Sustainable and Green Remediation

Course Number: CH-02-420

PDH: 4

Approved for: AK, AL, AR, DE, FL, GA, IA, ID, IL, IN, KS, KY, LA, MD, ME, MI, MN, MO, MS, MT, NC, ND, NE, NH, NJ, NM, NV, NY, OH, OK, OR, PA, SC, SD, TN, TX, UT, VA, VT, WI, WV, and WY

State Board Approvals

Florida Provider # 0009553 License #868
Indiana Continuing Education Provider #CE21800088
Maryland Approved Provider of Continuing Professional Competency
New Jersey Professional Competency Approval #24GP00025600
North Carolina Approved Sponsor #S-0695
NYSED Sponsor #274

How Our Written Courses Work

This document is the course text. You may review this material at your leisure before or after you purchase the course.
After the course has been purchased, review the technical material and then complete the quiz at your convenience.
A Certificate of Completion is available once you pass the exam (70% or greater).
If a passing grade is not obtained, you may take the quiz as many times as necessary until a passing grade is obtained).
If you have any questions or technical difficulties, please call (508) 298-4787 or email us at admin@PDH Pro.com.

396 Washington Street, Suite 159, Wellesley, MA 02481
Telephone – (508) 298-4787
www.PDH-Pro.com

Module 1: Introduction to Green and Sustainable Remediation

Learning Objectives

By the end of this section, you will be able to:

- **Identify** the core differences between Green Remediation and Green and Sustainable Remediation (GSR).
- **Evaluate** how GSR integrates with existing ITRC methodologies like Triad and Remediation Process Optimization (RPO).
- **Select** appropriate federal and state resources for quantifying environmental footprints in remediation projects.

Executive Summary: Green and Sustainable Remediation (GSR) represents an evolution in site cleanup that moves beyond site-specific risk mitigation to a holistic balance of environmental, social, and economic impacts. This framework is designed to be scalable across all project phases—from investigation to long-term monitoring—supplementing existing regulatory requirements with practical methodologies for footprint reduction and community benefit.

Problem Statement

The ultimate goal of remediation is to **protect human health and the environment**. Historically, remedies focused narrowly on site-specific risks. However, traditional approaches often overlook external social and economic consequences. By adopting a GSR framework, engineers can improve project outcomes while maintaining strict compliance with regulatory objectives.

Applicability

This framework is a generalized approach for integrating sustainability into site management decisions. It is designed for:

- **Cross-Sector Use:** Applicable to state regulators, federal employees, and private sector consultants/industry.
- **Scalability:** Effective for both small-scale sites and large, complex projects.
- **Life-Cycle Integration:** Intended to supplement every phase, including Remedial Investigation (RI) and Long-Term Monitoring (LTM).

⚠️ **Safety Constraint:** The GSR framework is intended to **supplement**, not supplant, any existing regulatory requirements, rules, or statutes.

Definitions and Core Concepts

GSR definitions are consensus-based but remain subject to interpretation based on the specific implementation context.

Sustainability

Sustainability involves the **holistic consideration** of environmental, social, and economic impacts, specifically evaluating how current activities affect future generations.

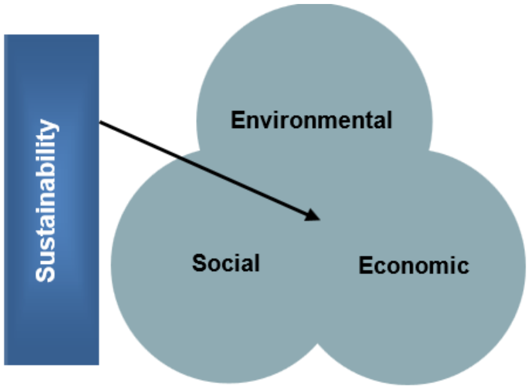

Figure 1-1. Sustainability schematic. Source: Based on IUCN 2006.

