Ecosystem Services Tools & Approaches to Support Remediation to Restoration to Revitalization

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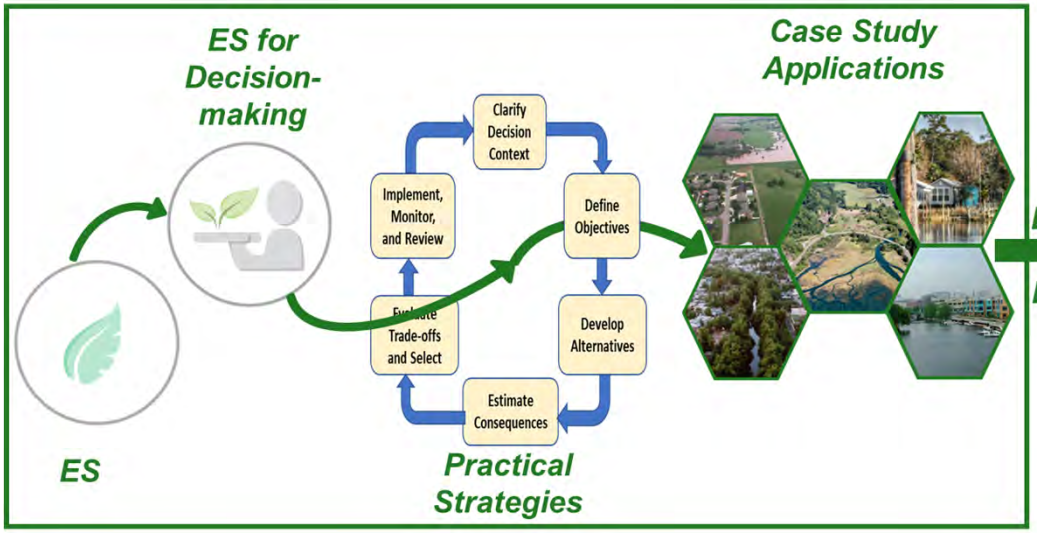
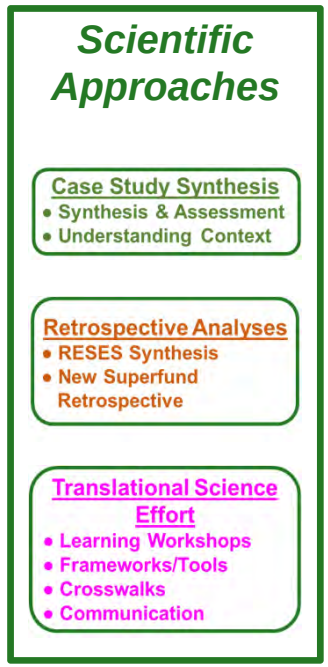
StRAP “Partner Needs”

- Approaches to create new and improved methods, data sets, and knowledge **from existing methods**
- Evidence **linking environmental conditions** of restored sites to human health and well-being
- Methods to demonstrate linkage between remediation/restoration and revitalization (R2R2R)
- Approaches to **simplify ecosystem services (ES) assessments**
- Efficiently communicating to the public how these cleanups will **benefit their communities by adding approaches** that start from community priorities/goals

The "Story Arc" for SHC 9.2



Lessons Learned

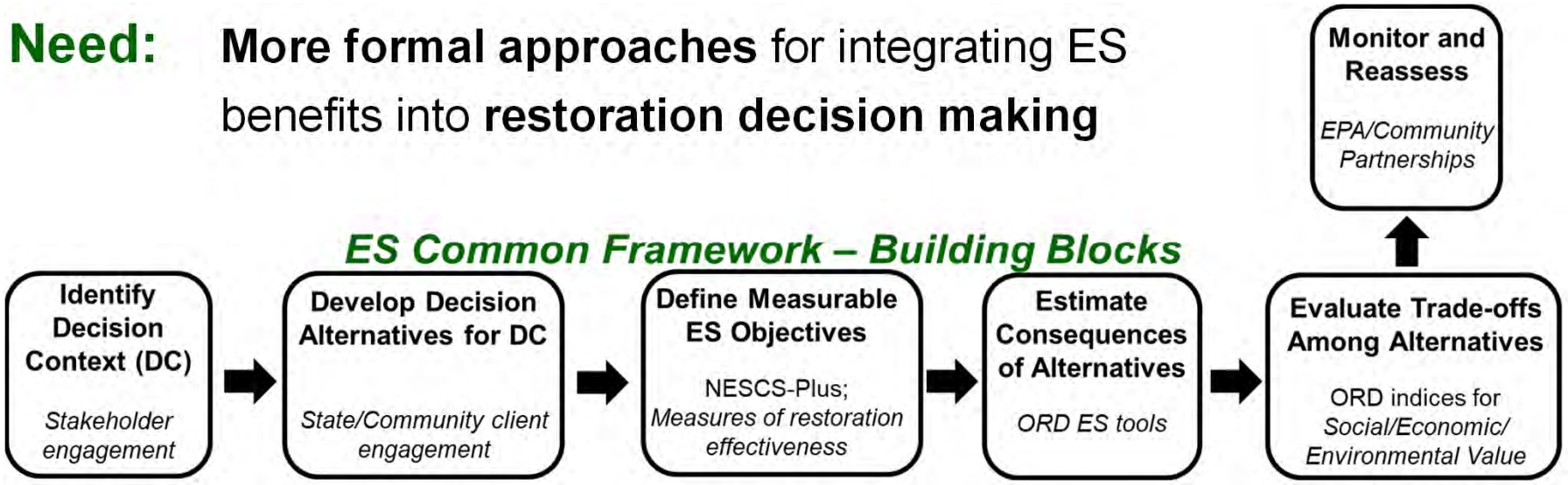


Benefits to Society

ES: Ecosystem Services

Transferring ES for Decision Support

Partner Need: **More formal approaches** for integrating ES benefits into **restoration decision making**



How: **Synthesize decision support elements** from coordinated case studies

Develop interactive **science communication** resources

Focus on utility & transferability of **practical strategies**:

- Between **impaired communities**
- Across **different issues** of concern

Case Studies focused by issue/context

Ada, OK

- Stakeholder engagement
- Trade-offs

Water Resource; Multi-use

Duluth, MN/Superior, WI

- Stakeholder engagement
- ES Endpoints in Decision Process

R2R2R

Mobile Bay, AL

- ID important ES
- Project Planning & Assessment

Stream Restoration

Tillamook Bay, OR

- Quantitative Data & Modeling
- Inform Cause & Effect

Shellfish Habitat/Forestry

San Juan, PR

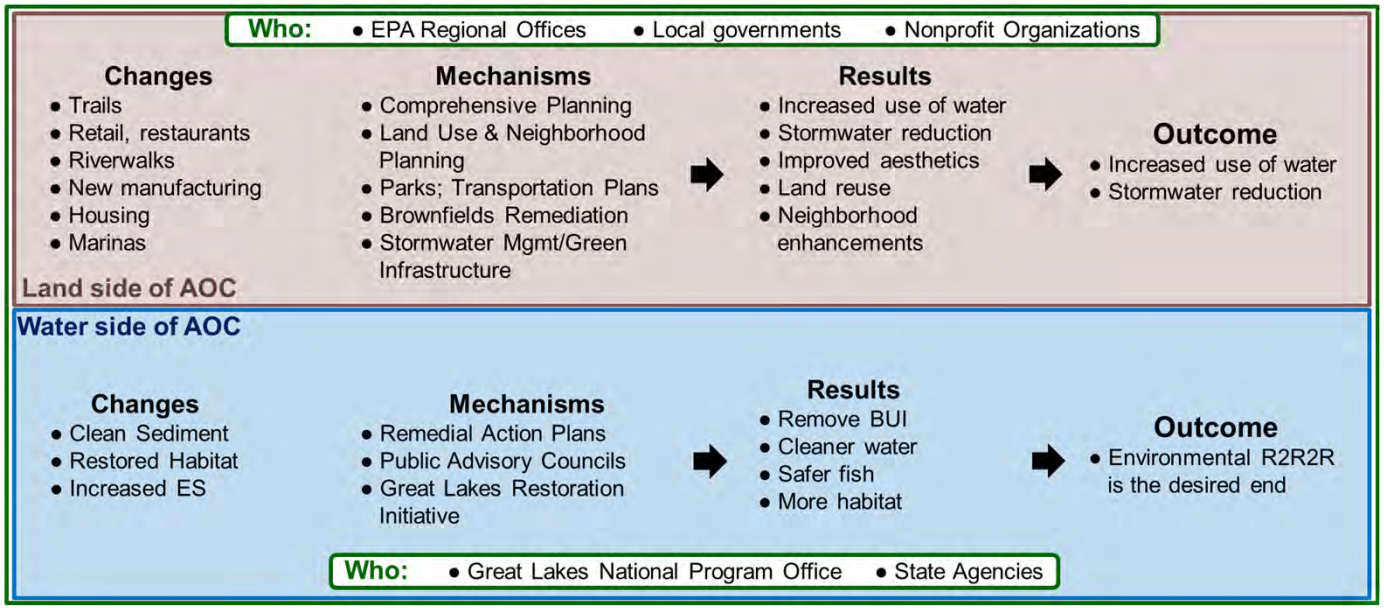
- Stakeholder engagement
- ES for Restoration Responses

