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Welcome – Thanks for joining us.
ITRC's Internet-based Training Program

Planning and Promoting Ecological Reuse of Remediated Sites

ITRC Technical/Regulatory Guidance: Planning and Promoting Ecological Land Reuse of Remediated Sites

This training is co-sponsored by the EPA Office of Superfund Remediation and Technology Innovation

Presentation Overview: The design and construction of the ecological end use as an integrated component of the remediation system will realize pronounced benefits. Ecological elements considered at the inception of planning for environmental remediation at Superfund, RCRA, and Brownfield sites can be a cost effective and an efficient way to restore, create, and improve wildlife habitat or the ecological system of the site. Incorporation of ecological elements can benefit multiple stakeholders, such as regulatory agencies, the regulated community (industry), local communities, and the general public.

This training is based on the ***ITRC Technical/Regulatory Guidance: Planning and Promoting Ecological Land Reuse of Remediated Sites*** (ECO-2, 2006). The document presents a process to promote ecological land reuse activities considering natural or green technologies instead of more traditional remedies. The guidance demonstrates that natural or ecological end uses are valuable alternatives to conventional property development or redevelopment. It contains the principal decision points in a flow diagram format and discusses the practicality of applying natural or green technologies to traditional remediation processes.

Natural and green technologies have the attributes to improve the ecology of the site as long as it is coincident with the intent of the lands use and does not jeopardize the elimination or reduction of the human or environmental risk. Ecological benefits and a process for calculating their value are included in the guidance and reviewed in this training.

ITRC (Interstate Technology and Regulatory Council) www.itrcweb.org

Training Co-Sponsored by: EPA Office of Superfund Remediation and Technology Innovation (www.clu-in.org)

ITRC Course Moderator: Mary Yelken (myelken@earthlink.net)

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ITRC (www.itrcweb.org) – Shaping the Future of Regulatory Acceptance

- Host organization
- Network
  - State regulators
    - All 50 states and DC
  - Federal partners

DOE DOD EPA

  - ITRC Industry Affiliates Program
  - Academia
  - Community stakeholders
- Wide variety of topics
  - Technologies
  - Approaches
  - Contaminants
  - Sites
- Products
  - Documents
    - Technical and regulatory guidance documents
    - Technology overviews
    - Case studies
  - Training
    - Internet-based
    - Classroom

The Interstate Technology and Regulatory Council (ITRC) is a state-led coalition of regulators, industry experts, citizen stakeholders, academia and federal partners that work to achieve regulatory acceptance of environmental technologies and innovative approaches. ITRC consists of all 50 states (and the District of Columbia) that work to break down barriers and reduce compliance costs, making it easier to use new technologies and helping states maximize resources. ITRC brings together a diverse mix of environmental experts and stakeholders from both the public and private sectors to broaden and deepen technical knowledge and advance the regulatory acceptance of environmental technologies. Together, we're building the environmental community's ability to expedite quality decision making while protecting human health and the environment. With our network of organizations and individuals throughout the environmental community, ITRC is a unique catalyst for dialogue between regulators and the regulated community.

For a state to be a member of ITRC their environmental agency must designate a State Point of Contact. To find out who your State POC is check out the "contacts" section at www.itrcweb.org. Also, click on "membership" to learn how you can become a member of an ITRC Technical Team.

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ITRC Course Topics Planned for 2008 – More information at www.itrcweb.org

Popular courses from 2007

- Characterization, Design, Construction, and Monitoring of Bioreactor Landfills
- Direct Push Well Technology for Long-term Monitoring
- Evaluate, Optimize, or End Post-Closure Care at MSW Landfills
- Perchlorate: Overview of Issues, Status and Remedial Options
- Performance-based Environmental Management
- Planning & Promoting Ecological Re-use of Remediated Sites
- Protocol for Use of Five Passive Samplers
- Real-Time Measurement of Radionuclides in Soil
- Remediation Process Optimization Advanced Training
- Risk Assessment and Risk Management
- Vapor Intrusion Pathway: A Practical Guideline

New in 2008

- Bioremediation of DNAPLs
- Decontamination and Decommissioning of Radiologically-Contaminated Facilities
- Enhanced Attenuation: Chlorinated Solvents
- Phytotechnology
- Quality Consideration for Munitions Response
- Remediation Technologies for Perchlorate Contamination
- Sensors
- Survey of Munitions Response Technologies
- Understanding the Behavior of LNAPL in the Subsurface
- More in development…

More details and schedules are available from www.itrcweb.org under “Internet-based Training.”

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Planning and Promoting Ecological Reuse of Remediated Sites

Logistical Reminders

- Phone line audience
  - ✓ Keep phone on mute
  - ✓ *6 to mute, *7 to un-mute to ask question during designated periods
  - ✓ Do NOT put call on hold
- Simulcast audience
  - ✓ Use ? at the top of each slide to submit questions
- Course time = 2¼ hours

Presentation Overview

- What are ecological enhancements
- Why is end use an important consideration
- Questions and answers
- Essential design elements of ecological elements
- Benefits of ecological reuse
- The story of the economic considerations of ecological reuse
- Links to additional resources
- Your feedback
- Questions and answers

No associated notes.

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Meet the ITRC Instructors

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Charles Johnson is the Solid Waste Unit Leader at the Colorado Department of Public Health and Environment in Denver, Colorado. Charles has worked with the Hazardous Materials and Waste Management Division since 1991. He issues hazardous waste operating and post-closure permits as well as oversees corrective action site inspections and characterization, remediation, and post-closure care projects. Charles routinely presents at conferences and is an instructor for ITRC's training courses on alternative landfill technologies and ecological reuse. Charles has been active in the ITRC since 2000 serving as Colorado's ITRC Point of Contact, a DNAPLS Surfactant and Cosolvent subteam leader, and team leader for both the ITRC Alternative Landfill Technologies team and the ITRC Ecological Reuse team. Charles earned a bachelor's degree in geology from the University of Texas in Austin in 1980, a master's in geology from Texas A&M in College Station, Texas in 1983, and a master’s in civil engineering from the University of Colorado in Denver, Colorado in 2005.

Chuck Harman is a Senior Associate Ecologist with AMEC Earth & Environmental located in Somerset, New Jersey. Since 2000, Chuck has worked at AMEC specializing in natural resource related assessment and management activities, including wetlands management and ecological restorations, ecological risk assessments, and natural resource damage assessments. He is responsible for the completion of ecological risk assessment projects and wetlands evaluations at hazardous waste sites and industrial facilities around the country. He has delineated wetlands using both the 1987 and 1989 methods manuals and has designed and managed wetland restoration projects as part of remediation activities. He has designed and conducted detailed evaluations of the potential for ecological impacts to wetlands from the implementation of remedial actions, including pump and treat systems. He has evaluated wetlands and other ecological receptors at sites located in sensitive habitats. Chuck has evaluated the efficacy of constructed wetlands to remove arsenic, chromium, and copper in stormwater. Prior to AMEC, he worked for 13 years in the environmental consulting field with McLaren/Hart Environmental Engineering. Since 2001, Chuck has contributed to ITRC as a team member and instructor for ITRC's Constructed Wetlands, Mitigation Wetlands, and Ecological Reuse teams. Chuck earned a bachelor's degree in wildlife ecology from Texas A&M University in College Station, Texas in 1977 and a master's in biology from Southwest Texas State University in San Marcos, Texas in 1986. Chuck is certified as a Professional Wetland Scientist by the Society of Wetland Scientists.

