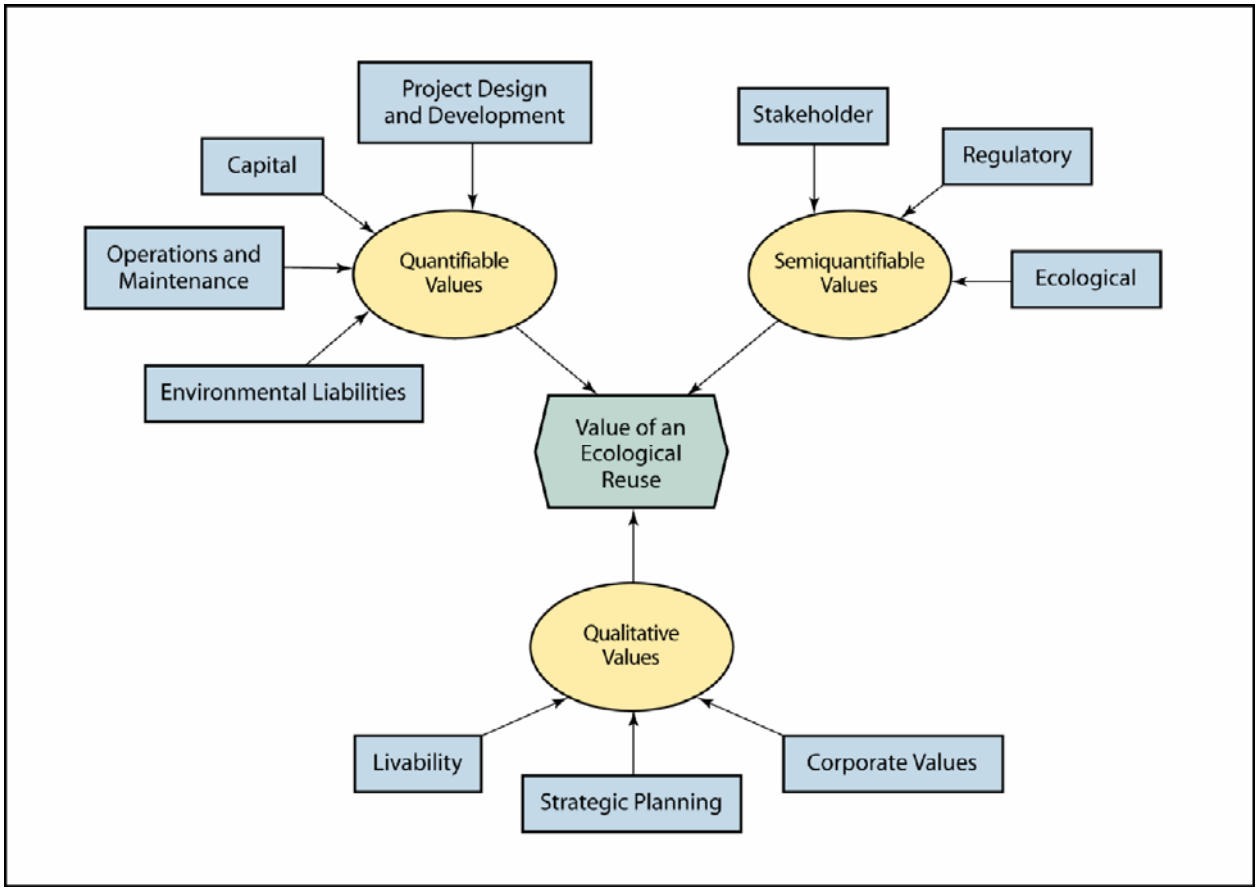


Figure 7-1. Influence diagram of quantifiable, semiquantifiable, and qualitative values

Table 7-1. Additional details of the value determination of an ecological land reuse

Quantifiable Values	Semiquantifiable Values	Qualitative Values
Project Design and Development	**Stakeholder**	**Livability**
• Meet remedial goals	• Community engagement	• Aesthetic appearance
• Alternative endpoints	• Social mores	• Noise, odor, visibility
• Cost recovery	• NGO engagement	• Health, safety, security
• Risk / site assessments	• Regional needs /compatibility	• Community character /sense of place
• Permitting and contracting	• Education opportunity	
• Security	• Recreational opportunity	**Corporate Values**
• Attractive nuisance	• Avoid property condemnation	• Core values and policies
	• Corporate shareholder value	• Company pride
Capital		• Moral /ethical responsibility
• Technology development	**Regulatory**	• Cultural alignment
• External funding	• Innovative approach	• Enhanced reputation
• Operations & maintenance	• Reimbursement solvency	• Employee morale

Quantifiable Values	Semiquantifiable Values	Qualitative Values
• Monitoring	• Relationship status	
• Reporting	• Precedence	**Strategic Planning**
• Property tax payments		• Public & government relations
• Project length	**Ecological**	• License to operate
	• Biodiversity benefits	• Sustainable legacy
Environmental Liabilities	• Erosion control	
• NRD offsets	• Stormwater management	
• Future use liabilities	• Conservation or mitigation	
• Supplemental environmental projects	• Greenhouse gas effects	
• Long-term cost liabilities		

7.1 Net Environmental Benefit Analysis

Decisions regarding the selection of remedial alternatives rarely include a formal quantification of their effect on natural resource service values. As a result, the potential exists for a remedial action to either create more natural resource harm/injury than the risk that is driving it or provide a marginal benefit for the effort expended. A net environmental benefit analysis (NEBA) is an approach that provides for the quantification of the effect on natural resource service values that would be associated with the implementation of an action (such as a remedial action) and compares these effects to predicted changes in the risk scenarios and costs. The NEBA approach allows for a systematic evaluation of changes in natural resource values (ecological and human use) associated with remedial alternatives so that consistent comparisons across alternatives can be conducted to achieve the greatest net environmental benefit at the lowest cost, while maintaining protection of HH&E. A NEBA can be particularly useful when the balance of risks and benefits from remediation of a site are ambiguous. Recent publications present a general framework for the NEBA method and include the use of the habitat equivalency analysis (HEA) approach for quantifying impacts to ecological receptors (Efroymnson et al. 2004).

7.1.1 Where Does NEBA Fit Within Regulatory Processes?

Regulatory agencies are obligated to (1) assess and understand the potential natural resource injury that may be incurred by remedial actions and (2) consider the relationship between risk reduction and cost. The NEBA approach is consistent with EPA risk management objectives; according to EPA Superfund ecological risk assessment (ERA) guidance:

> The risk manager must balance (1) residual risks posed by site contaminants before and after implementation of the selected remedy with (2) the potential impacts of the selected remedy on the environment independent of contaminant effects.
>
> In instances where substantial ecological impact will result from the remedy (e.g., dredging a wetland), the risk manager will need to consider ways to mitigate the

impact of the remedy and compare mitigated impacts to the threats posed by the site contamination.

The NEBA approach provides a framework to help comply with this guidance.

7.1.2 Integrating Remedial and Natural Resource Concerns

In 1999, the EPA OERR issued Office of Solid Waste and Emergency Response (OSWER) Directive 9285.7-28 P to the Superfund National Policy Managers in Regions 1 through 10. This directive was guidance intended to help Superfund risk managers make ecological risk management decisions that are based on sound science, to improve consistency across Regions, and to present a characterization of site risks that is transparent to the public. It provided risk managers with principles to consider when making ecological risk management decisions and questions risk managers and risk assessors should address.

During remedy selection, the EPA Directive asks that the risk managers examine the likelihood of the response alternatives to achieve success and the timeframe for a biological community to fully recover. The EPA suggests that an evaluation of ecological effects resulting from implementation of various alternatives be discussed in the feasibility study (FS) or the engineering evaluation/cost analysis (EE/CA) and should include input from the ecological risk assessor and the federal and/or state trustees responsible for the resources that may be impacted by the response. Despite the EPA 1999 guidance, the risks to resources due to the remedy are rarely formally quantified in common practice. The NEBA provides a methodology by which remedial impacts or benefits can be quantified. The methodologies include the use of HEA to quantify ecological gains or losses and benefits transfer to quantify human use benefits or losses. The NEBA approach allows for a systematic evaluation of changes in natural resource service flows associated with remedial alternatives so that consistent comparisons across alternatives can be conducted to achieve environmental objectives at the lowest cost.

7.1.3 Integration of NEBA into the CERCLA Process

The best time to conduct a NEBA is in conjunction with an FS. This allows for full consideration of natural resources issues to be integrated with the development of remedial alternatives. A NEBA can also be used to help screen out FS alternatives so that alternatives with disproportionate cost/benefit issues can be eliminated.

7.1.4 NEBA and Natural Resource Damage Assessment

The purpose of a NEBA is not to quantify natural resource injury to support an NRDA. The purpose of a NEBA is to provide information to support the identification of a remedy that provides the greatest net environmental benefit at the lowest cost, while maintaining protection of the environment. In some cases, the PRP will be faced with a formal claim for lost natural resource services through a regulatory-driven NRDA. Although NEBA is completely separable from an NRDA, it can play a primary role within the overall strategy regarding an NRDA. Regulators have discretionary authority to invoke an NRDA action. A NEBA can minimize the likelihood of a PRP facing a formal NRDA action through the development of a NEBA-supported site closure strategy. A NEBA-supported site closure strategy would identify the

alternative that minimizes remediation-related NRI (natural resource injury), best addresses NRI caused by past practices, and potentially includes offsetting restoration where necessary.

A NEBA allows the consideration of any actions that may augment ecological services to compensate for any ecological losses. For example, an ecological risk assessment may find that natural attenuation of contaminants in groundwater is not associated with unacceptable risks. Regulators representing interested stakeholders, however, may have concerns surrounding the uncertainty of those risk values. Drawing upon the scientific findings of landscape ecology[3], a proposed remedial action of natural attenuation coupled with additional green remedial techniques or site restoration to increase ecological services can be considered. The overall package of remedial actions combined with restoration is then evaluated using a NEBA to assess their combined impact on the total ecological services provided by a site.

7.1.5 NEBA Quantification Models

Within the NEBA approach, various economics-based methodologies can be used to quantify changes in ecological and human use service values. Traditionally, land value has been the dollar value set by real estate appraisals and reflects the local market conditions for commercial, industrial, and residential uses. Recently, natural resource agencies (NOAA, DOI, USFWS and others) have indicated their desire to value land (habitats) based upon the natural resource services (such as ecological, human use, and passive use) that these habitats provide to the public. Natural resource services are defined as the functions performed by a natural resource for the benefit of another natural resource and/or the public. NOAA guidance further classifies natural resource services as either (1) ecological services—the physical, chemical, or biological functions that one natural resource provides for another natural resource and thus indirectly provides value to the public (for example, the provision of food for wildlife, protection from predation, and nesting habitat, among others); or (2) human use services—the human uses of natural resources or functions of natural resources that provide direct value to the public (such as fishing, hunting, bird watching, boating, nature photography, and education, among others).

For measurement purposes, economists generally classify environmental benefits into three categories: direct human use services (recreation, aesthetics, timber harvest); indirect human use services (climate moderation, flood control, ground water recharge, nutrient uptake, basic ecosystem support services); and passive use services (preserving wildlife habitats for future generations). The NEBA approach uses a combination of some of the same tools as are used in benefit-cost analysis (for example, benefits transfer methodology) and some recently developed methodologies (HEA) to measure these environmental benefits depending upon the nature of the decision and how the information will be used. Economic methodologies have been developed to quantify changes to these value categories given actions that impact (habitat disturbance, development, contamination) or benefit (conservation, management, habitat restoration) the level of services being provided by a specific parcel of land. Within NEBA, these methodologies are used to quantify the natural resource service values associated with potential alternative

[3] Landscape ecology is the study of the distribution patterns of communities in ecosystems, the ecological systems that affect those patterns, and the changes in those patterns and processes over time. An example of landscape geology is the examination of ecological systems on a macro scale such as a flyway or land-based migratory pathway (broad corridors used by migrating birds and animals).

management actions. HEA is the primary ecological economic model used in an NEBA, while benefits transfer is commonly used to quantify human use gains/losses.

7.2 Quantifiable Values

Quantifiable values (Figure 7-1 and Table 7-1) contain elements in which values can typically be assigned to a cost figure. Quantifiable values include, but are not limited to:

- project design and development
- capital costs
- operations and maintenance
- environmental liabilities

Quantifiable values (Figure 7-1 and Table 7-1) contain elements in which values can typically be assigned to a cost figure.

Ecologically-based or natural remedial technologies often require lower capital, O&M or other one-time investment than traditional technologies; however these savings may be offset by increased monitoring or reporting requirements and/or longer remediation project life. Depending on the amount of earthwork, soil amendment, and plant and/or habitat materials required, ecological land uses may or may not offer the potential for reduced capital or one-time outlays. In some cases, the need for remediation equipment, and its associated cost, may be reduced due to the use of alternate remediation end points based on low risk to plants and animals and based on limited human access. Risk scenarios may allow for simpler site assessments, and thus reduce assessment cost. Overall remediation-related costs may be reduced due to the use of alternate remediation end points based on ecologically-based land use (low risk to plants and animals, limited human access). O&M costs may be reduced both through modification of the remediation endpoint and augmentation of higher O&M traditional remedial systems with natural remediation techniques. In addition, O&M costs unrelated to remediation typically decrease as the land use approaches a more natural state.

A holistic approach to quantifiable values can be best illustrated with the following examples using current year dollars:

> *Example 1 (part 1):* A site has a dissolved benzene plume moving toward residences. The MCL is 5 ppb, and there is no risk to the residents. Horizontal three phase extraction has already been successfully pilot tested at this site for hydraulic control; however, the local residents would prefer not to see equipment in or near their yards. Phytoremediation has been evaluated for this site and, technically, it has been accepted as a suitable remediation strategy. Based on the quantifiable values (see Figure 7-1 and Table 7-1) the following comparison is made in Table 7-2:

Table 7-2. Traditional horizontal three-phase extraction system versus ecological phytohydraulic barrier system

3-Phase Extraction System		
Capital	$1,000,000	installation now
OM&M	$150,000/yr	for 5 years future
TOTAL NPV (2.5% Rate)	$1,682,000	
Ecological Phytohydraulic Barrier System		
Design and Development	$110,000	R&D spent already
Capital	$200,000	installation now
OM&M	$75,000	for 2 years establishment future
OM&M	$10,000/yr	for 8 years after establishment future
TOTAL NPV (2.5% Rate)	$499,000	
Cost Avoidance (Value Added)	$1,183,000 ($1,682,000 – $499,000)	

In this case, there is an economic incentive to use the phytohydraulic barrier system, but the remedial track record with horizontal three-phase extraction is more established. For project managers who are adverse to risk or in cases where the economics are not so clear cut, the decision maker will need to consider other factors before deciding to use the ecological enhancement.

Example 2 (part 1): A refinery site has a dissolved benzene and MTBE plume moving towards a creek. The creek is the down gradient property boundary and the refinery is highly visible from a major regional bike path running parallel to the creek. Drinking water standards must be met before the plume leaves the property boundary.

Historically the creek was impacted by free phase hydrocarbons and an extensive pump-and-treat system with product skimming pumps was used to control groundwater gradient and recover product floating on the water table. Ultimately the creek was moved and rebuilt in an area not impacted by petroleum hydrocarbons and is protected from further impacts by a 2000-foot-long slurry wall. Revegetation of the new creek area was required by the USACE and coincided with refinery and stakeholder goals to create a green belt on the refinery side of the creek. 600 to 1,000 gallons per minute of groundwater continues to be pumped from 21 wells and treated through two large air stripping towers.

The current remediation plan is to create a phytoremediation natural attenuation treatment buffer zone behind the slurry wall to address remaining soil contamination and to treat and meet ground water standards at the point of compliance. Approximately 10 acres in a zone adjacent to the creek and slurry wall have been under active revegetation and irrigation for the past several years. The establishment of the phytoremediation attenuation treatment zone would allow shutdown of the groundwater pump and treat system.

Shown below in Table 7-3 is a comparison between costs for the operation of the pump and treat system and the ecological reuse phytoremediation natural attenuation zone system. Points of comparison are taken from Figure 7-1. In almost all cases the dollar values shown below are not estimates but are based on actual costs.

Table 7-3. Pump and treat versus ecological reuse

Project Phase	Pump and Treat	Ecological Reuse Treatment Zone
Design & Development	$0, sunk cost, already in place, estimated at $200,000 (in 1990 dollars)	$50,000 for GW modeling, plant selection
Capital	$0, sunk cost already in place, estimated at $1,000,000 (in 1990 dollars) Land occupied by system not available for refinery use	$100,000 for planting and irrigation system installation Attenuation zone located in creek floodplain
Operation & Maintenance	$300,000 per year for power, air, chemicals, operator time, servicing, permit requirements	$30,000 per year for additional planting, irrigation system maintenance, annual revegetation report. Note: costs should drop to $10,000 per year once USACE replanting requirements are met and ultimately drop to zero once irrigation is no longer required
Environmental Liabilities	If system fails, containment is lost Must meet NPDES permit requirements	System does not rely on pumps, wires or pipes to operate; attenuation zones work independent of human attention.

7.3 Semiquantifiable Values

The second category of cost elements is impact values (semiquantifiable values, Figure 7-1). Values in this category are traditionally not easy to quantify; however, generally, these items can be grouped or prioritized according to importance to the NPV analysis. For example, a poor relationship with a community could lead to increased litigation. It might not be possible to estimate the impact of this easily, but it can be assumed that in a high potential case certain estimable costs could double (high priority rank). Conversely, in a situation where a good community relationship exists, one could assume that there would be no multiplier to the estimable costs (low priority rank). Information needed to make this determination can come from historical work on other projects, benchmarking studies, and academia. Partnerships with conservation organizations have many advantages, including leveraging resources, providing technical guidance, and rewarding incentives for environmental innovation. NGOs and nonprofit organizations can also provide third-party credibility and an objective evaluation of projects. They can provide a reputable and unbiased review of a restoration, remediation, and management program for a contaminated facility.

Semi-quantifiable costs are traditionally not easy to quantify; however, these items can generally be grouped or prioritized according to importance to the NPV analysis.