Urban Wetlands

Understanding Decision Contexts

Improve client utility – Ethnographic methods

- Used to **identify & characterize barriers & constraints** faced by partners, communities, & ORD
- Knowledge can be applied to **improve client experience** & **utility**



"Context" – How

- **Unpack the "black boxes"** of actors, values, & program goals
- **Map** opportunities & barriers to help manage what cannot be controlled

Example in R2R2R

- Success **may look different** to different actors
- Expected **outcomes may vary** across programs, states, or cities

Past ES in Contaminated Sites Work

- **2016 RESES project:** ORD; RPMs (Remedial Project Managers); STLs (Superfund Technical Liaisons)
  - **Applied Lessons** from Green & Sustainable Remediation (GSR) approaches
  - **Provides:** RPMs understanding of ES; Guidelines for considering ES; Overview of potential tools
  - **Can inform steps:** Decision context; Stakeholder engagement; Alternatives analyses; Best Management Practices
  - **No one tool meets all needs**

Ecosystem Services at Contaminated Site Cleanups

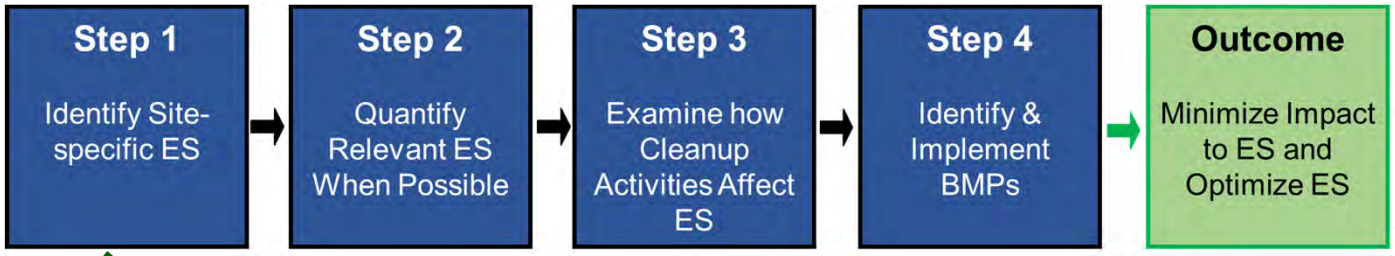
Coeur d'Alene River, ID

- Watershed scale site
- Undeveloped; mining
- Rocky Mountain west

Lower Darby Creek Area Philadelphia, PA

- Smaller site
- East Coast urban setting

Past ES in Contaminated Sites Work



ES Classification System

Lower Darby Creek Area/Clearview Landfill		
Beneficiary Category	**Beneficiary Subcategory**	**FEGS, Importance**
Government, Municipal, and Residential	Residential	
	Property Owners	flora, organisms (i.e., flowers, plants, etc.) that can be viewed
		presence of the environment, opportunity for placement of infrastructure and reduced/increased risk of erosion, fire, and pest infesta
Recreational	Experiencers and Viewers	presen organi
		fauna, viewed
		sounds
		fungi, organisms (i.e., mushrooms, shelf fungus, puffballs, etc.) that can be viewed
		flora, organisms (i.e., flowers, plants, etc.) that can be viewed
	Anglers	fish in the water
Subsistence	Food Subsisters	flora, edible organisms (i.e., flowers, plants, etc.) or associated products (i.e., fruit, greens, tubers, berries, sap) that are gathered for personal use (i.e., not for sale)
		fauna, edible organisms (i.e., birds, mammals, reptiles, etc.) that are hunted for personal use (i.e., not for sale)
Learning	Educators, Students, and Researchers	presence of the environment, opportunities to understand, communicate, educate, and research
Non-Use	People Who Care (Existence)	presence of the environment, knowing that the environment exists