Barbara Padlo is a Senior Financial Analyst located in Warrenville, Illinois and has worked for the Finance & Risk Group in the Remediation Management Function at BP since 2006. Prior to her role in Finance & Risk, she spent nine years in the Environmental Technology Development group within Remediation Management at BP, six years in Amoco Oil Company's Process Design and Economics group, and two years in Amoco Chemical Company (co-op engineer). Since 2002, she has been an active member of the ITRC Ecological Reuse team. Barb earned a bachelor's degree in chemical engineering in 1990 and a master's degree in environmental engineering in 1995 both from Illinois Institute of Technology in Chicago, Illinois.

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You Will Learn To…

- Identify regulatory flexibility and generate support for ecological land reuse
- Incorporate the concept of site service capacity into the decision making
- Ensure sound scientific and technical support for ecological land reuse practices
- Define and communicate the value of ecological land reuse
- Identify strategies for obtaining constructive and meaningful stakeholder involvement
- Recognize that ecological reuse can deliver greater value than conventional remedial design

Introduce as the key issues to be covered by the Internet-based training for the ITRC Technical/Regulatory Guidance: Planning and Promoting Ecological Land Reuse of Remediated Sites (ECO-2, 2006), available from www.itrcweb.org under "Guidance Documents" then "Ecological Enhancements."

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Key Points

- There are no regulatory barriers to using ecological endpoints
- Ecological reuse are not considered in lieu of protection of human health and the environment
- Benefits and constraints
- Incorporate site service capacity and future land use early in the remedial process
  - This is not typical
- Incorporate ecological enhancements proactively into remediation strategies
- Utilize a system to quantify the value of ecological enhancements using
  - Quantifiable parameters
  - Semi-quantifiable parameters
  - Qualitative parameters

The primary aspects for the regulators to consider as part of their concurrence process.

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Ecological Land Reuse

- Ecological enhancements
  - Habitat for plants and animals
  - While protecting human health and the environment
- Can include
  - Natural or traditional remediation technologies
  - End use restoring or increasing ecological value of the land
- Eco risk assessment vs. Eco enhancement

You will hear the team members refer to ecological and land reuse interchangeably throughout this training. This phrasing is a testament to how much progress has been made in this areas since we started on this project.

Ecological enhancement for plants and animals while still protecting human health and the environment. Discuss White Paper and Case Study: Making the Case for Ecological Enhancements (ECO-1, January 2004) and the concern with a bait and switch. This presentation is about real remediation including ecological enhancements based on sound science and technology.

White Paper and Case Study: Making the Case for Ecological Enhancements (ECO-1, January 2004) is available from www.itrcweb.org under “Guidance Documents” then “Ecological Enhancements.”

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The Technical and Regulatory Guidance Includes

- Benefits, incentives, and limitations for implementing ecological elements at environmentally impacted sites
- Case studies where the ecological elements are incorporated into the remedial design and/or end use
- Recommendations for the successful design of ecological elements at environmentally impacted properties
- Recommendations for improvements to foster greater acceptance and flexibility for the incorporation of ecological elements as components of remedial actions and end use
- Areas where additional scientific research is needed

Key concepts introduced and covered in the technical and regulatory guidance document.. We, as a group, are proponents of using ecological enhancement as part of remediation processes. We are not neutral on the subject. Certainly we recognize that ecological enhancements are not the best solution for all situations, but we can do so much more than cleaning up contaminated soil, water, and air. By working with the community early in the process, we have the opportunity the leave a positive legacy when we're finished with the remediation project.

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Programmatic Applicability

- Active sites
- Inactive sites
- CERCLA
- DOE: Radiological
- DoD: Base Closure
- RCRA
- Solid waste
- Voluntary cleanup
- Brownfields
- Mining sites
- Underground storage tank sites
- Real estate development/ redevelopment

As part of the project we evaluated which environmental and business program ecological land reuse project could be incorporated into. We initially identified that ecological enhancement had potential application on active and inactive sites. This incorporated virtually all remediation related sites, however these sites came be broken down into the following programmatic groups.

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Applications

- Ecological reuse as a final cleanup goal
  - Restore a wildlife habitat
  - Create habitat where there was not one before

Create or restore a safe, sustainable wildlife habitat as a final cleanup goal at compromised sites that once served as habitat (e.g. contaminated estuary).

Use sustainable habitat as a complement to a traditional remedy to enhance cleanup outcomes at sites that did not previously function as significant habitat (e.g. abandoned industrial land).

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

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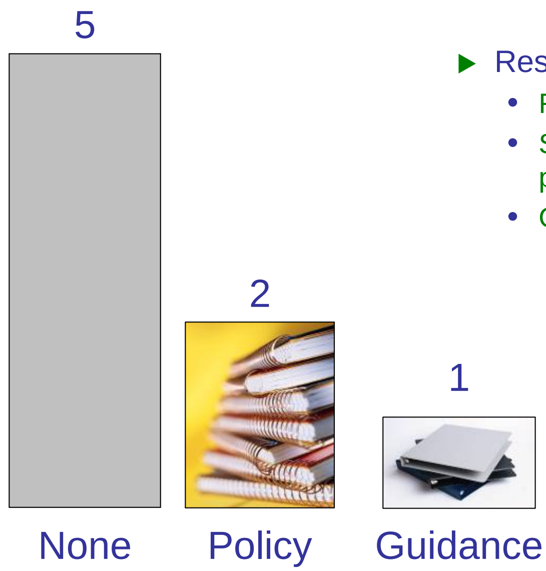
Agency Instruction for Ecological Reuse of Remedial or Corrective Action Sites



- Responses not selected
  - Regulation
  - Supplemental environmental policy (SEP)
  - Other written documentation

As part of the project, we developed a questionnaire that we sent to our participating ITRC states and all of the members on our team. I'd like to take a few minutes to go over some of the survey results.

We asked whether folks had any guidance, policy, or business practices related to the implementation of ecologic land reuse. Only 13% said they had guidance, 25% indicated they had policies, but by far and away the largest response was that they did not have any developed information related to the instruction for the implementation of ecological enhancements.

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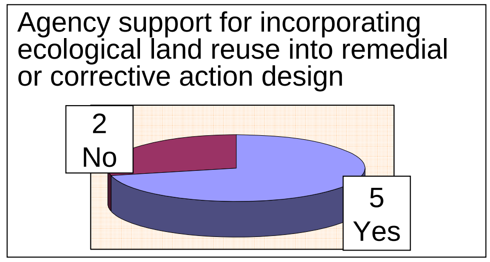
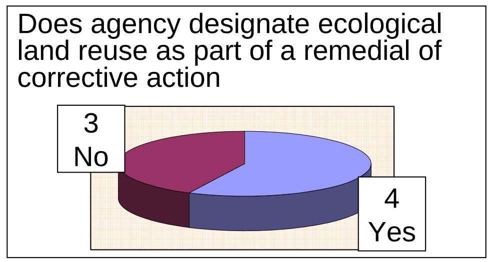
Ecological Land Reuse

- Restore ecological resources
  - Enhancing site's value
  - Maintain protection of human health and the environment
- Permanent and sustainable
- Not well accepted by regulators
- Not supported by remedial selection process





We also asked if the agency supported ecological land reuse as part of remediation project. Overwhelmingly, 71% of the responses indicated that agencies supported the use of ecological land reuse as part of remediation strategies.

In addition, 57% of the responding agencies indicated that they require or have integrated ecological land reuse into final remedies.

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Regulatory Authority Allowing Ecological Land Reuse

Voluntary Cleanup	4
LUST/Trust	3
CERCLA	3
RCRA	2

- Responses not selected
  - Air quality
  - Water quality
  - Solid waste
  - Brownfields
  - Other

We also evaluated which programs had the greatest use of ecological and reuse elements as parts of projects. Interestingly enough, as seen above, the program with the greatest percent of ecological enhancement integrated into their remedies were voluntary cleanup programs, followed by underground storage tank programs, CERCLA, and lastly RCRA subtitle C. This information indicates that we're having a number of ecological land reuse projects brought to regulatory agencies from outside development programs.

