



Advancing
Environmental
Solutions

Sustainable Resilient Remediation Training (SRR-1)

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Hosted by: US EPA Clean Up Information Network (www.clu-in.org)

Housekeeping

- ▶ Recording for On Demand Viewing

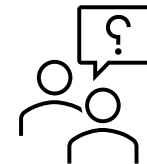


- ▶ Course Information and Materials:

<https://clu-in.org/conf/itrc/srr>



- ▶ Technical difficulties? Use Q&A Pod



- ▶ Certificate of Course Completion



ITRC – Shaping the Future of Regulatory Acceptance

- ▶ Host Organization
- ▶ Network - All 50 states, PR, DC
- ▶ Federal Partners
- ▶ ITRC Industry Affiliates Program
- ▶ Academia
- ▶ Community Stakeholders



DOE



DOD



EPA



▶ Disclaimer

- <https://srr-1.itrcweb.org/about-itrc/#disclaimer>

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Today's SRR Trainers:



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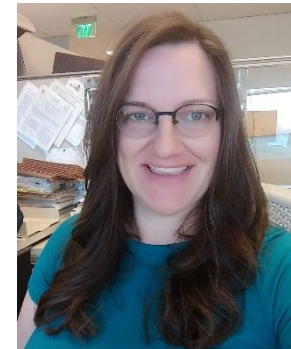
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★ Introduction

Resources, Background & Value of SRR
Economic & Social Benefits
Integrating SRR
Sustainable Best Management Practices



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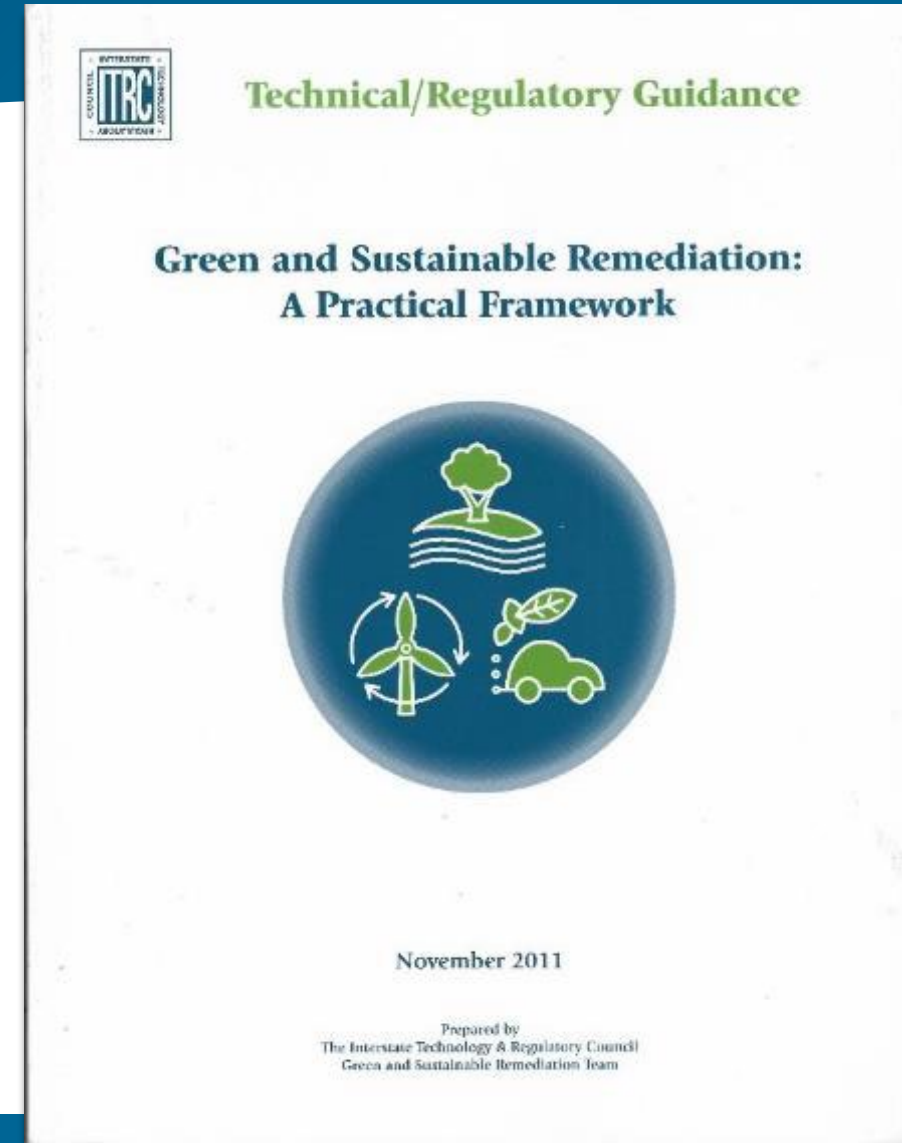
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Sustainable Resilient Remediation

- ▶ Sustainable resilient remediation (SRR) is an optimized solution to cleaning up and reusing a hazardous waste site that limits negative environmental impacts, maximizes social and economic benefits, and creates resilience against increasing threats.

Introduction

- ▶ Update of ITRC's Green and Sustainable Remediation: A Practical Framework (ITRC 2011a)
- ▶ Includes strong resilience component –increasing threat of extreme weather events, sea-level rise, & wildfires.
- ▶ Recommends consideration of social and economic costs & benefits of a cleanup along with environmental costs & benefits.



Why Sustainable Resilient Remediation

- ▶ Extreme Weather Increasing in Frequency & Magnitude:
 - Flooding
 - Hurricanes
 - Tornadoes
 - Droughts
 - Wildfires
 - Sea Levels Rising
 - Inundation
 - Erosion



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Contaminated Site Impacted by Climate Change

► Impacting Sites

- Flooding
- Fires
- Power outages
- Wind damage



Photos courtesy of Thomas O'Neill

Solutions – Sustainable Resilient Remediation

► Address Cause – Sustainability



► Address Result - Resilience



What the Report Contains

- Answers to frequently asked questions (FAQs) about SRR

Table 2-1. The value of SRR and references to case studies reflective of answers.

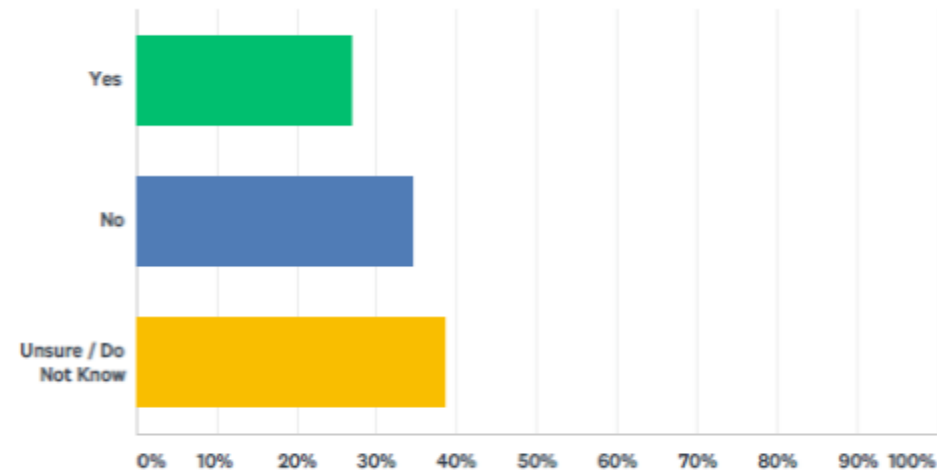
FAQ	Answer	Case Study Match(es)*
Do sustainable and resilient remedies improve long-term risk management?	Yes. Practitioners identify project risks not normally considered. Sustainable risk management includes emissions mitigation and community revitalization. Resilient risk management maximizes adaptive capacity to changing climatic conditions.	Santa Susana Field Laboratory, Area IV—used cost/risk reduction tools. Senator Joseph Finnegan Park used risk management in determining remedy scope that limits long-term risk.

What the Report Contains

- State Survey Summary: Conducted Fall 2019

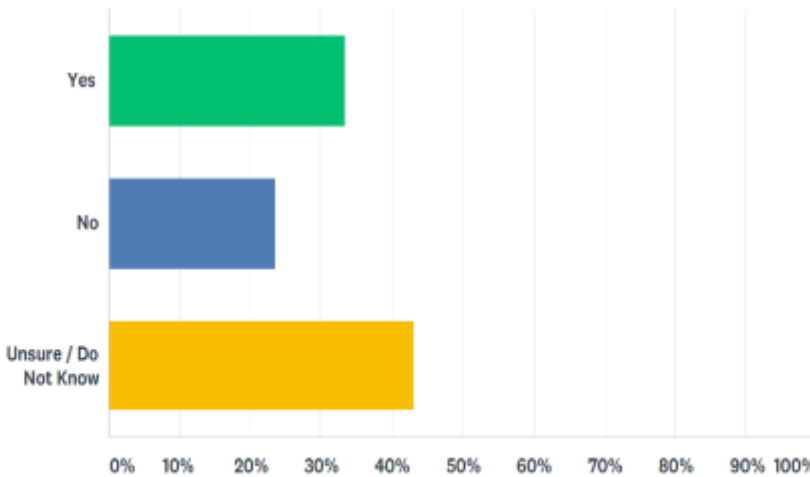
Q2 Does your state have any existing GSR regulation, policy, or guidance? (See GSR definition above)

Answered: 52 Skipped: 0



Q11 Does your state recommend/encourage GSR best management practices (BMPs) at contaminated site cleanup and redevelopment.

Answered: 51 Skipped: 1



What the Report Contains

- Online map with links to available state & federal resources to quickly find examples & best practices

Sustainable Resilient Remediation

[HOME](#)

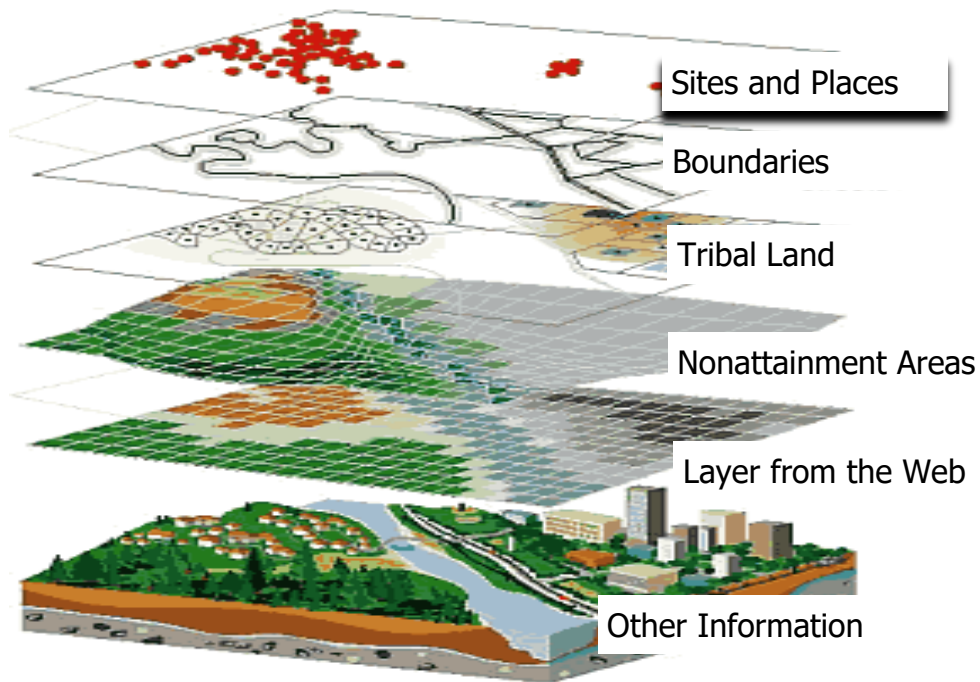
4. State Resource Map

The state resources map provides a way to locate information specific to each state. This section provides fingertip access to the building blocks of SRR, showcasing state and federal programs from around the United States.

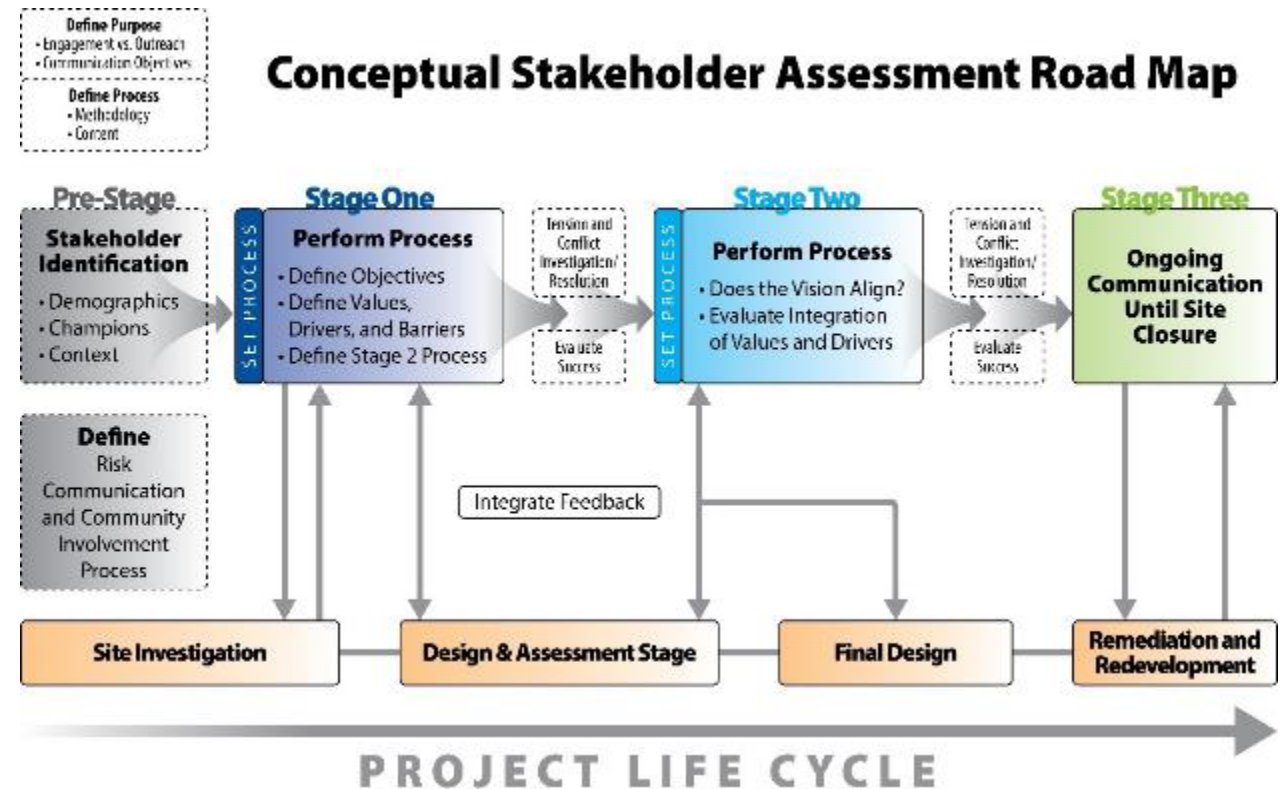


What the Report Contains

- Expanded information on resources for social & economic dimensions of sustainability