Target Journal: ***Environmental Science & Technology***

Past ES in Contaminated Sites Work

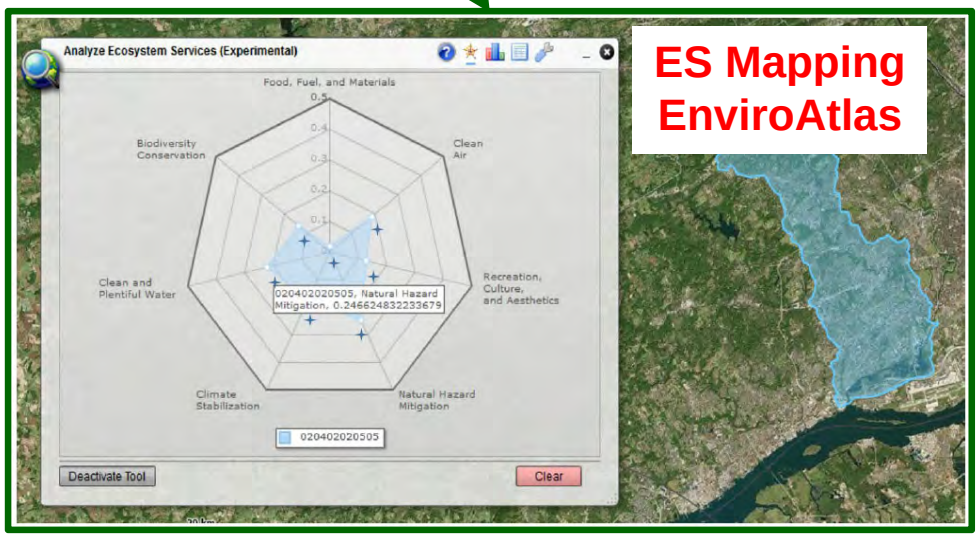
Step 1
Identify Site-specific ES

Step 2
Quantify Relevant ES When Possible

Step 3
Examine how Cleanup Activities Affect ES

Step 4
Identify & Implement BMPs

Outcome
Minimize Impact to ES and Optimize ES



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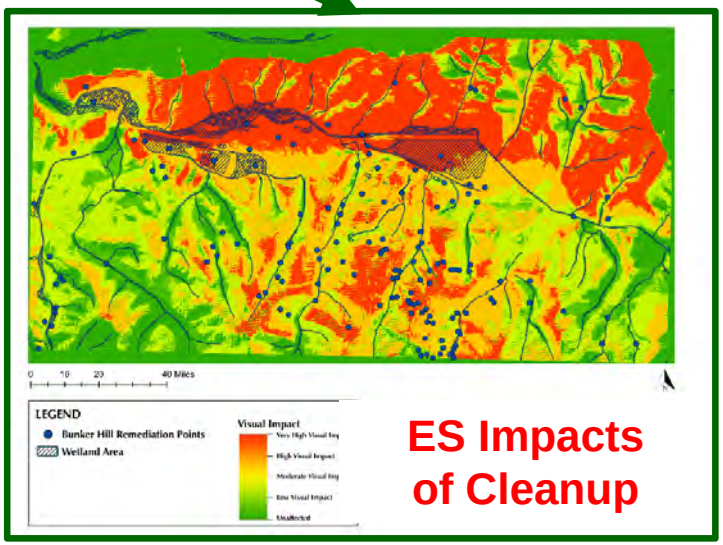
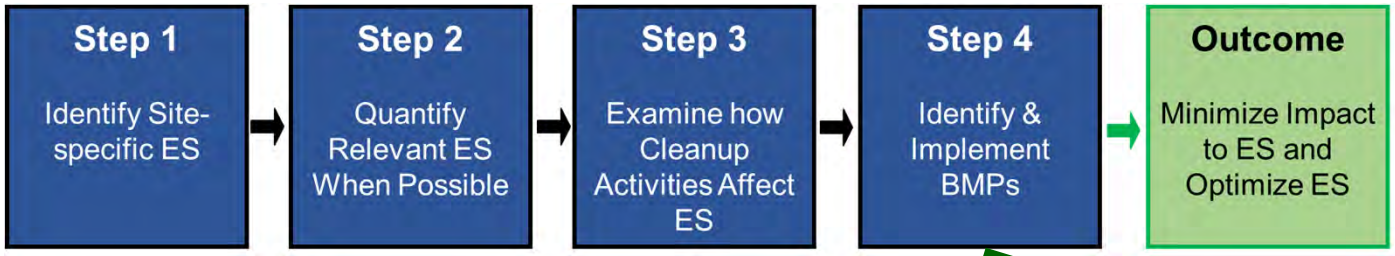


ES Impacts of Cleanup

Target Journal: ***Environmental Science & Technology***

Past ES in Contaminated Sites Work



Number of BMPs:	6	6	6	5	1	3	2	5
		STEP 1	STEP 2	STEP 3		STEP 4		
Category	Best Management Practice	BMP Opportunity Assessment	BMP Prioritization	BMP Selection	Rationale for not Selecting	BMP is Currently in Place	BMP is Planned for Implementation	Notes on Implementation
Site Preparation and Land Restoration	Cover filled excavations with biodegradable fabric to control erosion and serve as a substrate for ecosystems	✓	LOW		[illegible] cover includes synthetic liner, a drainage system and 2 feet of soil. This increases protectiveness of the cover and can still support native vegetation.			
Site Preparation and Land Restoration	For restoration use a suitable mix of trees, shrubs, grasses, and forbs to preserve or improve biodiversity and related ecosystem services	✓	HIGH	✓			✓	To provide habitat for pollinator species, eight areas of the containment cell's capped surface will be seeded with six species of native wildflowers.
Site Preparation and Land Restoration	Incorporate wetlands, grass swales, or grass-lined channels, bioswales, and other types of vegetated areas to enhance gradual infiltration and evapotranspiration, prevent soil and sediment runoff, and promote carbon sequestration	✓	HIGH	✓			✓	Rather than creating a sterile ditch, the cleanup parties designed a bioswale with multiple ecological components to provide habitat and control erosion.
Site Preparation and Land Restoration	Minimize clearing of trees and other vegetation throughout investigation and cleanup	✓	HIGH	✓		✓		Minimized area of land to be cleared for staging areas, pruned trees instead of removing them when possible; preserved riparian habitat along the bayou by minimizing work along the shore.
Site Preparation and Land Restoration	Restrict traffic to confined corridors to minimize soil compaction and land disturbance during site activities	✓	MEDIUM	✓		✓		Adjusted road access to preserve several large trees.
Site Preparation and Land Restoration	Downed trees and snags (standing dead trees) provide habitats for numerous species; do not remove unless required for safety or access and allow leaf litter to remain for natural mulching and weed control	✓	LOW	✓		✓		Log and root wads set aside during site preparation were installed in the bioswale as weirs to create spawning habitats for fish and other aquatic life

BMP Table & ES

Target Journal: ***Environmental Science & Technology***

New ES in Contaminated Sites Work

New "Retrospective" Research

- **Retrospective analysis** of ES and remedial BMPs employed
- **By:**
  - **Using** a **"lessons-learned"** approach
  - **Drawing** conclusions about **changes in ES as result of cleanup**
  - **Drawing** conclusions about **potential for improving ES** for site reuse
  - Advancing **generalizable guidelines** for considering ES, including:
    - **Effective communication** of ES concepts
    - **Involving the public** in site decisions

Current Plans: 2 Sites

Selection Criteria:

- Data availability & access
- Type of site cleanup
  - Different contaminants
  - Histories
  - Ecosystems
- Stakeholders identified & engaged

Translational ES for Contaminated Sites

Ecosystem Services and Translational Science

Translation or development of methods, knowledge, data sets, and tools to **facilitate** application of ecosystem services and their benefits as **decision support** in remediation, restoration, or revitalization contexts.

Co-developed Vision using a Steering Group

- RPMs and project managers are busier than ever
- Sustainability and greener cleanups concepts exist
- Work within existing processes
- May not be high priority

- **Use a Workshop Approach for "Targeted Learning"**
- **ORD:** ES concepts; **Partners:** Contam. Sites; **All:** Translational Science

Translational ES Workshop Vision

Workshop I - Processes & ES Tools (Summer ’20)

- **Cleanup Processes/Frameworks**
  - Superfund; Brownfield; RCRA
- **ES Assessments (value added)**
  - Concepts, strategies, & tools
  - Relevance for existing processes
  - Assumes can identify crosswalks to be developed

Workshop II - Elements & Crosswalks (Spring ’21)

- **Potential ES Elements**
- **ES Assessments (value added)**
  - Focus on Decision Points (who, what, when, how)
  - Existing; new opportunities
  - Future efforts; Case Studies

Workshop Participants

ORD:
ES;
Translational Science

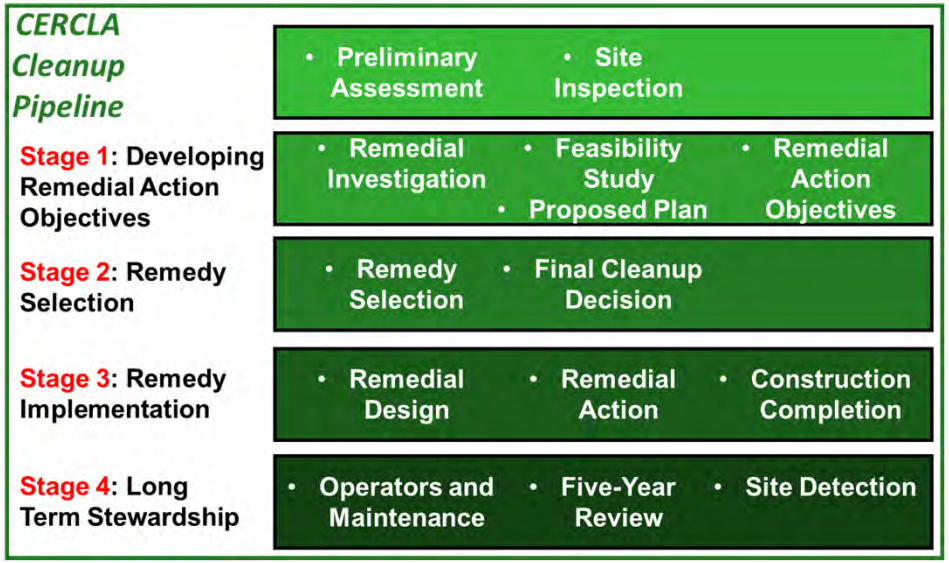
Contaminated Sites:
STLs; RSLs; RPMs; Brownfields PMs; OLEM; OECA

Cleanup Processes/Frameworks

- **Regulatory Processes**
  - CERCLA Pipeline
  - Brownfields process
  - RCRA Corrective Action Process
  - Beneficial Use Impairment (BUI) process

- **Other Relevant Frameworks**
  - Ecological Risk Assessment
    - (BERA; SLERA)
  - ASTM Greener Cleanups BMP
  - 4-Box ES "Consideration" (RESES)