16 **Traditional Technologies Cannot Successfully Be Used for Ecological Land Reuse in Your Organization Because ...**

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Regulation

1

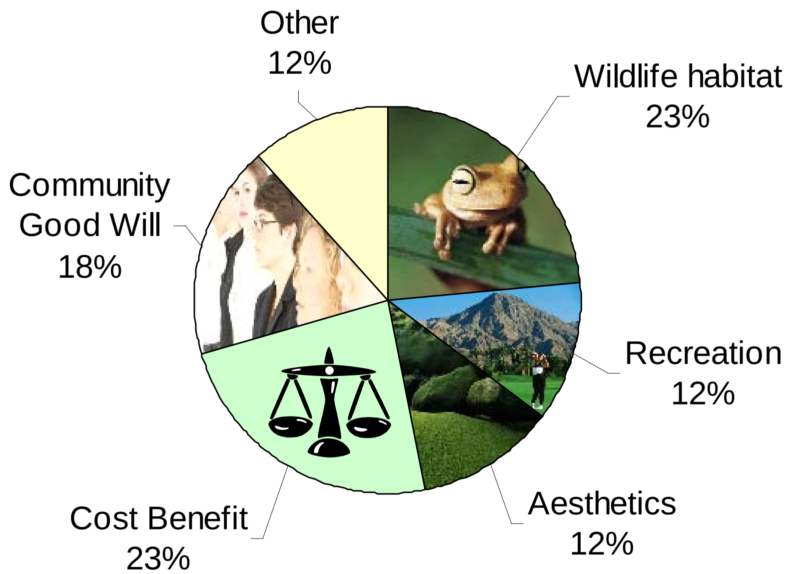
Other business practices

- Responses not selected
  - Policy
  - Guidance
  - Supplemental environmental policy (SEP)

We also wanted to ascertain what was identified as barriers to the implementation of ecological land reuse as part of remediation projects. Interestingly enough, the respondents indicated that they believe the regulations are the greatest impediment to the incorporation of ecological elements into remediation projects.

These responses taken together indicate some ironies and further support why we developed the ITRC Technical/Regulatory Guidance: Planning and Promoting Ecological Land Reuse of Remediated Sites (ECO-2, 2006). The responses indicate that as agencies we do not have adequate guidance to support and foster the use and implementation of ecological land reuse elements as elements of remediation projects. Even though we don’t have much in the way of regulations or guidance, we support the use of ecological enhancements as part of remediation projects. In fact, we have even required their inclusion in some projects. The irony of this situation is that even though we are support the use of ecological enhancements, outsiders believe the regulations are the greatest impediment to using ecological enhancements. This result also point out the need for this training.

17 What was the Goal for Using Ecological Land Reuse as Part of a Remedial or Corrective Action Project?



Discuss the various uses of ecological enhancements by category.

Elaborate on the development of community good will. This work can take soft or qualitative cost benefits and turn them into tangible cost benefits. Example: company wants to expand, works with community in the development of ecological enhancements as part of the remedy, gains community support as a good neighbor, may develop an economic advantage when trying to initiate new business locations.

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Ecological Land Reuse – Rules of Thumb

- Immediate threats to human health are removed
- Does not compromise protection of human health or cleanup goals
- Offsite migration is contained
- Provide net benefit to the region
- Sustainable without excessive maintenance
- Weigh ecological benefits vs. ecological risk
- Ecological reuse should not create a connection to risk pathways
  - Burrowing animals

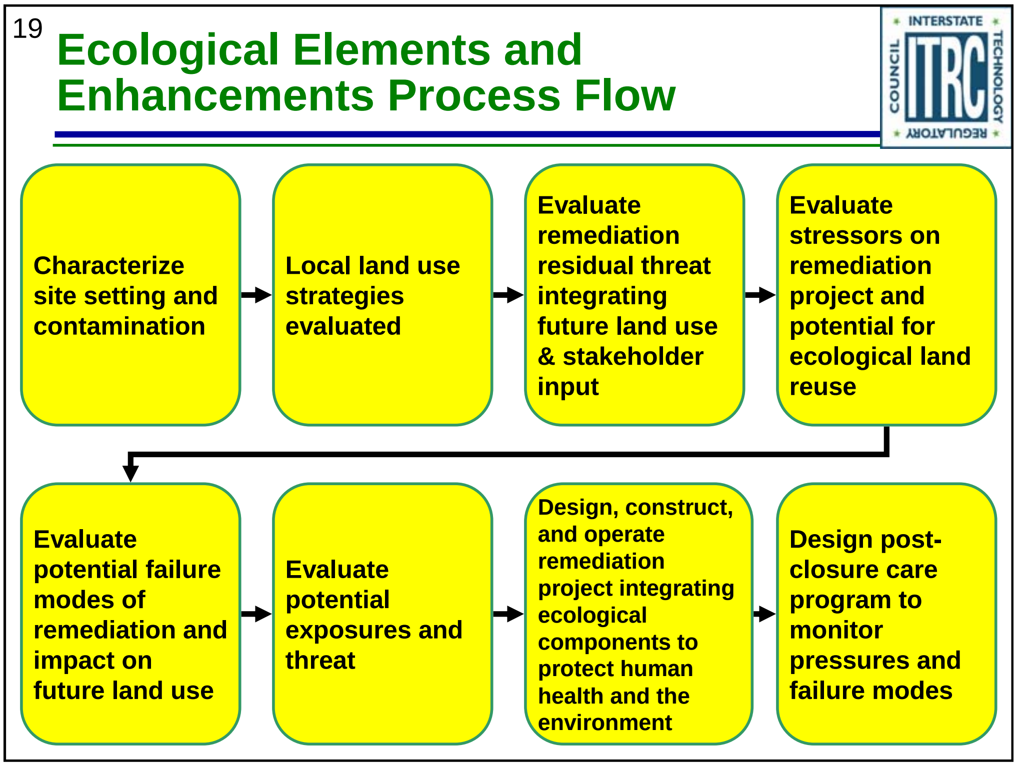
Discuss the above list.

Tie back to White Paper and Case Study: Making the Case for Ecological Enhancements (ECO-1, January 2004).

Indicate that even while integrating ecological land reuse to the remedy that real remediation is being conducted to protect human health and the environment.

Tie last bullet into the first two bullets.

White Paper and Case Study: Making the Case for Ecological Enhancements (ECO-1, January 2004) is available from www.itrcweb.org under "Guidance Documents" then "Ecological Enhancements."



This slide presents a simplified process integrating some known processes for a successful project.

1st characterization

2nd gain understanding of future land use opportunities

3rd evaluate and integrate residual remediation threat into potential future land use. Key to this process is input from stakeholders. Discuss history of RCRA C: my mess on my property, using my money, not a very strong impetuous and much fear in the exposure of going into the community and off site.

Learn to work with the stakeholder as assets of the process. Discuss Chattanooga example.

Gain an understanding of stressors, how these stressors may cause failures, and what type of threat the potential failures may present to potential future uses.

All of this process should be integrated into the post-closure care process that ties together the enhancements with the use, with the failure modes, with appropriate type of post-closure care requirements.