Semiquantifiable values can include:

- stakeholder involvement
- regulatory acceptance and approval
- ecological considerations

Example 1 (part 2): Here, a component of community engagement (stakeholder involvement) has already indicated a need for aesthetic quality to be met in this neighborhood. If this impact value is not satisfied by the installation of the horizontal 3-phase extraction, then potential repercussions can occur, such as litigation for trespass and other damages. The impact of this should be low since it is a small community that has not expressed displeasure with the pace of investigation, has willingly worked with all involved parties, but it has expressed an interest in additional green space. There are no conflicts with regional needs (stakeholder involvement) as there are no plans for future development which would require a faster remedial action. There is not a high regulatory demand at this site since the risk is very low (regulatory); however, the regulating body seems open to an alternative solution to appease the community concerns. The remaining items under semiquantifiable values fall into much the same category of low impact on costs (perhaps 0-5% of the quantifiable values in the negative for the horizontal extraction). For examples in which there would be a high impact, anywhere from 30-100% of the quantifiable values could be added to account for the semi-quantifiable factors. Our new economics reflect this change, as shown in Table 7-4:

Table 7-4. Traditional horizontal three-phase extraction system versus ecological phytohydraulic barrier system, revised

Traditional Horizontal 3-Phase Extraction System		
Capital	$1,050,00 0	Installation now (+5%)
OM&M	$157,500/yr	For 5 years future (+5%)
TOTAL NPV (2.5% Inflation, 9% discount)	$1,728,000	
Ecological Phytohydraulic Barrier System		
Design and Development	$110,000	R&D spent already
Capital	$200,000	installation now
OM&M	$75,000	for 2 years establishment future
OM&M	$10,000/yr	for 8 years after establishment future
TOTAL NPV (2.5% Inflation, 9% discount)	$499,000	
Cost Avoidance (Value Added)	$1,229,000 ($1,728,000 - $499,000)	

The cost avoidance increased from $1,183,000 to $1,229,000. By adding the semi-quantifiable factors to the analysis, the savings are even larger for using the ecological enhancement.

Example 2 (part 2): The city officials, EPA, state regulators, and citizen and bike path groups were keenly interested in remedial options in the area of the creek.

City officials grant building, occupancy, and other permits and levy operational taxes. EPA and state agencies administer corrective action orders and operational permits for the refinery. Citizen and bike path groups can influence, oppose, or support agency and refinery actions and operations. While these groups have little interest in the responsible parties' quantifiable values, they can have a great influence on those costs. Shown in Table 7-5 below are actual observations about these groups relative to the two treatment systems:

Table 7-5. Comparison of interested party influence, pump and treat versus ecological reuse

Interested Party	Pump and Treat	Ecological Reuse Treatment Zone
Stakeholder (City, Bike Path, Citizens)	Concern about groundwater treatment outfall to creek from aesthetic and water quality standpoint	• No point source discharge to creek • Strongly in favor of revegetation and habitat creation
Regulatory (EPA, State, City)	• Comfortable with conventional Pump & Treat • Recognize system has limitations and long-term operational issues	• Conceptually in favor of habitat creation • Point of compliance requirements must be met • Concern about contingency treatment should Treatment Zone fail • In favor of robust system that does not require company viability to function
Ecological	No effect on surface ecology	• Creates habitat • Creates greenbelt • Creates positive buffer zone between community and refinery

7.4 Qualitative Values

Finally, certain elements will not be feasible to quantify; however, these elements do have an impact on the project. These elements are qualitative values (Figure 7-1). When there are two projects that have similar estimable and impact values (in terms of NPV), the qualitative values may sway the choice of technology and end use.

When two projects that have similar estimable and impact values (in terms of NPV), strategic values may be the deciding factors.

Qualitative values can include the following:

- livability
- corporate values
- strategic planning

Example 1 (part 3): The strategic value of community character and sense of place is satisfied with the ecological enhancement option since the residents are

actively engaged in their hometown and feel like part of the solution. From a corporate perspective, this enhancement will satisfy corporate values of green responsibility. From a regulatory perspective, the law is satisfied while also maintaining a good relationship with the community. Finally, from a strategic planning perspective, there are no lingering bad feelings which could ultimately result in loss of market share or ability to work in other markets. If the economics between the horizontal extraction and the phytohydraulic control barrier had been very close, the track record of horizontal extraction as a benefit over the newer, less common phyto system could be evened out with the consideration of the strategic values.

Example 2 (part 3): The company managing this cleanup is sensitive to the qualitative values that allow business operation in the community and with the regulatory agencies. There is a clear understanding that support of qualitative values translate into economic benefits for company operations. Table 7-6 summarizes these considerations.

Table 7-6. Comparison of values, pump and treat versus ecological reuse

Value	Pump and Treat	Ecological Reuse Treatment Zone
Livability	• 50 foot twin air stripping towers • Discharge culvert to creek • Potential odor issues from MTBE	• Creates aesthetic greenbelt at edge of refinery • Community acceptance & support
Strategic Planning	Requires constant attention & maintenance	• Once in place minimal long-term costs • Promotes good relations with local Government Agencies
Corporate Values	Adds to discharge quantities to air & surface water	• Aligned with minimizing operation impact and restoration of land • Positive employee acceptance

Economic, technical, ecological, and aesthetic values all aligned to promote the selection of an ecological remediation solution for this project. Many options are open to environmental managers besides the traditional techniques—these green options should be considered because they have benefits that traditional cleanup methods cannot achieve. It should not be surprising that these projects can become showcases for ethical company values.

All of the elements mentioned in these three categories should be considered by the project team when considering the value of an ecological land reuse. Taken together, they develop a story for a given site that leads to enhanced decision making. Even if a factor is thrown out for lack of impact on the decision, it should still be considered to make sure all projects are evaluated consistently and completely. An attempt should be made to financially estimate as many of the pertinent factors as possible. The more elements moved to the estimable or quantifiable category, the stronger the analysis and the stronger the final decision.

8. COMMUNITY STAKEHOLDERS

Community stakeholders should be involved at an early stage in considering the use of the land following remediation. Experience has shown that projects benefit from stakeholder input and that the earlier that input is received, the more the stakeholders feel ownership of the outcome. While outreach efforts may exceed the specific regulatory requirements, they offer a more cooperative partnering between the facility, the regulatory oversight authority, and the community. Community involvement should be planned and executed with well-defined assurances and expectations.

Community stakeholders can include local, state, and federal government officials, representatives of affected tribes, NGOs, neighborhood action committees, or citizens of the surrounding community. When ecological enhancements are being considered, conservation groups, community planning groups, wildlife preservation and management groups, etc., should always be offered input into the consideration of ecological enhancements and the resulting habitat it creates. This involvement should address minimally the local, state, and federal laws, regulations, ordinances, guidance, and policy and planning provisions for community; efforts beyond specific mandates will also be valuable. Enhanced community involvement should lead to better, more acceptable, and defensible solutions and expedite site land reuse and the ultimate management of post closure care risks. One of the objectives of the responsible parties should be to integrate community stakeholders into all of their processes, since stakeholder discussions can clearly influence specific cleanup goals and use criteria.

When land use changes and the potential risk associated with the reuse modifications are re-evaluated, community stakeholders should be offered the opportunity to be involved and make their issues, needs, and concerns part of the modification outcome. The process, potential technologies, and alternatives analysis should be made easily available for community review and input. The community's involvement in answering the obvious question "Will it do any harm?" can be substantive— this question must be addressed carefully and honestly.

Examples can be cited in which an open process has been used and achieved documented successes or failures in particular situations. In the case of an evolving process and management system, a proposed solution may be believed to be likely to work, but may not have been tried in a comparable situation. In such a situation, accurate, complete, and clear information must be available. Explain why the process and technology is likely to work and describe the causes of possible failure scenarios. Review the following with stakeholders:

- How likely is the remediation system of technologies to fail?
- What is the consequence of that failure?
- What are the elements of the contingency plan?

Community stakeholders will embrace an opportunity to apply a new solution to a situation, particularly if it is likely to succeed; it benefits their community and offers a more appealing use of the property following completion. Be open about the potential risks and benefits. The community must be offered the opportunity to weigh the potential risks against the potential benefits, since they are most directly affected by the contamination and by the success or failure

of the technology. In certain cases, the community also bears the cost of the cleanup or may, through taxpayers, serve as the insurer of last resort.

In 1997 the State and Tribal Government Working Group (STGWG), working with DOE's Office of Science and Technology, developed a set of principles for the integration of tribes and community stakeholders into the process of evaluating and developing new technologies for the treatment of mixed low-level waste. Below is discussion of the applicable STGWG principles and how they translate to a situation wherein green or natural technologies are being considered for the remediation of contamination:

- *Minimize effluents*. Clean up contamination as quickly as possible. Avoid the generation of reaction side products and new contaminants.

- *Minimize effects on HH&E*. Protect present and future drinking water supplies. Minimize the potential for accidents.

- *Minimize waste generation*. Minimize the production of waste from the cleanup effort.

- *Address social, cultural, and spiritual considerations*. Minimize land use and habitat destruction in the cleanup process. Discuss the transport of chemical reagents with tribes and stakeholders and adapt such transport to address their concerns. Respect the social, cultural, and spiritual values of specific sites. Minimize noise and traffic. Protect local vistas. Include the costs of tribal and stakeholder participation in cost estimates and budgets. Include the costs of compliance with intergovernmental agreements in cost estimates and budgets. These cost estimates may also include evaluations of the energy use throughout the remedy's life cycle. If possible, these could include comparative remedy evaluations that are presented at stakeholder meetings.

- *Provide timely, accurate, complete, and understandable information in a time frame to consider prior to final decisions and determinations so stakeholders may have an impact on the remedy selection process*. Explain the technology screening and evaluation process. Provide information about any previous applications of the technology. Provide information about the hazards and risks and also potential hazards and risks, as well as benefits and potential benefits. These evaluations could include impacts on local and private wells, transportation, dust, noise, and air buffer zones. Keep the tribal and stakeholder representatives involved and informed throughout the evaluation, selection, permitting, and deployment processes. The upper levels of management of the company implementing the remedy need to understand the community concerns and be vested in the remediation process. Independent technical advisory resources should be made available to the tribes and stakeholders whenever services are available.

- *Incorporate tribal, stakeholder, and community involvement into the responsible party's planning process, the permitting process, and the monitoring, performance, and effectiveness of the project*. When an evolving process is considered, uncertainties about efficacy and risks of the technology create concerns in the community. Community acceptance of new processes and technologies is more likely if they are involved in an early and meaningful

manner. Such involvement will enable the early identification of significant issues and the joint resolution of these issues.

Achieving ecological land reuse requires much more than a few public meetings. All the participants in a site cleanup have an investment in how the problem is characterized, how the solution is defined, how the schedule is implemented, and how the project outcome fits with their needs and expectations. In this sense, all participants are stakeholders and incorporating ecological land reuse at a site entails accepting both the opportunity and the challenge to substantially involve the community throughout the entire remediation, including land reuse decision process. Without their involvement and support, the economic, political, and sustainability benefits may elude the project advocates and limit their ability to move beyond traditional Brownfields cleanup outcomes.

In the course of developing this guidance document the team examined a number of sites where ecological land reuse was part of the planned outcome. Two of these are especially noteworthy because of the extensive public/private relationships forged during the cleanup process between the traditional players in a site cleanup and those representing various interests within the local community. The salient features of these two sites and some important prerequisites for long-term success are summarized below and addressed in more detail in the case studies at Appendix C.

8.1 Urban Revival on a Grand Scale: Chattanooga, Tennessee

Chattanooga Tennessee has a rich history, which dates back over 10,000 years. It was once a large settlement of Native Americans, and the name Chattanooga means "mountain that comes to a point" in Cherokee. Surrounded by rugged mountains on three sides of the Tennessee River Valley, the site was a crossroads for travelers and trade between the coastal areas and the mid-west. DeSoto, the Spanish explorer, is believed to have passed through the area in the 1580's. Here, the Cherokee Nation crossed the river on the "trail of tears" in their tragic journey from the Appalachian Mountains to the government reservations in Oklahoma. During the 1800's, Chattanooga grew into a major railroad and industrial center. Because of its strategic location, several battles were fought in and around the town during the Civil War, including the Battle of Chickamauga in 1863.

Between 1880 and 1960, Chattanooga was the ninth largest industrial city in the U.S. and the largest on a per capita basis. Steel mills, metal fabrication and processing shops, rail yards, and warehouses dominated the downtown and riverfront landscape. It was known as the "Pittsburgh of the South". All this changed after WWII, as heavy industry gradually shut down or relocated. What was left behind was a city with a faltering economy, declining population, and a large number of contaminated industrial sites. Today, 19 sites within the city limits are on the NPL. By the late 1980's, it was clear that Chattanooga was dying and that the city must be saved.

Since then Chattanooga has made a remarkable comeback, reinventing itself by cleaning up its industrial legacy and transforming its formerly industrial downtown into a revitalized place to live, work, and play—a place that captures the very best of Americans towns. Chattanooga is now a top tourist destination, retirement magnet, showplace of American history, and playground

for boaters and weekend visitors from nearby Atlanta, Knoxville, Birmingham, and Nashville. The key to Chattanooga's ongoing success story began with the recognition by community leaders that they must rebuild in a way that re-engaged the residents and visitors with the city's greatest and enduring assets: the river, the mountains, and the area's remarkable history. It also included the understanding that private funding would be central to making it all possible and that new and robust public/private partnerships and institutions would be essential to effect consensus-based planning and to acquire the financial, political, and legal resources needed to implement the plans.

8.1.1 Return to the River

In 1984, Chattanoogans joined together in a community planning process called "Vision 2000." The discussions covered a spectrum of issues, from human rights to athletics, but restoring downtown's vitality was very much at the heart of the meetings. Coincidentally, a publicly appointed citizens group—the Moccasin Bend Task Force—was hosting community conversations about how to reclaim the Tennessee River as a public asset. Central to those discussions were the dual notions of public access and quality development along the riverfront. These concepts came together in the "Tennessee Riverpark Master Plan." Published in 1985, the 20-year plan called for $750 million worth of mixed-use development, enhancement, and conservation along 22 miles of the Tennessee River corridor as it passed through Chattanooga.

During the 1990s, Chattanooga started turning plans into bricks and mortar. The Tennessee Aquarium opened in 1992, the Chattanooga Visitors Center in 1993, the Creative Discovery Museum in 1995, and the IMAX 3D Theater in 1996. The renovated Walnut Street Bridge opened as a pedestrian-only bridge in 1993. Directly across the river from all of this activity, Coolidge Park (featuring a vintage carousel) opened in 1999, spawning a retail renaissance on the north shore. And on the south end of town, the convention center was being expanded a block away from a new conference center and hotel.

Tourist numbers grew, as did the numbers of communities from around the globe sending delegations to study Chattanooga's success. And yet, it was clear there was still work to be done if Chattanooga was going to continue its return to the river originally envisioned in the mid-1980s. Riverfront Parkway looked like a good place to start the return to the river.

Built in 1965, the parkway was a five-lane, high-speed highway that created a formidable barrier between the city and the river. Although city planners had viable designs for reconfiguring the state highway, the Tennessee Department of Transportation was reluctant to implement them. Mayor Corker pressed the case with Governor Don Sundquist and, in October 2001, Sundquist traveled to Chattanooga to transfer the parkway to city ownership. From that point forward, there were no limitations to what the city could envision for the waterfront. Meanwhile, three of Chattanooga's most revered cultural institutions were engaged in expansion and renovation discussions. The Tennessee Aquarium, the Creative Discovery Museum, and the Hunter Museum of American Art were responding to various operational demands and preparing to launch separate campaigns to fund $50 million worth of improvements. At the mayor's invitation, the three agreed to combine the projects into one massive riverfront redevelopment discussion.

8.1.2 The 21st Century Waterfront Trust

Thus was born the idea of 21st Century Waterfront Trust—a consolidated effort among the City of Chattanooga, the Tennessee Aquarium, the Hunter Museum of American Art, and the Creative Discovery Museum to raise $120 million to expand the art museum and the aquarium, enhance the core exhibits at the children's museum, and surround them with the finest riverfront setting in the country. Building on Chattanooga's impressive record of public participation, the Mayor invited the community to a planning session in February 2002. More than three hundred people came armed with their ideas to create a world-class waterfront. Their work was guided by Hargreaves Associates, a Cambridge, Massachusetts, firm with international waterfront design experience. The result of the meeting was an inspired plan to remake the riverfront near Ross's Landing, Chattanooga's birthplace.

The plan called for an expansive new green space, a public pier, and a hard-edge shoreline suitable for leisure boat mooring, along with other improvements to streetscape, public art, and public access. It entailed the reconfiguration and relocation of Riverfront Parkway and the creation of a passage beneath the parkway connecting Ross's Landing Park & Plaza and the river. With the unanimous support of the Chattanooga City Council, the plan was adopted in spring 2002. By itself, the riverfront renovation was an immense project, but it was about to get bigger with the addition of the expansions and renovations at the Aquarium, the Hunter, and the Creative Discovery Museum.

Yet another series of public meetings was held to gather ideas about ways in which Chattanooga could promote the region's scenic beauty and soft adventure opportunities. Eight hundred citizens showed up to share ideas during the planning meeting; the citizens stressed the need for accessibility balanced with stewardship. Planners used those principles as the foundation for the Chattanooga Outdoor Initiative, which was unveiled in January 2004. In the spring of 2004, Mayor Corker announced plans to set aside land on the north shore of the river—within the 21st Century Waterfront plan area—to accommodate the headquarters for the outdoor initiative. Planners hope this initiative will draw outdoors enthusiasts from around the world to enjoy hang gliding, whitewater kayaking and canoeing, hiking, caving, rock climbing, and numerous other activities in the immediate Chattanooga area.

Mayor Corker announced the creation of the 21st Century Waterfront Trust in his State of the City address on May 22, 2002, and boldly declared the funds would be raised and the projects completed by May 2005—only 36 months away. What seemed like an extraordinarily ambitious timeframe became a compelling fundraising case when donors became convinced that the fruits of their contributions would be tangible in just three years. The Mayor took the lead, getting the state legislature to institute a hotel/motel tax, with proceeds going to the riverfront's bonded debt service—a total of $56 million. Mr. Corker then personally participated in more than seventy fundraising meetings with key individuals and groups from the civic, corporate, and philanthropic communities, collecting pledges for $36 million. The grander vision for the waterfront also includes more than 200 new housing units along the riverfront and up First Street from the aquarium. The first of these developments, River Pier Landing Condominiums, opened in 2005.