CERCLA: Comprehensive Environmental Response, Compensation, & Liability Act (Superfund)



RCRA: Resource Conservation & Recovery Act

Workshop I – ES Tools

- Classification System
- Library for Coding & Searching FEGS

NESCS Plus

- FEGS Project Scoping
- Stakeholder Engagement

FEGS Scoping Tool

Enviro Atlas

- Spatial datasets
- Visualizations

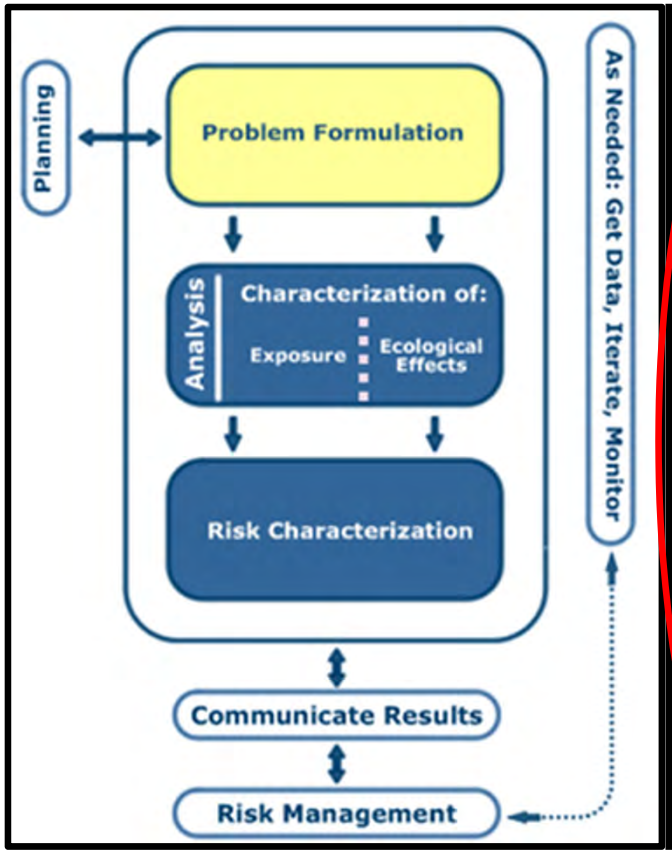
EcoService Models Library

- Published models for estimating ES

FEGS Metrics Report

- What to measure?
- FEGS Units

Workshop II – Potential Crosswalks



Crosswalk – Example ES Activities with Generic ERA Phases

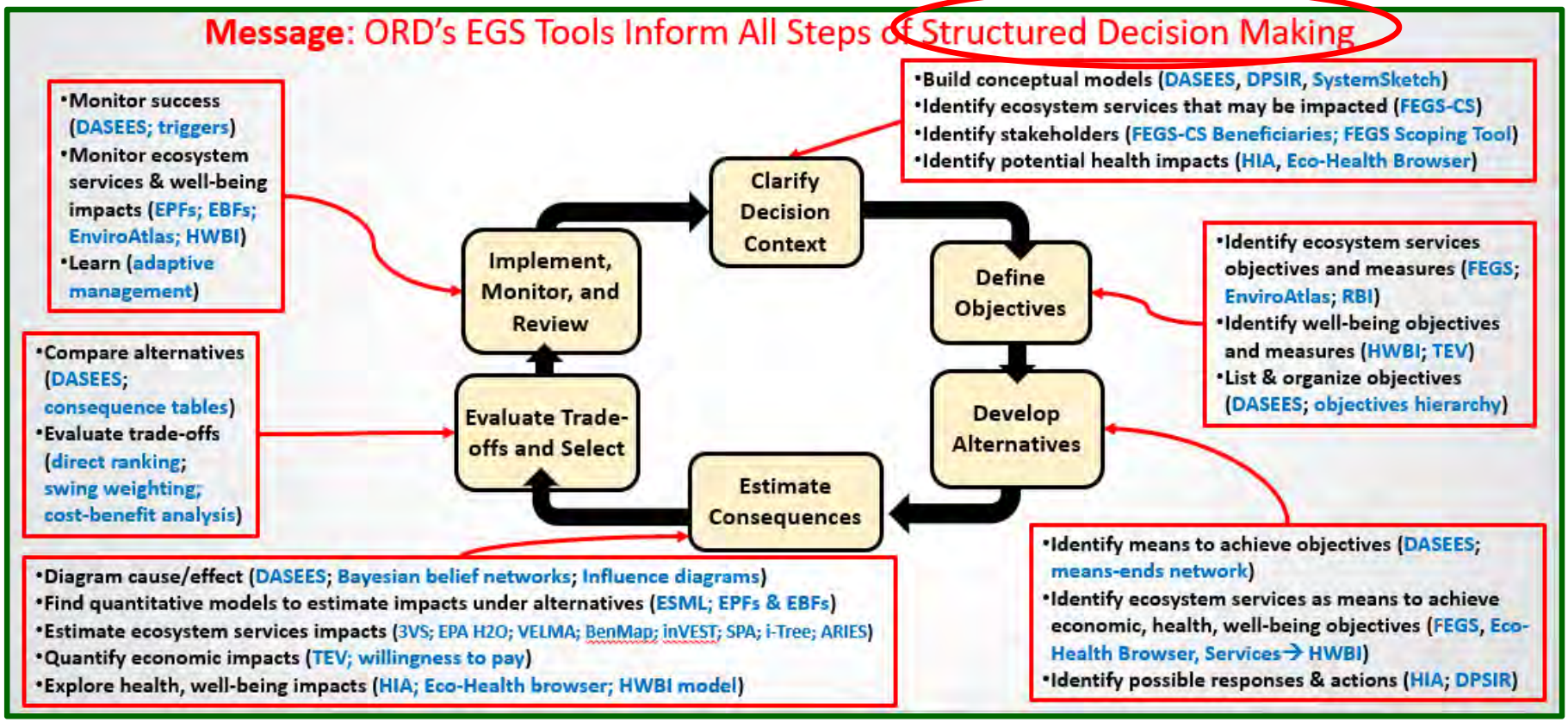
ERA Phases[a]	Example EGS Topics and Activities	Some Potential EPA EGS Tools[b]
Planning and Scoping	• Identify EGS in site landscape	• FEGS Scoping Tool[c] • FEGS Classification System • National Ecosystem Services Classification System (NESCS)
Problem Formulation	• Describe EGS benefits • Estimate magnitudes of EGS benefits • Incorporate EGS into conceptual site model (CSM)	• FEGS Scoping Tool[c] • EcoService Models Library (ESML) • Eco-Health Relationship Browser • EnviroAtlas • Decision Analysis for a Sustainable Environment, Economy, and Society (DASEES)[c]
Analysis	• Evaluate potential EGS/site contaminants connectivity • Evaluate potential effects of site contaminants on EGS • Evaluate EGS condition (functionality, impairment level) • Evaluate EGS resilience/vulnerability to site contaminants • Calculate EGS cost savings and other benefits • Assess EGS capacity (type, temporal, seasonal) • Assess EGS importance to stakeholders • Assess EGS maintenance effort and cost • Identify key features or parameters to protect EGS benefits	• EcoService Models Library (ESML) • EnviroAtlas • EPA H2O Tool • Rapid Benefit Indicators (RBI) Approach • Visualizing Ecosystem Land Management Assessments (VELMA) Model • Causal Analysis/Diagnosis Decision Information System (CADDIS)
Risk Characterization	• Compare costs and benefits of EGS • Characterize site contaminant threats to EGS • Characterize EGS impairment level by site contaminants	• EcoService Models Library (ESML) • EnviroAtlas • EPA H2O Tool • Rapid Benefit Indicators (RBI) Approach
Risk Communication[d]	• Articulate EGS benefits and costs	• All of the above

[a] From U.S. EPA 1998 [b] Descriptions and links available at: https://www.epa.gov/eco-research/ecosystem-services [c] Beta version - not yet publicly availab