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Advantages: Environmental Benefits

- Attracts wildlife
- Biodegrades environmental contaminants
- Enhances natural attenuation/biodegradation remedies
- Controls sediment and erosion
- Improves groundwater recharge
- Improves environmental stability
- Provides harvestable resource
- Provides migratory bird pathways

Also:

Hydraulically controls and treats landfill leachate

Controls dust

Stream bank buffer

Uses atmospheric carbon dioxide

Minimizes environmental exposures

Provides educational opportunity

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Advantages: Economic Benefits

- Enables more efficient use of limited resources
- May generate revenue
- Cost competitive
- Provides marketing and competitive advantage
- Provides opportunity to obtain environmental offsets
- Offers tax advantages

Also:

Provides use for waste materials

Provides source of recoverable resources

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Advantages: Public Benefits

- Education
- Good will and good neighbor
- Increased reputation
- Aesthetics
- Increased natural resources

No associated notes.

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Constraints

- Regulatory acceptance
  - Lack of familiarity
- Evaluation of site-specific, unique solutions
- Allergies
- Plant use
- No readily accepted valuation system
- Remedial creativity
- Cleanup standards applicable to habitat creation can require complex analyses
- Cleanup goals for ecological protection are often more stringent than for protection of human health

As with any new and innovative technology, there are some constraints associated with the many advantages.

Discuss the lists. Most of these constraints can be overcome by reading the ITRC Technical/Regulatory Guidance: Planning and Promoting Ecological Land Reuse of Remediated Sites (ECO-2, 2006), participating in this training, and practicing the science and art of integrating ecological land reuse into remediation projects.

ITRC Technical/Regulatory Guidance: Planning and Promoting Ecological Land Reuse of Remediated Sites (ECO-2, 2006) is available from www.itrcweb.org under “Guidance Documents” then “Ecological Enhancements.”

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Hazardous Waste Regulatory Flexibility

- § 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:
- (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).

We talked previously that a large number of parties believe that the regulations themselves are an impediment to the successful implementation of ecological land reuse into remediation projects.

We looking at the RCRA subtitle C Regulations narrative closure performance standard. Please do not read all of the language, but we'll familiarize you with the pertinent information. We're looking at RCRA sub C because it not only pertains to RCRA projects, but is also an applicable or relevant and appropriate requirement (ARAR) for many CERCLA projects.

It seems that through years of remediation practice that we've gained and appreciable understanding of the threats and risks to human health, however we're not as adept at evaluating the threat and risks to the environment. We are gaining an appreciable amount of knowledge related to assessing ecological threats and how to mitigate these threats.

These regulations, as stated above, allow for the use of alternative requirements so long as they are protective of human health and the *environment* (emphasis added). Protecting and restoring the environment may and should include the use of ecological land reuse as part of the remediation strategy. In fact, the regulations, and law, require us to do so.

Therefore, the perception identified in the questionnaire that the regulation prohibit or are an impediment to incorporating ecological enhancements is not accurate. This perception should be changed and the facts of the regulations used to allow and facilitate the use of ecological enhancements as part of remediation strategies.

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Additional Federal Regulatory Flexibility

- Hazardous Waste: Corrective Action
- Solid Waste
- Brownfields
- CERCLA

Similar language allowing the flexibility to integrate ecological enhancements as part of remediation strategies were found in the statues, regulations, guidance, or policies of the regulatory programs identified above.

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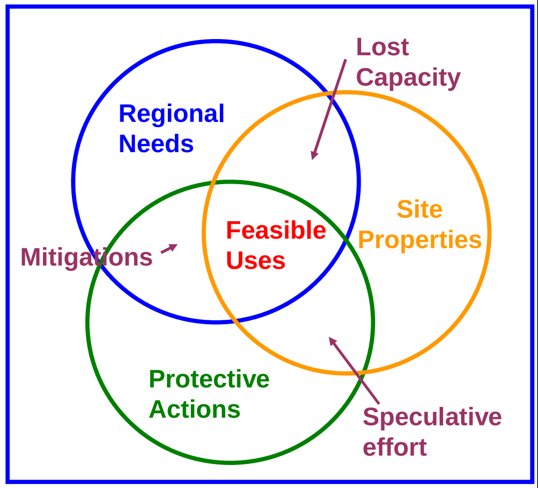
Service Capacity

- Balance
  - Regional needs
  - Site properties
  - Protective actions
- Lost capacity
  - Site's potential ecological service capacity
  - Not all capacities can be restored and remain protective
- Mitigations
  - Protective actions needed to restore site capacity
  - Perhaps capacities that cannot be restored
- Speculative efforts
  - Do not address regional needs
  - May be unnecessary



The service capacity of a site is dependent on its regional setting. A one-acre lot in downtown New York has a very different service capacity than a one acre lot in rural Napa, California.

Value to society: Site properties and its relationship to the surrounding region.

What may look useless ecologically may be a unique habitat to a certain species. Consider the ecological values and find ways to maintain those values even when the site is used for other purposes. Planning to meet human needs can be done while keeping essential attributes of natural systems intact. Don't discount the ecological values in favor of socio-physical development.

Identifying solutions to restore site ecological capacity. The best balance between regional needs, site properties, and the protective actions that will return safe feasible uses to the site.

Overlap of site properties and regional needs represent the site's potential ecological service capacity. Not all of the capacities can be restored and remain protective.

Identify the protective actions needed to restore site capacity and perhaps to mitigate those capacities that cannot be restored.

Efforts that do not address regional needs represent speculative efforts that may be unnecessary.

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Integrating Ecological Elements into the End Use

- Too many times ecological considerations are incorporated
  - As an after thought
  - Following the remediation project
- Using an integrated process to complete design and construction as a single phase
  - More pronounced benefits
  - Scale of economies
- Commercial and industrial end land uses

Too many times ecological considerations are incorporated into remediation and closure projects as an after thought, or worse, following the remediation project.

The design and construction of the ecological elements can realize more pronounced benefits in the remediation process and a scale of economies by completing the design and construction as a single phase of the integrated process.

Site development can be postponed

Mixing green-space land uses with commercial/industrial uses

Water handling and treatment facilities can be integrated into the remediation process, and can themselves be ecologically enhanced by integrating them into naturalized water systems (naturalized ponds, fountains, wetland treatment)

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Natural Remediation Technologies

- Phytoremediation
- Engineered or natural wetlands treatment
- Remediation by natural attenuation
- Enhanced in situ bioremediation

www.itrcweb.org

ITRC guidance documents are available at www.itrcweb.org under “Guidance Documents.” Information about associated Internet-based training courses is available at www.itrcweb.org under “Internet-based Training” and “Archives.”

These guidance documents and trainings are a complication of tools that can be used to facilitate and support the development of ecological land reuse elements into remediation strategies.

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Traditional vs. Green Technologies Table 5-2

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

This table provides some comparisons between categories of traditional remediation technologies and remediation technologies that can better support ecological land reuse as an end product of a remediation project.

Discuss the technologies and provide a little comparison.

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Mixed End Use Table 5-3

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 pond Rip rap, 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

This table presents examples of end uses and different remediation elements that can be used to support the previous table's remediation categories.

While not all sites are suitable for ecological end uses as discussed in the evaluation of site service capacity, it should be at least considered as an element of the remediation strategy.

Discuss the upward greening categories and the difference between the benefits/results of using ecological elements compared to the traditional elements. Again, we can do so much better than simply cleaning up the dirt, water, and air. We can give back to communities by using these ecological enhancements and provide a positive environmental legacy long after remediation has been successfully completed.

The greening of an area should tie back to the successful use of our previously defined process integrating future land use evaluation, stakeholder input, closure and remediation techniques integrating ecological land reuse into the stressors, failures, and post-closure care needs. All of this planning in turn sets up the potential options for the design phase of the project which will be addressed next.

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Questions and Answers

No associated notes.