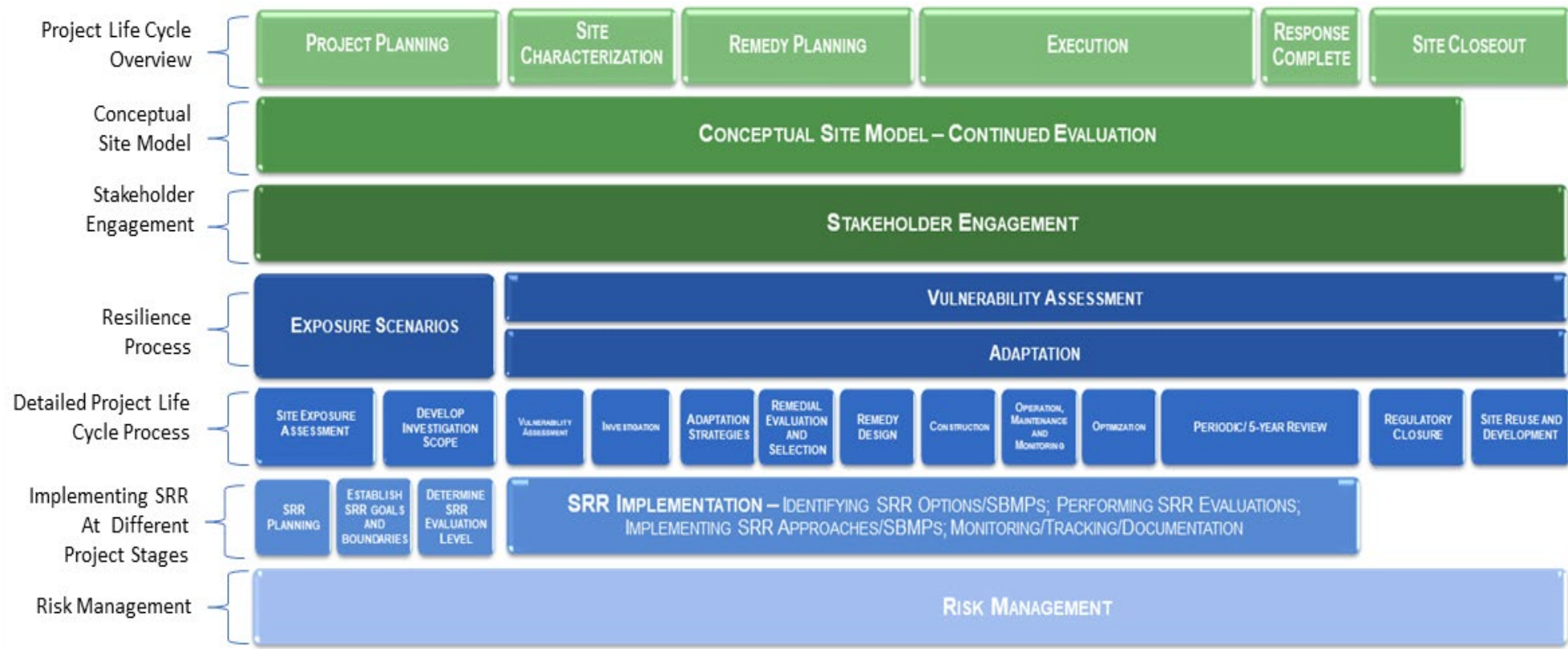


USEPA EJ Screen



What the Report Contains

- An updated framework that illustrates how and why sustainability and resilience should be integrated throughout the remedial project life cycle



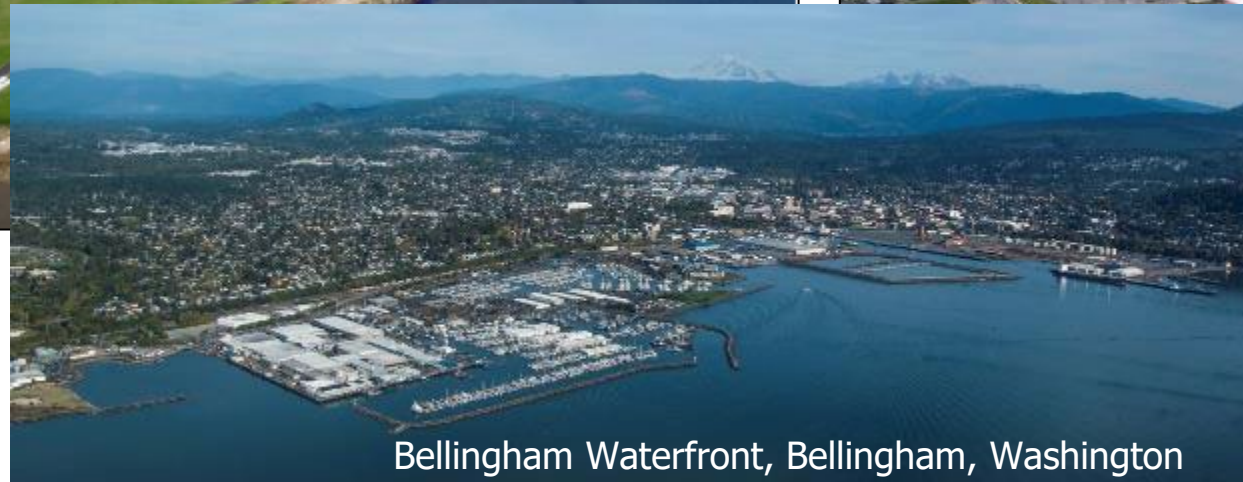
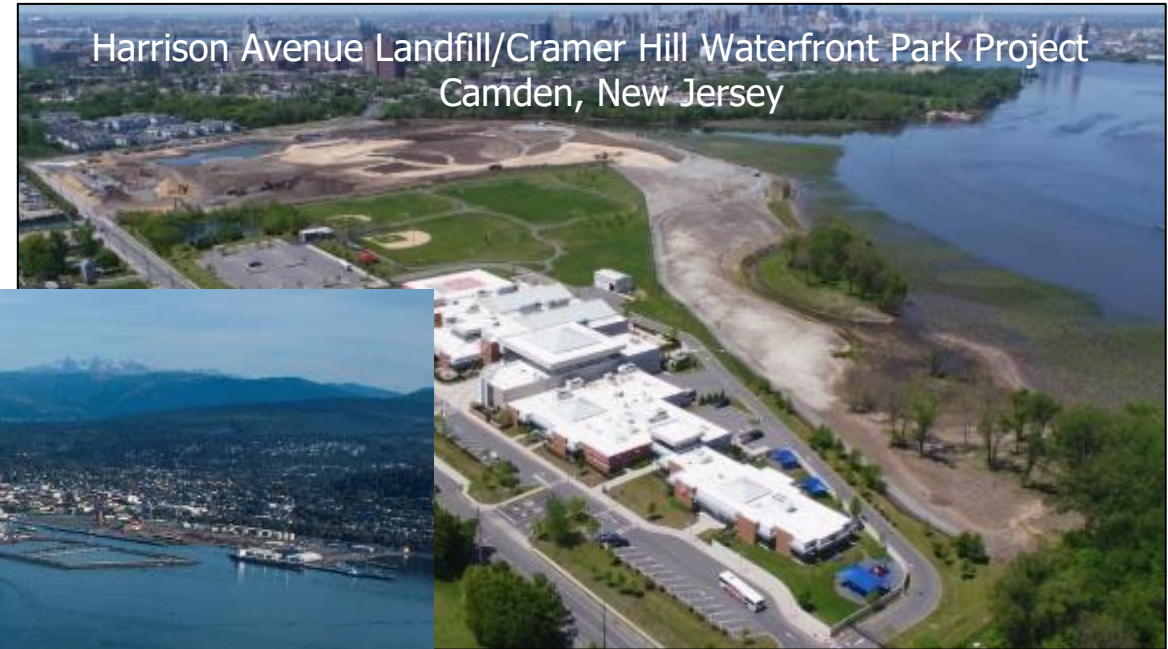
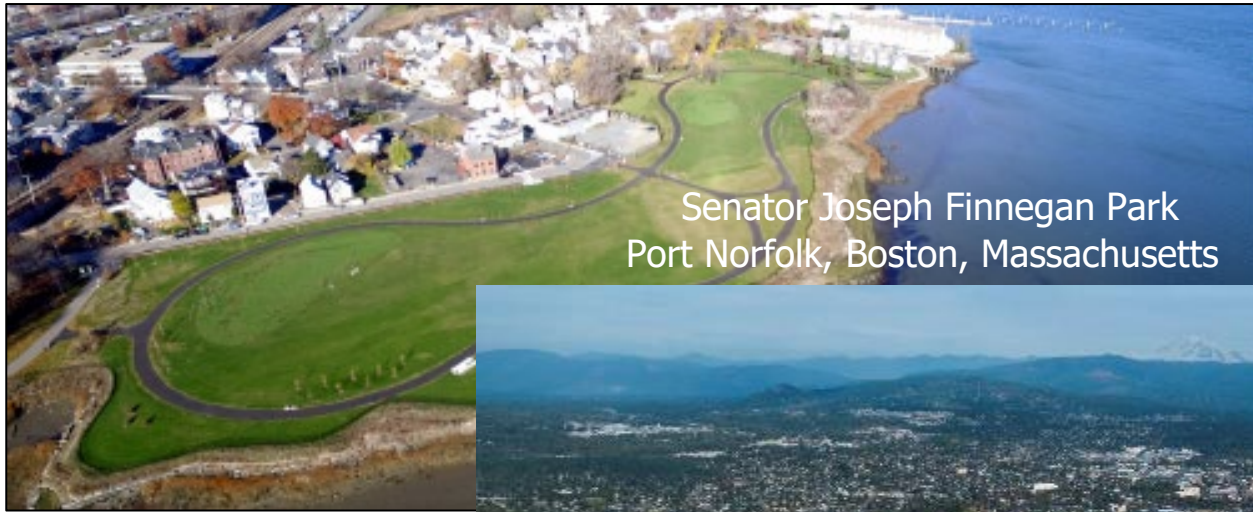
What the Report Contains

► Appendix D. Sustainable Best Management Practice Checklists

A	B	C	D	E	F	G
APPLICABLE?		COMPLETE?		Extreme Event or Impact	SBMP	Description
Y	N	Y	N			
Y				Universal	Whenever possible use green infrastructure and natural solutions such as native plantings over impervious, man-made solutions. Green infrastructure and natural solutions are typically more resilient. Native plantings should be native to the existing climate with tolerances for the types of climate events the site is likely to experience in the near future.	Remedy Design and Implementation
Y	N			Universal	Generate primary or secondary power from on-site renewable resources independent of the utility grid. It is important to note that during extreme climate scenarios, even green infrastructure may not be sufficiently resilient to withstand weather extremes.	Remedy Design and Implementation
	N			Universal	Integrate electronic devices for remote control of equipment during extreme weather or wildfires.	Remedy Design and Implementation
	N			Universal	Integrate sensors linked to electronic control devices to trigger either shutdown of equipment or an alarm to alert workers to shut down equipment.	Remedy Design and Implementation
Y				Universal	Move or locate remedy components away from potential danger zones (USEPA 2013).	Remedy Design and Implementation
Y				Universal	Stormproof infrastructure by repairing, retrofitting, or relocating facilities and equipment to prevent damage and disruptions during extreme weather or wildfire events.	Remedy Design and Implementation
Y				Universal	Document SBMPs implemented in completion reports.	Remedy Design and Implementation
Y				Universal	Evaluate the performance of the SBMPs in place following an extreme event	Operation, Maintenance & Monitoring
Y				Universal	Include maintenance of the SBMPs in the site OM&M Plan and evaluate that the SBMPs are properly maintained	Operation, Maintenance & Monitoring
Y				Universal	Regularly update the vulnerability assessment and adapt SBMP implementation to match any changing site conditions	Operation, Maintenance & Monitoring
					Review the CSM on a defined and regular basis to determine if adaptations to remedy design and	

What the Report Contains

- Case studies illustrating the application of SRR considerations



What the Report Contains

Future Recommendations

- Economic/social/environmental balance at local level
- Risk management implementation (use more relevant local information)
- Demonstrated value from SRR techniques
- Research & focus on adaptive capacity
- Metrics development to track progress SRR actions & goals
- Guidance/standardized methods for conducting vulnerability assessments
- Case studies of intentional resiliency implementation
- Periodic site reviews that include an evaluation of resiliency
- Greater focus on SRR in site design phase



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Introduction

★ **Resources, Background & Value of SRR**

Economic & Social Benefits

Integrating SRR

Sustainable Best Management Practices



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See Section 1 Introduction of the SRR Webpage Document

SRR Resources

- ▶ Frequently Asked Questions (FAQs) – Section 2
- ▶ Case Studies
 - Case Study Matrix – Section 2 and Appendix A
 - Advancing the Practice: Social and Economic Dimensions of Sustainability and Resilience – Section 5
- ▶ Tech Sheets for Selected State Resources – Section 3 and Appendix C
- ▶ State Resources Map – Section 4
- ▶ Sustainable Resilience Remediation Framework – Section 6
- ▶ Sustainable Best Management Practice Checklist – Section 7 and Appendix D

Use Resources to Learn and Navigate

SRR Resources – State Resources Map (Section 4)

- ▶ Climate Resilience
- ▶ Green and Sustainable Remediation (GSR)
- ▶ Wildfire Resilience
- ▶ Examples of the information you will find:
 - Laws and regulations
 - Executive orders (EOs) state and federal
 - Policy and guidance
 - Other resources
 - State case studies
 - Federal resources

Sustainable Resilient Remediation

[HOME](#)


4. State Resource Map

The state resources map provides a way to locate information specific to each state. This section provides fingertip access to the building blocks of SRR, showcasing state and federal programs from around the United States.



Figure 4-1. Interactive State Resource Map

SRR Resources – State Resources Map



Search this website

1. Introduction

2. Importance and Value of Sustainable Resilient Remediation

3. Perspectives


4. State Resource Map

5. Advancing the Practice: Social and Economic Dimensions of Sustainability and Resilience

6. Integrating Resilience and Sustainability into the Remedial Project Life Cycle

7. Key Sustainable Best Management Practices for Sustainable Resilience to Extreme Weather Events

The state resources map provides a way to locate information specific to each state. This section provides fingertip access to the building blocks of SRR, showcasing state and federal programs from around the United States.



Have updated information?
Click to submit!

Key to State Resources






Laws and Regulations
(Statutes, Regulations, Rules)

Executive Order

Policy/Guidance

Resources
(Plans and Strategies, Reports, Websites)