As for the rest of the 21st Century construction, work is underway and projects will be completed and open to the public in 2006; however, upgrades will continue to indefinitely. When the ribbons are cut, it will be 20 years, almost to the month, since the "Tennessee Riverpark Master Plan" was published announcing Chattanooga's intention to redevelop its riverfront and reconnect to its river over the span of two decades. Chattanooga will have "returned to the river" on schedule. Mayor Corker is quick to point out that the work is never done. "Every generation has a role to play in building a great city," the Mayor states. Clearly, though, this generation has given the next a great deal to work with.

It is within the context of this broader urban renaissance that the North Shore Renaissance Park, formerly known as the GE Roper Case Study, is presented in this guidance document. The GE Roper Site was formerly a metal enameling plant. It covers 23 acres on the Tennessee River directly across from the Tennessee Aquarium and is next door to the eight-acre Coolidge Park. The remediation plan creates wetlands, walking paths, and a children's park. The site will be used for recreation and as an educational center emphasizing wetland ecology. The reclamation will cost $12.2 million dollars and is part of the $120 million 21st Century Waterfront project, of which $51 million is being provided by the private sector and $69 million is being funded by a dedicated city lodging tax. The wetlands and park are expected to open to the public in 2005. A full case study of the North Shore Renaissance Park and GE Roper site is included in Appendix C.

8.2 New Beginnings - The Woodlawn Wildlife Area, Port Deposit, Maryland

Designating a site's end use to be ecologically based can depend largely on coordinated conservation efforts among a number of stakeholder entities; collaboration among various groups is becoming increasingly common as a way of dealing with environmental issues. The survival of many species, in particular those with extended ranges or that exhibit migratory behavior, can also depend on the integration of community needs in order to achieve successful land stewardship. Such stakeholder affiliations address pressing conservation issues on a landscape scale while allowing individual partner groups to continue working at the local level. Individual site programs, such as New Beginnings - The Woodlawn Wildlife Area, are generally more effective when partnered with organizations working for conservation at broader scales.

New Beginnings - The Woodlawn Wildlife Area is a former landfill listed on the EPA's NPL due to groundwater contamination. Working closely with EPA and state agencies, Bridgestone Americas Holding, Inc., implemented a cleanup action at the former landfill that included the addition of a two-foot soil cap and groundwater monitoring. Bridgestone assumed responsibility for the remediation of the site and, as part of their management approach, a wildlife habitat enhancement program is being implemented by the WHC and local community groups. Bridgestone purchased fifty acres of land adjacent to the landfill, and, in collaboration with WHC, has focused on this area and the former landfill for community involvement and environmental education. These strong community-based projects receive increased public recognition and environmental awards by related industry associations. This case study demonstrates the value of key partnerships between the community, NGO's, and the traditional remediation players.

The property lies in a mostly rural setting north of Baltimore in Cecil County, Maryland, surrounded by rapidly expanding residential development in a formerly agricultural area. Its history of industrial use began in the 1950s, when the 37-acre site was first used as a sand and gravel quarry. During the 1960s and 1970s, it was used to dispose of agricultural, municipal, and industrial wastes from the surrounding area. Upon the signing of the Record of Decision (ROD) in 1993, restorative efforts were altered due to new data that showed an unanticipated natural attenuation of the contaminated groundwater. At that time, a new plan for site cleanup was established in partnership with EPA, state, and local authorities. As a result of the natural attenuation and the recommendations for habitat enhancement from WHC, the remedy was altered to allow for a vegetative, loose soil cap. The alternative capping approach opened the door for wildlife habitat enhancements on the landfill, including planting native trees, shrubs, and wildflowers around the landfill cap, planting in an island configuration as opposed to rows, and placing raptor perches on the landfill.

Table 8-1. New Beginnings facts

PRP Company:	Bridgestone Americas Holding, Inc.
Location:	Cecil County, MD
Remedial Designation:	Superfund (federal)
Urban/Rural:	Rural
Type of contaminant:	Vinyl Chloride
Size of site:	90 acres
Prior to WHC Involvement:	ROD was approved for traditional capping procedure, to be fenced off and intensively managed for foreseeable future.
Nature of WHC Involvement:	WHC Opportunities Report was written and a revised ROD was approved. Funding from Bridgestone to fully implement WHC's Wildlife at Work program, work with engineering consultants in aligning habitat management goals with site O&M, engage community members and stakeholders, and implement a WHC Corporate Lands for Learning program.
Project Vision:	Develop and foster habitat management and environmental education programs through community and stakeholder engagement to the point where these partners take stewardship over the property to ensure long-term success of the ecological reuse of the site.
Economic Incentive:	Traditional capping costs ~$26 million; Bridgestone saved ~$17 million in long-term maintenance by revising ROD to reflect ecological reuse of the site.

Management of wildlife habitat and stakeholder engagement at New Beginnings is coordinated by the Wildlife Habitat Council through community volunteerism in Cecil County. The Woodlawn Wildlife Team consists of these representatives:

Table 8-2. New Beginnings - The Woodlawn Wildlife Area team members and roles

Team Member	Role
Bridgestone Americas Holding, Inc.	PRP and support of all projects
EPA	Regulator
Arcadis	Consultant and contractor for O&M
Wildlife Habitat Council	Non-profit/ NGO - coordinates stakeholder outreach and habitat management and has certified the New Beginnings program.
Boys and Girls Club of Cecil County	Outdoor activities and environmental education for youth
Fair Hill Nature Center	Collaboration in developing environmental education workshops
Maryland Cooperative Extension	Master Gardener classes offered on site
Perryville Middle School	Outdoor field trips and environmental education
West Nottingham Academy	Outdoor field trips, environmental education
Cecil County Government	County level support of projects and coordination with local Land Trust
Maryland Department of Natural Resources, Forest Service	Site induction into State Forest Stewardship program
Boy Scout Troop 28 - Rising Sun, MD	Volunteer-based Eagle Scout projects completed on site
Tri-State Bird Rescue and Research	Uses New Beginnings as a release site for orphaned and injured birds
Cecil County Bird Club	Performs Christmas and migration counts at New Beginnings

Benefits of implementing ecological reuse at *New Beginnings - The Woodlawn Wildlife Area* include the following:

- public gains a community asset—open space and environmental education
- Bridgestone viewed as a positive community contributor
- wildlife habitat created/enhanced
- revised remedy implementation saved approximately $17 million
- demonstration site for others to emulate

8.3 Integrating Stakeholders into Problem Solving Teams

One of the foremost challenges in the consideration of ecological land reuse options is that all the participating stakeholders need to recognize that their respective roles in the process are sometimes in conflict and are sometimes congruent. Most people expect site cleanups to be litigious and involve adversarial activities. In fact, the greatest opportunities for win-win solutions usually emerge when the participants choose a different approach based on mutual respect, trust, and, above all, openness to new approaches and the creativity that often springs up in groups operating outside of historical limits. Both case studies (City of Chattanooga and New Beginnings - The Woodlawn Wildlife Area) have demonstrated the success possible when the goal becomes "creating a better world around all of us" rather than cleaning up someone's mess. The following Table 8-3 summarizes who the stakeholders usually are in these projects and how they can participate in the restoration of a contaminated area.

Table 8-3. Principal project stakeholders

Stakeholder	Contribution	Importance	Interest	Example/case study
State and Federal Government Regulators	Enforcement	Usually define the framework within which decisions are made	Training on green technologies and success stories	The Woodlawn Wildlife Area - 1993 ROD amended in 1999 to allow for a vegetative cap.
Industry	Site owner, principal source of cleanup funds, major stake in reuse decisions, receptive to community goodwill and benefits from their support	May control opportunity for land redevelopment, early involvement may improve quality of results & economic benefits	Regulators should be aware of regional land use needs and communicate opportunities to industry	Participation in Wildlife Habitat Council programs, (see Appendix C) industry land donations to land trusts, Nature Conservancy, and other groups
Local community (as a whole as well as organized community and business groups)	Community acceptance and potential active support to other project participants in considering ecological reuse	Could make the economic and political difference in whether eco-reuse is a real option for the site	Meetings with community leaders, local media coverage well before key decisions are made	Chattanooga and The Woodlawn Wildlife Area
Environmental non-governmental organizations	Can provide third party accreditation, source of expertise in wildlife habitat issues and assessments, facilitation of projects, volunteer labor, and political advocacy for reuse options	Can augment and/or stimulate local community initiative and can facilitate community outreach and participation where applicable	Local community leaders should initiate contact with these groups	Wildlife Habitat Council Programs, Chattanooga, and The Woodlawn Wildlife Area
Consultants	Key technical advisor and project planner for site owner and project contractors	With regulators, they define the framework within which decisions are made	Training on green technologies and success stories	Chattanooga and The Woodlawn Wildlife Area
Academics	Source of expertise for technology applications and wildlife habitat issues, network to similar projects elsewhere, and voluntary labor	Especially valuable in helping project consultants keep current on new approaches	Early involvement helps overcome erroneous perceptions about technical and economic constraints	Chattanooga and The Woodlawn Wildlife Area
Philanthropic Foundations	Potential source of funds and project credibility for reuse options	Can augment and/or stimulate local community initiative	Early involvement improves chances of meeting	Chattanooga and The Woodlawn Wildlife Area

Stakeholder	Contribution	Importance	Interest	Example/case study
			Foundation criteria	

All the entities described above have important roles in the overall remediation process. If ecological reuse is to become a viable possibility, however, early and significant involvement by the local community and relevant NGOs is critical to both initial success and the ultimate sustainability of the site ecological end-use.

The ITRC Ecological Land Reuse Team observed common threads in successful ecological land reuse applications for site cleanups. They are as follows:

- technically sound methods for remediation
- ecological reuse and wildlife habitat enhancement as a design component
- credible third party respected by all stakeholders
- all stakeholders involved
- clear opportunities for the community to use the project/participate in the demonstration
- efforts made by the industry and stakeholders was voluntary
- trust established early on in the process

Economics are central to the motivation and expectations of almost all the parties involved in the process. As pointed out in Section 7, impact values and, more importantly, strategic values are vital to the acceptance of the project and the outcome. Qualitative values such as these have a economic benefits to the industry or the party who is financially responsible for the cleanup; these values can also help streamline the overall life cycle of the project. This practice creates a better community, while cleaning up the environment, because the community is shaped by its members.

9. FINDINGS, RECOMMENDATIONS, AND OPPORTUNITIES

Based on published literature, state-specific and industry experience, and a review of the applicability and value of ecological land reuse at remediated sites, the ITRC Ecological Land Reuse Team has identified the following findings, recommendations, and opportunities for further research.

9.1 Community Partnerships

Finding

Most communities have a keen interest in their surroundings, which includes the projected land reuse of contaminated sites. The community often is capable and willing to help define the reuse of an existing property, especially when a threat to HH&E is removed and the appearance of the site is left better than before. Community support for the entire cleanup project can foster

community acceptance of the remediation process. That effort should also include the following parties:

- local groups or agencies that may have the best and most site specific information concerning local habitat.
- local conservation districts which can readily offer technical assistance regarding local land use and land management

Recommendation

Site owners are encouraged to engage community partners as early as possible to help understand and evaluate the site's environmental service capacity including ecological resources.

9.2 Ecological Elements

Finding

Ecological enhancements can save money, protect the environment, and should be an integral part of the remedial strategy. (See Section 7, Cost Considerations).

Recommendation:

Planners should address each element in Figure 7-1 and Table 7-3 to comprehensively evaluate all projects, including the net incremental increases to the economic, social, and ecologic benefits as a result of incorporation of ecological enhancements.

In addition planners should pursue the following options:

- Take advantage of available tax credit programs. (See ITRC ECO-1, 2003 "Making the Case for Ecological Enhancements").
- Take advantage of existing credit opportunities which create incentives for ecological land reuse (e.g. mitigation banking, conservation of private grazing land, Natural Resource Conservation Service, and Natural Resource Damage Assessment (NRDA). Each of these programs has their own legal and regulatory framework which should be reviewed prior to utilization. There may be additional credit opportunities than those listed above.
- Evaluate ecological end use as potentially the most beneficial approach, considering the economic, social and ecological services in which environmental liabilities are managed.

9.3 Ecological Risk

Finding

The belief is widespread that an ecological risk assessment will be triggered when using an ecological element in a remediation strategy or that an ecological risk assessment may trigger a lower or more stringent cleanup level. The code of Federal Regulations § 264.101 requires

protection of both human health and the *environment* (emphasis added), thus ecological risk assessments are already required in the regulatory regimes applicable to these sites.

Recommendation

Regulated facilities with a historical release must protect the environment as well as human health. Therefore, based on regulatory requirements, remedial design must consider ecological risk as well as human health risk regardless of end use. A choice between the two is not an option.

9.4 Remediation Outcome

Finding

SARA regulations (1986, http://www.epa.gov/superfund/action/law/sara.htm) stress the importance of permanent remedies and innovative treatment technologies in cleaning up hazardous waste sites. Selecting an ecological element as part of the land reuse does not necessarily dictate a more stringent cleanup; however, sometimes a more stringent cleanup is necessary.

Recommendation

Establishing ecological land reuse as the remediation outcome because it can offer a more permanent remedy, sustained protection of the environment, and a positive legacy for the community after the remediation efforts are concluded.

9.5 Ecological End Uses

Finding

Generally, an enhancement is an additional activity or a feature of the selected remedy that is not necessary to support the effectiveness of the remedy in protecting HH&E given the reasonably anticipated future land use (RAFLU) for the site. Examples of enhancements include compaction of a protective cap beyond what might be needed to keep it from settling under the RAFLU, or the addition of clean fill beyond that required to make a remedy protective of future users. EPA cannot fund or require PRPs or others to fund “betterments” or “enhancements” of a remedy. EPA can, however, fund and support ecological end use when the ecological element is an integral part of the remediation (for instance, groundwater control, stream bank stabilization, institutional controls, remedy control, administration mechanisms, or other appropriate controls). Communities, landowners, and other stakeholders may provide the additional funds, ideas, or other resources needed for such enhancements.

Recommendation

Planners should incorporate ecological end uses as an integral part of the remediation to increase/improve habitat for plants and animals, while protecting HH&E. An ecological element can include natural remediation technologies and/or also represent an end use which

restores/increases the ecological value of the land. While it may be unclear how these ecological reuses may specifically offset future NRDA claims, there is significant technical and regulatory basis for applying the increased value of the ecological resource to the NRDA to determine the net cost of lost resources.

9.6 Costs

Finding

From technology selection to final disposition of the property, there are numerous cost elements to be considered. A comparison of the relative economic advantages of two alternative approaches, one having moderate initial costs, high O&M costs, and a short duration and the other having low initial costs, moderate O&M/administrative costs, and a long duration can be made through an NPV, NEBA, or combination of these approaches.

Recommendation

Planners should consider the complete life cycle of the project for an accurate economic picture of the alternatives.

9.7 Opportunities

Ecological service as a reuse element is still emerging, and additional information or data is necessary to fully realize the broad benefits of ecological land reuse. New research and reporting needs to accomplish the following:

- Explain and document the service capacity offered by a given area and how that capacity can be fulfilled by remediation systems.
- Track, manage and evaluate the ecological land reuses and how it may positively impact the surrounding and interconnected systems (in conjunction with state wildlife action plans to facilitate evaluation of the interactions with off-site capacity development).
- Document the impact ecological land reuse of remediated, reclaimed or restored sites has on migratory flyways, wildlife corridors and watersheds.
- Better establish the methodologies and implementation strategies that incorporate research centers/organizations, educational/learning groups, redevelopment grants, volunteer organizations, owners/operators, and NGO organizations to create ecological end use projects that will provide the desired service.
- Document the integration of environmental remediation technologies into a sustainable ecological end use.
- Integrate information from sites which have restored or created ecological benefits, into a learning center or database which is readily available to all stakeholders.
- Include the evaluation of ecologically based remediation strategies instead of only mechanical systems in order to move towards more non-mechanical sustainable ecological based systems. These systems must be capable of the same level of environmental and human health protection, plus provide a more wildlife and human user friendly end use.

- Document ecologically based mechanisms that provide sustainable institutional controls (for example, conservation easements, covenants, deeds, long-term stewardship mechanisms, or other operation and maintenance tools).
- Better understand the mechanisms and institutional controls that can be placed on property to manage any residual threats and ensure sustainability The ITRC Post Closure Care team recommends that States should develop a template they can use, and adjust to their own use, to track and evaluate the environmental effectiveness of land use controls placed on a site. This might be best accomplished through a national organization that represents the states. (See Section 4.8.2, ITRC ALT-4 2006).
- Document the improved quality of life of the individual and the livability of the community where ecological end use or elements are incorporated into the urban and suburban environment. This may be accomplished by evaluating the service capacity developed by the reuse strategy. This may be partially evaluated via the NEBA, NRDA, or cleanup decision making processes.

10. REFERENCES

Beidenharn, David S., D. S. Elliott and C. C. Watson, 1997, *The Wes Stream Investigation and Streambank Stabilization Handbook pp*. http://www.pubs.asce.org/wwwdisplay.cgi?9803161

Brown, Sally and Chuck Henry (Draft 20001)"Using Biosolids for Reclamation/Remediation of Disturbed Soils" University of Washington. http://faculty.washington.edu/clh/whitepapers/biosolidswhite.pdf

Brown, Sally, Mark Sprenger, Amanda Maxemchuk, and Harry Compton. (2005) "Ecosystem Function in Alluvial Tailings after biosolids and Lime Addition" Journal of Environmental Quality 34:1 139-148. http://jeq.scijournals.org/cgi/content/abstract/34/1/139.

Chapman, D., N. Iadanza, and T. Penn. 1998. Calculating resource compensation: an application of the service-to-service approach to the Blackbird Mine hazardous waste site. National Oceanic and Atmospheric Administration Damage Assessment and Restoration program Technical Paper 97-1.

DOI, 1997. 43CFR11. Natural Resource Damage Assessments. 43 Vol 1, 10/1/97.

Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. *Classification of Wetlands and Deepwater Habitats of the United States.* FWS/OBS-79/31. Washington, D.C.: Office of Biological Services, U.S. Fish and Wildlife Service.

Eyre, F. H., editor. 1980. *Forest Cover Types of The United States And Canada*. Society of American Foresters, Washington, D. C.