Example: Crosswalk ERA Phases & ES Tools

Workshop II – Potential Crosswalks

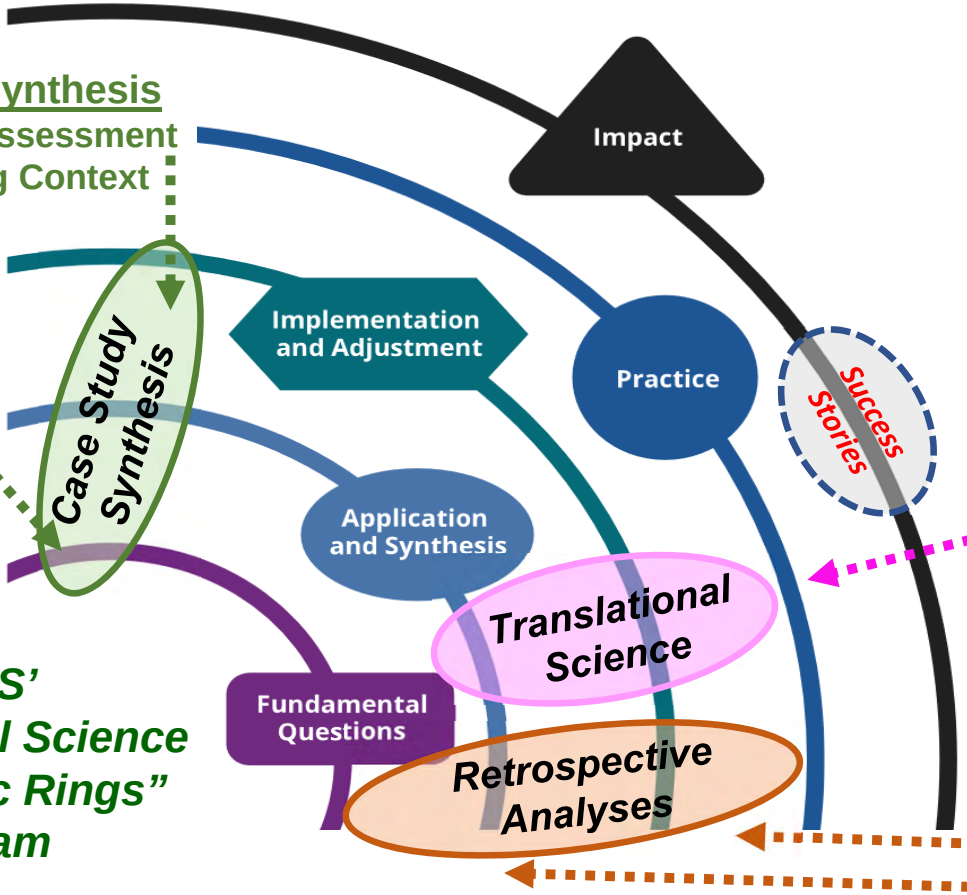
"Rosetta Stone" Concept



Translational Science and ES Research

ORD Investing in Translational Science Approaches

Case Study Synthesis
- Synthesis & Assessment
- Understanding Context



NIEHS' Translational Science "Concentric Rings" Diagram

Translational Science Effort
- Learning Workshops
- Frameworks/Tools
- Crosswalks
- Communication

Retrospective Analyses
- RESES Synthesis
- New Superfund Retrospective

NIEHS: National Institute of Environmental Health Sciences

Anticipated, Long-term Impacts

With these anticipated results:

- **<u>The Agency</u>** will be able to:
  - **Increase** project team member **knowledge/toolkit** on environmental benefits of cleanups
  - **Enhance existing Green & Sustainable Remediation efforts** with addition of ES dimensionality

- **<u>States, Communities, and PRPs</u>** will be able to:
  - Identify/examine **new ways to describe benefits** of cleanups
  - **Improve communication** of successful cleanups having environmental components

- **<u>ORD/Scientists</u>** will be able to advance:
  - Capacity to "**Speak OLEM**"
  - **Translational science and communication** efforts on the utility of ES concepts
  - **<u>The</u> science leadership role** in incorporating environmental benefits for contaminated cleanups

Impact of ORD Work

ES Applications in Case Study

"…one of the best demonstrations of state-provincial partnership I have seen is some time – perhaps ever!"

- Bob Lambe, Executive Secretary, Great Lakes Fishery Commission

Ecosystem Services in Contaminated Sites

"Very helpful listing and description of specific tools and resources."

- Chuck Maurice (STL)

"… this paper will be a good resource for RPMs motivated to attempt to consider ES."

- Hilary Thornton (RPM)

"… have laid out a great integrative systems approach. … will be an important contribution for furthering ES usage in the Agency."

- Bruce Duncan (RSL)

References 1

EPA Strategic References:

- 2019-2022 SHC Strategic Research Action Plan: https://www.epa.gov/research/sustainable-and-healthy-communities-strategic-research-action-plan-2019-2022
- 2017 Superfund Task Force Recommendations: https://www.epa.gov/superfund/superfund-task-force-recommendations
- FY 2018-2022 EPA Strategic Plan: https://www.epa.gov/planandbudget/fy-2018-2022-epa-strategic-plan

Cleanup-relevant Frameworks:

- ASTM Standard Guide for Greener Cleanups (2016; E2893-16e1): www.astm.org
- Beneficial Use Impairment for the Great Lakes AOCs: https://www.epa.gov/great-lakes-aocs/beneficial-use-impairments-great-lakes-aocs
- CERCLA Cleanup Pipeline and RCRA Corrective Action Process (Freed et al., 2020 presentation "Translational Science, Ecosystem Services, and Environmental Law and Governance")
- Ecosystem Services at Contaminated Site Cleanups. EPA 542-R-17-004. https://www.epa.gov/sites/production/files/2017-09/documents/ecosystem_services_at_contaminated_site_cleanups_ef_issue_paper.pdf
- Maurice, et al. 2018. Incorporation of Ecosystem Goods and Services into Ecological Risk Assessment. EPA/600/H-19/032. https://cfpub.epa.gov/si/si_public_record_report.cfm?Lab=OSP&dirEntryId=347291
- US EPA. 2008. Green Remediation: Incorporating Sustainable Environmental Practices into Remediation of Contaminated Sites Technology Primer. EPA 542-R-08-002. https://www.epa.gov/remedytech/green-remediation-incorporating-sustainable-environmental-practices-remediation
- US EPA. 2012. Methodology for understanding and reducing a project's environmental footprint. EPA 542-R-12-002. https://www.epa.gov/greenercleanups/methodology-understanding-and-reducing-projects-environmental-footprint
- US EPA. 2015. Ecosystem services as assessment endpoints in ecological risk assessment—Technical background paper. EPA/100/F-15/004. https://www.epa.gov/risk/ecosystem-services-ecological-risk-assessment-endpoints-guidelines
- USEPA. 2020. Greener Cleanups: https://www.epa.gov/greenercleanups

References 2

Translational Science References:

- Pettibone, et al. 2018. Expanding the concept of translational research: making a place for environmental health sciences. *Environmental Health Perspectives* 126(7): 074501.