Case Study





SRR Resources – State Resources Map



Figure 4-1. Interactive State Resource Map

Source: ITRC SRR Team

SRR Resources – State Resources Map

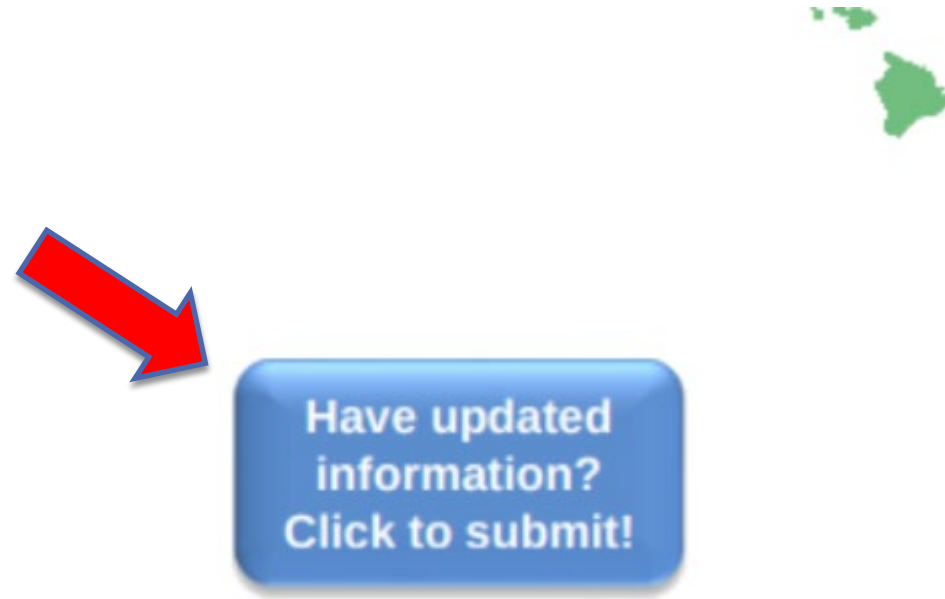


Figure 4-1. Interactive State Resource Map
Source: ITRC SRR Team

SRR Resources – State Resources Map

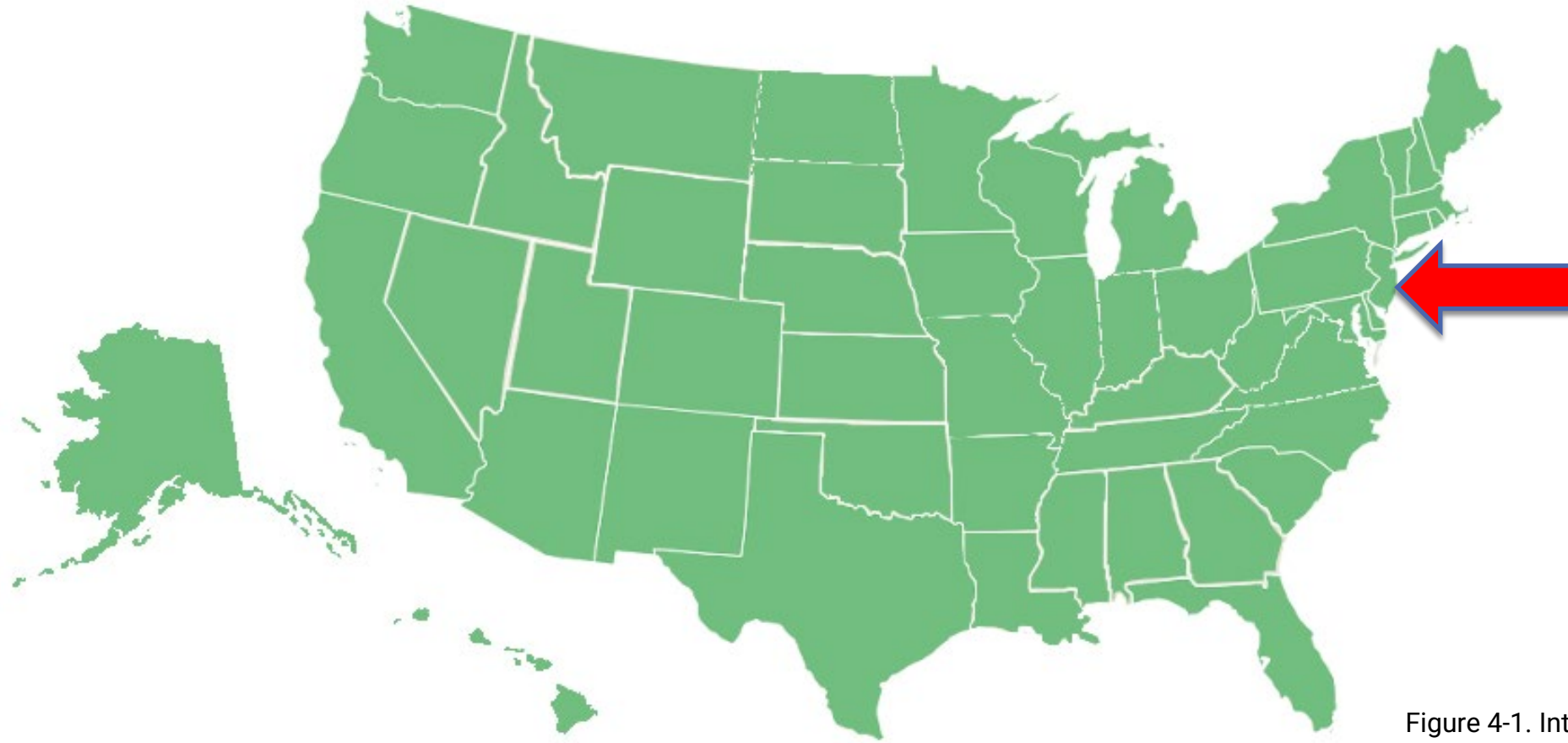


Figure 4-1. Interactive State Resource Map
Source: ITRC SRR Team

SRR Resources – State Resources Map



Figure 4-1. Interactive State Resource Map
Source: ITRC SRR Team

SRR Resources – State Resources Map

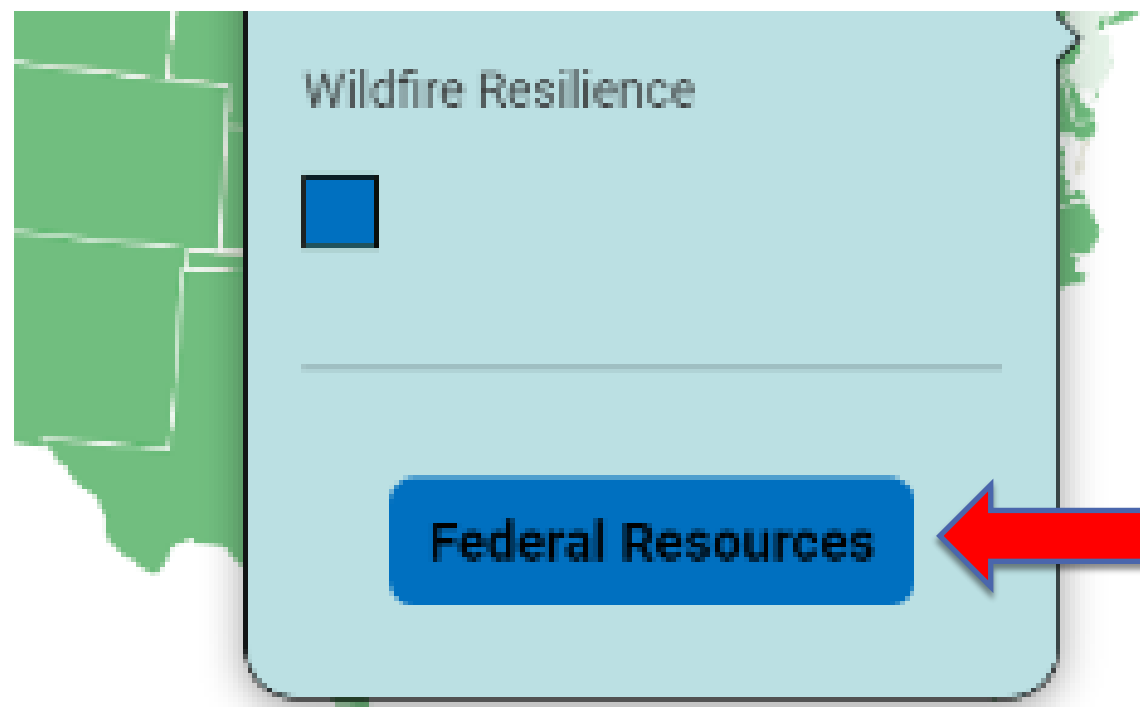


Figure 4-1. Interactive State Resource Map
Source: ITRC SRR Team

SRR Resources – State Resources Map



Figure 4-1. Interactive State Resource Map
Source: ITRC SRR Team

SRR Resources – State Resources Map

New Jersey

Sustainable and Resilient Remediation

Regulation / Statute

Remediation legislation approved in 2019 that establishes in law that the NJDEP shall encourage the use of green and sustainable practices during site remediation.

<https://www.njleg.state.nj.us>

https://www.njleg.state.nj.us/2018/Bills/AL19/263_.PDF

SRR Resources – Case Studies

- Case Studies in Section 5: Advancing the Practice: Social and Economic Dimensions of Sustainability and Resilience

Harrison Avenue Landfill/Cramer Hill Waterfront Park Project Camden, New Jersey



Figure 5-9. Conceptual graphic of the waterfront park

Source: www.nj.gov/dep/nrr/cramer-hill.htm

SRR Resources – Life Cycle & Framework Integration

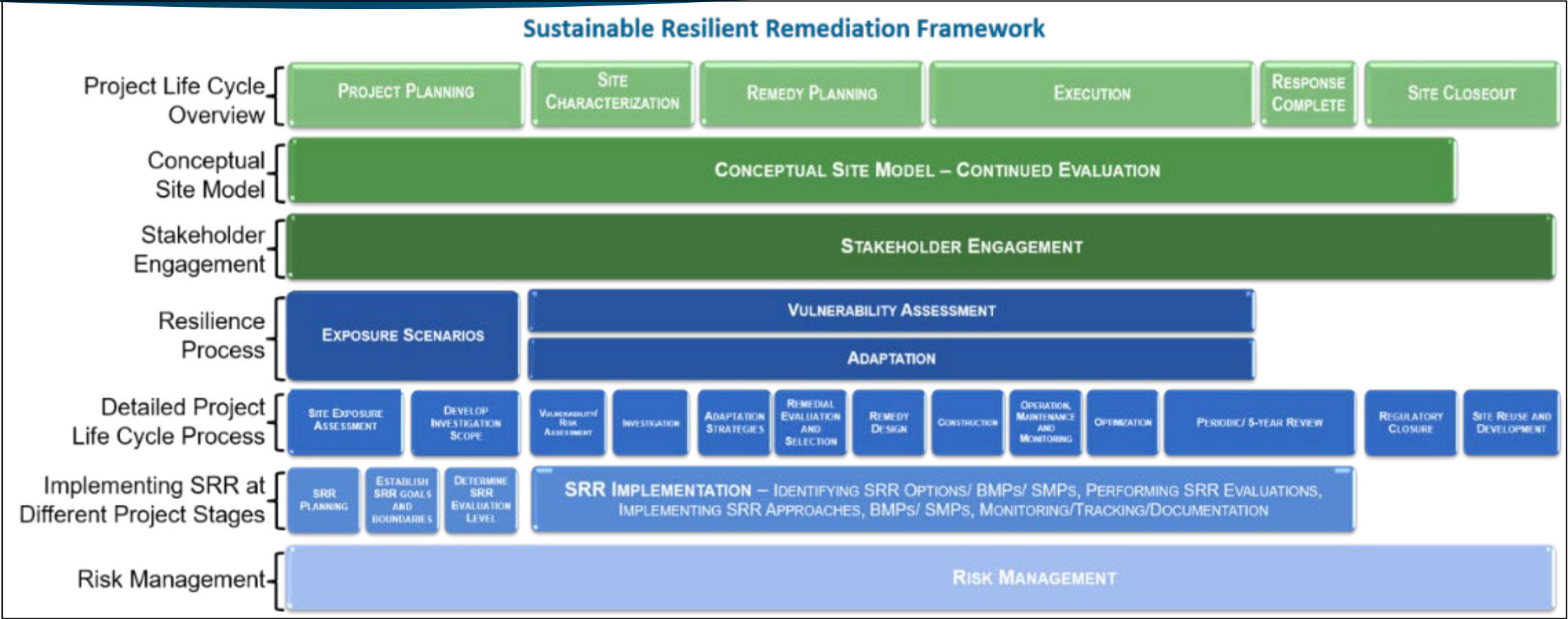


Figure 6-1. SRR framework. Source: ITRC SRR Team

SRR Resources – Life Cycle & Framework Integration

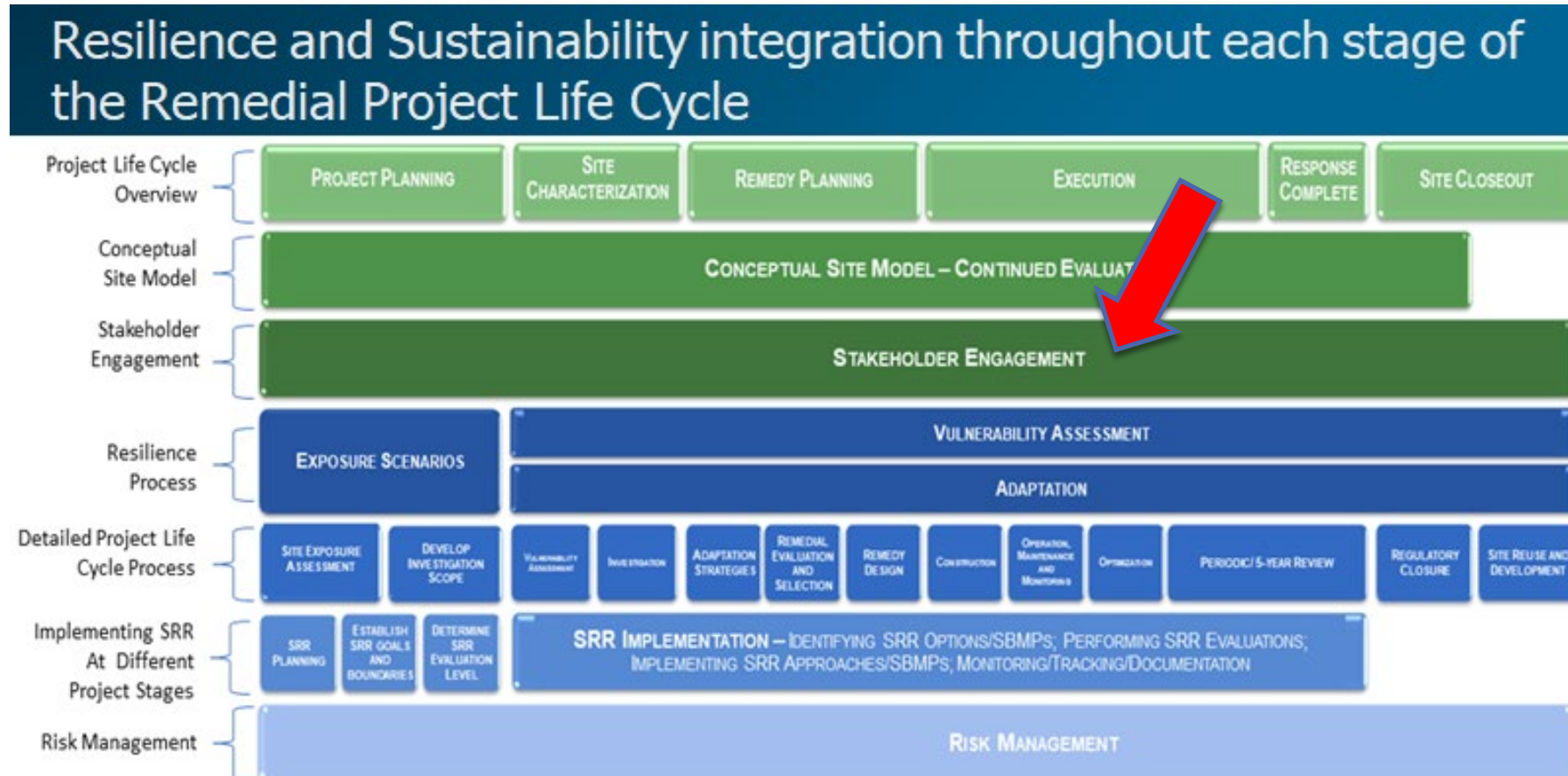


Figure 6-1. SRR framework. Source: ITRC SRR Team

SRR Resources – Life Cycle & Framework Integration

[Return to Framework](#)

6.1.2 Stakeholder Engagement

The social dimension of SRR includes consideration of critical stakeholder needs and concerns (often called stakeholder values). In this context, site-specific objectives, goals, and processes for an SRR assessment are informed by multiple stakeholder values ([Cundy et al. 2013](#)). Project stakeholders can include emergency personnel, utility providers, and hazardous waste management specialists ([Kumar and Reddy 2020](#)). Transforming sustainable, resilient benefits and mitigating unintended impacts to **environmental justice** ([Section 5.2](#)) and other underserved communities are core components of SRR **risk management** ([Section 6.1.6](#)).

SRR Resources – Life Cycle & Framework Integration

6.1.2 Stakeholder Engagement

[Return to Framework](#)



The social dimension of SRR includes consideration of critical stakeholder needs and concerns (often called stakeholder values). In this context, site-specific objectives, goals, and processes for an SRR assessment are informed by multiple stakeholder values ([Cundy et al. 2013](#)). Project stakeholders can include emergency personnel, utility providers, and hazardous waste management specialists ([Kumar and Reddy 2020](#)). Transforming sustainable, resilient benefits and mitigating unintended impacts to **environmental justice** ([Section 5.2](#)) and other underserved communities are core components of SRR **risk management** ([Section 6.1.6](#)).