Efroymson, R.A, J.P. Nicolette, and G. W. Suter. 2003. *A Framework for Net Environmental Benefit Analysis for Remediation or Restoration of Petroleum-Contaminated Sites*. DOI: 10.1007/s00267-004-0089-7. key words NEBA; Net environmental benefit analyais; ecological risk assessment; petroleum; remediation;ecological restoration. ORNL/TM-2003/17. http://www.esd.ornl.gov/programs/ecorisk/net_environmental.html

FISRWG (10/1998). *Stream Corridor Restoration: Principles, Processes, and Practices.* By the Federal Interagency Stream Restoration Working Group (FISRWG)(15 Federal agencies of the US gov't). GPO Item No. 0120-A; SuDocs No. A 57.6/2:EN 3/PT.653. ISBN-0-934213-59-3. http://www.nrcs.usda.gov/technical/stream_restoration/

Fonseca, M. S., B. E. Julius, and W. J. Kenworthy. 2000. Integrating biology and economics in seagrass restoration: How much is enough and why? Ecol. Eng. 15:227-237.

Garbisch, E.E. 2002. *Dos and Don'ts of Wetland Construction, Creation, Restoration , and Enhancement*, St. Michaels, Md.: Environmental Concern, Inc.

Gill, M. D., Hauser, V. L., Horin, J. D., Weand, B. L., and Casagrande, D. J., 1999, *Landfill Remediation Project Manager's Handbook*, prepared for the Air Force Center for Environemntal Excellence, Brooks Air Force Base, Texas.

Gregory, James R; Jack G. Weichmann. *Branding Across Borders: A Guide to Global Brand Marketing*. 2002. <http://www.amazon.com/exec/obidos/tg/detail/-/0658009451/qid=1128971397

Harker, D, S. Evans, M. Evans and K. Harker. 1993. *Landscape Restoration Handbook*. Lewis Publishers, Boca Raton, 98 pp., plus appendices.

Hayes, C.H.. 1988. *Wetland Protection in Superfund Remediations,* USEPA Office of Cooperative Environmental Management. USEPA 600/9-89/012.

Hunter, M.L. Jr. 1990. *Wildlife, forests, and forestry / Principles of managing forests for biological diversity*. Regents/Prentice Hall. Englewood Cliffs, N.J.

Interstate Technology and Regulatory Council (ITRC), Phyto-1, *Phytotechnologies Technical and Regulatory Guidance Document.* 2001.

ITRC Phyto-2, 2001 *Phytotechnology Technical and Regulatory Guidance Document*, April 2003.

ITRC Wetlands-2, 2005, *Technical Guidance for Characterization, Design, Construction, and Monitoring of Mitigation Wetlands.*

ITRC Wetlands-1 2003, *Technical and Regulatory Guidance Document for Constructed Treatment Wetlands.*

ITRC ALT-2, 2003 *Technical and Regulatory Guide for Design, Installation and Monitoring of Alternative Final Landfill Covers*.

ITRC, ISB-3 1999, *Natural Attenuation of Chlorinated Solvents in Groundwater: Principles and Practices*, Reprinted 1999.

ITRC Eco-1, 2004, *Making the Case for Ecological Enhancements.*

King, D. M., and K. J. Adler. 1991. Scientifically defensible compensation ratios for wetland mitigation. U. S. Environmental Protection Agency Office of Policy, Planning and Evaluation. Washington, D. C.

King, D., Wainger, L., Bartokius, C. and J. Wakely. 2000. Expanding wetland assessment prcedures: Linking indices of wetland function with services and values. Unites States Army Corps of Engineers, Research laboratory Report ERD/EL TR-00-17.

Massotta, M. J., J. J. Opaluch, and T. A. Grigalunas. 1994. Natural resource damage assessment: the role of resource restoration. Nat. Resour. J. 34:153-178.

Mitsch, W.J. and J.G. Gosselink. 2000. *Wetlands, 3rd Ed*. John Wiley & Sons, New York. 920 pp.

Mitsch, W. J., and J. G. Gosselink. 1993. *Wetlands*. New York: Wiley and Sons, Inc. "National Wetlands Mitigation Action Plan." 2002. Available on the Internet at http://www.usace.army.mil/inet/functions/cw/hot_topics/Mit_Action_Plan_24Dec02.pdf.

National Research Council. 1992. *Restoration of Aquatic Ecosystems*: Science, Technology, and Public Policy. National Academy Press, Washington D.C.

Nicolette Joseph P. 2004 (Personal Communication), 2005, *Natural Resource Valuation and Net Environmental Benefit Analysis (valuing ecological and human use services)* Vice President,

CH2MHILL Director, Natural Resource Liability and Asset Management, Atlanta, Georgia. 770-517-9154. jnicolet@ch2m.com

Nicolette, J. P., T. Barber, R. K. Markarian, T. W. Cervino, and D. V. Pearson. 1995. A cooperative Natural Resource Damage Assessment (NRDA) Case Study: Colonial Pipeline Release, Reston, Virginia. Proceedings of the Water Environment Federation Specialty Conference: Toxic Substances in Water Environments. Cincinnati, OH, May 1995.

Nicolette, J. P., M. Rockel, and M. J. Kealy. September 2001. Quantifying ecological changes helps determine best mitigation. Pipe Line & Gas Industry 52-57.

NOAA Damage Assessment and Restoration Program. 1995. *Habitat equivalency analysis. How much restoration is enough?* Silver Spring, MD.

NOAA Damage Assessment and Restoration Program. 1997. *Scaling compensatory restoration actions, guidance document for Natural Resource Damage Assessment*.

NOAA, 1998. *Calculating resource compensation: an application of the service-to-service approach to the Blackbird Mine hazardous waste site. NOAA Damage Assessment and Restoration Program*. Technical Paper 97-1. October 16, 1998.

Pierce, G. J. 1993. *Planning Hydrology for Constructed Wetlands*. Poolesville, Md.: Wetland Training Institute.

Rosgen, D. (1996). *Applied River Morphology*, Wildland Hydrology, Pagosa Springs, CO. http://www.geog.soton.ac.uk/users/WheatonJ/Definitions/QD0408.htm -

Society of Ecological Restoration, 2004, *The SER International Primer of Ecological Restoration, Science and Policy Working Group*, Version 2, October, 2004. http://www.ser.org/content/ecological_restoration_primer.asp

Sopper, William E. (1993) *Municipal Sludge Use in Land Reclamation*. Lewis Publishers, Boca Raton, Florida.

Sprecher, S. W. 2000. "*Installing Monitoring Wells/Piezometers in Wetlands*" WRAP Technical Notes Collection, ERDC TN-WRAP-00-02. Vicksburg, Miss.: U.S. Army Engineer Research and Development Center.

United States of America vs. Melvin A. Fisher et al. 1997. 92-10027-CIV-DAVIS.

United State Environmental Protection Agency 2000, *Institutional controls: A site Mangers Guide to Identifying, Evaluating, and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups*, EPA 540-F-00-005, OSWER 93550-74FS-P, September 2000.

USEPA, 2004, *Guidance for Preparing Superfund Ready for Reuse Determinations at Superfund Sites* OSWER 9365.0-33 February 18, 2004 .

USEPA, 2003, *Guidance on Completion of Corrective Action Activities at RCRA Facilities*'' 68 FR 8757 (Feb 25, 2003).

USEPA 2000 "Poland Biosolids Smelter Waste Reclamation Project" EPA 832-R-00-009, Region 03, Philadelphia, PA. http://www.epa.gov/owm/mtb/biosolids/polabroc.pdf

USEPA, 1999, *Issuance of Final Guidance: Ecological Risk Assessment and Risk Management Principles for Superfund Sites*, OSWER Directive 9285.7-28 October, 1999.

USEPA and DOI 1999. Coordination of Environmental Response and Natural Resource Restoration under OPA and CERCLA--Reference Guide. U. S. Environmental Protection Agency and U. S. Department of the Interior. Washington, D. C.

USEPA, 1997, *CERCLA Coordination with Natural Resources Trustees*, OSWER Directive Number 9200.4-22A.

USEPA, 1997, *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments*: EPA 540-R-97-006 OSWER 1997.

Unsworth, R. E., and R. C. Bishop. 1994. Assessing natural resource damages using environmental annuities. Ecological Economics 11:35-41.

Washington Department Of Fish And Wildlife 2003, *Aquatic Habitat Guidelines: An Integrated Approach To Marine, Freshwater, And Riparian Habitat Protection And Restoration, Integrated Streambank Protection Guidelines*, April 2003, in coordination with Washington Department Of Transportation, Washington Department Of Ecology.

Wilson, Mathew A. November 2004 *Ecosystem Services at Superfund Redevelopment Sites Revealing the Value of Revitalization Landscapes Through the Integration of Ecological Economics* Spatial Information Group subcontract to Systems Research and Applications Corporation. Prepared for the US EPA, OSWER (Contract 68-W-01-058).

11. BIBLIOGRAPHY

Other helpful resources not cited in this document include the following:

NRDAR Regulations, 43 CFR Part 11 (http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=3213c039b1728fb0d5e35ea4883facbb&tpl=/ecfrbrowse/Title43/43cfr11_main_02.tpl)

The Society for Ecological Restoration (SER, http://www.ser.org)

National Oceanic and Atmospheric Agency

- Damage Assessment Remediation and Restoration Program
- Related Documents: Technical Papers - Library - DARP
- Related Documents - Cooperative Assessment Process (CAP) - Partnerships - DARP
- Laws and Regulations/Legal Documents: Referenced Laws, Regulations, and Agreements - Library - DARP
- CPRD IMS Sites Related Documents - Cooperative Assessment Process (CAP) - Partnerships - DARP
- NOAA Office of Response & Restoration

Department Of Interior

- NRDA Process (http://www.doi.gov/oepc/response/a13.htm)
- NRDA Training Module (http://www.doi.gov/oepc/response/a00.htm)

Environmental Protection Agency

- Natural Resource Damages, NRD, Superfund, US EPA (http://www.epa.gov/superfund/programs/nrd/index.htm)
- NRD-Related Publications, NRD, Superfund, US EPA (http://www.epa.gov/superfund/programs/nrd/nrd_info.htm)
- EPA Workshop - Introduction to Ecological Restoration: Integrating Ecological Mitigation Measures and Ecological Enhancements into Remedial Activities at Contaminated Sites [US

EPA Mid-Atlantic]
(http://www.epa.gov/reg3hwmd/risk/eco/restoration/workshops/intro_eco_rest.htm)

United States Coast Guard

- National Pollution Funds Center
- Natural Resource Damage Claims

Appendix A

Acronyms

ACRONYMS

ARAR	applicable or relevant and appropriate requirement
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
EE/CA	engineering evaluation/cost analysis
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
FISRWG	Federal Interagency Stream Restoration Working Group
FS	feasibility study
HEA	habitat equivalency analysis
HH&E	human health and the environment
IC	institutional control
ITRC	Interstate Technology and Regulatory Council
NCP	National Contingency Plan
NEBA	net environmental benefit analysis
NGO	nongovernmental organization
NPL	National Priority List
NPV	net present value
NRDA	natural resource damage assessment
NRDC	natural resource damage claims
NRI	natural resource injury
O&M	operations and maintenance
OERR	Office of Emergency and Remedial Response
OSWER	Office of Solid Waste and Emergency Response
PRP	potentially responsible party
QA/QC	quality assurance/quality control
RAFLU	reasonably anticipated future land use
RCRA	Resource Conservation and Recovery Act
RFI	remedial field investigation
RI	remedial investigation
ROD	Record of Decision
STGWG	State and Tribal Government Working Group
USACE	U.S. Army Corps of Engineers
WHC	Wildlife Habitat Council

Appendix B

Glossary

GLOSSARY

amenities. Ecological features, traits, or characteristics that add to the physical or material comfort of human societies.

benefits. A good, service, or attribute of a good or service that promotes or enhances the well being of an individual, an organization, or a natural system.

bioremediation. Biological decontamination of soil, water, or other environmental media.

damage assessment. An accounting of the magnitude, physical extent, and types of damage suffered by an ecosystem.

ecological capital. Stock of ecological goods and facilities devoted to providing ecosystem services.

enhancement. Any improvement of a structural or functional attribute, or "increase in one or more values of all or a portion of an existing wetland by man's activities, often with the accompanying decline in other wetland values" (Lewis 1990).

ecosystem services. Valuable functions ecosystems provide free of charge to human societies, including maintenance of atmospheric gases; regulation of the hydrologic cycle; provision of potable water, fertile soil, wood, fish, and other consumable products; processing of wastes; pollination of crops; and the genetic library from which people have domesticated crops and are now designing new foodstuffs.

hydric soils. Soils that are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions in the upper portion. Developed under sufficiently wet conditions to support the presence of vegetation typical to wet areas (hydrophytic vegetation).

mitigation. Actions taken to avoid, reduce, or compensate for the effects of environmental damage, including activities that restore, enhance, create, or replace damaged ecosystems.

no net loss. A policy by which the total amount of some habitat type is not decreased though individual units may change.

phytoremediation. The use of plants for biological decontamination.

reclamation. Putting a natural resource to a new or altered use.

rehabilitation. Improvements to a natural resource that return it to a good condition but not the condition prior to disturbance. Also, "replacing selected original attributes of particular value to humans... or putting a natural resource to a new or greatly-altered use to serve human purposes." (Cairns, John, Jr. 1991. "The status of the theoretical and applied science of restoration ecology". *The Environmental Professional* 13 (3) p 187.)

restoration. Return of an ecosystem to a close approximation of its condition prior to disturbance.

service capacity. The ability to produce jobs, housing, environmental habitat, mineral resources, agricultural goods, and other societal values.

APPENDIX C

Case Studies

CASE STUDIES

C.1 NEW BEGINNINGS - THE WOODLAWN WILDLIFE AREA (PORT DEPOSIT, CECIL COUNTY, MARYLAND)

C.1.1 Site Description

The property lies in a mostly rural setting north of Baltimore in Cecil County, Maryland, and is surrounded by rapidly expanding residential development in a formerly agricultural area. Its history of industrial use began in the 1950s, when the 37-acre site was used as a sand and gravel quarry. During the 1960s and 1970s, it was used to dispose of agricultural, municipal, and industrial wastes from the surrounding area. As with most landfills at that time, the undersurface of the landfill was not lined with an impermeable barrier, enabling infiltration of contamination from the landfill waste into groundwater. Consequently, EPA placed the site on the NPL in 1987. A thorough environmental investigation was undertaken to identify existing and potential future impacts to groundwater, soil, surface water, or air quality from landfill wastes, and to select a restoration strategy. Vinyl chloride detected in the groundwater was attributed to waste materials disposed in the landfill by Bridgestone Americas Holding, Inc. (formerly Firestone) while the landfill was in operation. The company took responsibility for managing the site and purchased an adjoining 58-acre property to better enable site access to complete the study while establishing monitoring wells to track possible groundwater contamination. It is this portion of the property that has become a focal point for wildlife habitat enhancement, as well as providing natural resource education to the surrounding community.

C.1.2 Site Reuse Description

Since the site was documented not to pose a threat to human health, wildlife, or the environment, Bridgestone Americas Holding, Inc. explored the possibility of returning the land to the community and partnered with the WHC in 1997 to develop a sustainable wildlife conservation area. Since January 2000, WHC and Bridgestone Americas Holding, Inc. have collaborated extensively with local community members, youth groups, schools, extension services and local conservation groups. Together, these groups have worked toward a common vision for both the landfill and adjacent areas—restoring and conserving high wildlife habitat value and providing environmental education opportunities.

C.1.3 Stakeholder Involvement

In addition to the stakeholder collaboration required to enable consensus for an amended ROD, Bridgestone Americas Holding, Inc. and the WHC together provide supervision of this managed habitat and community education center. Management of wildlife habitat at New Beginnings is facilitated through community volunteerism in Cecil County. The Woodlawn Wildlife Team consists of representatives from Bridgestone Americas, WHC, Maryland Cooperative Extension, Fair Hill Nature Center, Cecil County Boys and Girls Club, Arcadis, several public and private schools within the county, and local bluebird expert and WHC 2001 Community Partner of the Year award winner Jerry Newman, who monitors all bird boxes installed onsite. Together, the team works to enhance habitat for native wildlife, manage the encroachment of invasive species and develop environmental education programs for students of all ages within Cecil County.

C.1.4 Site Assessment Approach and Cleanup

EPA placed the Woodlawn landfill on its NPL in 1987. Along with the various substances typically found in groundwater beneath landfill sites, the chemical vinyl chloride was also present. A typical CERCLA site investigation was completed which resulted in a typical landfill remedy: an impermeable (RCRA Subtitle C-compliant) cap and groundwater pumping to capture all flow from the site, with subsequent treatment.

The ROD was signed in 1993, after which data collected for remedial design demonstrated that naturally occurring microorganisms were utilizing the waste as a food source and naturally attenuating groundwater contamination. Upon confirmation of natural attenuation, a new plan for site cleanup was established in partnership with EPA and state and local authorities, and the ROD was amended in 1999. Instead of an impermeable landfill cap, a vegetated soil cap was created to enable rain and oxygen to infiltrate and help sustain the naturally occurring bacteria, and natural attenuation of groundwater replaced pumping and treatment. The alternative capping approach opened the door for wildlife habitat enhancements on the landfill including planting native trees, shrubs, and wildflowers around the landfill cap in an island configuration (as opposed to rows) and placing raptor perches on the landfill. Hiking trails and environmental education facilities (such as signs) are also planned for the landfill area after vegetation is well established.

C.1.5 Reuse

The former landfill and an adjacent area are part of an ongoing effort to transform the land into a thriving wildlife area and to establish a unique natural resource in Cecil County, Maryland, for community use.

C.1.6 Obstacles

The demonstration of natural attenuation was a technical challenge since it was not common at that time. This site was the first natural attenuation remedy at a landfill in EPA Region III. Reaching consensus between EPA and the state took considerable time

and effort. The natural attenuation demonstration and work to amend the ROD were undertaken under the auspices of the remedial design phase, which had specific deadlines. In order to stay compliant with the Administrative Order, two remedial designs were completed in parallel. Contingency provisions were put into the alternate design in case the remedy should fail to perform as intended.

An attempt was made to demonstrate equivalency of the soil cap with a RCRA Subtitle C cap; however it was finally determined that the site had been closed under State Subtitle D equivalent standards from an earlier date, therefore only those regulations were determined applicable.