ORD ES Relevant Frameworks & Tools

- EnviroAtlas: https://www.epa.gov/enviroatlas
- EcoService Models Library: https://www.epa.gov/eco-research/ecoservice-models-library
- VEMLA: https://www.epa.gov/water-research/visualizing-ecosystem-land-management-assessments-velma-model-20
- Rapid Benefits Indicators Approach: https://www.epa.gov/water-research/rapid-benefit-indicators-rbi-approach
- NESCS Plus – building blocks (tool to be released Summer 20200:
  - https://www.epa.gov/eco-research/national-ecosystem-services-classification-system-framework-design-and-policy
  - https://www.epa.gov/eco-research/final-ecosystem-goods-and-services-classification-system-fegs-cs

- Hall. 2017. National and Regional FEGS Metrics and Indicators 2016 Workshop Report. U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-17/189. https://cfpub.epa.gov/si/si_public_record_report.cfm?dirEntryId=338508&Lab=NHEERL
- Tashie, & Ringold. 2019. A critical assessment of available ecosystem services data according to the Final Ecosystem Goods and Services framework. *Ecosphere*, *10*(3), e02665.
- Williams, et al. 2018. How the Community Value of Ecosystem Goods and Services Empowers Communities to Impact the Outcomes of Remediation, Restoration, and Revitalization Projects. EPA/600/R-17/292. https://cfpub.epa.gov/si/si_public_record_report.cfm?Lab=NHEERL&dirEntryId=343618
- Yee, et al. 2017. Practical strategies for integrating final ecosystem goods and services into community decision-making. EPA/600/ 457 R-17/266. https://cfpub.epa.gov/si/si_public_record_report.cfm?dirEntryId=337461&Lab=NHEERL

Extra Slides

- ORD & Translational Science
- SHC 9.2 Team
- SHC 9.2 “placement” in StRAP Conceptual Diagram
- Approach to the transition between ES for environmental decision making to ES for contaminated site applications
- History of Ecosystem Services Consideration in Contaminated Sites
- Examples of 4 process frameworks for contaminated cleanups

ORD and Translational Science

*Translational Science Definitions**

Translational Science: "The field of investigation which seeks to understand the scientific and operational principles underlying each step of the translational process."

Translation: "The process of turning observations in the laboratory, clinic, and community into interventions that improve the health of individuals and the public."

* **Austin, C.P. 2018.** "Translating translation" *Nature Review | Drug Discovery, 17. July, 2018.*

ORD and Solutions-Driven Research * *

ORD is adopting a 3-pronged strategy for solutions-driven research:

1) Apply principles of solutions-driven research broadly across ORD's six national research programs;

2) Conduct pilot translational science projects that apply and evaluate methods of solutions-driven research that address well-defined and unmet needs of partners and stakeholders;

3) Conduct case studies of previous and current research activities that embody the principles of solutions-driven research, which will help inform a list of best practices

* * **SHC 2019-2022 StRAP**. EPA 601K20004 March 2020

SHC 9.2 Team

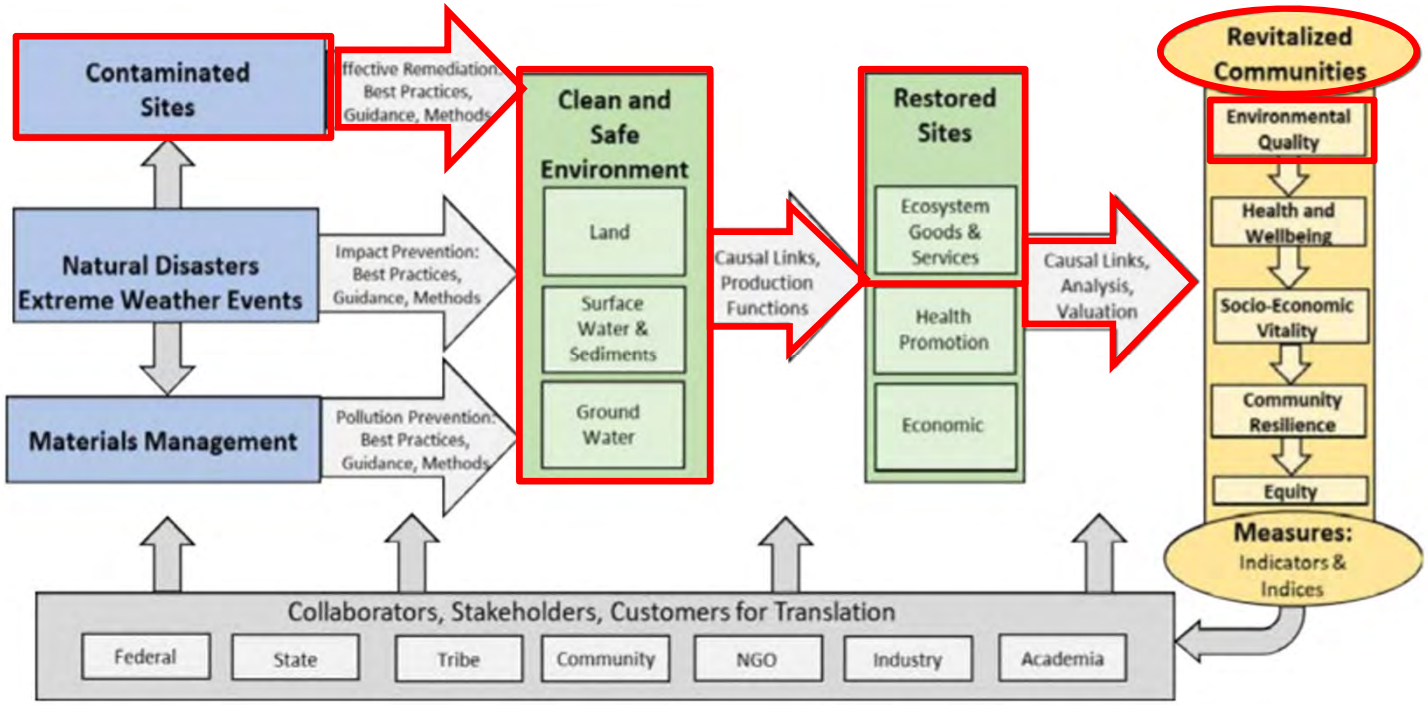
ORD Team

- **Matt Harwell** (Output Lead)
  - **Richard Fulford** (Product Lead)
  - **Mike Kravitz** (Product Lead)
  - **Matt Harwell** (Product Lead)
- Tim Canfield
- Ted DeWitt
- Joel Hoffman
- Bob McKane
- Susan Yee
- Kathleen Williams
- Leah Sharpe
- Tammy Newcomer-Johnson
- John Johnston
- Jessica Daniel
- Annie Neale
- Paul Ringold
- Aaron Ferster
- Mike Nye
- Autumn Oczkowski
- Marilyn TenBrink
- Marc Russell

Partners/Collaborators

- RSLs/STLs
- EPA Regional Superfund and RCRA Corrective Action Programs
- RSMs
- OLEM: OSRTI & OBLR
- GLNPO
- NEPs
- OW
- OECA/OSRE
- Others

SHC 9.2 Placement in the SHC StRAP



Vision for SHC RA9.2 Research

- Application of ecosystem services tools and approaches in support of R2R2R decision making including:

  - Assessments of **methods** for quantifying and mapping ecosystem services **in different decision contexts**

  - Evaluation of **potential application** of methods to support decision making **in remediation, restoration, or revitalization contexts**

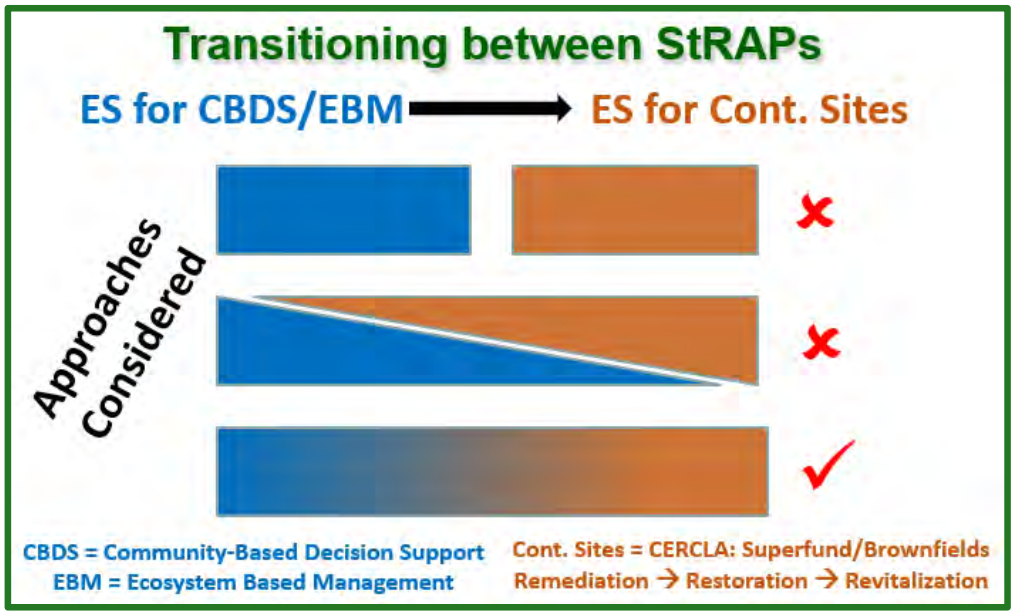
  - **Translation** or development of methods, knowledge, data sets and tools to facilitate application of ecosystem services and their benefits **as decision support** in remediation, restoration, or revitalization contexts

Case Study Synthesis

Retrospective Analyses

Translational Science

ORD ES Research Transition



EPA Strategic Plan Objective 1.3

"One of EPA's top priorities is accelerating progress on Superfund sites."