SRR Resources

Case Study Matrix

Section 2; Appendix A

Frequently Asked Questions

Section 2.2

Tech Sheets

Appendix C

Sustainable BMP Checklists

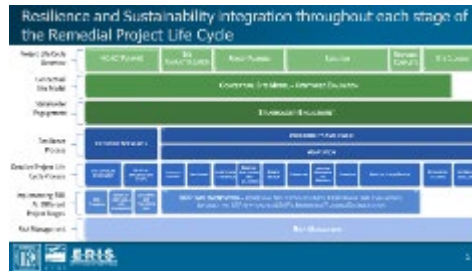
Section 7; Appendix D

SRR Resources Summary

- ▶ Frequently Asked Questions (Section 2)
- ▶ Case Studies (Section 2; Appendix A, and Section 5.10)
- ▶ Tech Sheets for Selected State Resources (Section 3 and Appendix C)
- ▶ State Resources Map (Section 4)
- ▶ Sustainable Resilience Remediation Framework (Section 6)
- ▶ Sustainable Best Management Practice Checklists (Section 7 and Appendix D)



State Resource Map



SRR Framework



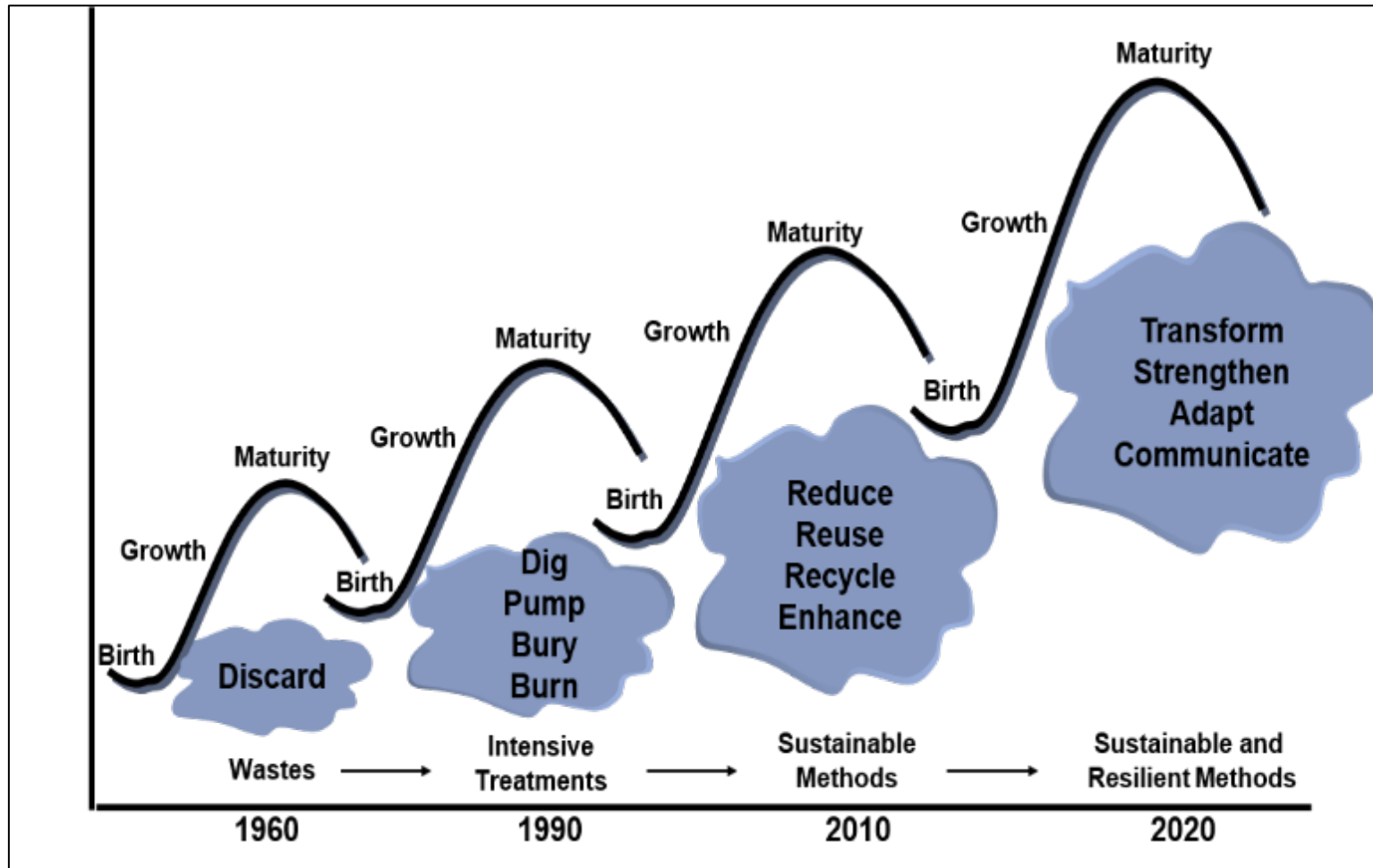
Case Studies

SRR – History, Importance and Value

- ▶ Background, Context, History
- ▶ Extreme Weather Events, Sea-Level Rise, & Wildfires
 - Impacts to integrity of environmental remediation solutions and, in turn, the public health and environment of the surrounding communities
- ▶ Case Study Matrix
- ▶ Frequently Asked Question (FAQs) Answers

Use SRR Value to Educate Others

Evolution of Environmental Remediation to SRR



Document Figure 2-1. Evolution of environmental remediation to SRR. *Source: Adapted from Ellis and Hadley (2009).*

SRR Sustainability Principles and Practices

Start of Sustainable and Resilient Remediation

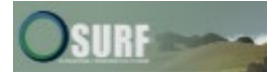
US EPA
2008



Green Remediation:
Incorporating Sustainable
Practices into Remediation of
Contaminated Sites



SURF
2009



Sustainable Remediation
White Paper—Integrating
Sustainable Principles,
Practices, and Metrics into
Remediation Projects



ITRC
2011



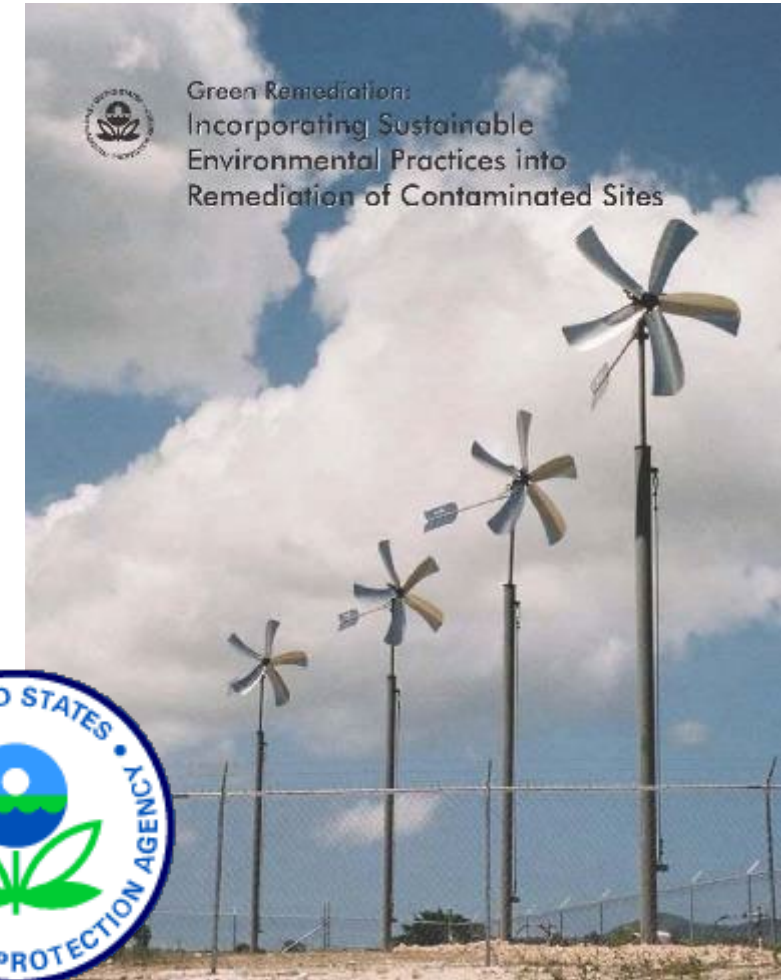
Overview Document: Green
and Sustainable Remediation:
State of the Science and
Practice

Technical & Regulatory
Guidance: Green and
Sustainable Remediation: A
Practical Framework

SRR Sustainability Principles and Practices

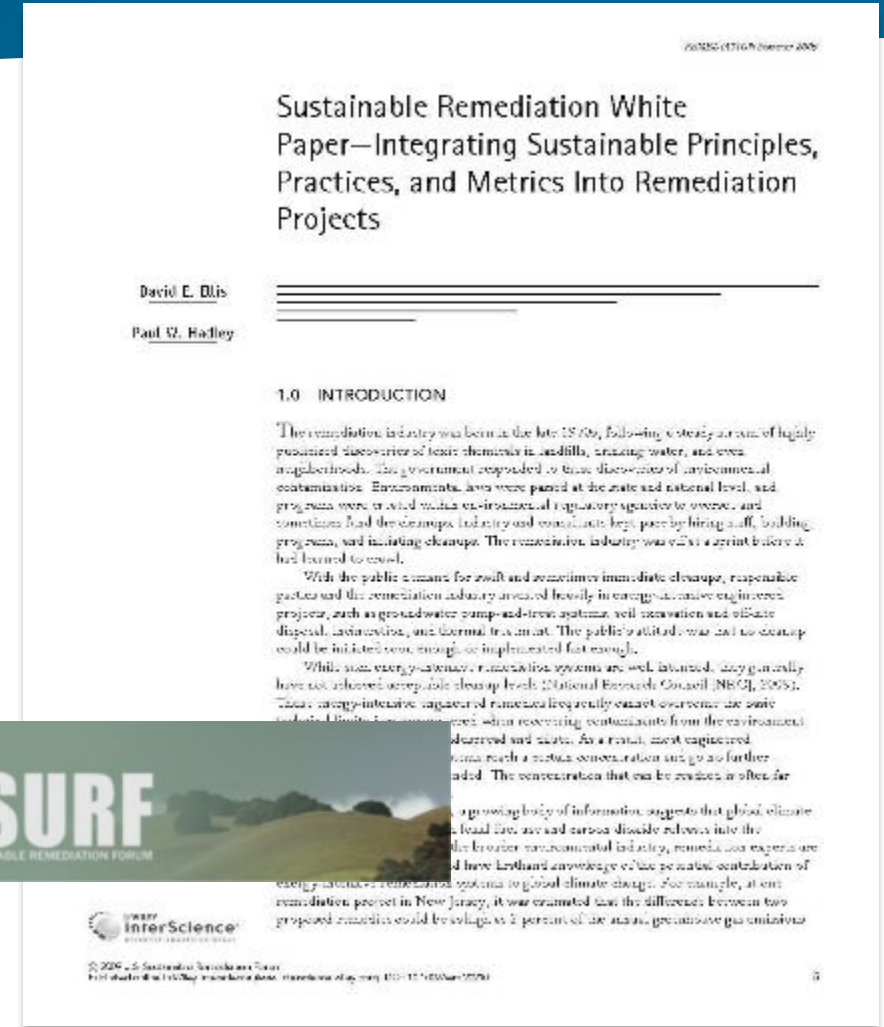
Start of Sustainable and Resilient Remediation

- ▶ USEPA (2008): [Green Remediation: Incorporating Sustainable Practices into Remediation of Contaminated Sites](#)



SRR Sustainability Principles and Practices

► Sustainable Remediation Forum (SURF) (2009) Integrating Sustainable Principles, Practices, and Metrics into Remediation Projects



SRR Sustainability Principles and Practices

- ▶ Technology Overview Document:
Green and Sustainable Remediation:
State of the Science and Practice
(May 2011)
- ▶ Technical and Regulatory Guidance:
Green and Sustainable Remediation:
A Practical Framework
(November 2011)



Why is SRR valuable?

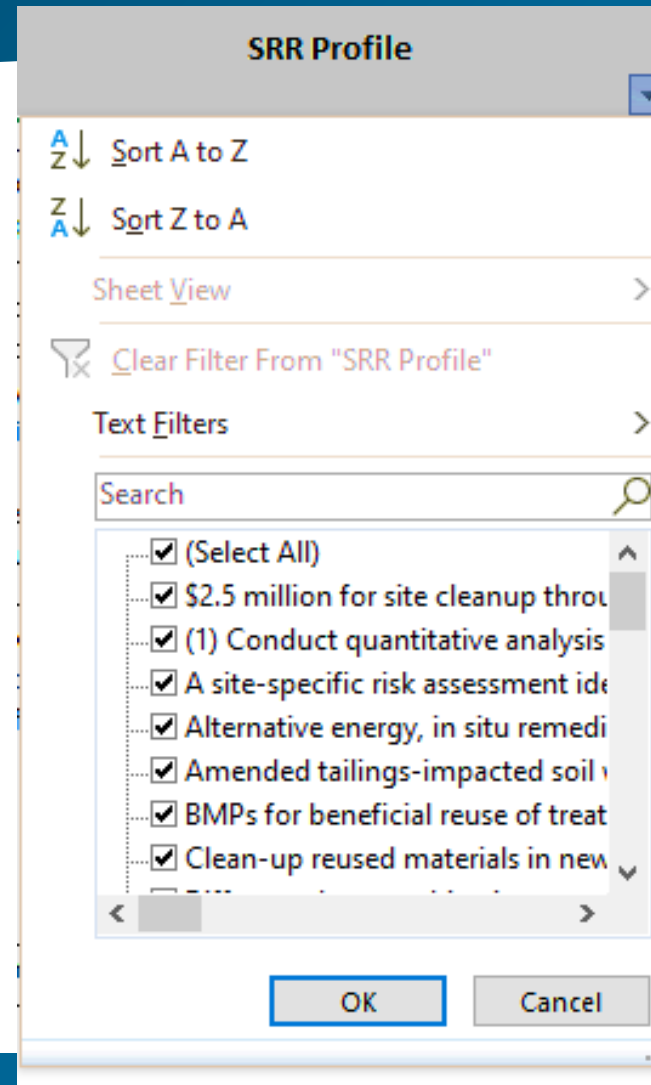
“...60% of all nonfederal NPL sites are in areas that may be impacted by flooding, storm surge, wildfires, and/or sea-level rise.” GAO, 2019

- ▶ Resilience measures have favorable economic returns on investment (NIBS 2018)
- ▶ Environmental impacts can add costs to the clean up
- ▶ Social impacts include the need to spend more after environmental impacts to restore communities to whole

Importance and Value – Case Studies

► What you will find in the case studies:

- Name, Location
- Overview of remediation activities
- Elements of SRR performed at that site
- Offset/avoidance achieved
- Tools used to support SRR work
- References and links
- Regulatory program(s)



The screenshot shows a dialog box titled "SRR Profile". It contains several sections: "Sort A to Z" and "Sort Z to A" with arrows, a "Sheet View" section with a right arrow, a "Clear Filter From 'SRR Profile'" button, and a "Text Filters" section with a right arrow. Below these is a "Search" field with a magnifying glass icon. A list of items is shown with checkboxes, all of which are checked: "(Select All)", "\$2.5 million for site cleanup thro", "(1) Conduct quantitative analysis", "A site-specific risk assessment ide", "Alternative energy, in situ remedi", "Amended tailings-impacted soil", "BMPs for beneficial reuse of treat", and "Clean-up reused materials in new". At the bottom are "OK" and "Cancel" buttons.