WHC biologists reviewed the ecological conditions and setting of the site and wrote an "Opportunities Report" describing potential activities to be undertaken at the site to enhance conditions for wildlife and public participation and education. That report was included as a reference in the alternate remedial design in order to help illustrate the alternate vision for managing the site. The inclusion of WHC's recommendations was deemed helpful in convincing some more resistant regulatory personnel that the alternate remedy was in fact more beneficial than the traditional remedy. Several public meetings were held to help educate the public. The public was mostly supportive, and relatively few comments were received regarding the ROD amendment. Funding for the extra work under the design phase was problematic, since the parallel designs cost several hundred thousand dollars more than just one; however the potential cost savings from the alternate remedy justified the extra upfront expense.

C.1.7 Costs and Funding

The cost estimate from the original ROD was over $23 million, and internal company estimates were even higher (up to $50 million, due to anticipated difficulties with groundwater capture and metals treatment). The total cost of the revised remedy implementation is approximately $6 million, saving at least $17 million. In addition, the risk of cap failure is far lower (compared to the original Subtitle C cap), as are construction and overall maintenance risks and costs. All costs were paid by Bridgestone Americas Holding, Inc., of which some was recovered from other PRPs.

C.1.8 Economic and Other Incentives

New Beginnings has become part of the Maryland Department Natural Resource's (MDNR) Forest Stewardship Program, where landowners are provided assistance to manage their wooded areas. Citizens have volunteered their time, planting over 300 native trees and shrubs, including red and white oak, red maple, flowering dogwood, sumac, highbush blueberry, elderberry, and winterberry. The Forest Stewardship Program is designed to encourage landowners to "practice forest stewardship and leave the land and its resources in a better condition for future generations." WHC and Bridgestone Americas Holding, Inc. believe that the purpose of this program fits the vision of a perpetually protected and restored natural area at New Beginnings.

The MDNR plan works in union with WHC's habitat management strategy. MDNR identifies fish and wildlife habitat improvements as the plan's primary goal with outdoor recreational and educational activities as additional objectives. As with all forest stewardship plans, the New Beginnings plan is crafted for a 15-year period and will require steady monitoring and maintenance. Bridgestone Americas Holding, Inc. now saves almost $800 a year with a property tax decrease. The plan lasts for 15 years before requiring renewal, resulting in possible savings of over $11,000 over the course of the Plan (inspections are required every three years at approximately $100 each time).

As part of site O&M, Bridgestone Americas Holding, Inc. partnered with Perdue Farms, Inc. to use their "AgriRecycle" product, a slow-release, high-nutrient, and high organic content fertilizer made from chicken farming waste. This product captures value from this waste stream, while helping keep excess nutrients out of Chesapeake Bay. Because of its slow release characteristics, high nutrient value, and relative low cost, this product will enable less frequent fertilizer applications, saving thousands of dollars.

Community groups, local schools, and volunteers, with the help of WHC biologist staff, will be responsible for the success of the Forest Stewardship Program at New Beginnings. Nest box care, invasives species control, erosion repair, trail maintenance, and tree reforestation will be ongoing projects in and around the former landfill. This and many other habitat and community projects have provided tremendous positive public relations benefits for Bridgestone Americas Holding, Inc. and the local community.

The collaborative approach used at New Beginnings earned Bridgestone Americas Holding, Inc. a special certificate of recognition from EPA, distinguishing the site for continued wildlife habitat efforts, use of recycled materials, strong community involvement, and innovative cleanup technology. Barry Breen, Principal Deputy Assistant Administrator, EPA OSWER, presented the honor to Tim Bent, Director of Environmental Affairs, Bridgestone Americas Holding, Inc, during WHC's conference entitled "Restoring Greenspace: Using Ecological Enhancements on Region 2&3 Contaminated Sites."

C.1.9 Time

The landfill was closed in 1981, the site was listed in 1987, and the remedial investigation phase culminated in the ROD in 2003. The ROD was amended in 1999, and construction was completed in 2001. The original remedy implementation was estimated to take 30 years or more to complete, whereas the revised remedy is expected to be complete within 15 years of construction (it is now ahead of that schedule). The land use provisions of the remedy are permanent, through deed restrictions placed on the land to allow only conservation-related land use.

C.1.10 Other Comments

New Beginnings - The Woodlawn Wildlife Area, was named officially by a local student, Sierra Maxwell, from Perryville Middle School, in a local contest. The new name

represents the vision that many have for this site—a turnaround of the waste disposal history of the site, into a refuge for wildlife and a place to learn.

An Arbor Day celebration was hosted onsite in 2003, with 150 students from local schools participating in hands-on activities while learning about proper tree planting methods, tree care, and conservation methods for local wildlife. In 2004, Earth Day was a pivotal event with WHC highlighting the partnership of Bridgestone Americas Holding, Inc. and Perdue AgriRecycle, LLC. As part of the long-term ongoing restoration plans at the site, an organic-derived fertilizer created by Perdue AgriRecycle called Microstart60® is being used to help improve soil quality on this former landfill as an environmentally responsible alternative to traditional chemical-based fertilizers. Ramona Trovato, Senior Advisor to the Assistant Administrator, EPA OSWER, and Anthony Iacobone, Remedial Project Manager, EPA Region III, who manages the site, expressed their support and encouragement for the use of organic fertilizers. Senator Barbara Mikulski (D-MD) issued congratulatory letters to the participants of the Earth Day gathering.

The adjacent 58 acres of buffer land bordering on the former landfill is the central area for community involvement housing bat boxes and bluebird nest boxes. Presently, over 16 species of songbirds have been documented using the nest boxes. An education pavilion and separate information kiosk, built through Eagle Scout projects, serve as shelters for workshops. A three-acre wildflower and grass meadow was planted on this adjoining property with the help of the Cecil County Land Trust and a District Conservationist for Cecil County. In preparation for the meadow, invasive species were removed to allow six species of native warm-season grasses and 17 species of wildflowers to be sown along with a cover crop of oats. The meadow provides many benefits for a wide variety of wildlife including insects, mammals, songbirds, and upland game birds. In an effort to incorporate an education component while benefiting the site, local students volunteered their time to construct nature trails that wind along the site. As the vegetation matures over the landfill, additional public-use amenities such as trails and educational resources will be added, further increasing the value to the community.

Visit New Beginnings - The Woodlawn Wildlife Area on the web at:
http://www.wildlifehc.org/brownfields/woodlawn.cfm

Contact Information:
Wildlife Habitat Council
8737 Colesville Road, Suite 800
Silver Spring, Maryland 20910
www.wildlifehc.org
greenspace@wildlifehc.org
301-588-8994
301-588-4629 Fax

Timothy A. Bent
Director, Environmental Affairs

Bridgestone Americas Holding, Inc.
535 Marriott Dr.
Nashville, TN 37214
615-937-1426

C.2 NORTH SHORE WETLANDS PARK, 21ST CENTURY WATERFRONT PROJECT (CHATTANOOGA, TENNESSEE)

C.2.1 Site Description

The North Shore Wetlands Park (formerly the GE Roper Property and now Renaissance Park) is located at a 23.5-acre former industrial site on the banks of the Tennessee River across from Chattanooga's downtown business and tourism district. The site had been agricultural land prior to the mid 1900's and since has contained a manufacturing facility with 26 connected buildings and one remote building built at various times between the mid 1950's and the early 1980's. The site was owned by GE/Roper and in recent times has manufactured kitchen ranges and appliances. The site is located just west of the Market Street Bridge and Coolidge Park—an eight-acre urban park. The property abuts the Tennessee River to the south and Manufacturer's Road to the north. Railways served the parcel until 1987, connecting the site to the main line located adjacent to Manufacturer's Road. A prominent site feature is a perennial stream known as Market Street Branch, which bisects the property and flows southwestward to the Tennessee River. This stream enters the site at the northeast corner and exits at the southwest corner of the property flowing into the Tennessee River. The project is located in an urban setting. The adjacent district contains commercial and industrial uses. The residential communities of North Chattanooga begin within four blocks of the site.

Through its unique design, the park will combine ecological, historical, educational, and recreational features to meet the community's articulated vision: "create an open space that demonstrates respect for the environment and that celebrates Chattanooga's rich local heritage." The project environmental cleanup and building demolition is now completed, except for some capping to occur on site. Construction is currently underway to develop the North Shore Wetlands Park. Development is being phased with the first phase completion schedule in May 2005.

C.2.2 Site Reuse Description

C.2.2.1 Ecological Features

Created Wetland. This 1.5-acre constructed wetland will collect, clean, and release urban runoff from the 475-acre urban catchment of Northern Chattanooga. Created by the removal of solid waste (byproducts of former industrial processes on the site) from the water table and the installation of a unique system of planted landform shelves and mats

of wetland plants, the constructed wetland will improve water quality on site and beyond, and serve as both an educational and beautiful space to observe and inhabit.

Flooded Forest. The lower 13 acres of the park sit within the Tennessee river's 10- and 100-year flood plains, and are regularly inundated. Through education and restoration efforts, the park will return native flooded woodland ecologies to this area, providing habitat for native flora and fauna, and acting as an important link in the ribbon of green that continues to expand along the Tennessee River.

Regenerative Nursery. Located above the former Burner Plant, this small educational nursery will grow the native plant materials to be used in the ecological regeneration of the site's flooded forest areas. School groups will come to study native plant ecology and participate in the reforestation of the North Shore Wetlands Park.

C.2.2.2 Historical Features

Cherokee Trail. During the period of the Cherokee Removal, the Trail of Tears overland route crossed the lower portion of the North Shore Wetland Park. Today, meandering bands of paths and plantings specific to the Cherokee agricultural and medicinal practice will commemorate Cherokee presence and contributions to the community.

Meig's Allée. An allée within the forest will mark the site of the former first bridge to span the Tennessee River, providing visual access and connection from the northern half of the park all the way across to the Tennessee Aquarium and Ross' Landing on the south shore.

Bridge Blockhouse. At the head of Meig's Allée, the earthen base of the historic bridge blockhouse (1864) will be resurrected as a spot for interpretation.

Underwater Wrecks. A frothy carpet of bubbles will roil the Tennessee River over the spot where the steamboat Chattanooga finally sank in 1921, adjacent to the North Shore Wetland Park, ending the era of the steamboat

C.2.2.3 Educational Features

Outdoor Center. Located on the northern edge of the site along Manufacturer's Road, the Outdoor Center will act as the gateway to the park. It will be home to the new Outdoor Chattanooga Foundation as well as the relocated offices and activities of the Chattanooga nature center and house a café and other visitor facilities.

Amphitheater. Adjacent to the pavilion, this amphitheater built into park landforms will accommodate groups visiting the site to learn about its extensive cultural heritage and environmental richness.

Interpretive Features. Interpretive panels and small educational stations highlighting some of the historic and contemporary qualities of the site will be positioned across the park.

C.2.2.4 Recreational Features

Canoe launch. A launch with ample parking will allow locals and visitors to experience the Tennessee River by canoe and kayak.

Riverwalk. Stretching from Chickamauga Dam 22-miles to the newly designated Moccasin Bend National Park, a portion of Riverwalk will pass through the North Shore Wetlands Park.

Forest and Wetland Boardwalks. Suspended over the created wetland and slicing through the flooded forest, boardwalks both ongrade and in the air will allow for a unique vantage point as visitors travel north and south across the site.

Picnic Areas. At the southern edge of the park, along the Tennessee river and the Riverwalk, the flooded forest will peel back its canopy a bit to let light down on picnic facilities—tables, barbecue pits—and play areas designed to allow families to enjoy a day outside.

C.2.3 Stakeholder Involvement

Chattanooga today enjoys national acclaim both as a revitalized city and for the community process that transformed it, now known as "The Chattanooga Way." In 1982, Chattanooga began to awaken to its waterfront potential. City and county officials appointed a joint task force to study possibilities along the Tennessee River. The three-year community planning effort involved hundreds of meetings and thousands of people. The Tennessee Riverpark Master Plan outlined a 25-year development process for the 22-mile riverfront corridor on either side of the Tennessee river. Over 1,600 people turned out to see the Master Plan unveiled at the Convention Center in 1985.

The river continued to remain a critical component of community planning initiatives. During "Vision 2000", a 20-week series of open forums involving more than 4,000 people, citizens talked freely about the goals and ideas they had for their community as Chattanooga approached the 21st century. A key theme to emerge was "celebrate the river".

The Tennessee Riverpark Master Plan and Vision 2000 led to a $1.5 billion dollar investment in downtown and along the banks of the Tennessee River, which produced the world's largest freshwater aquarium, over 100 new shops, restaurants, attractions, and hotels, an award winning park, a restored walking bridge, and the 22-mile Tennessee Riverpark greenway. Unprecedented public/private partnership has turned the riverfront wasteland into a sparkling promenade and lush parkland.

C.2.4 Site Assessment Approach and Cleanup

The site assessment and investigation was carried out over 8 years without an end use decided. Supplemental testing was carried out over two years with the end use of a public park probable. The areas of concern were identified as general contaminated fill used to expand the industrial plant buildings up to the late 1960's, a waste settling pond capped in the earlier 1970's, and the impact of these on the groundwater.

Removal of the contamination was considered, however, the volume and varied nature of the contaminants were cost prohibitive. A design for the park was developed that integrated the remedial actions with the end use and even transformed the contaminated soil areas in to sculptured landforms. Remedial systems included a low-permeable cover over the contaminated area to prevent contact with contaminants and limit infiltration of water into the contaminated soil, and also the installation of a subdrain to prevent groundwater seeps at the base of contaminated fill embankment. A small scale phytoremediation area will be in place to supplement the subdrain and depending on water quality monitoring results the constructed wetland could potentially treat the groundwater seeps. Long-term institutional controls will be implemented by the City to restrict groundwater use and to maintain the effectiveness of the remedial systems. These remedial actions are being performed under Tennessee Department of Environment and Conservation's Voluntary State Remediation Program

C.2.5 Reuse

Chattanooga is now embarking on its next ambitious initiative, the $120 million dollar 21st Century Waterfront Plan designed to link the community even more closely to its riverfront. From concept to construction, this latest initiative is well on its way to completion in May 2005.

The concept of an urban wetland park emerged as a clear directive during the extensive public/private planning process that surrounded the development of the waterfront plan. Over the course of several months, hundreds of people met in focus groups, public meetings, and open community forums to discuss the plan. On the south shore in the downtown district, the community envisioned extensive changes along the shoreline. A combination of new elements—retail shops, galleries, restaurants, piers and boat docks, riverside condominiums, pedestrian walkways, and parkscapes—would serve to entice people to the river. Major expansions of the Tennessee Aquarium, Hunter Museum of Art, and the Creative Discovery Museum would add to the thriving tourist industry and continue to attract local residents.

On the north shore the community found the perfect spot to fulfill its desire to create more open space. The overwhelming success of nearby Coolidge Park, which opened in 1999, left people hungry for more. But this time, the public wanted a park of a different sort—a space that would visibly demonstrate the community's respect for the environment and the unique ecosystem that surrounds Chattanooga

C.2.6 Obstacles

Broad community support was not sought for this project—it was already a given. The community expected the site be made safe to enjoy and provide a positive environmental example of "returning to the river". The challenge was to achieve integration between the resulting landscape and the remedial engineering that would in the end create a park in which people would not be able to perceive the difference between the two. Finally, the remediation industry has a reputation of being very conservative and problem oriented rather than solution oriented; this mindset presented another challenge in the design process.

C.2.7 Costs and Funding

The overall Riverpark Master Plan investment in a revitalized Chattanooga since 1985 exceeds $1.5 billion dollars, with over 83% funded from private sources. Mayor Corker announced the creation of the 21st Century Waterfront Trust on May 22, 2002, and boldly declared the funds would be raised and the projects completed by May 2005 — only 36 months away. What seemed like an extraordinarily ambitious timeframe became a compelling fundraising case when donors became convinced that the fruits of their contributions would be tangible in just three years.

Sources of funding for the 21st Century Waterfront Trust

Public funds	$ 66 million*
Private funds pledged/raised to date	$ 51 million
Yet to be raised	$ 3 million
Total	$120 million

* Local government's share comes from a dedicated hotel occupancy tax, which will generate $54 million; the balance comes from state and federal sources, and land sales.

Uses of funding for the 21st Century Waterfront Trust

Public Space improvements	$ 67.4 million
Hunter Museum of American	$ 19.5 million
ArtCreative Discovery Museum	$ 30 million
Tennessee Aquarium	$ 3.1 million
Total	$120 million

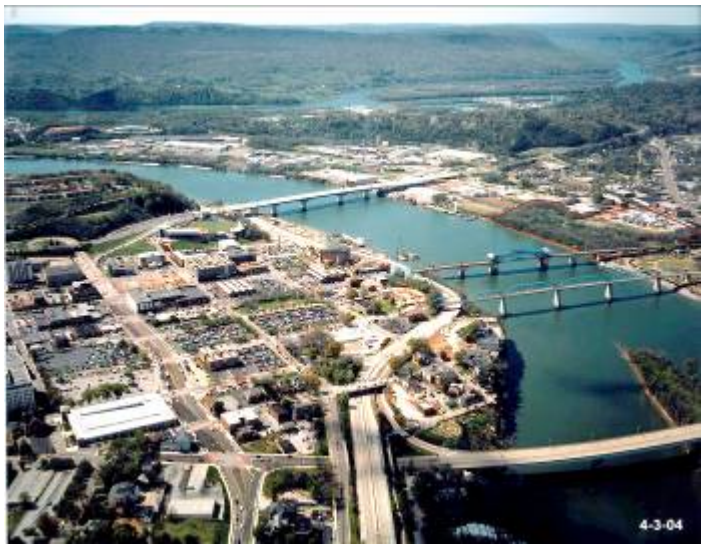
The 21st Century Plan is projected to serve as catalyst for an additional $50 million in private development along the river and downtown. The North Shore Wetlands Park is part of the Public Space Improvements budget in the above table. The park cost is $12.2 million of which $500,000 was for land purchase, $2,000,000 was for site remediation, $1,000,000 is for roads and parking, and $8,710,000 is for park construction.

C.2.8 Economic and Other Incentives

Incentives are long term and include the creation of two new development parcels and increase in adjacent property valves.

C.2.9 Time

Construction is currently underway. The park is schedule to partially open to the public in May 2005, however the evolution of the park ecosystems will occur over a much longer time span.