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Basic Conceptual Approach

- Release of organic or inorganic constituents results in the loss of an ecological resource
- Remedial action addresses the constituent release and resolves threat to human health and the environment
- Unless the remedial action is the ecological enhancement, the remedial action does not restore the impacted resource to its pre-existing condition
- Ecological enhancement is initiated to
  - (1) restore the impacted resource to its pre-existing condition and/or
  - (2) increase the ecological value of other resources onsite as a means of improving the ecological service capacity of the site as a whole

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.

33

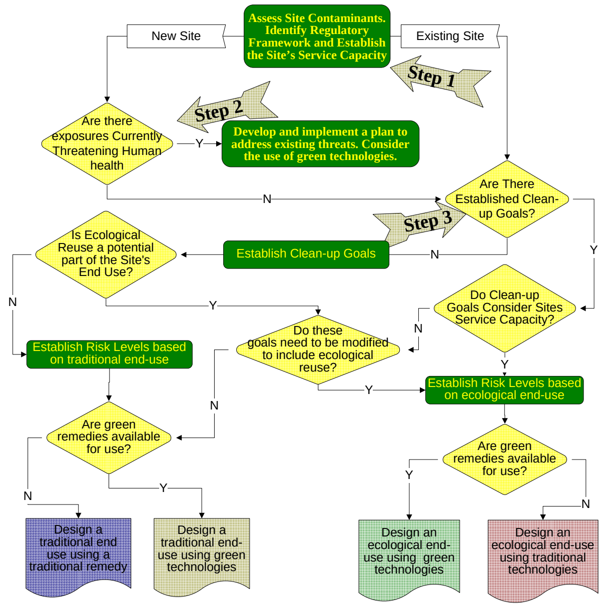
Ecological Risk Assessment vs. Ecological Restoration

- Ecological risk assessment
  - Iterative process to assess the potential for adverse ecological impacts to occur as a result of exposure of an ecological receptor to a chemical of concern
  - Usually conducted prior to engineering/remediation
  - Overall objective is to develop ecologically-based cleanup goals
  - Can be used to assess ecological impact of remedy
- Ecological restoration
  - The restoration of a previous ecosystem, including reestablishment of ecological function and communities
  - Occurs as part of or after remedial implementation
  - ERA can be used to assess the potential success of post-remedial ecological restoration

No associated notes.

34

Decision Tree (Figure 5-1)



This table is found in the ITRC Guidance document and shows the decision process to be followed leading to the design of ecological end-use projects in association with various remedial technologies. ITRC Technical/Regulatory Guidance: Planning and Promoting Ecological Land Reuse of Remediated Sites (ECO-2, 2006) is available from www.itrcweb.org under "Guidance Documents" then "Ecological Enhancements."

35

Targeted Upland Ecosystems

- Common target systems
  - Forests
  - Shrubs
  - Meadows
- Included as part of excavation or capping
- Determining factors
  - Assemblage of surrounding systems
  - Functions of desired systems
  - Local precipitation
- Can incorporate wildlife habitat enhancement techniques

Upland sites with xeric or mesic hydrologic conditions would necessitate the incorporation 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) into the ecological reuse plan. These upland resources are discussed in more detail next. Uplands impacted by significant subsidence could create an opportunity to establish wetland environments.

36

Targeted Freshwater Ecosystems

- Aquatic systems considered and evaluated based on form
- Restoration part of remedial action or conducted in conjunction with it
- Common target systems
  - Stream corridor restoration
  - Pond/lake restoration
- Can use simple habitat enhancement techniques
  - Boulders, weirs, fish passages, rock shelters
  - Fish stocking, aquatic plant installation

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.

37

Targeted Wetland Ecosystems

- One study noted that 74% of CERCLA sites in eastern U.S. were associated with wetlands
- End-use considerations can be included as part of regulatory mitigation requirements
- Types of wetlands
  - Palustrine
  - Lacustrine
  - Riverine
  - Estuarine
- ITRC Technical and Regulatory Guidance for Characterization, Design, Construction and Monitoring of Mitigation Wetlands (WTLND-2, February 2005) and associated Internet-based training available at www.itrcweb.org

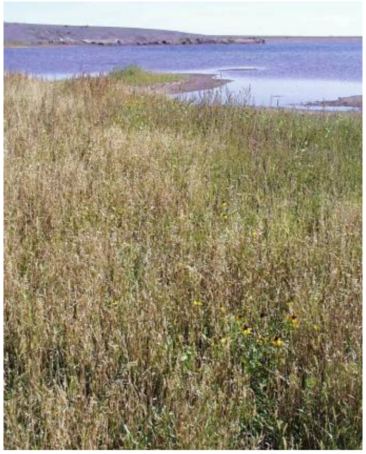
Freshwater wetland reuse can include restoration of a contaminated wetland or creation of a new wetland or enhancement of a degraded wetland. In each instance, the action to restore, create, or enhance the wetland will be based on wetland mitigation practices that are described in ITRC Technical and Regulatory Guidance for Characterization, Design, Construction and Monitoring of Mitigation Wetlands (WTLND-2, February 2005). The type (e.g., marsh, scrub/shrub, swamp, vernal pools) 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 (e.g., marsh) is the physical expression of the wetland hydrology that is present, governed by plant dispersal and establishment.

ITRC documents are available from www.itrcweb.org under “Guidance Documents.”

38

Shoreline Restoration and End Use

- Includes restoration and/or enhancement of shoreline areas
- Beach replenishment includes pumping sand through pipelines onto the beach
- Monitoring of aquatic plants, fish, and birds
- Can be done in conjunction with
  - Coastal meadow development
  - Recontouring shoreline
  - Improvement of tidal flushing
  - Stabilization of habitats



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 would then be 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 would be needed to protect aquatic plants, fish, and birds.

Choosing an Ecological End Use

- Ecological services that have been lost on a
  - Regional basis
  - Site basis
- Target end-use ecological functions
- Remedial approach to addressing onsite contamination
- Regulatory requirements for mitigation

Decision making at a site scheduled for remediation with an interest of placing the remediated property back into use requires a clear understanding of the region relative to future conditions of the property and options to remediate the contaminated site - 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 blend and complement a residential, industrial, and open space infrastructure. The ability of a remediated property to support the community and surrounding landscape requires understanding the surrounding capacity.

40

Service Capacity

- Service capacity
  - Ability to offer societal values
  - Based on
    - Properties
    - Relationship to the surrounding region
- Ecological service capacity = value to ecological users
- Ecological end use
  - Habitat for fish or wildlife usage

Service capacity is the ability of a site to offer certain societal values based on its properties and relationship to the surrounding region.

Ecological service capacity would be the value that the site offers to ecological users. Incorporating an ecological end use into the remedial action requires planning to restore or enhance the properties of the site to provide viable habitat for fish or wildlife usage.

41

Coordination with Remedial Action

- Primary goal: mitigate threat to human health and the environment
  - Determined by physical actions to meet established clean up goals
- How can the service capacity that has been impacted by contamination and the remedy be restored?
  - Net Environmental Benefit Analysis (NEBA)
  - Conducted on as part of the planning phase of the remedial action
  - Scaled to meet the needs of
    - Land owner
    - Regulatory agencies
    - Community

Transforming a degraded habitat at a site into an ecological asset may present a variety of challenges. The initiation of an ecologically based project at a site that is subject to remediation can be entail different challenges than implementing conventional remediation technologies. However, the initiation of remedial activities at a site represents a unique opportunity to leverage limited resources and achieve an improved outcome. When a remediation project is completed, then the sustainable ecological elements will have a legacy of ecological enhancements that will remain as a positive asset to the community.

A Net Environmental Benefits Analysis (NEBA), may be used to weigh the cost of various remedial options (e.g., contaminant removal, engineered controls, or institutional controls) against the environmental costs and benefits of each alternative. Using NEBA, acceptance for restoring to a non-pristine baseline can be obtained if the benefit from having some habitat value at the site outweighs the potential for adverse effects from contaminants left in place.