Appendix A. Case Studies
in Sustainable Resilient
Remediation

Importance and Value

SRR IS Important & HAS Value

- ▶ Making sure that remediation is successful
- ▶ Ensuring that valuable resources are not wasted by poor planning
- ▶ Promoting social and economic benefits

“...sustainability considers the remedy’s impact on the environment, resilience considers the environment’s impact on the remedy...” ITRC, SRR-1

Photos Courtesy of the NJDEP



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Introduction

Resources, History & Value of SRR

★ **Social & Economic Evaluations & Benefits**

Integrating SRR

Sustainable Best Management Practices



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Understand the Social & Economic Dimensions of SRR

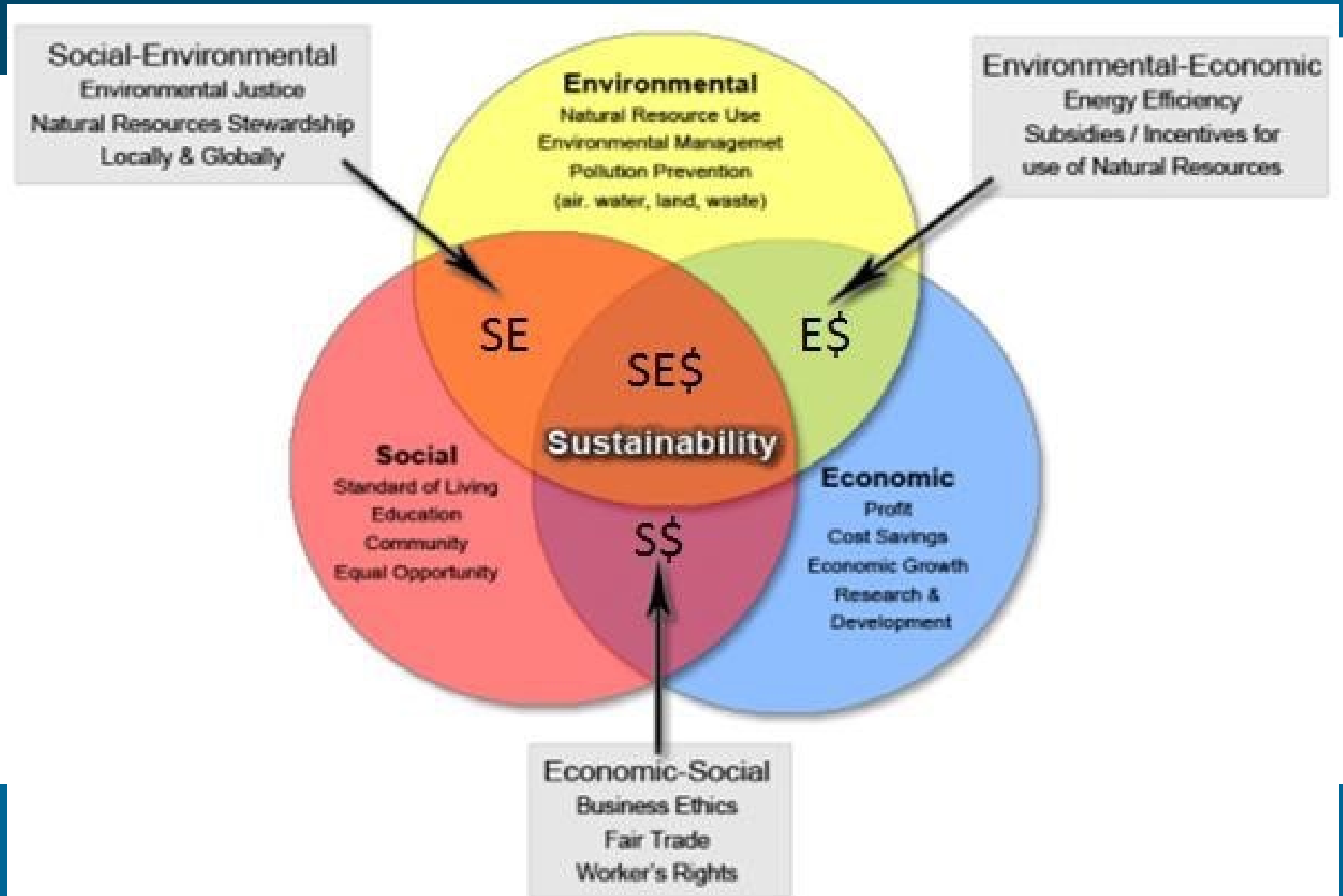
- ▶ Social & economic impacts of remediation on communities
- ▶ Environmental justice
- ▶ Outcomes linked to metrics or progress indicators
- ▶ Sustainability & resilience into brownfield sites
- ▶ Social & economic SRR evaluations
- ▶ Ecosystem services
- ▶ Case studies

Use Metrics & Indicators to Document

Sustainable resilient remediation is an optimized solution to cleaning up and reusing contaminated sites that, among other things, maximizes social and economic benefits.



The Three Pillars of Sustainability



Courtesy of USEPA

Considering Social & Economic Impacts of Remediation on Communities

- ▶ SRR is more than an environmental concept that asks us to be efficient with resources
- ▶ Project teams must also consider the impacts of the cleanup on communities
- ▶ SRR requires the:
 - Gathering of community data as well as environmental data
 - Consideration how a site or its cleanup might differently affect different communities
 - Balance among the three pillars of sustainability (environmental, social, & economic)

Stakeholder Engagement

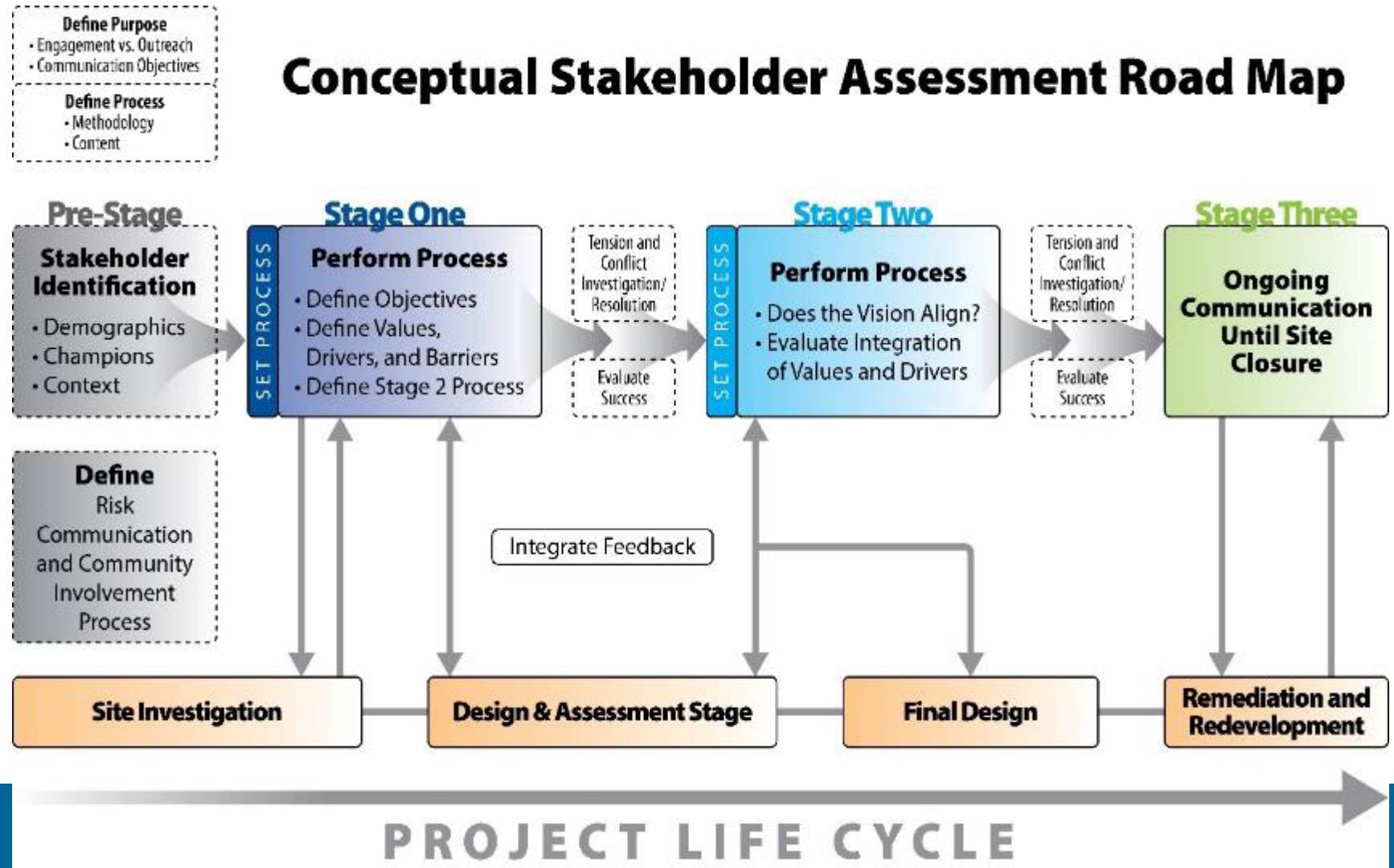


Figure 5-5. Conceptual stakeholder assessment road map.
Source: *Ridsdale and Harclerode (2019)*. Used with permission.

Environmental Justice

The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.

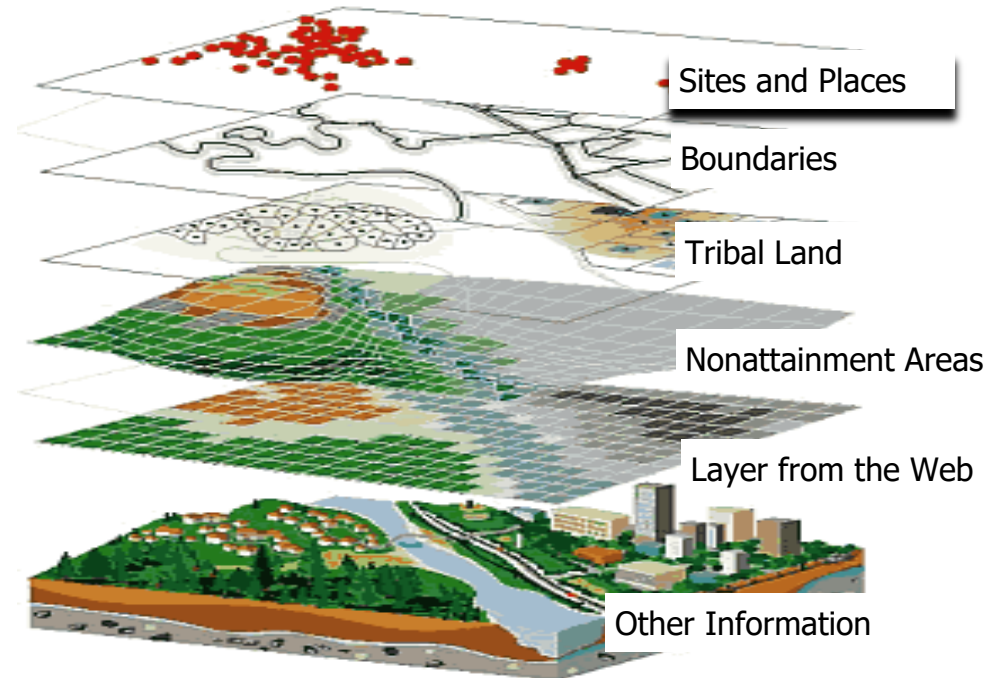
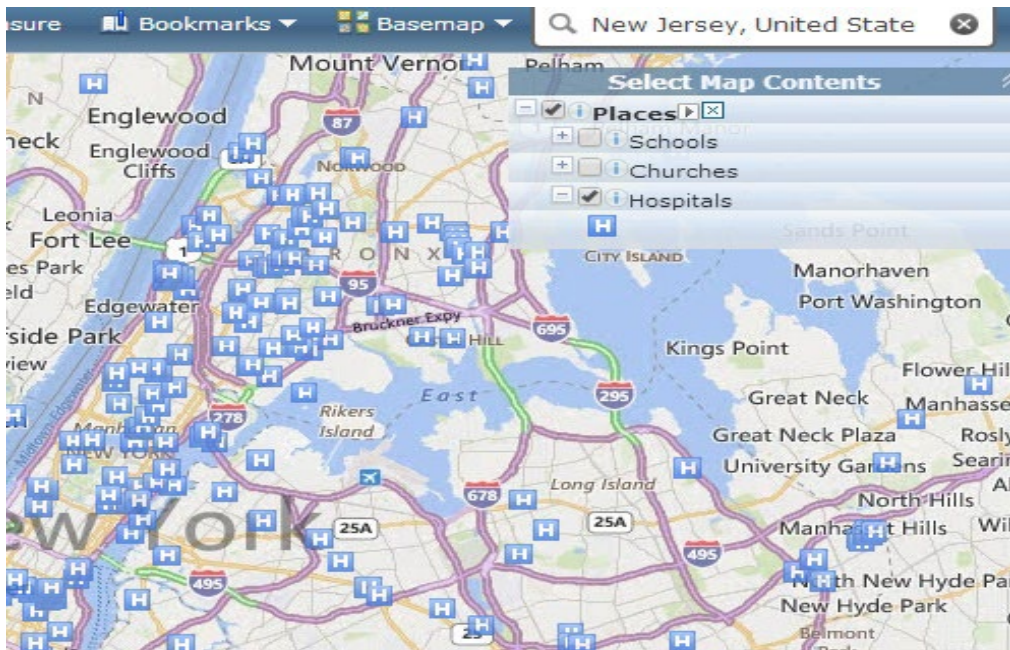


Fair Treatment

Meaningful Involvement

EJ Screen

- USEPA EJ Screen: <https://www.epa.gov/ejscreen>



Section 5.2: Special Considerations for Low-Income and Minority Communities

State Environmental Justice Resources Examples

California: CalEnviroScreen 3.0, California Office of Environmental Health Hazard Assessment

Maryland: MD EJScreen, Community Engagement, Environmental Justice, & Health

Washington: Washington Tracking Network, Washington State Department of Health

New Jersey: <https://www.nj.gov/dep/ej/>

Social and Economic Evaluations Levels

Level 1 (Sustainable Best Practices):

Adopt and incorporate those social and economic BMPs that promote quality-of-life improvements and mitigate unintended impacts that directly affect the community and indirectly affect broader society.

Level 2:

Combines the selection and implementation of SBMPs with some degree of qualitative or semi-quantitative evaluation.

Level 3:

Combines the selection and implementation of SBMPs with a rigorous quantitative evaluation.

Both Level 2 & 3 assess how site cleanup and restoration activities may result in beneficial or unintended social, economic, and environmental impacts.

Social and Economic Evaluations for SRR



Level 1 Evaluation

Identify and Adopt
Sustainable Best Practices

Social and Economic Evaluations for SRR



Level 2 Evaluation

Combines selection & implementation of SBMPs with some qualitative or semi-quantitative evaluation

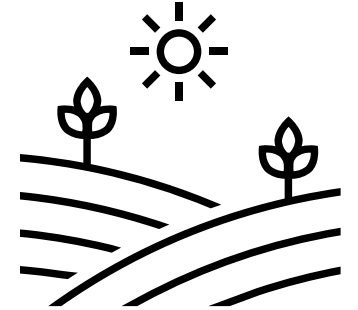
Social and Economic Evaluations for SRR

Level 3 Evaluation

Combines selection & implementation of SBMPs with rigorous quantitative evaluation

Linking Desired Outcomes to Metrics

- ▶ Develop cleanup/remedial options that fit the needs of:
 - Site conditions
 - Site reuse
 - Community concerns
- ▶ Examples include:
 - Addressing contamination that poses a risk to human health or the environment
 - Incorporating resilient technologies that addresses and even mitigates future impacts of climate change
 - Addressing contamination that migrates off site
 - Developing remedy options that allow for sustainable reuse



Brownfields: Incorporating Sustainability & Resilience

- ▶ Redevelopment can lead to healthier more economically secure communities.
- ▶ Can play important role in addressing climate change threats and strengthening the community by incorporating sustainability and resiliency into the remediation and redevelopment processes.
- ▶ The Climate Smart Brownfield Manual is one resource that provides a comprehensive approach for communities to think about climate mitigation, adaptation, and resilience for the redevelopment of Brownfields.

Ecosystem Services

► All the processes and outputs provided by nature:

- Provisioning services (food, fuel, water)
- Regulating services (air quality, fresh water)
- Supporting services (soil formation, photosynthesis)
- Cultural services (recreation and tourism)



Ecosystem System Services, cont.

- ▶ ES can provide a profound enhancement to any assessment because they bridge the ecosystem-human health divide
- ▶ Incorporating ES into the ecological risk assessment process has the potential to improve the environmental and socio-economic outcomes of contaminated site cleanup
- ▶ Over the last three years, one of EPA's priorities was to focus on incorporating ES into remediation, restoration, and revitalization of degraded areas.

Ecosystem Services, cont.

- ▶ To that end, a workgroup of EPA's Ecological Risk Assessment Forum prepared a report that:
 - ▶ (1) introduces EPA's ES-based concepts and tools;
 - ▶ (2) explores potential ways to incorporate ES in ecological risk assessments at contaminated site investigations; and
 - ▶ (3) uses a hypothetical case study to delineate how ES-based tools can be used and/or support measurement and assessment endpoints that are incorporated in the ecological risk assessments of hazardous site investigations.

Ecosystem Services, cont.