View of Chattanooga's waterfront project

View of Chattanooga's waterfront project

Site plan for Chattanooga's waterfront project

C.3 DOE ROCKY FLATS NATIONAL WILDLIFE REFUGE (JEFFERSON, BOULDER, AND BROOMFIELD COUNTIES, COLORADO)

C.3.1 Site Description

Rocky Flats is a 6,240-acre property located 16 miles northwest of Denver, Colorado. The site lies along the Front Range of Colorado at the interface of the Great Plains and Rocky Mountains where it supports a diverse mosaic of vegetation communities. Many areas of the Rocky Flats site have remained relatively undisturbed for the past 30 to 50 years, which has allowed for diverse natural habitat and associated wildlife. Publicly-owned open space of 50,000 acres is adjacent to the site on three sides.

The Rocky Flats site is a former nuclear defense facility operated by DOE. All weapons manufacturing was performed in a 600-acrea area in the middle of the site known as the Industrial Area. Currently, the site is managed by DOE. A 1,800-acre area in the northern half of the site is designated as the Rock Creek Reserve and is managed in accordance with the 2001 Rock Creek Reserve Integrated Natural Resources Management Plan. The DOE's National Renewable Energy Laboratory manages 280 acres dedicated to wind turbine power research. In 1992, the mission of the Rocky Flats site changed from weapons production to environmental cleanup and facility closure. The DOE is completing the cleanup in accordance with the Rocky Flats Cleanup Agreement under oversight by EPA and the Colorado Department of Public Health and Environment (CDPHE).

C.3.2 Site Reuse Description

In December 2001, the President signed the Rocky Flats National Wildlife Refuge Act to include the site as a unit of the National Wildlife Refuge System managed by the U.S. Fish & Wildlife Service (FWS). The Refuge Act provides for permanent federal ownership of the Rocky Flats and the establishment of a National Wildlife Refuge. The Act also provide for DOE retention of administrative jurisdiction over lands and facilities that are part of the remedy at Rocky Flats. The FWS has completed its Comprehensive Conservation Plan (CCP) for Refuge management. Under the Refuge Act, most of the acreage will become the Refuge following certification from the EPA that cleanup and DOE facility closure have been completed. An area consisting of about 1,500 acres in the center of the site will likely be retained by DOE for long-term cleanup and monitoring. When portions of the site become a Refuge, the FWS will assume management responsibility and ownership for those areas for a 15 year planning period. The CCP decision is to manage habitat, public use programs for environmental education, a visitor center, a hunting program, multi-use recreation trails, and wildlife migration corridors protection. The Refuge is scheduled to open in 2008.

C.3.3 Stakeholder Involvement

The DOE, its regulators, local stakeholders, and natural resource trustees have been actively discussing post closure land use at Rocky Flats since the early 1990's. In 1994, the Future Site Use Working Group, a citizen-based initiative, was convened to provide DOE with recommendations on cleanup and future land use. In 1998, the Rocky Flats Industrial Area Transition Task Force, another citizen-based group , in its report recommended that "all facilities and infrastructure be decontaminated, demolished and removed," although the task force left open the possibility of reconstructing industrial facilities at a later date.

While the FWS is completing its public outreach and planning process for the Refuge management plan, DOE continues to collaborate with environmental regulators, citizen advisory board members, public, local governments, and the FWS, for final cleanup and future long-term maintenance and monitoring plans for the industrial area and buffer lands that will require restricted access (also referred to as the DOE's industrial or retained area).

The FWS started its project scoping process with other public agencies in 2002 and executed its formal scoping period required by the National Environmental Policy Act (NEPA) for development of a CCP and Environmental Impact Statement (CCP/EIS). They published a "Notice of Intent" in the Federal Register (67 FR 54667) to notify the public of the FWS's intent to begin the CCP/EIS process, including public meetings in surrounding counties and many written outreach materials.

On 19 August 2002, the Service hosted a meeting for representatives from various state and federal agencies interested in the future management of the Rocky Flats site. Representatives from 23 separate agencies participated. Local tribal nations were notified to solicit their input for the scoping process. Also, six focus group meetings were held to convene a forum to better explore key issues and management alternatives on: recreation, environmental education, public perception/public information, remediation and contamination management, trails, and vegetation and wildlife management.

After the scoping period, the FWS developed alternatives for the CCP of the Refuge. In 2003, they held public workshops in four counties. In 2004, the FWS addressed 5,000 comments, received through public hearing testimony, letters and emails. Comments came from 251 individuals and 34 agencies or organizations; 933 people sent letters and petitions. All substantive issues raised in the comments were addressed in the Final CCP/EIS and the Record of Decision published in 2005 (http://www.rockyflats@fws.gov). Any substantive changes to the CCP or the long-term monitoring and maintenance plan during the 15-year management period will involve a public involvement process. Routinely, both DOE and FWS will provide the public new information as it becomes available.

C.3.4 Site Assessment, Cleanup, and Long-term Care

The Rocky Flats mission includes nuclear deactivation and decommissioning, waste management and shipment, special nuclear material removal, environmental cleanup and facility closure. DOE's Office of Legacy Management will be responsible for the long-term management of lands retained by DOE, and for compliance with the long-term requirements of post closure care.

Surface soil containing greater than 50 picoCuries per gram of plutonium are now removed. Disturbed soils from the removal of buildings and remedial actions are being revegetated with native seed mixes. The DOE will enforce land use controls of subsurface soil contamination to ensure protection and preclude certain uses. Materials in the two existing landfills will be maintained with soil covers and monitoring systems, restricted public access and surrounding buffer lands. In the industrial area, passive groundwater collection and treatment systems are being used to clean up groundwater contaminated with volatile organic compounds, nitrate, and uranium; these are anticipated to remain in operation. Surface water monitoring will continue.

C.3.5 Obstacles

The FWS addressed 5,000 comments during development of the FWS's Comprehensive Conservation Plan/EIS. Controversial issues included contamination and cleanup, public use, and hunting. Concerns about existing contamination levels at the site, DOE's cleanup efforts, and the implications of these issues on all other aspects of future Refuge management overshadowed all other issues during the comment period. Particular issues of concern included whether any public use is safe and appropriate and how the Refuge would be demarcated from the DOE retained area. The FWS's ROD suggests that barbed-wire agricultural fence, signs, and permanent obelisks will effectively demarcate the interior property boundary, keep livestock out of the DOE lands, and clarify that these lands are closed to public access. Agricultural fencing will not adversely affect wildlife movement or be visually obtrusive. The final decisions and associated reuse protectiveness certifications will be decided by DOE, EPA, and CDPHE.

C.3.6 Time, Costs, and Funding

In 1992, Congress targeted Rocky Flats for shutdown. In the mid-90's, the goal was set to remove bomb-making material from the site by 2015. Early forecasts estimated that Rocky Flats cleanup and closure would take 60 years and cost $37 billion dollars. The Rocky Flats facility closure schedule is 2006, with a total cost of $7 billion dollars.

C.3.7 Contact Information

DOE's Rocky Flats Office web site:
https://www.rfets.gov/eddie/

FWS Rocky Flats National Wildlife Refuge web site:

http://rockyflats.fws.gov/

DOE's Office of Legacy Management Rocky Flats web link:
http://www.gjo.doe.gov/LM/sites/maps/co/rocky_flats/rocky.htm

Tish O'Conor
Office of Legacy Management
letitia.o'conor@hq.doe.gov
202-586-6570

C.4 FERNALD CASE STUDY, SOUTHWEST OHIO

C.4.1 Site Description

The Fernald site formerly produced uranium metal for the DOE nuclear weapons complex. It is currently listed on the NPL and is undergoing CERCLA remediation. The site covers 1000 acres, and the entire site will undergo natural resource restoration following remediation.

C.4.2 Site Reuse Description

The end use is designated as an educational Park focusing on site history and ecology. Restoration is well integrated with remediation by taking advantage of postexcavation topography to determine the habitat type. Deep excavation and stormwater retention basins are readily converted to ponds and wetlands. Excavations into subsoil are being converted to native grasslands due to their ability to compete well on low nutrient soils. The federally listed endangered Indiana Bat has been documented onsite and restorations are intended to improve that habitat. Infiltration basins are being developed adjacent to wetlands to aid in groundwater remediation (i.e. natural injection wells). The decision to implement restoration on the site was and combination of public participation and the state of Ohio NRD claim

C.4.3 Stakeholder Involvement

A 30 day public comment period will be held on two separate documents. One of the documents is the NRRP. The second document for public comment is DOE's Environmental Assessment for Proposed Final Land Use (EA). This NEPA document presented DOE's preferred final land use for the Fernald site. The preferred alternative is natural resource restoration for the majority of the site with the exception of 115 acres occupied by the On-Site Disposal Facility and 23 acres for potential commercial development. The public comment period on both the NRRP and the EA ended October 20, 1998.

C.4.4 Site Assessment Approach and Cleanup

The cleanup is being performed under CERCLA. Examples of past impacts include releases of contaminants to Paddy's Run and the Great Miami Aquifer. Future impacts are based upon planned remedial actions. An example of a future impact is the removal of trees and habitat associated with the Southern Waste Unit excavation. The information contained in the impact assessment was used in a model (habitat equivalency analysis) to provide an estimate of the required restoration actions. The estimate was then used in conjunction with planned remedial actions to develop the restoration plan.

C.4.5 Reuse

The end use of the site is an educational park focusing on site history and ecology. The NRRP provides conceptual restoration plans for the post remediation landscape at Fernald. It maximizes the benefits of existing natural features such as the Paddy's Run stream corridor and forested wetlands. Additionally, the plan accounts for the postexcavation surface which includes many deep holes and large areas stripped of topsoil. The NRRP focuses on the use of native plants to develop habitats representative of those historically expected in southwestern Ohio. The plan also includes a ground water education component yet to be determined.

C.4.6 Restoration Plan

The restoration plan for the site includes the following actions and elements:

- expand Paddy's Run corridor
- reforestation and enhancements
- open water habitat with connecting wetland systems
- native prairie grasslands and savannas
- aesthetic barriers
- ground water project

C.4.7 Other Comments

Further information is available at:
http://offo2.epa.state.oh.us/FERNALD/Restoration/restoration.htm

Contact Information:
Thomas A. Schneider
Office of Federal Facility Oversight
Ohio EPA
T 937-285-6466
F 937-285-6404
http://offo2,epa.state.oh.us
tom.scheider@epa.state.oh.us

C.5 NET ENVIRONMENTAL BENEFITS ANALYSIS

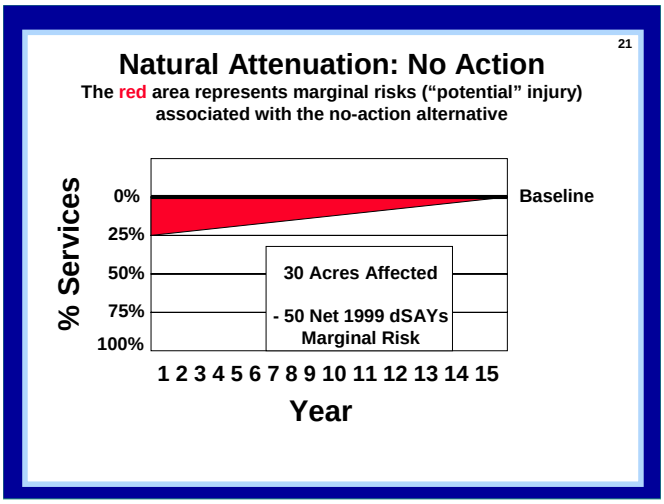
In a northeast state, a NEBA was conducted to convince regulators (EPA and the state) that a remedial action of dredging part of an estuary would provide little or no ecological benefits. The NEBA-supported strategy allowed a coupling of natural attenuation with a restoration option to replace any potential lost services due to the uncertainty embodied within the risk assessment. The costs from the proposed dredging action were 20 times as great as the NEBA-led action.

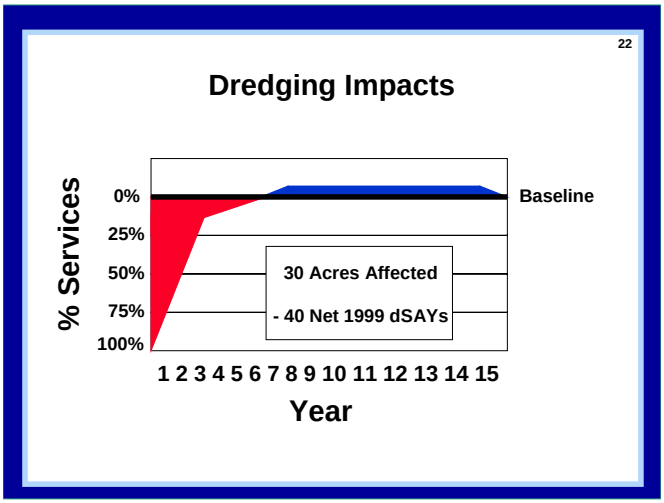
Using information collected from the ecological risk assessment, as well as site characterization studies, a depiction of the potential service losses over time and their recovery to baseline was made. The preferred remedial action by the regulators was to dredge a significant volume of sediments. The NEBA was used to demonstrate and provide an argument for natural attenuation. The regulators, however, were concerned about marginal risks ("potential" injury) that could occur during the interim of the natural attenuation process.

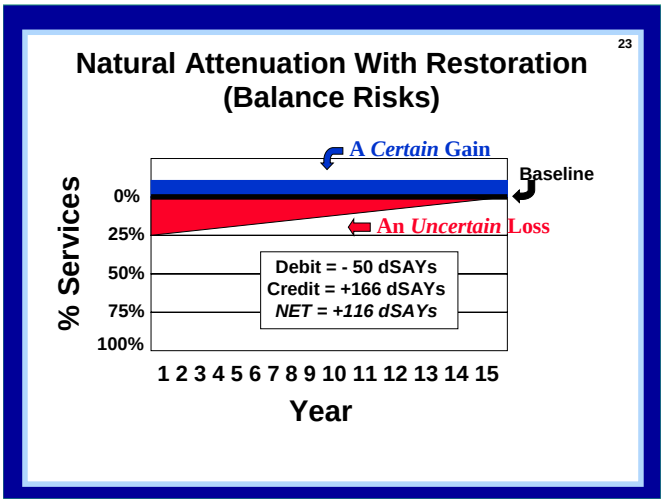
It was demonstrated that although there was a very high likelihood of "no unacceptable risks" present, there was potentially some uncertainty regarding those marginal risks. The agreed upon solution was to propose a restoration action (preservation of habitat) that delivered sediment services with certainty to offset those potentially uncertain lost sediment services. For this case, natural attenuation with restoration was the selected dominant strategy in terms of both environmental benefits and costs. Graphics and a summary table depicting the three alternative actions are presented below:

Responsible Party:	Large chemical company
Location:	Long Island Sound, Connecticut
Example Provided By:	Mark Rockel, CH2M HILL
Action:	State CERCLA with Agreed Order
Case Background:	Site was former trap and skeet range. Lead shot contamination in uplands, intertidal, and subtidal areas. Client had soil washed uplands and intertidal. AO stipulated dredging over 16 acres of subtidal.
Equivalency Valuation:	Evaluated environmental tradeoffs of three remedial actions using habitat equivalency analysis (HEA) within Net Environmental Benefits Analysis framework.
Define Outcome:	Upland land appraised value was $500K. Responsible party negotiated land exchange to city in lieu of intensive remediation and received a covenant not-to-sue for natural resource damages.

Further information regarding the NEBA approach and process can be obtained from Joseph Nicolette (jnicolette@ELMLLC.com, 770-517-9154)


21
Natural Attenuation: No Action
The red area represents marginal risks ("potential" injury) associated with the no-action alternative
% Services
0%
25%
50%
75%
100%
Baseline
30 Acres Affected
- 50 Net 1999 dSAYs
Marginal Risk
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Year


22
Dredging Impacts
% Services
0%
25%
50%
75%
100%
Baseline
30 Acres Affected
- 40 Net 1999 dSAYs
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Year


23
Natural Attenuation With Restoration (Balance Risks)
A Certain Gain
Baseline
An Uncertain Loss
% Services
0%
25%
50%
75%
100%
Debit = - 50 dSAYs
Credit = +166 dSAYs
NET = +116 dSAYs
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Year

NEBA Table

Remedial Action	Cost ($)	Net Envir. Benefit
Dredging	16 M $	-50 dSAYs +10 dSAYs Net -40 dSAYs
Natural Attenuation	0.5 M $	-50 dSAYs
Natural Attenuation With Restoration	1.0 M $	-50 dSAYs +166 dSAYs Net +116 dSAYs

Appendix D

Nongovernmental Organizations involved in Ecological Restoration

ORGANIZATIONS INVOLVED IN ECOLOGICAL RESTORATION

D.1 NONGOVERNMENTAL

NGOs or local nonprofit organizations can offer many avenues for continued development of habitat programs and opportunities to link local restoration efforts with national programs in site remediation and restoration. Collaborative partnerships with conservation groups, industry organizations, and federal agencies offer a commitment to land stewardship. Partnerships with conservation organizations have many advantages, including leveraging resources, providing technical guidance and rewarding incentives for environmental innovation. One example is the WHC, a nonprofit, nonlobbying organization dedicated to increasing the quality and amount of wildlife habitat on corporate, private, and public lands. WHC devotes its resources to building partnerships with corporations and conservation groups to create solutions that balance the demands of economic growth with the requirements of a healthy, ecologically diverse, and sustainable environment.

NGOs and nonprofit organizations can also provide third-party credibility and an objective evaluation of projects. WHC, for example, offers a Corporate Wildlife Habitat Certification/International Accreditation Program, which is designed to provide recognition to corporate entities for the successful implementation of substantial wildlife habitat management programs. Sites that demonstrate a long-term commitment to managing habitat for wildlife are bestowed with WHC certification in recognition of such efforts.