42

Factors Determining the Choice of an Ecological End Use

- Size of the site
  - The larger the site, the greater the likelihood of supporting 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 in close proximity of the site can effectively increase the habitat area

The ecological end-use project for a given site will depend on a variety of circumstances, not the least of which are the desires 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 will have to consider input from local, state, and possible federal regulatory agencies, as well as resource management agencies in identifying the specifics of the proposed ecological end-use project.

43

Factors Determining the Choice of an Ecological End Use (continued)

- Surrounding land uses
  - The type of land use activities surrounding the site can affect the ability of the 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

No associated notes.

44

Approaches to Ecological End Use

- Incorporate as part of green technologies
- Incorporate as part of traditional remedial technologies
- Incorporate as the remedial technology

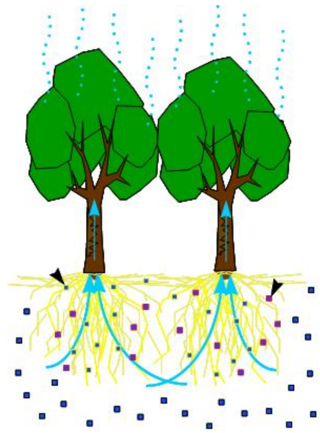


During the planning phase of a remediation program the performance of the effort should be scaled to what the owner, regulatory oversight agency, and the nearby community expects the forecasted use of the property after completion. This guidance naturally focuses on ecological end uses. Ecological end 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.

45

Design an Ecological End Use Using Green Technologies

- Green technologies
  - Use plants to
    - Draw water
    - Extract toxics
    - Assist in microbial digestion of toxics
  - Provide cover
  - In some way, aid the remedial objective while also providing habitat
- See ITRC *Phytoremediation Decision Tree* (Phyto-1, December 1999) available at www.itrcweb.org under "Guidance Documents" and "Phytotechnologies"



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 providing habitat while in use. See ITRC Phytoremediation Decision Tree (Phyto-1, December 1999) available at www.itrcweb.org under "Guidance Documents" and "Phytotechnologies."

46

Designing Ecological Land Reuse Using Traditional Remediation Technologies

- Ecological reuse is incorporated to compensate for impacts to environment at point of remediation
  - Excavation, capping, groundwater pump and treat
- Issues to be considered
  - Biodiversity
  - Scope of the ecological end-use project
- The goal is to initiate the project site along a developmental pathway that will lead, ultimately, to a self-sustaining ecosystem

There are many instances where ecological reuse or enhancements can be part of the remedial solution. One will want to involve key stakeholders in defining how the property will be used, and tailor the remedy and land use controls 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.

47

Using Principles of Biodiversity

- Using small patches of natural communities in an area will help sustain regional diversity
- Buffer zones between natural communities are important
- Full restoration of native plant communities sustains diverse wildlife populations
- The more complex the habitat, the greater the number of wildlife species
- A high diversity of plant species assures a year-round food supply
- Species survival depends on maintaining minimum population levels
- Generally, low intensity land management sustains more species and costs less than high intensity

Planners for an ecological end use at a given site should approach their project with the goal of generating a diverse ecosystem. The ability to develop the sustainability of a project will be based on understanding how an ecosystem works, the various interactions that occur between biological components, such as plants and animals, and the abiotic components, such as soil and water.

48

Planning

- Multidisciplinary team
- Define goals
- Ecological characterization (delineate the vector of the system)
- Develop a site plan
- Identification and selection of plants
- Site preparation and implementation
- Control of invasive and undesirable plants
- Long-term monitoring and maintenance

The ability of an ecological reuse project to progress along a trajectory to a sustainable state begins with proper planning of the project. The development of an ecological reuse project begins with the assembly of a multi-disciplinary team to design the project. Especially with any ecological land reuse project (e.g. wetland based), a wide assortment of experts may be needed, including remediation specialists, biologists, ecologists, horticulturists, engineers, agronomists, geologists, and soil scientists.

49

Success

- Characteristic assemblage of species
  - Pre-disturbance
  - Community structure
- Native plant species
- Outlook for continued development and stability
- Sustain an applicable reproductive population
- System functions normally
- Potential threat is eliminated
- Resilient to stress events
- Sustaining and persistent

The implementation of successful ecological elements or enhancements entails detailed planning and an understanding of the complexities of ecological restoration in coordination 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.

50

Goals and Objectives

- Goals
  - Site conditions required to be achieved by the project
- Objectives
  - Number and composition of plant species
  - Structure of vegetation
  - Functions of the community
  - Aesthetics

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. 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.

51

Characterization

- Species composition
- Community stratification
- Relative frequency, dominance, and abundance of species
- Presence of exotic, invasive, or undesirable species
- Existing fauna
- Hydrology
- Soils
- Predisturbance characteristics of the site

In the early stages of planning of the 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.

52

Site Plan

- Plans and specifications
- Schedules
- Budget
  - Site preparation
  - Installation of plants
  - Post installment activities
- Site boundaries
- Adjacent use
- Expected performance

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 post-installation 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.

53

Identification and Selection of Plants

- Types, locations and sizes of the vegetative communities
  - Individual species that make up the community
  - Plant size, available form
  - Local source
- Timing of planting
- Benefits of each species
- Planting methods
- Mulching
- Amendments
- Supplemental watering

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. ITRC Technical and Regulatory Guidance for Characterization, Design, Construction, and Monitoring of Mitigation Wetlands (WTLND-2, February 2005) and associated Internet-based training available at www.itrcweb.org.

54

Site Preparation

- Completed exactly as specified (with reasonable field flexibility)
  - Elevations
  - Grades
  - Planting material
- Site preparation
- Soil erosion and sediment control

Construction of the ecological reuse project requires great attention to detail to ensure that the project is successful. Extremely close attention must be paid to ensure that elevations, grades, and planting materials are completed exactly as shown in the mitigation plan and construction details. Some degree of flexibility does need to be maintained such that field changes can be easily introduced to address site-specific conditions that arise during construction.

55

Invasive and Undesirable Species

- Must allow ecological reuse to move along the intended trajectory
- Use manual controls or herbicides
- Contact local conservation or county extension services

- http://www.invasive.org/
- http://www.invasivespecies.gov/
- http://plants.usda.gov/

Invasive and 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.

56

Monitoring and Maintenance

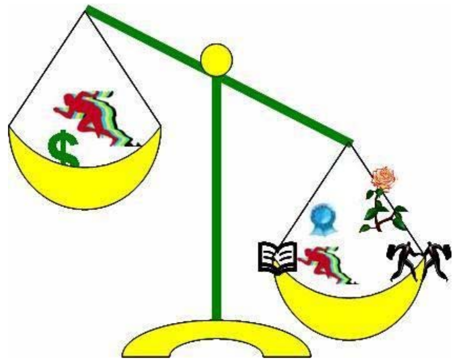
- How will performance be measured
- Based on performance standards (see step 3 in decision tree)
  - Periodicity and frequency
- Corrective measures
  - Fencing
  - Replanting
  - Predator control
  - Redesign and reconstruction

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.

57

Ecological Land Reuse Valuation

- A system to evaluate the practical aspects of ecological land reuse

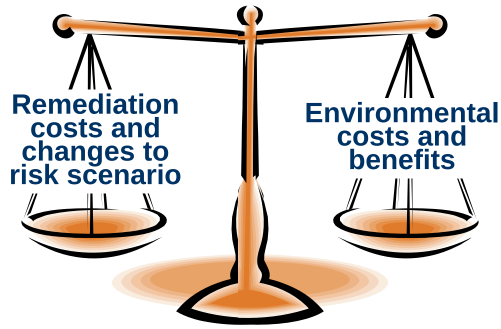


No associated notes.