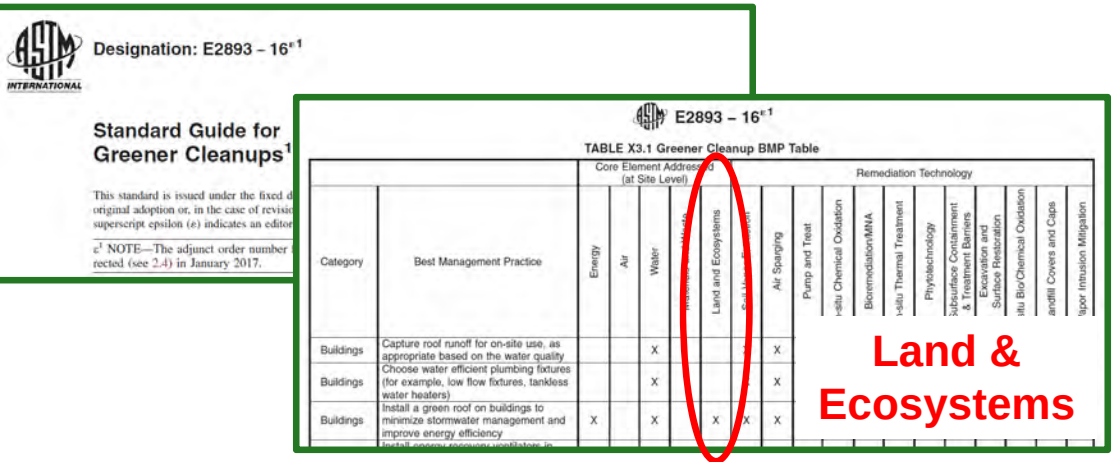
Superfund Task Force Recommendations, Strategy 2

"EPA can play a significant role in helping communities realize the associated health, economic and social benefits that accompany Superfund site redevelopment."

History of ES Consideration in Cleanups 1

Green & Sustainable Remediation (GSR)

- **2008** – Green remediation program to **reduce environmental footprint** of site cleanups
- **2012** – *Methodology for Understanding and Reducing a Project's Environmental Footprint*
- **2013** – *Standard Guide for Greener Cleanups*
  - Core element: **Protect Land and Ecosystems**



Designation: E2893 – 16ε1

Standard Guide for Greener Cleanups[1]

This standard is issued under the fixed d
original adoption or, in the case of revisi
superscript epsilon (ε) indicates an editor

ε1 NOTE—The adjunct order number
rected (see 2.4) in January 2017.

E2893 – 16ε1

TABLE X3.1 Greener Cleanup BMP Table

Category	Best Management Practice	Core Element Addressed (at Site Level): Energy	Air	Water	Land and Ecosystems	Remediation Technology: Air Sparging	Pump and Treat	In-situ Chemical Oxidation	Bioremediation/MNA	In-situ Thermal Treatment	Phytotechnology	Subsurface Containment & Treatment Barriers	Excavation and Surface Restoration	In-situ Bio/Chemical Oxidation	Landfill Covers and Caps	Vapor Intrusion Mitigation
Buildings	Capture roof runoff for on-site use, as appropriate based on the water quality			X		X										
Buildings	Choose water efficient plumbing fixtures (for example, low flow fixtures, tankless water heaters)			X		X										
Buildings	Install a green roof on buildings to minimize stormwater management and improve energy efficiency	X		X	X	X										

Land & Ecosystems

Risk Assessments

- **2015** – *Ecosystem services as assessment endpoints in ecological risk assessment*

Ecosystem Services (ES) for Contaminated Sites

EPA United States Environmental Protection Agency

EPA 542-R-17-004
August 2017

Engineering Forum Issue Paper

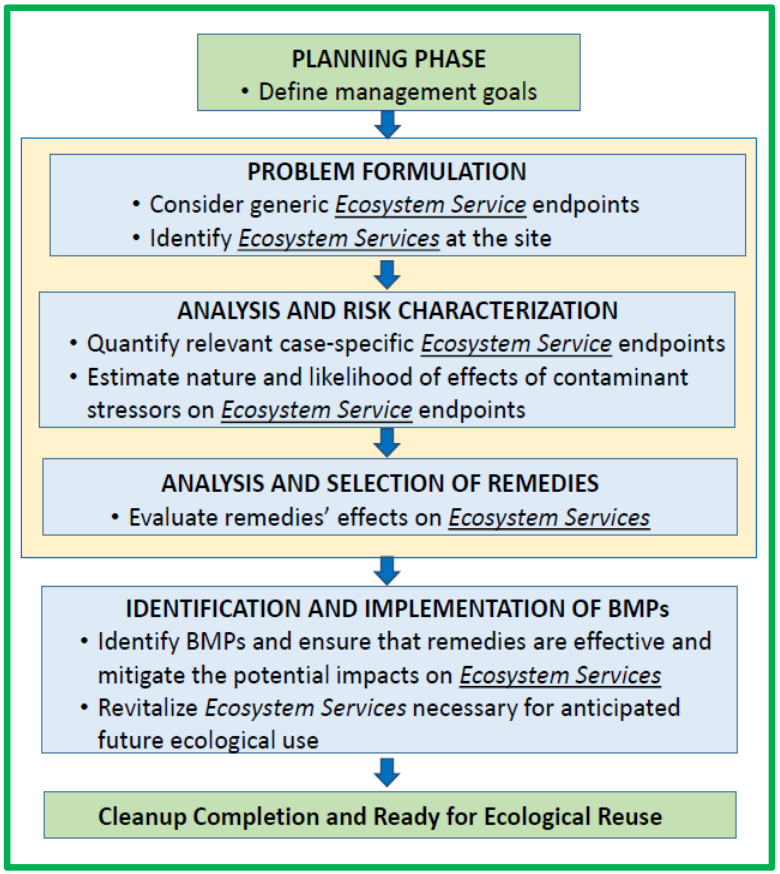
Agriculture-to-wetland project at the Lower Basin of Coeur d'Alene River Superfund site in northern Idaho. Photo Credit: Jewel Lipps

Ecosystem Services at Contaminated Site Cleanups

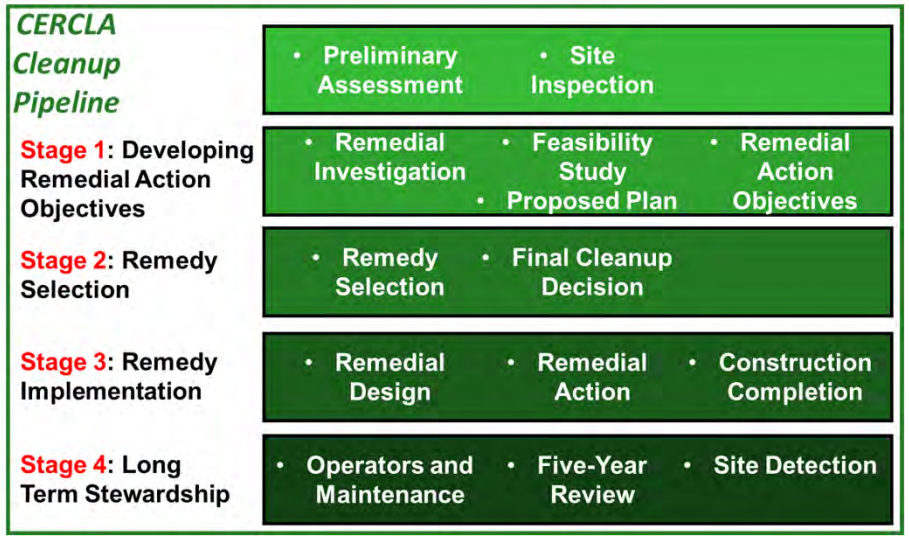
History of ES Consideration in Cleanups 2