Examples of national NGOs that can provide services in ecological restoration include the following:

Wildlife Habitat Council
8737 Colesville Road, Suite 800
Silver Spring, MD USA 20910
(301) 588-8994
(301) 588-4629 FAX
E-mail: greenspace@wildlifehc.org
http://www.wildlifehc.org/brownfield_restoration/

The Nature Conservancy
4245 North Fairfax Drive, Suite 100
Arlington, VA 22203-1606
(800) 628-6860
(703) 841-4850
www.tnc.org

Wildlands Project
P.O. Box 455
Richmond, VT 05477
(802) 434-4077
(802) 434-5980 FAX
www.wildlandsproject.org
Reed Noss, Chief Scientist

Audubon International
46 Rarick Road
Selkirk, NY 12158
(518) 767-9051
(518) 767-9076 FAX
www.audubonintl.org
Kevin Fletcher, Programs Director

Ducks Unlimited

One Waterfowl Way
Memphis, TN 38120
(800) 45-DUCKS
(901) 758-3825
www.ducks.org
Bruce D.J. Batt, Ph.D., Chief Biologist

Revitalization Institute
99 Canal Center Plaza,
Suite 300
Alexandria, VA 22314
(703) 706-4780
(703) 684-0465 FAX
www.revitalizationinstitute.org
Storm Cunningham, Executive Director

Society for Ecological Restoration
285 W. 18th Street, Suite 1
Tucson, AZ 85701
(520) 622-5485
(520) 622-5491 FAX
www.ser.org
Mary Kay C. LeFevour, Executive Director

D.2 GOVERNMENT

D.2.1 United States Fish and Wildlife Service

United States Fish and Wildlife Service homepage:
http://www.fws.gov

USFWS Regional Offices:

Region 1
(Washington, Oregon, California, Nevada, Idaho, Hawaii)
Regional Director: Dave Allen
Secretary: Jackie Moseley
911 NE 11th Avenue
Portland, Oregon 97232-4181
Phone: 503-231-6118
Fax: 503-872-2716

California &Nevada Operations Office
Regional Director: Steve Thompson
Secretary: Judy Frye
2800 Cottage Way, Suite W2606
Sacramento, California 95825
Phone: 916-414-6464
Fax: 916-414-6486

Region 2
(New Mexico, Arizona, Oklahoma, Texas)
Regional Director: Dale Hall
Secretary: Donna Shoemaker
P.O. Box 1306
Albuquerque, New Mexico 87103
Phone: 505-248-6282
Fax: 505-248-6910

Region 3
(Minnesota, Indiana, Missouri, Michigan, Wisconsin, Ohio, Illinois, Iowa)
Regional Director: Robyn Thorson
Secretary: Pat Jelinek
Federal Building, 1 Federal Drive
Fort Snelling, Minnesota 55111
Phone: 612-713-5301
Fax: 612-713-5284

Region 4
(Kentucky, Arkansas, Tennessee, North Carolina, South Carolina, Georgia, Alabama, Mississippi, Louisiana, Florida, Virgin Islands, Puerto Rico)
Regional Director: Sam Hamilton
Secretary: Peggy Kendrick
1875 Century Boulevard
Atlanta, Georgia 30345
Phone: 404-679-4000
Fax: 404-679-4006

Region 5

(Virginia, West Virginia, Maryland, Pennsylvania, New York, Delaware, New Jersey, Connecticut, Maine, Massachusetts, Vermont, New Hampshire, Rhode Island)
Regional Director: Marvin Moriarty
Secretary: Tammy Hogan
300 Westgate Center Drive
Hadley, Massachusetts 01035
Phone: 413-253-8300
Fax: 413-253-8308

Region 6
(Colorado, Montana, Nebraska, Utah, Wyoming, Kansas, North Dakota, South Dakota)
Regional Director: Ralph Morgenweck
Secretary: Debbie Schreiner
P.O. Box 25486
Denver, Colorado 80025
Phone: 303-236-7920
Fax: 303-236-8295

Region 7
(Alaska)
Regional Director: Rowan Gould
Secretary: Tauline Davis
1011 East Tudor Road
Anchorage, Alaska 99503
Phone: 907-786-3542
Fax: 907-786-3306

D.2.2 Endangered Species Contacts

Washington, D.C. Office
U.S. Fish and Wildlife Service
Endangered Species Program
4401 N. Fairfax Drive, Room 420
Arlington, VA 22203
http://endangered.fws.gov

Pacific Region—Region One
Chief, Division of Endangered Species
U.S. Fish and Wildlife Service
Eastside Federal Complex
911 N.E. 11th Ave.
Portland, OR 97232-4181
http://pacific.fws.gov/ecoservices/

Southwest Region—Region Two
Chief, Division of Endangered Species
U.S. Fish and Wildlife Service
P.O. Box 1306
Albuquerque, NM 87103
http://ifw2es.fws.gov/EndangeredSpecies

Midwest Region—Region Three
Chief, Ecological Services Operations
U.S. Fish and Wildlife Service
Bisphop Henry Federal Building
One Federal Drive
Ft. Snelling, MN 55111-4056
http://midwest.fws.gov/endangered

Southeast Region—Region Four
Chief, Division of Endangered Species
U.S. Fish and Wildlife Service
1875 Century Blvd., Suite 200
Atlanta, GA 30345
http://southeast.fws.gov/es/T&E%20Species.htm

Northeast Region—Region Five
Chief, Division of Endangered Species
U.S. Fish and Wildlife Service
300 Westgate Center Drive
Hadley, MA 01035
http://northeast.fws.gov/Endangered

Mountain-Prairie Region—Region Six
Regional Coordinator, Endangered Species Program
U.S. Fish and Wildlife Service
Lakewood, CO 80225
http://mountain-prairie.fws.gov/endspp/

Alaska Region—Region Seven
Endangered Species Coordinator
U.S. Fish and Wildlife Service
Division of Endangered Species
1011 E. Tudor Rd.
Anchorage, AK 99503
http://alaska.fws.gov/fisheries/endangered/

D.2.3 Partners for Fish and Wildlife Program

The mission of the U.S. Fish and Wildlife Service is, by working with others, to conserve, protect, and enhance fish and wildlife and their habitats for the continuing benefit of the American people. Since 1987, the Service's Partners for Fish and Wildlife program helps accomplish this mission by offering technical and financial assistance to private (non-federal) landowners to voluntarily restore wetlands and other fish and wildlife habitats on their land (http://partner.fws.gov)

Region 1
Region 1 Coordinator
Marilynn Friley
911 North East 11th Avenue
Portland, OR 97232-4181
503-231-6154
FAX: 503-231-2050

Region 1 State Coordinators
California
Debra Schlafmann
(Asst: Dan Strait)
2800 Cottage Way
W-2610
Sacramento, CA 95825
916-414-6446
FAX: 916-414-6462

Hawaii (and Pacific Islands)
Benton Pang
300 Ala Moana Blvd.
Rm. 3122
Honolulu, HI 96813
808-541-3441
FAX: 808-541-3470

Idaho (Southwest and Eastern)
Dennis Mackey
1387 South Vinnell Way, Suite 368
Boise, ID 83709
208-378-5267
FAX: 208-378-5262
Idaho (Northern Five Counties)
Juliet Barenti (see Eastern Washington)

Nevada
Laurie Sada or Bridget Nielson
1340 Financial Boulevard
Suite 234
Reno, NV 89502
775-861-6300
FAX: 775-861-6301

Oregon
Amy Horstman
2600 S.E. 98th Avenue
Suite 100
Portland, OR 97266
503-231-6179
FAX: 503-231-6195

Washington (Eastern)
Juliet Barenti or Kathleen Fulmer
11103 East Montgomery #2
Spokane, WA 99206
509-891-8005
FAX: 509-891-6748

Washington (Western)
Paco Rodriguez
510 Desmond Dr.
Suite 102
Lacey, WA 98503-1273
360-753-9440
FAX: 360-753-9008

Region 2 - Southwest Region (AZ, NM,OK, TX)

Region 2 Coordinator
Mike McCollum
711 Stadium Drive E
Suite 252
Arlington, TX 76011
817-277-1100
FAX: 817-277-9057

Region 2 State Coordinators
Arizona
Marty Jakle
2321 W. Royal Palm Rd.,
Suite 103
Phoenix, AZ 85021-4951
602-242-0210 (x213)
FAX: 602-242-2513

New Mexico
Nancy Derey
2105 Osuna NE
Albuquerque, NM 87113
505-761-4707 (x4707)
FAX: 505-346-2542

Oklahoma
Jontie Aldrich
Ken C. Williams
222 South Houston,
Suite A
Tulsa, OK 74127
918-581-7458
FAX: 918-581-7467

Texas
Don Wilhelm
711 Stadium Drive
Suite 252
Arlington, TX 76011
817-277-1100
FAX: 817-277-1129

Region 3 - Great Lakes, Big Rivers
(IL, IN, IA, MI, MN, MO, OH, WI)

Region 3 Coordinator
Greg Brown
1 Federal Drive, Federal Building
Fort Snelling, MN 55111-4056
612-713-5475
FAX: 612-713-5287

Region 3 - State Coordinators
Illinois
Wayne Fischer
4469 48th Avenue Court
Rock Island, IL 61201
309-793-5800 (x518)
FAX: 309-793-5804

Illinois (greater Chicago area)
Mike Redmer
1250 South Grove, Suite 103
Barrington, IL 60010
847-381-2253 (x216)
FAX: 847-381-2285

Indiana
Jeffrey Kiefer
620 South Walker
Bloomington, IN 47403-2121
812-334-4261 (x212)
FAX: 812-334-4273

Iowa
Jim Munson
Neal Smith NWR
PO Box 399
Prairie City, IA 50228
515-994-3400
FAX: 515-994-3459

Michigan
Jim Hudgins
2651 Coolidge Road
East Lansing, MI 48823
517-351-4230
FAX: 517-351-5419

Minnesota
Lori Woff (acting)
Federal Building

720 Mall Germain St.
St. Cloud, MN 56301
320-253-4682
FAX: 320-253-0710

Missouri
Kelly Srigley-Werner
101 Park DeVille Drive, Suite A
Columbia, MO 65203
573-234-2132 (x112)
FAX: 573-234-2181

Ohio
Vacant
Contact Region 3's
Regional Coordinator

Wisconsin
Jim Ruwaldt
4511 Helgensen Drive
Madison, WI 53718-6747
608-221-1206 (x14)
FAX: 608-221-1357

Region 4 - Southeast Region
(AL, AR, FL, GA, KY, LA, MS, NC, SC, TN)

Region 4 Coordinator
Ronnie Haynes
1875 Century Blvd.
Atlanta, GA 30345
404-679-7138
FAX: 404-679-7081

Region 4 - State Coordinators

Alabama
Randy Roach
2001 Eaat Plaza Office Plaza
P.O. Box Drawer 1190
Daphne, AL 36526
334-441-5181
FAX: 334-441-6222

Arkansas (primary contact)
Melvin Tobin
1500 Museum Road, Suite 105
Conway, AR 72032
501-513-4473
FAX: 501-513-4480

Arkansas (alternate contact)
Thomas L. Edwards
WHM-AR
110 Industrial St.
Hazen, AR 72064
870-255-3812
FAX: 870-255-3784

Florida (north FL)
Jay Herrington
6620 South Point Drive S.
Suite 310
Jacksonville, FL 32216
904-232-2580 (x120)
FAX: 904-232-2404

Florida (south FL)
Kathy O'Reilly-Doyle
Florida Panther NWR
3860 Tollgate Blvd.
Suite 300
Naples, FL 34114
941-353-8442 (x232)
FAX: 941-353-8640

Florida Panhandle
Chris Metcalf
Panama City Fisheries Office
1601 Balboa Avenue
Panama City, FL 32405
850-769-0552
FAX: 850-763-2177
Georgia
Robert Brooks
4270 Norwich Street Extension
Brunswick, GA 31520-2523
912-265-9336 (x25)
FAX: 912-265-1061

Kentucky
J. Brent Harrel
3761 Georgetown Rd.
Frankfort, KY 40601
502-695-0468
FAX: 502-695-0468

Louisiana (primary contact - see also 2nd MS entry)
Andy Dolan
646 Cajundome Blvd.
Suite 400
Lafayette, LA 70506
337-291-3119
FAX: 337-291-3139

Mississippi
Dan Seay
Bob Strader
Calvin Lunceford
6578 Dogwood View Pkwy
Jackson, MS 39213
601-321-1138 (Dan)
601-965-4903 (Bob)
601-321-1133 (Calvin)
FAX: 601-321-4340 (Dan and Calvin)
FAX:601-965-4010 (Bob)

North Carolina
John Ann Shearer
551-F Pylon Drive
P.O. Box 33726
Raleigh, NC 27636-3726
919-856-4520 (x17)
FAX: 919-856-4556

Puerto Rico/Caribbean Ecosystem
Leopoldo Miranda
P.O. Box 491
Boqueron, PR 00622
787-851-7297
FAX: 787-851-7440

South Carolina
Joe Cockrell
176 Croghan Spur Road
Suite 200
Charleston, SC 29407
843-727-4707 (x17)
FAX: 843-727-4218

Tennessee
Bradley Bingham
446 Neal St.
Cookeville, TN 38501
931-528-6481 (x205)
FAX: 931-528-7075
Region 5 - Northeast Region
(CT, DE, MA, MD, ME, NH, NJ, NY, PA, RI, VA, VT, WV)

Region 5
Region 5 Coordinator
Steve Hill
300 Westgate Center Drive
Hadley, MA 01035-9589
413-253-8614
FAX: 413-253-8482

Region 5 - State Coordinators
Connecticut
Bill Kolodnicki
Stewart B. McKinney NWR
P.O. Box 1030
Westbrook, CT 06498
860-399-2513
FAX : 860-399-2515

Delaware
Al Rizzo
177 Admiral Cochrane Dr.
Annapolis, MD 21401
410-573-4500
FAX: 410-269-0832

Maine
Ron Joseph
1033 South Main St.
Old Town, ME 04468
(207) 827-5938 (x15)
FAX: 207-827-6099

Maryland
Al Rizzo
177 Admiral Cochrane Dr.
Annapolis, MD 21401
410-573-4500
FAX: 410-269-0832

Massachusetts
William Neidermyer
70 Commercial Street
Concord, NH 03301-5087
603-223-2541
FAX: 603-223-0104

New Hampshire
William Neidermyer
70 Commercial Street
Concord, NH 03301-5087
603-223-2541
FAX: 603-223-0104

New Jersey
Eric Schrading
927 North Main Street, Building D
Pleasantville, NJ 08232
609-646-9310
FAX: 609-646-1456

New York
Carl Schwartz
3817 Luker Road
Cortland, NY 13045
607-753-9334
FAX: 607-753-9699

Pennsylvania
David Putnam
315 South Allan Street, Suite 322
State College, PA 16801
814-234-4090 (x236)
FAX: 814-234-0748

Rhode Island
Greg Mannesto
Ninigret NWR
Shoreline Plaza / Route 1A, P.O. Box 307
Charlestown, RI 02813
401-364-9124
FAX: 401-364-0170

Vermont
Eric Derleth
11 Lincoln Street
Door 7
Essex Junction, VT 05452
802-872-0629 (x13)
FAX: 802-872-9704

Virginia
Bridgett Costanzo
6669 Short Lane
Gloucester, VA 23061
804-693-6694 (x125)
FAX: 804-693-9032

West Virginia
John Schmidt
694 Beverly Pike
Elkins, WV 26241
304-636-6586
FAX:304-636-7824

Region 6 - Mountain-Prairie Region
(CO, KS, MT, NE, ND, SD, UT, WY)

Region Six Coordinator
Lance Kuester
134 Union Boulevard
P.O. Box 25486
Denver Federal Center
Denver, CO 80225
303-236-8145 (x 605)
FAX: 303-236-4792

Region 6 - State Coordinators

Colorado
Bill Noonan
755 Parfet St, Suite 361
Lakewood, CO 80215
303-275-2435

FAX: 303-275-2371

Kansas
Damien Miller
315 Houston, Suite E
Manhattan, KS 66502
785-539-3474 (x107)
FAX: 785-539-8567

Montana
Jim Stutzman
Benton Lake NWR
922 Bootlegger Trail
Great Falls, MT 59404-6133
406-727-7400 (x24)
FAX: 406-727-7432

Nebraska
Kenny Dinan
203 W. 2nd Street
Federal Building, 2nd Floor
Grand Island, NE 68801
308-382-6468 (x13)
FAX: 308-384-8835

North Dakota
Kevin Willis
3425 Miriam Avenue
Bismarck, ND 58501-7926
701-355-8526
FAX: 701-355-8533

South Dakota
Kurt Forman (acting)
520 B Third Ave. N.
P.O. Box 247
Brookings, SD 57006
605-697-2500
FAX: 605-697-2505

Utah
Al Trout / Karl Fleming
58 South 950 West
Brigham City, UT 84302-3362
435-723-5887 (x*822)
FAX: 435-723-8873

Wyoming
Mark J. Hogan
170 North 1st Street
Lander, WY 82520
307-332-8719
FAX: 307-332-9857Region 7 - Alaska Region
Region 7 Coordinator
Michael Roy
1011 East Tudor Road
Anchorage, AK 99503
907-786-3925
FAX: 907-786-3350

D.3 JOINT VENTURES PROGRAM

Joint Ventures Coordinators

Charles Baxter, Coordinator
Seth Mott, Assistant Coordinator
Lower Mississippi Joint Venture Office
U.S. Fish and Wildlife Service
2524 South Frontage Road, Suite C
Vicksburg, Mississippi 39180-5269
Phone: (601) 634-1708
Fax: (601) 636-9541

Jim Cole, Coordinator
Intermountain West Joint Venture
2369 West Orton Circle, Suite 50
West Valley City, Utah 84119
Phone: (801) 975-3330
Fax: (801) 975-3331

Dick Dyer, Coordinator
Atlantic Coast Joint Venture
Lower Great Lakes-St. Lawrence Basin
Joint Venture
300 Westgate Center Drive
Hadley, Massachusetts 01035-8200
Phone: (413) 253-8553
Fax: (413) 253-8480

Greg Esslinger, Coordinator
Gulf Coast Joint Venture
U.S. Fish and Wildlife Service
P.O. Box 1306
Albuquerque, New Mexico 87103
Phone: (505) 248-6876
Fax: (505) 248-6803

Jim Leach, Coordinator
Upper Mississippi River and
Great Lakes Region Joint Venture
U.S. Fish and Wildlife Service
Fort Snelling, Minnesota 55111
Phone: (612) 725-3313
Fax: (612) 725-3013
Alt. Fax: (ARD) (612) 725-1755

Carol Lively, Coordinator
Prairie Pothole Joint Venture
U.S. Fish and Wildlife Service
P.O. Box 25486, Denver Federal Center
Denver, Colorado 80225
Phone: (303) 236-8145, x689
Fax: (303) 236-8680

Steve Moran, Coordinator
Rainwater Basin Joint Venture
1233 N. Webb Road, Suite 100
Grand Island, Nebraska 68803-1333
Phone: (308) 385-6465
Fax: (308) 385-6469