58

NEBA = Net Environmental Benefits Analysis

- Effects on ecological and human use environmental service values
  - Weighs the negative and positive
  - Predicted changes in the risk scenarios and costs
- Alternatives
  - Systematic comparison
  - Ranking
- Achieves
  - Greatest net environmental benefit
  - At the lowest cost
  - While maintaining protection of human health and the environment



Weighs the cost of various remedial options (e.g., contaminant removal, engineered controls, or institutional controls) against the environmental costs and benefits of each alternative. Weighs the effect (negative and positive) on environmental service values (ecological and human use) that would be associated with the implementation of a remedial action and compares these effects to predicted changes in the risk scenario's and costs.

Allows for a systematic comparison and ranking of alternatives to achieve the greatest net environmental benefit at the lowest cost, while maintaining protection of human health and the environment.

Economic Benefits

- Cost competitive
- Provides opportunity to obtain environmental offsets
- Provides use for waste materials
- Enables more efficient use of limited resources
- May generate revenue
- Provides marketing/competitive advantage
- Provides source of recoverable resources
- Offers tax advantages

No associated notes.

60

Public Benefits

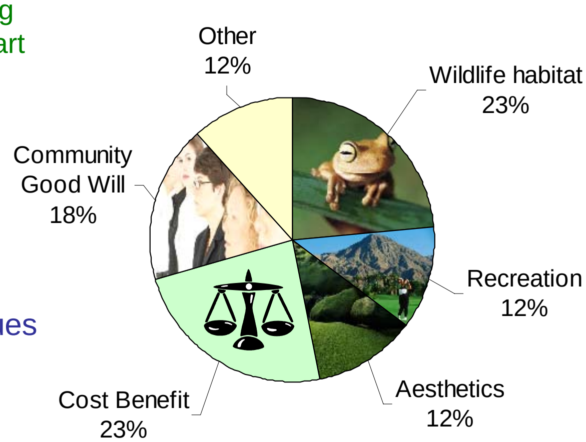
- Local conservation groups may be supportive of projects containing ecological land reuse
- Creates educational opportunity
- Improve community image
- Provide seed beds and breeding grounds for non-government organizations and non profits
- Improved public relations and corporate reputation

No associated notes.

61

Cost Considerations

What was the goal for using ecological land reuse as part of a remedial or corrective action project?

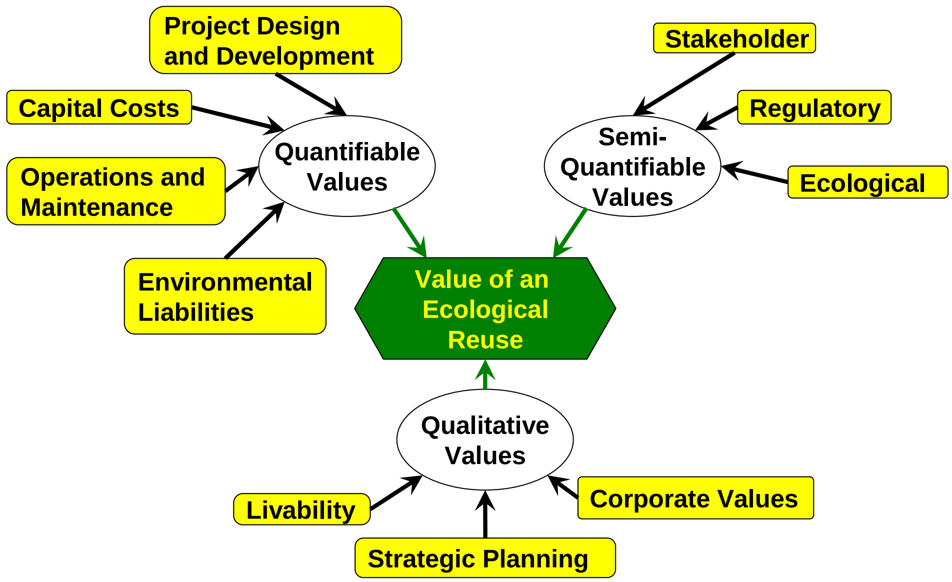


- Quantifiable Values
- Semi-Quantifiable Values
  - Use a multiplier
- Qualitative Values
  - Tell it as part of the story

No associated notes.

62

Influencing Factors



No associated notes.

63

Refinery Example

- Description
  - 2-acre open area on outer perimeter covered with grass
  - Total Petroleum Hydrocarbons (TPH) impacts 3-7 feet below ground surface
  - Costs
    - $5,000 per year for maintenance of grass area
    - Estimated $50,000 remediation will be required in approximately 10 years
- Ecological enhancement proposal for this site
  - Re-vegetate the area using native, deep-rooted prairie species
  - Costs
    - $20,000 for plant screening tests
    - $15,000 for initial planting
    - $5,000 per year for the first 3 years for re-planting
    - $5,000 per year for site maintenance
  - Potentially avoid the $50,000 remediation with increased bioremediation from deep rooted species

Refinery has a 2-acre open area on outer perimeter covered with grass. The area has Total Petroleum Hydrocarbons (TPH) impacts 3-7 feet below ground surface. Current operations includes $5,000 per year for maintenance of grass area. An estimated $50,000 remediation will be required in approximately 10 years.

Quantifiable Values

- Project design and development
  - Meet remedial goals
  - Alternative endpoints
  - Cost recovery
  - Risk / site assessment
  - Permitting and contracting
  - Security
  - Attractive nuisance
- Capital costs
  - Technology development
  - External funding
- Operation and maintenance costs
  - Monitoring
  - Reporting
  - Property tax payments
  - Project length
- Environmental liabilities
  - Future use liabilities
  - Supplemental environmental projects
  - Long-term cost liabilities

No associated notes.

65

Quantifiable Values – Applied to the Refinery Example

- Project design and development
  - Meet remedial goals
    - All alternatives must be protective of human health and the environment
  - Alternative endpoints
    - Our proposal will stimulate bioremediation, avoid $50,000 remediation in 10 years
  - Cost recovery
  - Risk / site assessment
  - Permitting and contracting
  - Security
    - This land is ultimately for reuse, no need for additional cost
  - Attractive nuisance
    - Part of monitoring
- Capital costs
  - Technology development
    - $20k
  - External funding
- Operation and maintenance costs
  - Monitoring
    - $10k/year (3 years)
    - $5k/year (7 additional years)
  - Reporting
  - Property tax payments
  - Project length
- Environmental liabilities
  - Future use liabilities
    - None/recreational
  - Supplemental environmental projects
  - Long-term cost liabilities
    - Avoid remediation in 10 years

No associated notes.

66

Refinery Example
– Evaluating Quantifiables

- Base case – leave grass area as is
  - $5,000/year maintenance
  - $50,000 remediation in 10 years
  - Net Present Value (NPV) = $71,000
- Ecological enhancement
  - $20,000 plant screening test
  - $15,000 initial planting
  - $5,000/year for 3 years re-planting
  - $5,000/year maintenance
  - Net Present Value (NPV) = $83,000
- Additional cost over 10 years for ecological enhancement
  - Delta NPV =
    - NPV ecological enhancement - NPV base case =
    - $83,000 - $71,000 = $12,000

In this example, Net Present Value (NPV) calculations used 2.5% inflation, 7% discount rate.

Semi-Quantifiable Values

- Stakeholder
  - Community engagement
  - Social mores
  - Non-government organization engagement
  - Regional needs and compatibility
  - Educational opportunity
  - Recreational opportunity
  - Avoid property condemnation
  - Corporate shareholder value
- Regulatory
  - Innovative approach
  - Reimbursement solvency
  - Relationship solvency
  - Precedence
- Ecological
  - Biodiversity benefits
  - Erosion control
  - Stormwater management
  - Conservation or mitigation
  - Greenhouse gas effects

No associated notes.