- ▶ Ecosystem services assessment tools help you describe, quantify, and sustain the benefits nature offers humans and weigh the impact of decisions.
- ▶ EPA's tool portal helps select the best tools for your scenario.
- ▶ EPA's Ecosystem Services (ES) Tool Selection Portal: <https://d1fdbfnpwly4te.cloudfront.net/paths>
- ▶ Operationalizing Ecosystem Services Endpoints and Assessment Tools for Supporting Risk Assessments in Contaminated Site Cleanups:
 - ▶ https://cfpub.epa.gov/si/si_public_file_download.cfm?p_download_id=546731&Lab=CPHEA

Case Study: Phoenix Park (Camden, New Jersey)



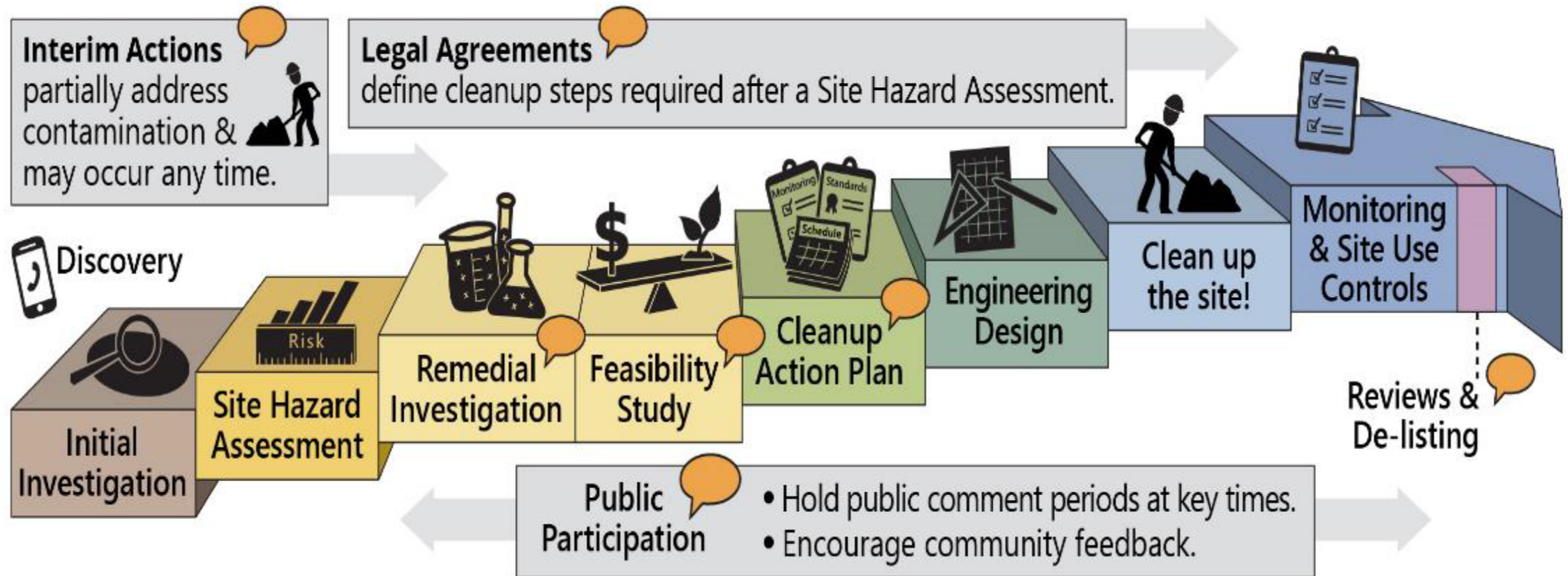
Before

Photos Courtesy of the NJDEP

After



Case Study: Bellingham Bay, Washington



Courtesy of Washington State Department of Ecology

Case Study: Bellingham Bay, Washington



Before

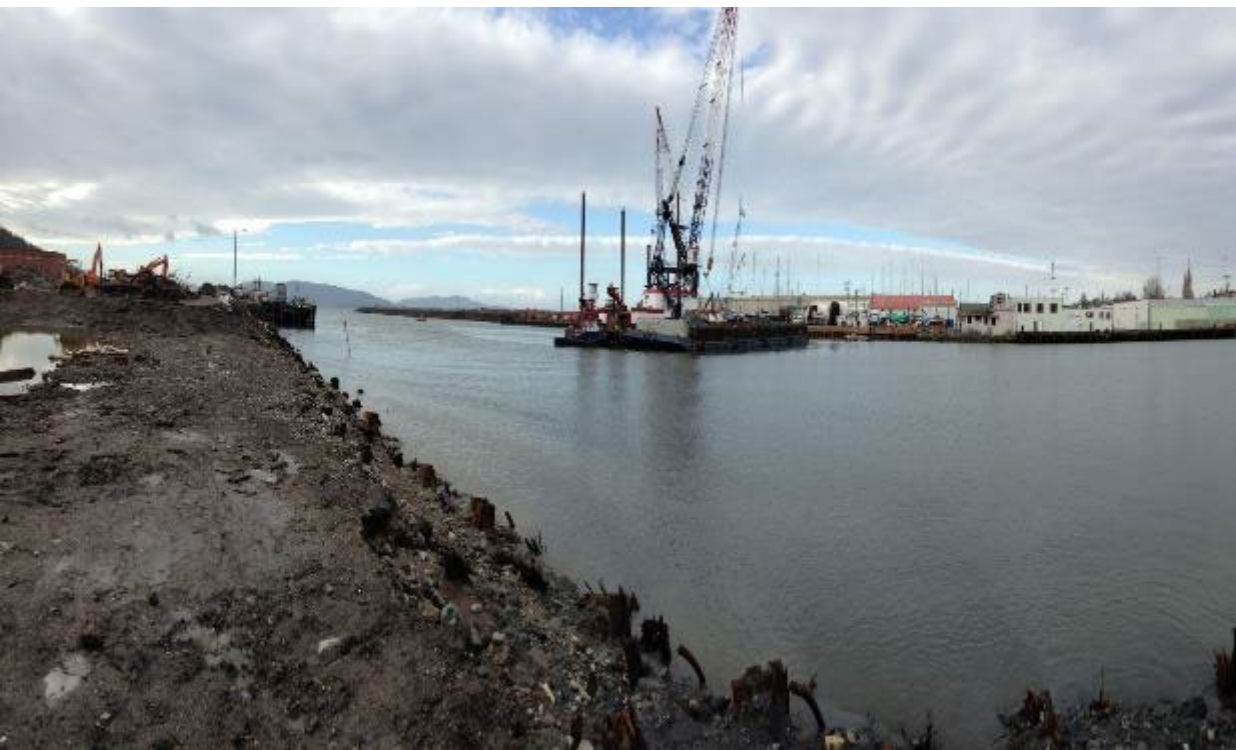
Cleanup Areas



After

Courtesy of Washington State Department of Ecology

Case Study: Bellingham Bay, Washington



Before



After

Waypoint Park

Courtesy of Washington State Department of Ecology

Summary



Collect Data



**Engage
Community**



**Think About
Future &
Resilience**



**Don't Forget
Ecosystem
Services**



**Make World
Better Place**

Questions?

Please use the Q&A Pod to submit questions.





Advancing
Environmental
Solutions

Introduction

Resources, History & Value of SRR

Social & Economic Evaluations & Benefits

★ **Integrating SRR**

Sustainable Best Management Practices



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Integrating SRR Key Concepts



**Integrate “Social”
considerations
through
stakeholder
engagement**



**Consider
natural
resource
utilization
throughout
project**

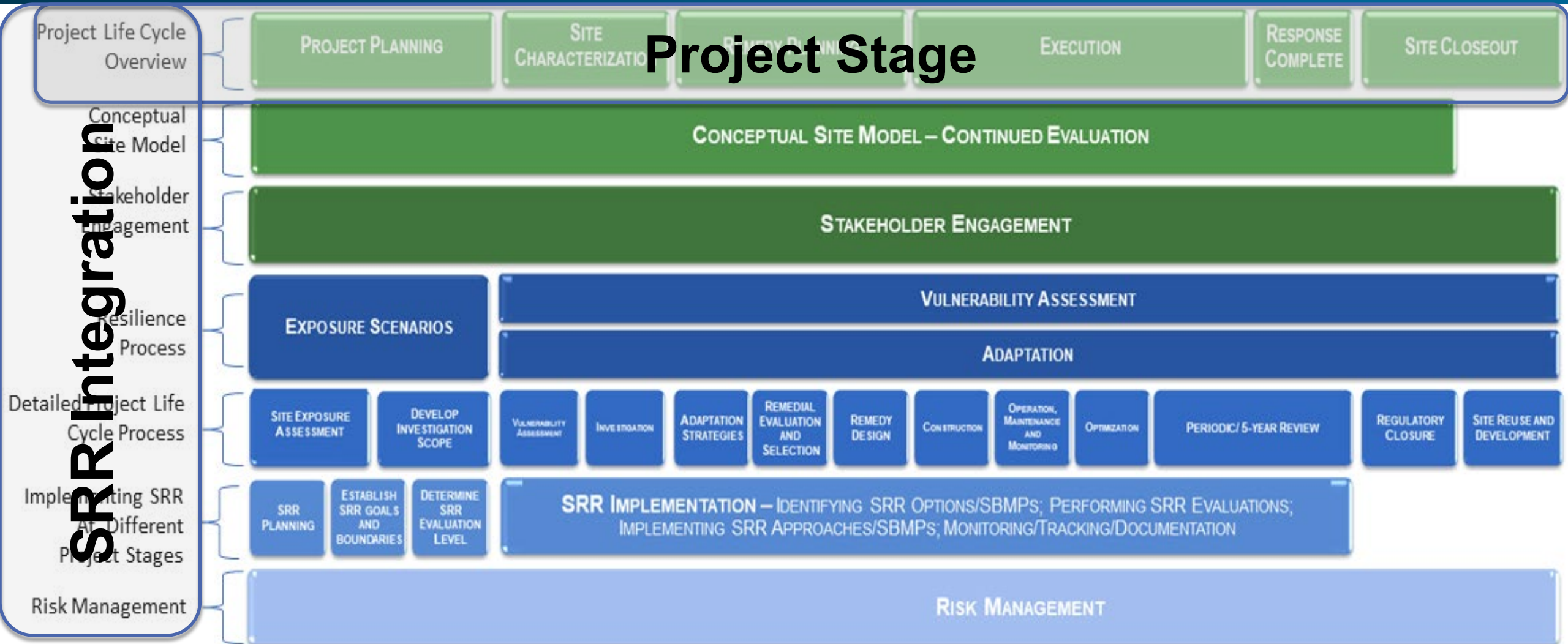


**Seek ways to
continuously
improve
carbon
footprint**



**Address
vulnerability to
changing
climate,
weather and
fire hazards**

SRR Integration throughout each stage of the Remedial Project Life Cycle



Project Planning – starts with the SRR Conceptual Site Model

- ▶ Considers variability of climate & wildfire threats
- ▶ Seeks stakeholder engagement
- ▶ Integrates threats and stakeholder concerns into remedy
- ▶ Updated throughout remedy implementation

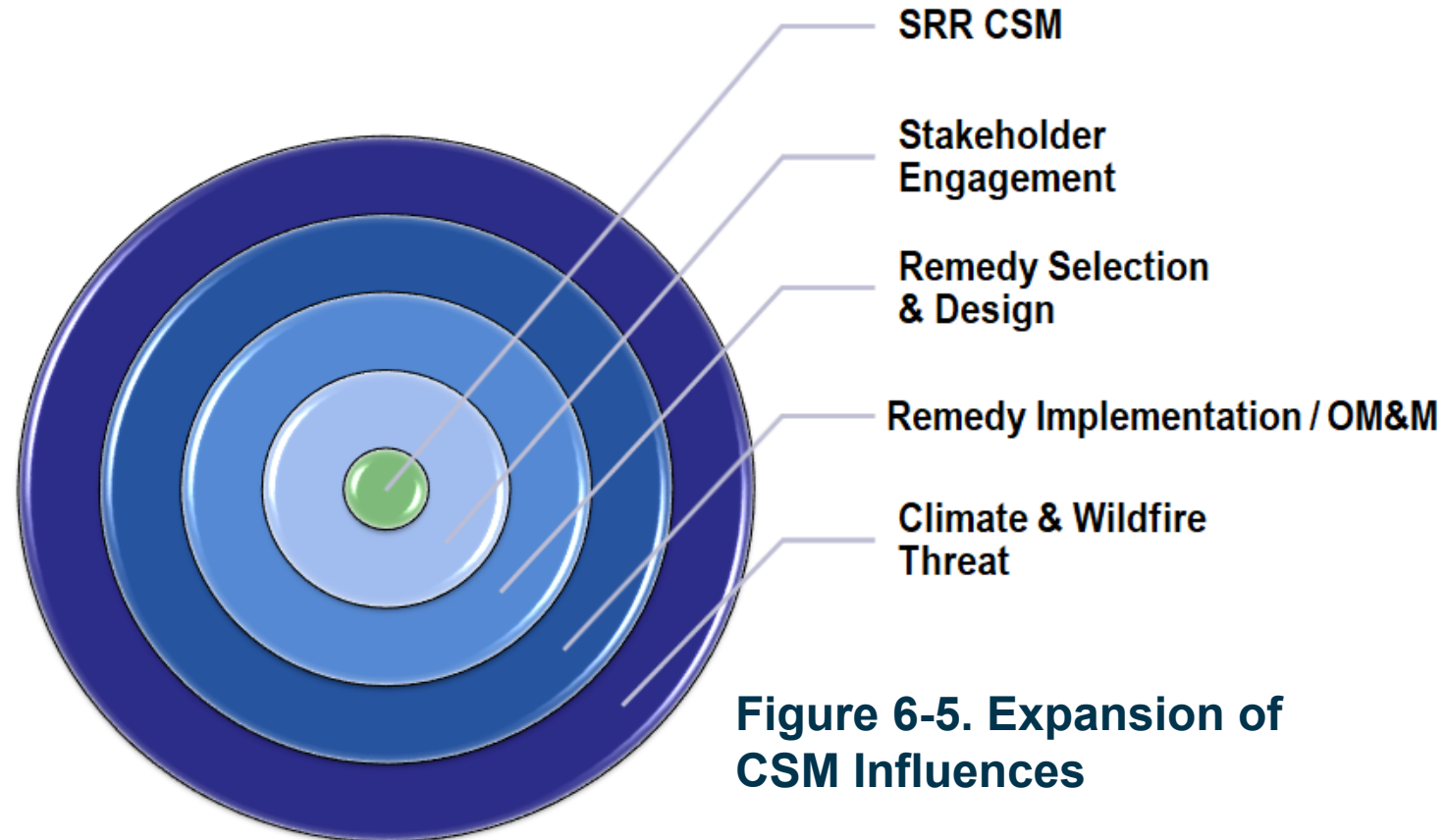
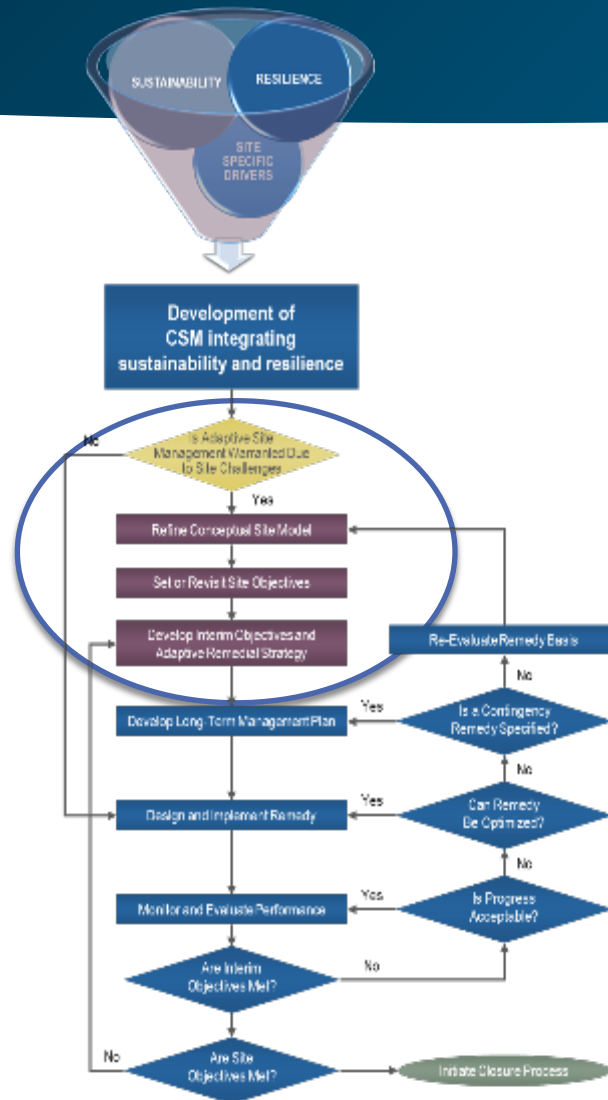


Figure 6-5. Expansion of CSM Influences

CSM is the heart of the project



► The SRR CSM is:

- Built with end use in mind
- Incorporates climate and wildfire data
- Adapts as site-specific challenges are discovered
- Incorporates environmental, economic and social benefits
- Results in a solution that is resilient and sustainable

RESOURCES:

[SRR State Resource Map](#)

[U.S. Climate Resilience Toolkit](#)

[Environmental Footprint Analysis Spreadsheet](#)

[SiteWise](#)

Figure 6-4. SRR CSM.