Green Remediation

Green remediation is the practice of considering all environmental effects of remedy implementation and incorporating options to minimize the environmental footprints of cleanup. This typically involves:

- Implementation of **Best Management Practices (BMPs)**.
- Performing **environmental footprint** analyses.

Green and Sustainable Remediation (GSR)

GSR is the site-specific employment of products, processes, technologies, and procedures that **mitigate contaminant risk** while balancing community goals, economic impacts, and environmental effects.

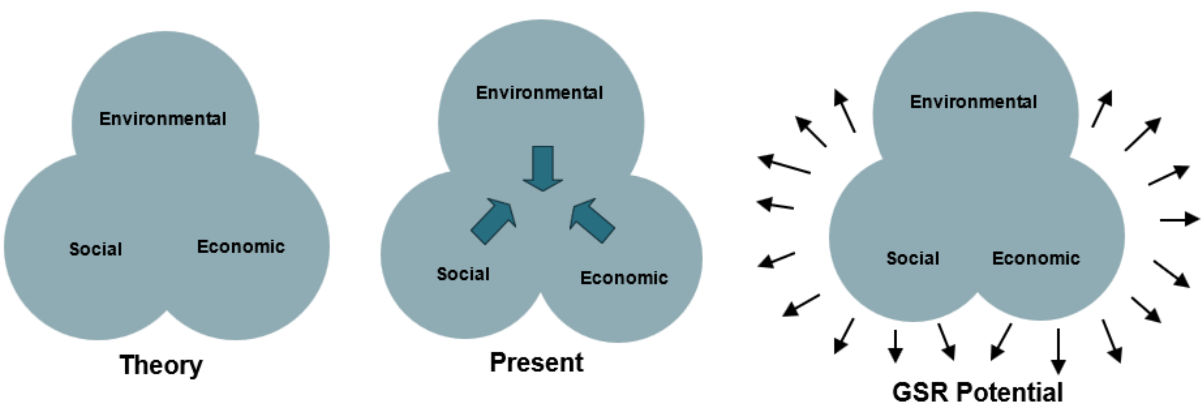

Figure 1-2. Schematic representation of GSR concept development.

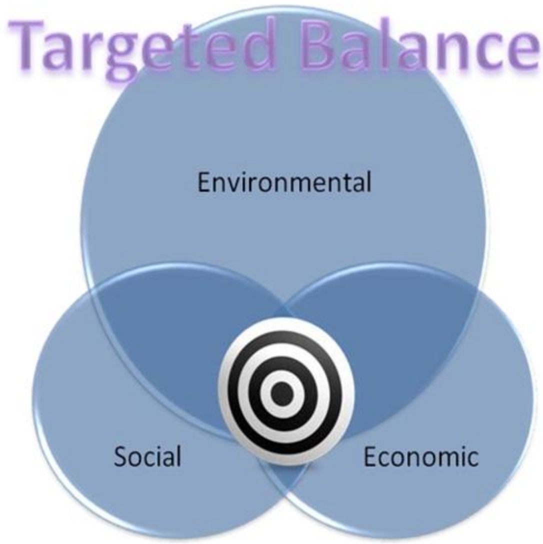

Figure 1-3. GSR targeted balance.

Greenwashing

Greenwashing occurs when GSR claims are made without supporting evaluations or backup documentation.

- **Documentation:** Engineers must provide documented evaluations where GSR was considered.
- **Transparency:** Assumptions must be based on publicly available or generally accepted sources.

Relationship to Other ITRC Teams and Products

GSR does not exist in a vacuum; it leverages and enhances several established ITRC methodologies.

The Triad Approach

The Triad approach (Systematic Planning, Dynamic Work Strategies, and Real-Time Measurement) correlates directly to GSR by:

- **Reducing** field mobilizations and resource expenditures.
- **Minimizing** waste generation and laboratory shipping requirements.
- **Lowering** transportation-related air emissions (GHGs).