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Semi-Quantifiable Values – Applied to the Refinery Example

- Stakeholder
  - Community engagement
    - Scouts are involved
  - Social mores
    - Residents happy with new planting
  - Non-government organization engagement
    - Wildlife Habitat Council certification?
  - Regional needs and compatibility
    - Need for more recreational area
  - Educational opportunity
  - Recreational opportunity
  - Avoid property condemnation
  - Corporate shareholder value
- Regulatory
  - Innovative approach
    - Remediating before we have to
  - Reimbursement solvency
  - Relationship solvency
  - Precedence
- Ecological
  - Biodiversity benefits
    - Increased
  - Erosion control
    - Increased
  - Stormwater management
  - Conservation or mitigation
  - Greenhouse gas effects

No associated notes.

Incorporating Semi-Quantifiable Values

Use of multiplier to incorporate semi-quantifiable values in a net present value calculation

Impact	Multiplier
Low	5-20%
Moderate	20-50%
High	50-200%

Low effect, 15%

No associated notes.

70

Refinery Example
– Evaluating Semi-Quantifiables

- Base case – leave grass area as is
  - $5,750/year maintenance **($5k + 15%)**
  - $50,000 remediation in 10 years
  - New NPV = $77,000
- Ecological enhancement
  - $20,000 plant screening test
  - $15,000 initial planting
  - $5,000/year for 3 years re-planting
  - $5,000/year maintenance
  - Net Present Value (NPV) = $83,000
- Additional cost over 10 years for ecological enhancement
  - New delta NPV =
    - NPV ecological enhancement - NPV base case =
    - $83,000 - $77,000 = $6,000

In this example, Net Present Value (NPV) calculations used 2.5% inflation, 7% discount rate.

71

Qualitative Values

- Livability
  - Aesthetics
  - Noise, odor, visibility
  - Health, safety, security
  - Community character, sense of place
- Corporate values
  - Core values and policies
  - Company pride
  - Moral and ethical responsibility
  - Cultural alignment
  - Enhanced reputation
  - Employee morale
- Strategic planning
  - Public and government relations
  - License to operate
  - Sustainable legacy

No associated notes.

72

Qualitative Values – Applied to the Refinery Example

- Livability
  - ↑ Aesthetics
  - Noise, odor, visibility
  - Health, safety, security
  - ↑ Community character, sense of place
- Corporate values
  - ↑ Core values and policies
  - ↑ Company pride
  - Moral and ethical responsibility
  - Cultural alignment
  - ↑ Enhanced reputation
  - ↑ Employee morale
- Strategic planning
  - ↑ Public and government relations
  - License to operate
  - Sustainable legacy

No associated notes.

73

Refinery Example
– Evaluating Qualitatives

- Ecological enhancement
  - Negative $6,000 NPV (cost) over 10 years
- Balance
  - Qualitative benefits
  - Risk
    - Risk of the future remediation of the base case remaining at $50,000 in 10 years
    - If the future remediation is actually $60,000 in 10 years, the delta NPV would be <u>zero</u>

We have a negative $6,000 NPV (cost) over 10 years to use the ecological enhancement.

This must be balanced against the qualitative benefits identified with the ecological enhancement

Furthermore, it must be balanced against the risk of the future remediation of the base case remaining at $50,000 in 10 years.

If the future remediation is actually $60,000 in 10 years, the delta NPV for the ecological enhancement would be <u>zero</u>.

No associated notes.

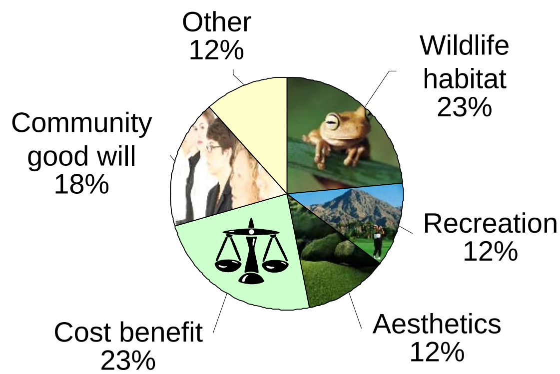
No associated notes.

76

The Story

- Consider all the elements so projects can be evaluated consistently and completely
- Establish a financial estimate for all elements and move as many as possible to the estimable category
- Following evaluation of these elements conduct a NPV (Net Present Value) analysis
- Include impact variables as a simple multiplier
- Include qualitatives as part of the story

What was the goal for using ecological land reuse as part of a remedial or corrective action project?



No associated notes.

77

Ecological Land Reuse Wrap-up

- No regulatory barriers to using ecological endpoints
- Not considered in lieu of protection of human health and the environment
- Proactively incorporate into remediation strategies
- Site service capacity improves decision making
- Scientific and technically supported practice
- Constructive and meaningful stakeholder involvement is key to establishing remediation land end use
- Greater value than conventional remedial design
- Tell the story
  - Use a system to quantify and qualify the value

There are no regulatory barriers to using ecological endpoints

Ecological reuse are not considered in lieu of protection of human health and the environment

Incorporate ecological enhancements proactively into remediation strategies

Tell the story by using a system to quantify and qualify the value of ecological enhancements

Site service capacity improves your decision making

Ecological land reuse is a scientific and technically supported practice

Constructive and meaningful stakeholder involvement is key to establishing remediation land end use

Ecological reuse can deliver greater value than conventional remedial design

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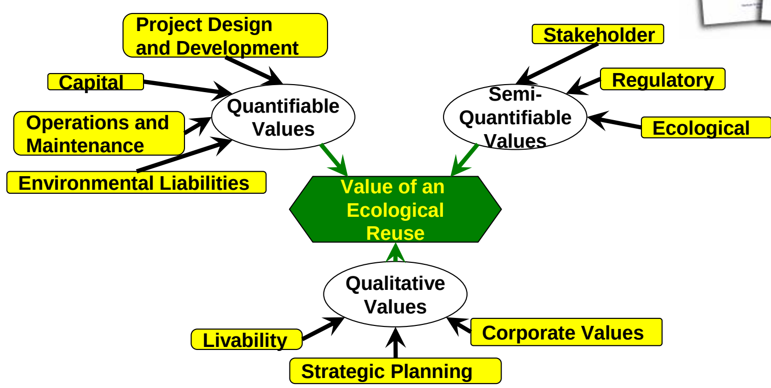
Thank You for Participating

- Links to additional resources
  - http://www.clu-in.org/conf/itrc/ecoreuse/resource.cfm
- 2nd question and answer session



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Your feedback is important – please fill out the form at:

http://www.clu-in.org/conf/itrc/ecoreuse

The benefits that ITRC offers to state regulators and technology developers, vendors, and consultants include:

✓Helping regulators build their knowledge base and raise their confidence about new environmental technologies

✓Helping regulators save time and money when evaluating environmental technologies

✓Guiding technology developers in the collection of performance data to satisfy the requirements of multiple states

✓Helping technology vendors avoid the time and expense of conducting duplicative and costly demonstrations

✓Providing a reliable network among members of the environmental community to focus on innovative environmental technologies

How you can get involved with ITRC:

✓Join an ITRC Team – with just 10% of your time you can have a positive impact on the regulatory process and acceptance of innovative technologies and approaches

✓Sponsor ITRC's technical team and other activities

✓Be an official state member by appointing a POC (State Point of Contact) to the State Engagement Team

✓Use ITRC products and attend training courses

✓Submit proposals for new technical teams and projects