Climate Change Factors for the SRR CSM

Climate Change Factor	Sustainable Best Management Practice											
	General	Wind	Snow and Hail	Groundwater Levels	Flooding	Bank and Shoreline Erosion	Post Wildfires	Pre-Wildfires	Sea-Level Rise	Evapotranspiration	Storm Surge	Permafrost
<i>Changes in Precipitation</i>												
Increased	x		x	x	x	x			x		x	
Decreased	x			x			x	x		x		
<i>Changes in Temperature</i>												
Increased	x						x	x	x			
Decreased	x		x									x
<i>Changes in Water Table Level</i>												
Increase	x			x	x				x		x	
Decrease	x			x								
<i>Other</i>												
Increased Frequency or Intensity of Storms	x	x	x		x		x	x			x	

Table 7-1. Relevant SBMPs based on climate change factors.

SRR Stakeholder Engagement

PROJECT PLANNING



SITE CLOSEOUT

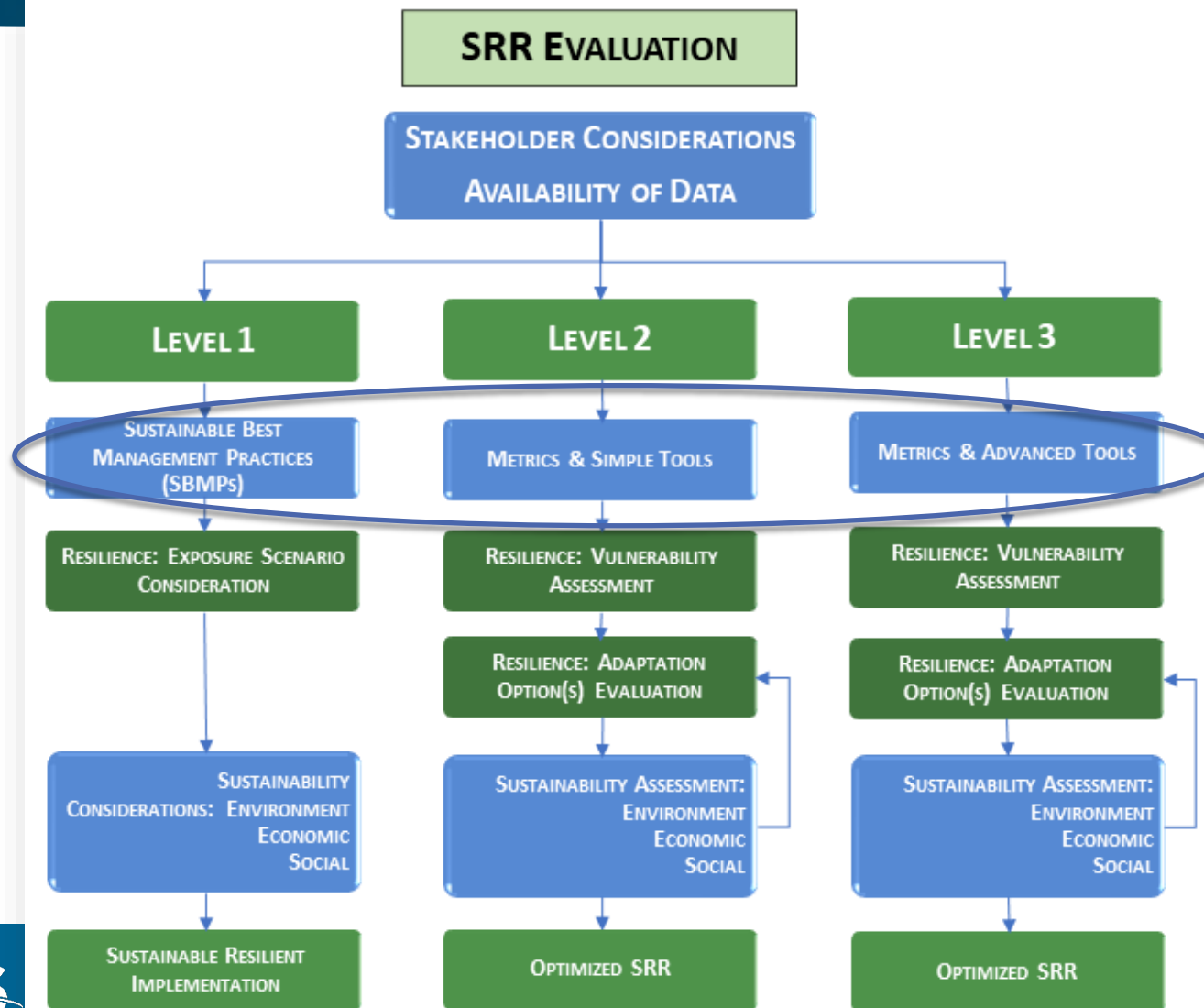
- ▶ Stakeholder values consideration
- ▶ Planning Stage:
 - Stakeholder roadmap
 - Purpose and process for engagement
 - SMART SR objectives
 - How SR will be measured and achieved
 - Remedy impact on social and economic factors



Source: ITRC [Risk Communication Toolkit](#)

SRR Levels of Evaluation:

Determine what is the appropriate level for your project



► Increasing level of evaluation:

- Qualitative
- Semi-quantitative
- Quantitative

Figure 6-7.
SRR evaluations.

Site Characterization: Additional SRR Considerations

SITE
CHARACTERIZATION



**Collect data on
extreme weather
and wildfires**



**Collect data for
resilient remedy
design**



**Incorporate site
vulnerability and
risk assessments**

Site Characterization: Vulnerability Assessment

SITE
CHARACTERIZATION



Incorporate local and regional climate data into CSM



Collect data to evaluate vulnerability to climate change and extreme weather during the remedial action and long-term site management



Assess vulnerability and identify data gaps to achieve robust vulnerability assessment



Reevaluate vulnerabilities/data gaps as remedy becomes more clear

Remedy Planning Phase

REMEDY PLANNING

↓
REMEDIAL
EVALUATION
AND SELECTION

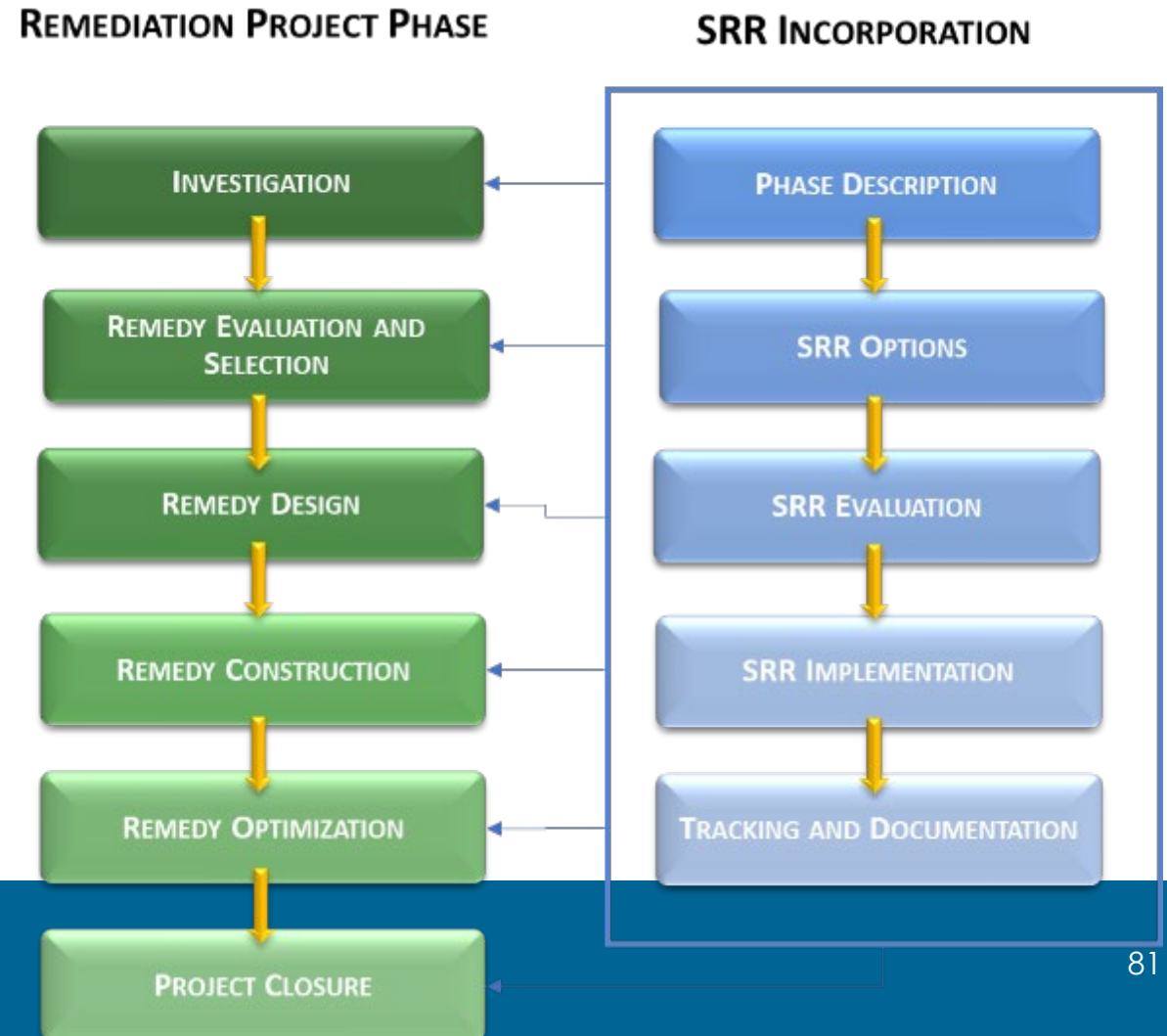
- ▶ Overall goal = meet Remedial Action Objectives (RAOs)
 - For SRR: select remedies with low impact that attain RAOs and align with stakeholder, community and economic developments needs
- ▶ All remedies should be effective and resilient short- and long-term
- ▶ Best opportunity to create lasting SRR influence

Implementing SRR: Remedy Planning

REMEDY PLANNING

- ▶ Define resilience metrics
- ▶ Vulnerability assessment of technologies using established project metrics
- ▶ Can vulnerabilities be mitigated through adaptation or SBMPs?
- ▶ For each alternative, identify adaptation strategy, SBMPs
- ▶ Calculate the level of effort and cost of adaptation
- ▶ Document and include in the remedy evaluation

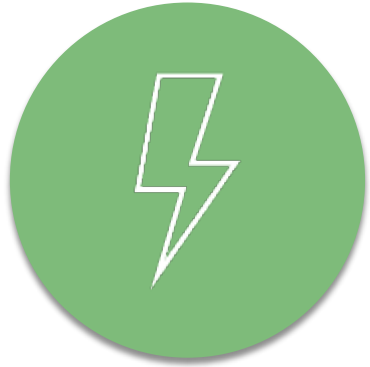
Figure 6-10 SRR Implementation



Incorporating SRR into Remedy Design

REMEDY PLANNING

REMEDY
DESIGN



**Update vulnerability
assessment,
Evaluate potential
risks, are they risk
acceptable?**



**Considerations
with
sustainable
and resilient
approach**



**Incorporate
optimal SBMPs
in design**



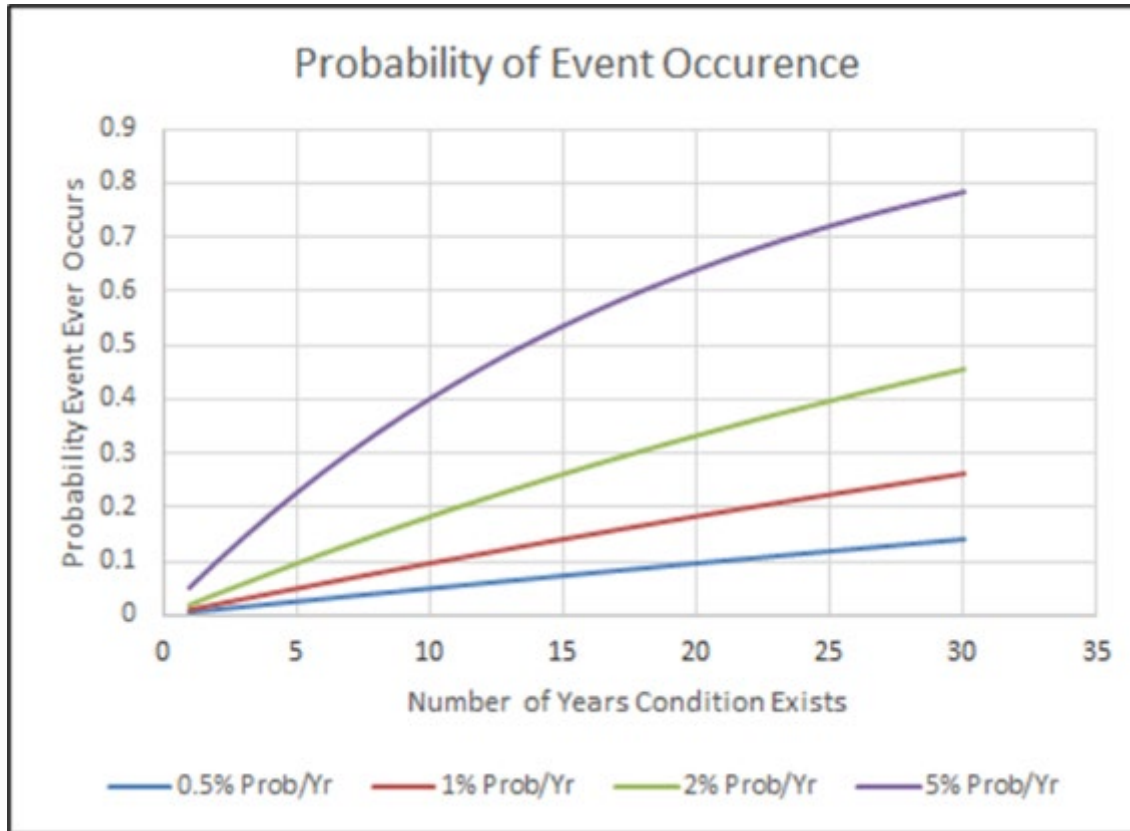
**Document the
remaining risk
that was
accepted**

Risk Management

PROJECT PLANNING



SITE CLOSEOUT



- ▶ **Remediation Risk Management:** Is the remedy vulnerable; will a climate event disrupt remedy during project lifecycle?
- ▶ **Resilient Risk Management:** Is the selected remedy resilient to the identified vulnerabilities?
- ▶ **Sustainable Risk Management:** Are there unintended impacts of the remedy: environmental, economic, social - that require mitigation?

Figure 6-12 Probability of Extreme Weather Event or Wildfire occurring vs Length of Time

OM&M – SRR Considerations



May account for high percentage of overall footprint – how can you reduce?



Timeframe is longer and more susceptible to climate change and extreme weather impacts – how do account for these potential impacts?