Direct-Push Well Technology

The use of **direct-push wells** supports GSR by reducing investigation-derived waste (IDW) and speeding up installation, which leads to fewer mobilizations compared to conventional drilling.

Remediation Process Optimization (RPO)

RPO is the systematic periodic evaluation of systems to ensure maximum efficiency.

- **GSR Application:** The O&M phase provides the best opportunity for GSR.
- **Example:** Switching from high-horsepower blower-driven systems to **passive venting with solar-powered igniters** (stick flares).

Performance Based Environmental Management (PBEM)

PBEM is a goal-oriented methodology focused on end results. GSR builds on PBEM by adding the "triple bottom line" (environmental, social, economic) to the achievement of cleanup goals.

Project Risk Management

Remediation Risk Management (RRM) anticipates uncontrollable circumstances. Coordinating RRM with GSR creates **synergistic opportunities**, such as addressing long-term liability and sustainability concerns simultaneously to reassure stakeholders.

Life-Cycle Cost Analysis

This method compares remediation alternatives by estimating the **total annual cost of ownership** in today's dollars, amortized over the life of the project, rather than just initial capital costs.

Survey of State Interest

A survey conducted by the ITRC GSR Team revealed:

- **Zero Barriers:** Most states reported no regulatory barriers to GSR.
- **High Interest:** There is significant enthusiasm for practical methodologies and **GSR metrics**.

State Regulatory Perspectives

Implementation varies by state based on management exposure and financial constraints. While largely **voluntary** for states, **Executive Order 13514** mandates sustainability considerations for federal agencies, which may impact states using federal funding.

Federal Agency Perspectives

U.S. Environmental Protection Agency (EPA)

The EPA identifies **five core elements** of a green cleanup.

1. Minimize total energy use and maximize use of renewable energy
   - Minimize energy consumption (e.g., use energy-efficient equipment)
   - Power cleanup equipment through on-site renewable energy sources
   - Purchase commercial energy from renewable resources
2. Minimize air pollutants and greenhouse gas emissions
   - Minimize the generation of greenhouse gases
   - Minimize generation and transport of airborne contaminants and dust
   - Use heavy equipment efficiently (e.g., diesel emission reduction plan)
   - Maximize use of machinery equipped with advanced emission controls
   - Use cleaner fuels to power machinery and auxiliary equipment
   - Sequester carbon on site (e.g., soil amendments, revegetate)
3. Minimize water use and impacts to water resources
   - Minimize water use and depletion of natural water resources
   - Capture, reclaim, and store water for reuse (e.g., recharge aquifer, drinking water irrigation)
   - Minimize water demand for revegetation (e.g., native species)
   - Employ best management practices for storm water
4. Reduce, reuse, and recycle material and waste
   - Minimize consumption of virgin materials
   - Minimize waste generation
   - Use recycled products and local materials
   - Beneficially reuse waste materials (e.g., concrete made with coal combustion products replacing a portion of the Portland cement)
   - Segregate and reuse or recycle materials, products, and infrastructure (e.g., soil, construction and demolition debris, buildings)
5. Protect land and ecosystems
   - Minimize areas requiring activity or use limitations (e.g., destroy or remove contaminant sources)
   - Minimize unnecessary soil and habitat disturbance or destruction
   - Minimize noise and lighting disturbance

Figure 1-4. EPA's core elements of green cleanup.

💡 **Design Tip:** Footprint analyses should be conducted in concert with remedy selection, design, or optimization rather than as a standalone after-the-fact study.

U.S. Air Force (AFCEE)

The Air Force utilizes specific tools to automate GSR metrics:

- **Sustainable Remediation Tool™ (SRT™):** Calculates emissions (CO2, NOx, SOx, PM10), energy, and safety risk.
- **Performance Tracking Tool (PTT):** Evaluates mass removal vs. cost projections.
- **CleanSWEEP:** A decision tool for alternative energy (solar/wind) at remediation sites.