David G. Paullin, Coordinator
Central Valley Habitat Joint Venture
Suite 275, 2233 Watt Avenue
Sacramento, California 95825-0509
Phone: (916) 979-2085
Fax: (916) 979-2092

Carey Smith, Coordinator
Pacific Coast Habitat Joint Venture
Eastside Federal Complex
911 N.E. 11th Avenue
Portland, Oregon 97232-4181
Phone: (503) 231-6171
Fax: (503) 231-6116

Kathy Wood, Coordinator
Playa Lakes Joint Venture
U.S. Fish and Wildlife Service
P.O. Box 1306
Albuquerque, New Mexico 87103
Phone: (505) 248-6877
Fax: (505) 248-6803

D.4 USFWS Division of Environmental Quality Links

Region 1
Pacific Region (California, Idaho, Nevada, Oregon, Washington, Hawaii and the Pacific Islands)
Environmental Contaminants:
Prevention, Investigation & Monitoring:
http://pacific.fws.gov/ecoservices/envicon/pim/default.htm
Natural Resource Damage Assessment:
http://pacific.fws.gov/ecoservices/envicon/nrda/default.htm

Region 2
Southwest (Arizona, New Mexico, Oklahoma and Texas)
Environmental Contaminants Home Page:
http://ifw2es.fws.gov/contaminants/

Environmental Contaminants Hot Links:
http://ifw2es.fws.gov/contaminants/links.cfm

Environmental Contaminants Literature References:
http://ifw2es.fws.gov/contaminants/references.cfm
Environmental Contaminants Publications:
http://ifw2es.fws.gov/Library/ListDocs.cfm?Topic=Environmental+Contaminants&Section=Contaminants

Region 3
Great Lakes/Big Rivers (Illinois, Indiana, Iowa, Michigan, Missouri, Minnesota, Ohio and Wisconsin)

Environmental Contaminants Site:
http://midwest.fws.gov/nrda/nrda.html

Region 5
Northeast (Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia and West Virginia)
Chesapeake Bay Field Office Environmental Contaminants Site:
http://www.fws.gov/r5cbfo/envcont.htm
Maine ES Field Office Environmental Contaminants Page:
http://mainecontaminants.fws.gov
New York ES Field Office Environmental Contaminants Page:
http://nyfo.fws.gov/ec/ecdesc.htm

Region 6
Mountain/Prairie Region (Colorado, Kansas, Montana, North Dakota, Nebraska, South Dakota, Utah and Wyoming)
Environmental Contaminants Home Page:
http://www.r6.fws.gov/contaminants/
Contaminants Issues in the Region:
http://www.r6.fws.gov/contaminants/Ec-issue.htm
Bibliography of Publications:
http://www.r6.fws.gov/contaminants/papers/r6ecpubs.htm

Region 7 (Alaska)
Environmental Contaminants Site:
http://alaska.fws.gov/fisheries/contaminants/index.htm
Email: batinfo@batcon.org
Web: http://www.batcon.org

I

Bat Conservation International
P.O. Box 162603
Austin, TX 78716
Phone: (512) 327-9721
Fax: (512) 327-9724

Boy Scouts of America
http://www.scouting.org/nav/enter.jsp?s=xx&c=lc

Girl Scouts of the USA
http://www.girlscouts.org/councilfinder/

Land Trust Alliance
1331 H Street NW, Suite 400
Washington, DC 20005-4734
Phone: (202)-638-4725
Fax: (202)-638-4730
Email: lta@lta.org
Web: http://www.lta.org

Organization for Bat Conservation
39221 Woodward Avenue
Bloomfield Hills, MI 48303
Phone: (248) 645-3232
Email: obcbats@aol.com
Web: http://www.batconservation.org

Purple Martin Conservation Association
Edinboro University of Pennsylvania
Edinboro, PA 16444
Phone: (814) 734-4420
Fax: (814) 734-5803
Email: pmca@edinboro.edu
Web: http://www.purplemartin.org

Bird Conservation Directory
Includes contact info and program info for Partners in Flight, North American Bird Conservation Initiative (NABCI), Joint Ventures and many other bird groups.
http://www.abcbirds.org/directory/directory.htm

The North American Butterfly Association (NABA)
http://www.naba.org/

Online Directory of Conservation District Officials
http://www.nacdnet.org/directory/index.htm

On-line River and Conservation Directory (helps find local conservation groups)
http://www.rivernetwork.org/library/libnetdirsearch.cfm

State Association of Conservation Districts
http://www.nacdnet.org/resources/cdsonweb.html

Society for Ecological Restoration

The Society for Ecological Restoration International is a non-profit organization infused with the energy of 2300 members—individuals and organizations who are actively engaged in ecologically-sensitive repair and management of ecosystems through an unusually broad array of experience, knowledge sets, and cultural perspectives. They are scientists, planners, administrators, ecological consultants, first peoples, landscape architects, philosophers, teachers, engineers, natural areas managers, writers, growers, community activists, and volunteers, among others. The Society does not itself engage in restoration projects; its mission is "to promote ecological restoration as a means of sustaining the diversity of life on Earth and reestablishing an ecologically healthy relationship between nature and culture."

International Office
1955 W. Grant Rd. #150
Tucson, AZ 85745
(520) 622-5485
info@ser.org, http://www.ser.org

Appendix E

State Survey

STATE SURVEY

Respondent	Affiliation	Telephone	E-mail
Dom DeAngelis	Exxon Mobil Corporation	703-846-6123	dom.deangelis@exxonmobil.com
Lucinda Jackson	ChevronTexaco	510-242-1047	luaj@ ChevronTexaco.com
Jody Kershaw	Illinois Environmental Protection Agency (IEPA)	217-524-3285	jody.kershaw@epa.state.il.us
Tom Harris	Louisiana Department of Environmental Quality (LDEQ)	225-219-3421	tom.harris@la.gov
David S. Jewett	Herrington Lake Conservation League, Inc.	859-748-0299	dsjewett@aol.com
David Tsao	Atlantic Richfield Company (a BP-affiliated company)	630-836-7169	tsaodt@bp.com
Frances Klahr	Missouri Department of Natural Resources	573-522-1347	frances.klahr@dnr.mo.gov

Question	Response	Number of Responses
5. Please specify your job affiliation.		
	Regulator	3
	Facility Owner	1
	Facility Operator	0
	Facility Owner/Operator	2
	Stakeholder	1
	Consultant	1
	Academic	0
	Natural Resource Damage Coordinator	1
6. Other affiliation than those from above		
	Natural Resource Damage Coordinator	
7. Please describe your job responsibility, including area of regulatory expertise or practice and science or engineering responsibilities.		
	Project Manager for financial and technical management of ExxonMobil-related Superfund (CERCLA) sites, within the XOM Remediation, Superfund Group, including funding and cleanup of sites.	
	Manage environmental remediation and restoration for oil and gas operations worldwide.	
	Project Manager in the Bureau of Land Division of Remediation. Oversee cleanup of hazardous substances at sites not addressed by another Federal or State cleanup program.	
	Supervisor, Toxicological Services Section Human Health and Ecological Risk Assessments.	
	Primarily involved in fundraising and administration of citizen led coalition involved in lake and associated watershed cleanup, pollution abatement and habitat enhancement projects.	
	Responsible for applying the best environmental technologies at remediation sites. Specialist in phytotechnologies/wetlands.	

Question	Response	Number of Responses
8. Does your organization have a regarding achieving unrestricted use as part of a remedial/corrective action?		
	Policy	2
	Guidance	0
	Regulation	1
	Supplemental Environmental Policy (SEP)	0
	Other written documentation	0
	none	5
9. Does your organization have a [See Dropdown List] regarding ecological land reuse as part of remedial/corrective actions?		
	Policy	2
	Guidance	1
	Regulation	0
	SEP	0
	Other written documentation	0
	none	5
10. Does your organization integrate actions to support or supplement ecological land reuse into remedial/corrective action final remedy selections? For example; supporting a wildfile habitat over a capped feature or remediated site.		
	Yes	5
	No	2
11. Does your organization have a policy, guidance, regulation, SEP, or business practice that may preclude ecological reuse of the land following remediation?		
	Yes	1
	No	6
12. If you answered Yes to question 11, please explain the policy or business practice.		
	35 Illinois Administrative Code (IAC) Part 742 Tiered Approach to Corrective Action Objectives (TACO). These regulations are procedures for developing risk-based remediation objectives. These objectives are based on risks to humans through exposure and by	

Question	Response	Number of Responses
13. Has your organization designated ecological land reuse as part of remedial/corrective actions?		
	Yes	4
	No	3
14. If you answered Yes to question 13, please explain how ecological land reuse has been used in past remedial/corrective actions within your organization (please provide citation or location where a copy can be obtained).		
	1) Engineered wetlands for groundwater cleanup. 2) Property grants for wildlife refuges. 3)Use of land banks to purchase wetland credits in lieu of remediation (w/ US Wetlands Service). 4) Restoration of wetlands and streams impacted by mine drainage (St	
	Bioremediation followed by restoration, phytoremediation, constructed wetlands, wetlands enhancement, native Plant restoration, habitat management	
	Corrective Action - (http://www.epa.state.il.us/land/cleanup-programs/cleanups-state-authority.html) State funded abandoned 40-acre landfill located within the IL River Section of the IL and Mississippi Rivers Sand Areas Natural Division. Dry sand prairie	
15. If you answered Yes to question 13, please specify under which regulatory authority an ecological land reuse was established.		
	RCRA	4
	CERCLA	1
	Voluntary Cleanup	0
	Solid Waste	0
	Brownfields	0
	LUST/Trust	0
	Air Quality	0
	Water Quality	0
	Other	3

Question	Response	Number of Responses
16. If you answered Other to question 15, please provide describe the regulatory authority under which ecological land reuse was established.		
	RCRA	2
	CERCLA	3
	Voluntary Cleanup	4
	Solid Waste	0
	Brownfields	0
	LUST/Trust	3
	Air Quality	0
	Water Quality	0
	Other	0
17. If you answered Yes to question 13, what was the goal for using ecological land reuse as part of the remedial/corrective action? (check all that apply)		
	Wildlife habitat	4
	Recreation	2
	Aesthetics	2
	Cost Benefit	4
	Community Good Will	3
	Other	2
18. If you answered Other to question 17, please describe why ecological land reuse was used as part of the remedial/ corrective action.		
	Other - Agency requirement for remediation of eco areas.	
	Corrective Action - Due to existence of State-endangered/threatened species at the landfill, under the IL Endangered Species Protection Act (520 ILCS 10/5.5) and Section 17 of the IL Natural Areas Preservation Act [525 ILCS 30/17], IEPA submitted a Conser	
19. If you answered Yes to question 13, what actions were used to achieve the ecological land reuse? (check all that apply)		
	Wetlands creation	4
	Woodlot management	0
	Invasive species management or removal	0
	Nesting bird boxes	0
	Recontouring	0
	Snag creation	0
	Shelter creation	0
	Anti-perching devices	0

Question	Response	Number of Responses
	Vegetative planting	0
	Other	0
20. Please provide the citation or copy and contact information associated with your answer to question 19. In addition, if you answered Other to question 19 please describe the actions that were used to achieve ecological land reuse.		
	Other - 1) Excavation and removal of contamination, with replanting of natural species (Sayreville Superfund Site, NJ). 2) Mountain recontouring and lining of streams to alleviate mine drainage (Stibnite Mine, ID).	
	Contact Lucinda Jackson for details	
	Jody Kershaw project manager for sand prairie landfill, contact info. above. Prior to construction IDNR mapped "sensitive areas" that were off-limits to any alterations due to the areas being known locations of species occurrence. The construction schedule	
	Too many. Installed feeders/guzzlers, alternative perching devices	
21. If you have not designated ecological land reuse as part of a remedial corrective action (see question 13); what are the reasons?		
	Other - 1) Excavation and removal of contamination, with replanting of natural species (Sayreville Superfund Site, NJ). 2) Mountain recontouring and lining of streams to alleviate mine drainage (Stibnite Mine, ID).	
	Contact Lucinda Jackson for details	
	Jody Kershaw project manager for sand prairie landfill, contact info. above. Prior to construction IDNR mapped "sensitive areas" that were off-limits to any alterations due to the areas being known locations of species occurrence. The construction schedule	
	Too many. Installed feeders/guzzlers, alternative perching devices	
22. If you answered Other to question 21 please explain.		
	Other - 1) Excavation and removal of contamination, with replanting of natural species (Sayreville Superfund Site, NJ). 2) Mountain recontouring and lining of streams to aleviate mine drainage (Stibnite Mine, ID).	
	Contact Lucinda Jackson for details	
	Jody Kershaw project manager for sand prairie landfill, contact info. above. Prior to construction IDNR mapped "sensitive areas" that were off-limits to any alterations due to the areas being known locations of species occurrence. The construction schedule	
	Too many. Installed feeders/guzzlers, alternative perching devices	

Question	Response	Number of Responses
23. Does your State or organization have an assessment system to qualitatively or quantitatively valuate the benefits associated with ecological land reuse.		
	Yes	2
	No	5
24. Please identify the assessment criteria your State or organization has to determine whether to accept and implement ecological land reuse in a remediation project.		
25. Please specify the location where the assessment systems or valuation criteria from questions 24 can be obtained or viewed. (Please provide the copy location, legal citation, or Website address).		
	See Federal EPA guidance documents on conducting Ecological Risk Assessments and Federal Trustee Guidelines on NRD assessments (NOAA and Fish and Wildlife Service).	
	www.ky.gov	
	See WHC	
26. What type of green or natural technologies have been used in your state or organization in past remedial or corrective action projects?		
	Wetlands	5
	In Situ Bioremediation	6
	Phytotechnologies	4
	Natural Attenuation	6
27. If you answered Other in question 26 please list or describe your other green or natural technologies.		
	Soil capping of slowly biodegradable contaminants (e.g., PCBS and metals)	
	Fungal	

Question	Response	Number of Responses
28. What reason does your organization have for not considering using green or natural technologies as part of remediation or corrective action projects?		
	1) Not cost effective 2) Contamination too high to be remediated w/ a green technique 3)Contamination required to be removed (e.g., PBCs on surface above 1ppm or subsurface at 10ppm)	
	Costs	
	We will considering using green or natural technologies as part of remediation or corrective action projects, but they are seldom proposed.	
29. For each of the following three (3) technology categories, check if barriers are driven by Regulation, Policy, Guidance, SEP or Other Business Practice, which prevents inclusion of ecological enhancements into remediation or corrective action projects.		
	Yes	4
	No	2
30. Traditional Technologies (technologies routinely accepted) cannot successfully be used for ecological land-reuse in my state or organization because barriers are driven by.		
	Regulation	2
	Policy	0
	Guidance	0
	SEP	0
	other business practices	1
31. Innovative Technologies (Technologies not routinely accepted and still being tested) cannot successfully be used for ecological land reuse in my state or organization because barriers are driven by.		
	Regulation	1
	Policy	0
	Guidance	1
	SEP	0
	other business practices	0

Question	Response	Number of Responses
32. Green Technologies (technologies using natural or biological based materials) cannot successfully be used for ecological land reuse in my state or organization because barriers are driven by.		
	Regulation	1
	Policy	0
	Guidance	1
	SEP	0
	other business practices	0
33. If you answered Other Business Practices to any of the previous three questions, please explain your answer below.		
	Cost	
34. If you found that you could not answer one of the previous questions because a yes-no or multiple choice answer did not provide your answer, please list the question number and answer below.		
	Not involved with mandated cleanups. Only limitation is raising enough money to do it.	
	Please see answer to #22. However, sites dealt with under existing state law could be handled differently, and if green technologies aren't incorporated, it could be the result of either an internal policy or budgetary constraints.	
35. Would you be interested in attending a 1 1/2 to 2 day classroom style training course on the topic of ecological land reuse as the endpoint in a remediation project?		
	Yes	3

Appendix F

ITRC Contacts, Fact Sheet, and Product List

ECOLOGICAL LAND REUSE TEAM CONTACTS

Charles Johnson, Team leader
CO Dept. of Public Health and Environment
303-692-3348
charles.johnson@state.co.us

Steve R. Hill, ITRC Program Advisor
RegTech, Inc./ITRC
208-442-4383
srhill1@mindspring.com

Ramesh Belani
PA Dept. of Environmental Quality
Department of Environmental Protection
484-250-5756
rbelani@state.pa.us

Ken Beard
PA Dept. of Environmental Quality
Dept. of Environmental Protection
717-783-9475
kbeard@state.pa.us

Greg Biddinger
ExxonMobil Biomedical Sciences, Inc
800 Bell St., Rm 4155F
Houston, Tx 77005
713-656-4978
gregory.r.biddinger@exxonmobile.com

John Chambliss
Committee to Beautify Chattanooga
423-756-7274
johnchambliss@bellsouth.net

Gregory DeCowsky
DE Dept. of Natural Resources and Environmental Control
302-395-2610
Gregory.DeCowsky@state.de.us

Mike Fitzpatrick
EPA HQ Corrective Action
Washington DC
703-308-8411
Fitzpatrick.maik@epa.gov

Gregory Fletcher
Suncor Energy (USA, Inc)
303-286-5889
gfletcher@suncor.com

Kris Geller
NJ Dept. of Environmental Protection
609-633-2318
Kris.geller@dep.state.nj.us

Charles Harman
AMEC Earth & Environmental
732-302-9500
charles.harman@amec.com

Dave Jewett
Community Stakeholder
Lexington, Kentucky
859-748-0299
dsjewett@aol.com

Lucinda Jackson
ChevronTexaco
510-242-1047
luaj@chevrontexaco.com

Raisa Marks
Wildlife Habitat Council
301-588-8994
rmarks@wildlifehc.org

Dave Mosby
US Fish and Wildlife Services
dave.mosby@fws.gov

Letitia O'Conor
U.S. DOE HQ, Legacy Management
202-586-6570
Letitia.O'Conor@hq.doe.gov

Barb Padlo
Atlantic Richfield Company
Warrenville, IL
630-836-7136
padlobi@bp.com

Roger Payne
Arkansas Department of Environmental Quality
501-682-0777
payne@adeq.state.ar.us

Steve Rock
EPA
513-569-7149
rock.steven@epa.gov

Tom Schneider
Ohio EPA
Office of Federal Facilities Oversight
937-285-6466
tom.scheider@epa.state.oh.us

Eleanor Wehner
Texas Commission on Environmental Quality
512-239-2358
ewehner@tceq.state.tx.us