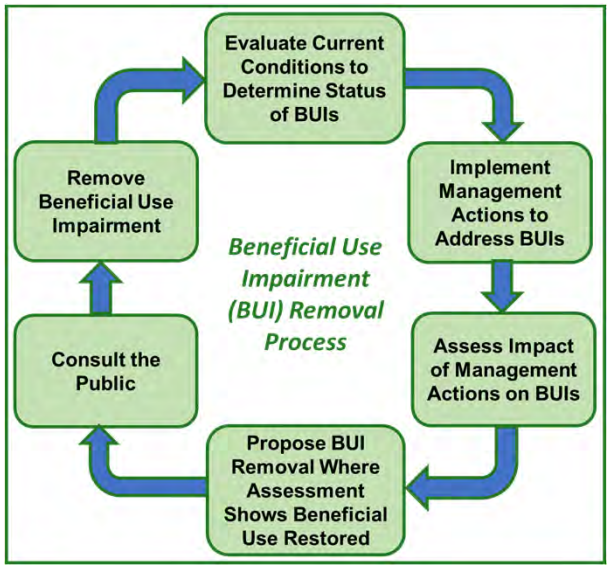
ES to inform Contaminated Site Cleanup Processes

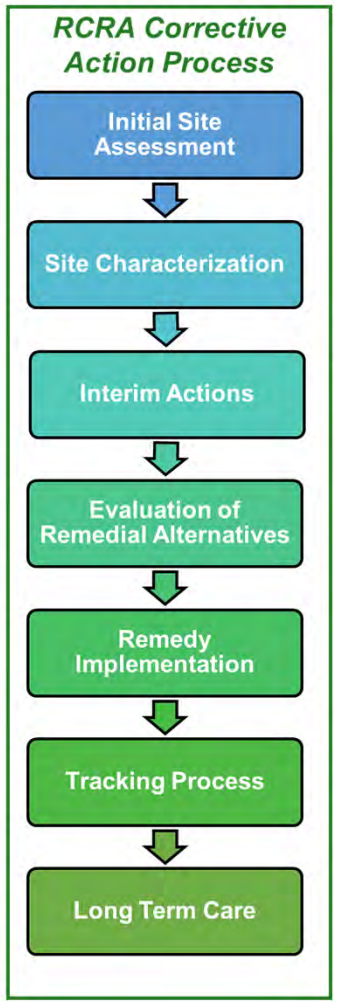
- 2017 – *Engineering Forum Issue Paper:* Ecosystem Services at Contaminated Site Cleanups
  - **Engagement with the public and stakeholders** about anticipated future ecological use
  - **Replicable, defensible** selection of greener cleanup BMPs
  - Can inform environmental decision-making at **different parts of clean-up process**
  - **Transparent documentation** of the ecosystem conditions on the site "before and after" cleanup
  - **Communication of the benefits** & societal relevance of ecological risk-based cleanups

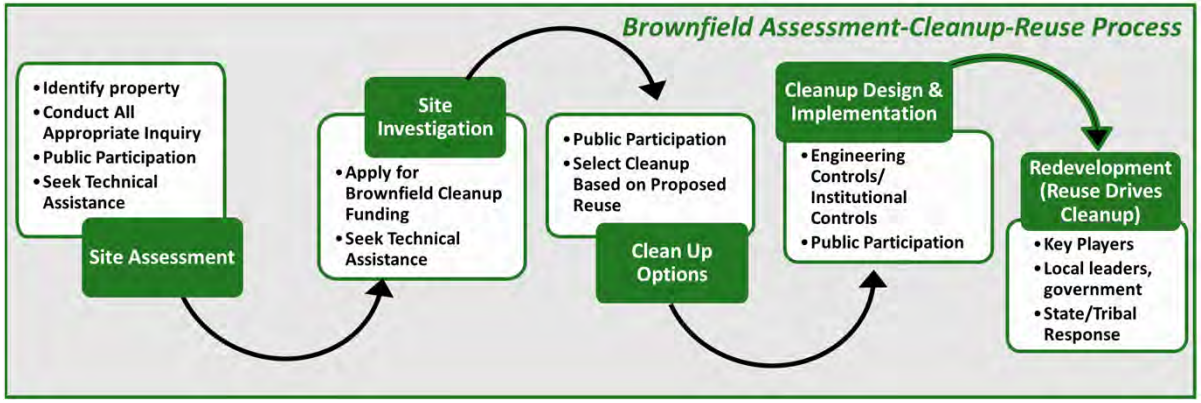


Cleanup Process Frameworks (some)

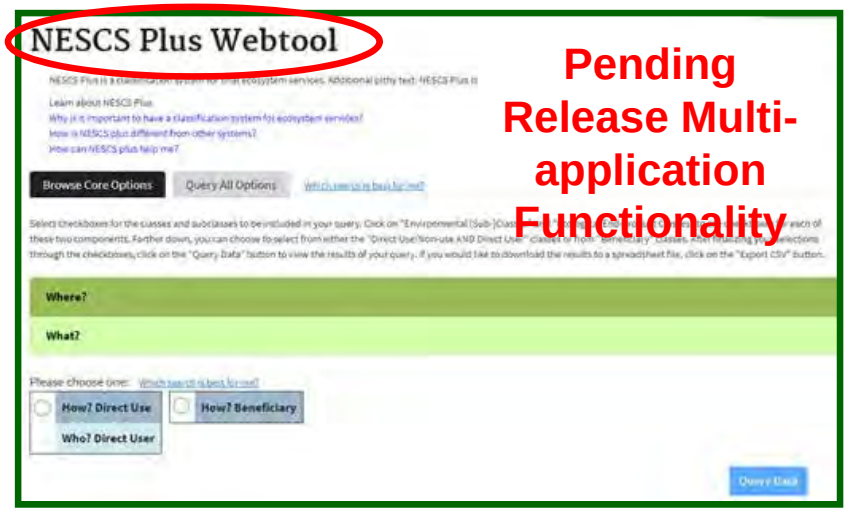








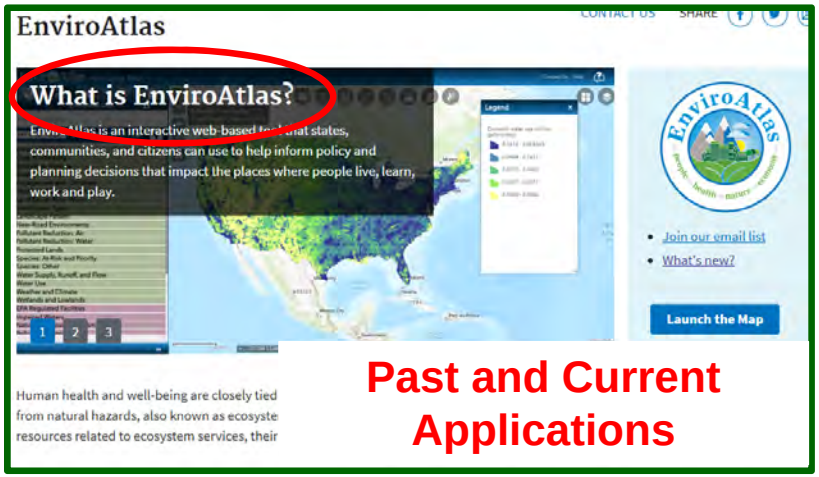
ORD ES Tools/Contaminated Sites



Pending Release Multi-application Functionality

Ongoing Landfill Cleanup Application

2019 Case Applications



Past and Current Applications