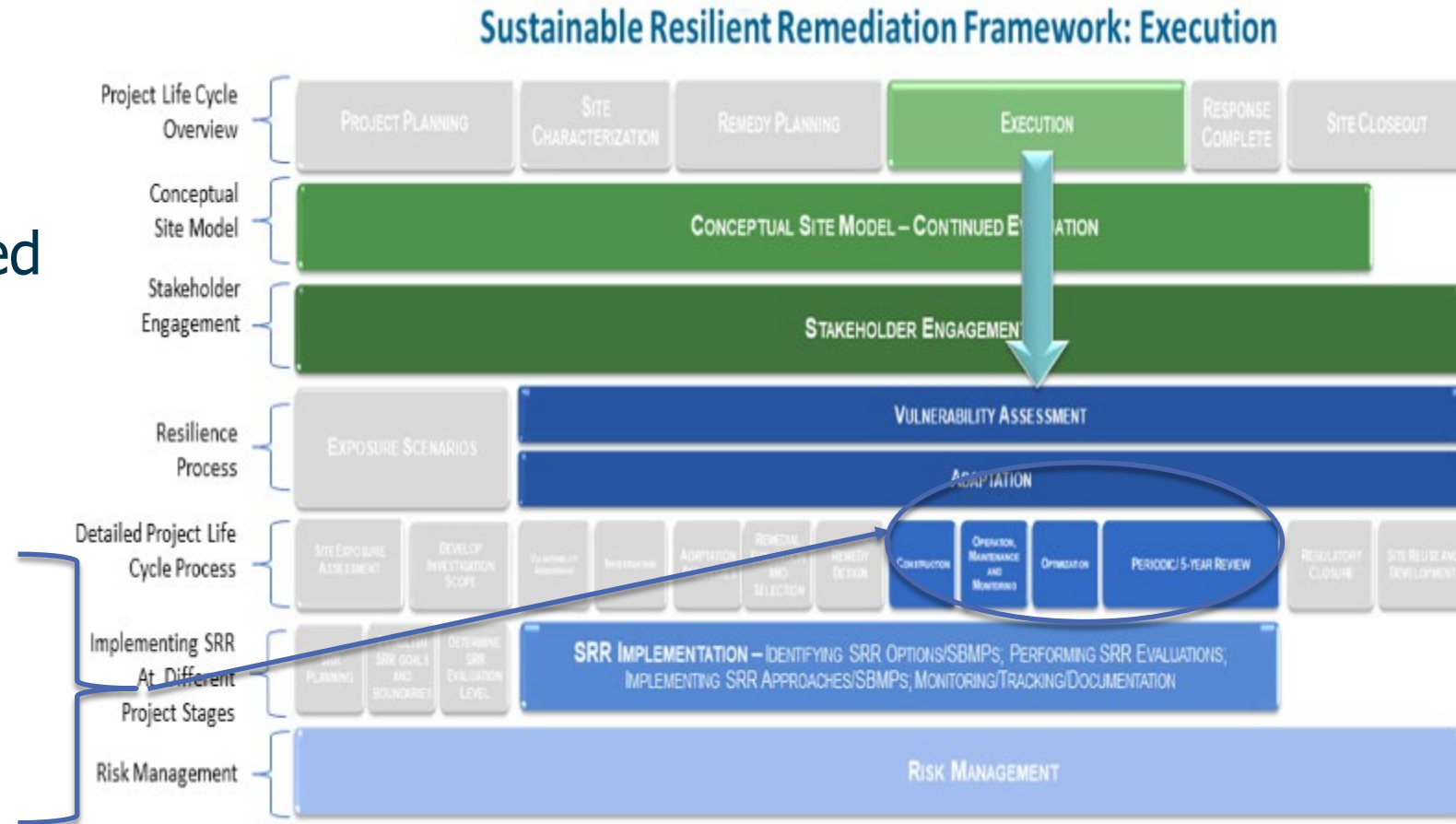
May include opportunities to replace equipment, reduce energy usage, reduce waste reduce noise and other impacts

Optimization – SRR Considerations

EXECUTION

- ▶ Improve performance, efficiency and footprint
- ▶ Revisit design assumptions against changed or anticipated conditions
- ▶ Opportunity to transition to Adaptive Strategy

Operation
OM&M
Optimization
5-yr Review



Site Reuse and Redevelopment – SRR Considerations

- ▶ Provides an opportunity to positively impact the community
- ▶ Engage stakeholders in the community
- ▶ Future climate change addressed?
- ▶ Perform vulnerability assessment
- ▶ Cost-benefit analysis



Image from www.epa.gov/land-revitalization

SRR Case Study – Pharmacia Upjohn, CT

- ▶ SRR during characterization:
 - Treat investigation derived waste on site
 - Utilize existing structures
 - Use passive / no purge sampling
 - Use ultra low-sulphur diesel fuel
 - Use electric, hybrid, CNG vehicles



Photo Source: [U.S. EPA, August 2015](#)

SRR Case Study – Pharmacia Upjohn, CT

► SRR during remedy:

- Incorporate vegetation for carbon sequestration
- Recycled slag in barrier wall
- Onsite materials for capping and backfill
- Excavation areas as retention basins
- Local S&G for permeable barriers
- Cut and fill to avoid offsite disposal
- Use in-situ vs ex-situ soil mixing
- Support biodiversity with habitat enrichment



Photo Source: [U.S. EPA](#), August 2015

SRR Case Study – Pharmacia Upjohn, CT



- ▶ Ecological enhancements
- ▶ New freshwater wetland
- ▶ Wetland will serve to manage site-wide stormwater management

Photos Source: [U.S. EPA, August 2015](#)



Two-thirds of 78-acre site will be an ecological preserve. Seventeen acres will be redeveloped for commercial/industrial

Integrating SRR Summary

Accounting for variability of climate and wildfire threats throughout every phase the Project Life Cycle can substantially reduce long-term site management risks

Early stakeholder engagement can greatly help inform the social and economic aspects for a sustainable remedy

The SRR CSM integration of climate and wildfire data along with stakeholder perspectives provides for sustainable and resilient decision making throughout the project life cycle



Advancing
Environmental
Solutions

Introduction

Resources, History & Value of SRR

Social & Economic Evaluations & Benefits

Integrating SRR

★ **Sustainable Best Management Practices**



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Sustainable Best Management Practices (SBMPs)

- ▶ Effective and practical methods or techniques to build or adapt a cleanup site to climate change
- ▶ Minimize impact or damage to the environment and community



Use **SBMPs** as Project Minimums

Sustainable Best Management Practices for SRR



Search this website

- Remediation Project Life Cycle
- 7. Key Sustainable Best Management Practices for Sustainable Resilience to Extreme Weather Events and Wildfires
- 8. Recommendations for the Future
- 9. References
- Appendix A. Case Study Matrix
- Appendix B. State Survey and State Survey Results

Sustainable Resilient Remediation

HOME

Welcome

Sustainable Resilient Remediation



Extreme weather events and wildfires are increasing and could impact hazardous waste sites and undermine the primary goal of cleanups, which is protecting human health and the environment. Confronted with these risks, assessing and designing remedies with decades-long time frames should be reevaluated. **Sustainable resilient remediation** (SRR) is an optimized solution to cleaning up and reusing a **hazardous waste site** that limits negative environmental impacts, maximizes social and

Sustainable Best Management Practices for SRR



Sustainable Best Management Practices for SRR

7.1 SBMPs Universally
Relevant to Extreme Weather
Events and Wildfires

7.2 Wind

7.3 Snow and Hail

7.4 Fluctuating Groundwater
Elevation Levels

7.5 Flooding

7.6 Bank and Shoreline
Erosion

7.7 Pre-Wildfire

7.8 Post-Wildfire

7.9 Sea-Level Rise

7.10 Evapotranspiration

7.11 Storm Surge

7.12 Permafrost Thaw

- ▶ Some SBMPs are universally relevant regardless of extreme event
- ▶ Each extreme event includes:
 - An overview
 - Recommended secondary or cascading extreme events to review
 - SBMPs by phase of remediation

Sustainable Best Management Practices for SRR

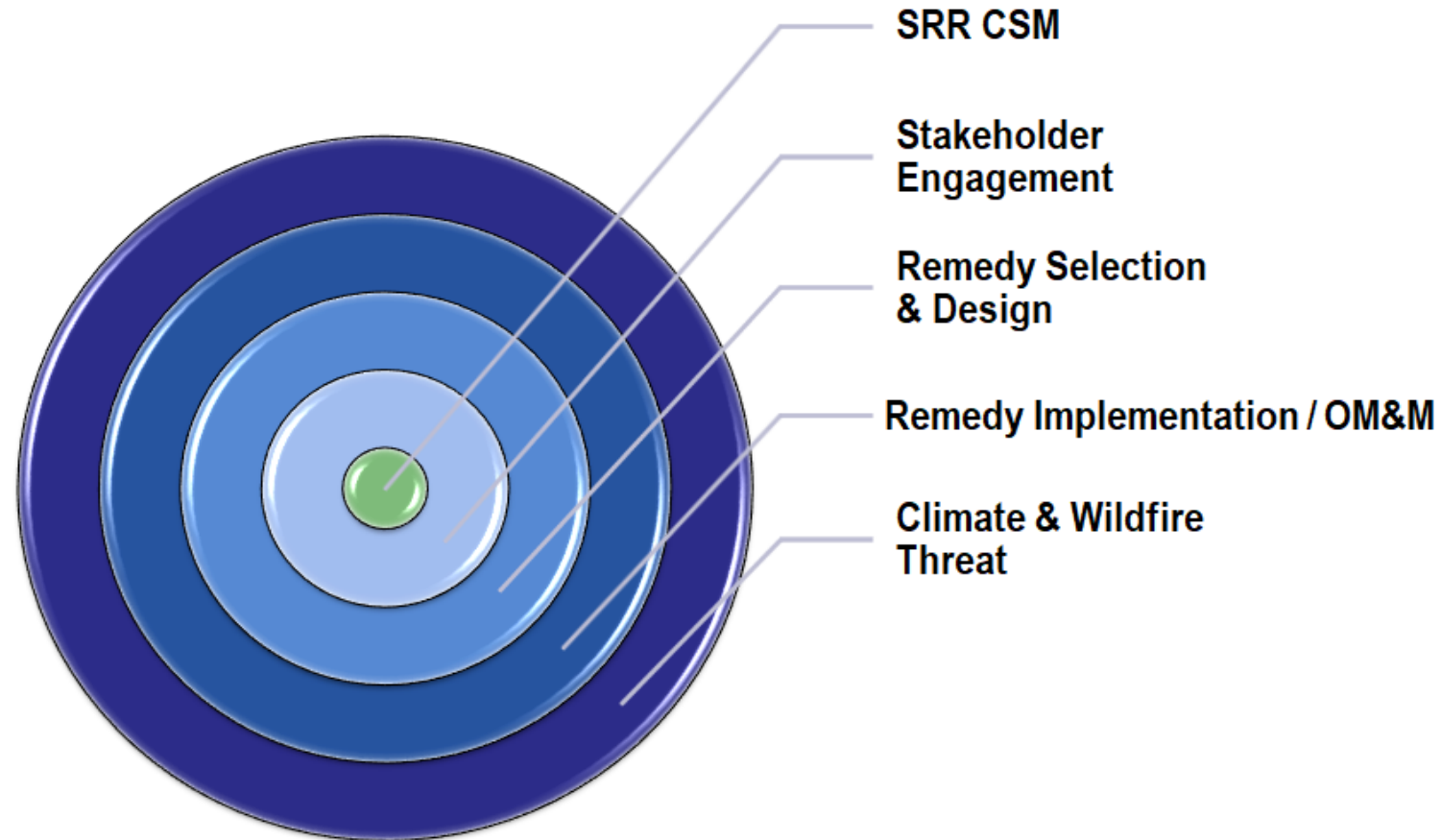


Figure 6-5. Expansion of CSM influences.

Sustainable Best Management Practices for SRR



Assessing
Vulnerability



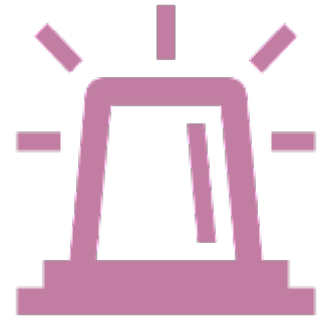
Planning



Design and
Implementation



OM&M



Crisis
Management

Sustainable Best Management Practices for SRR

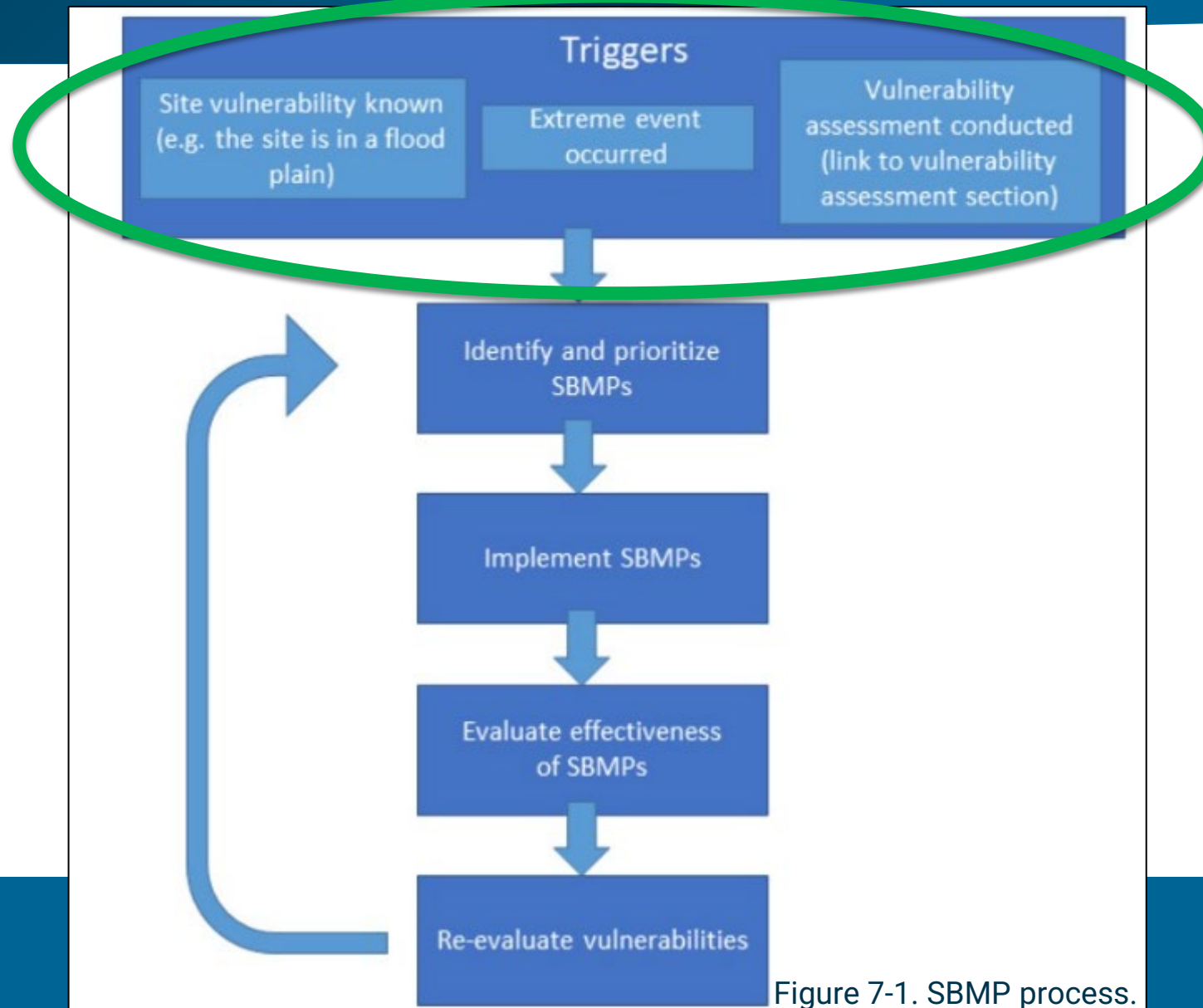


Figure 7-1. SBMP process.

Sustainable Best Management Practices for SRR

Table 7-1. Relevant SBMPs based on climate change factors.

	Universal	Wind	Snow and Hail	Fluctuating Groundwater Elevation Levels	Flooding	Bank and Shoreline Erosion	Pre-Wildfire	Post-Wildfire	Sea-Level Rise	Evapotranspiration	Storm Surge	Permafrost Thaw
Changes in Precipitation												
Increase	X		X	X	X	X			X		X	
Decrease	X			X			X	X		X		X
Changes in Temperature												
Increase	X					X	X	X	X			X
Decrease	X		X									
Changes in Water Level												
Increase	X			X	X	X			X		X	X
Decrease	X			X		X	X	X		X		
Other												
Increased storm frequency or intensity	X	X	X		X	X	X	X			X	

Sustainable Best Management Practices for SRR

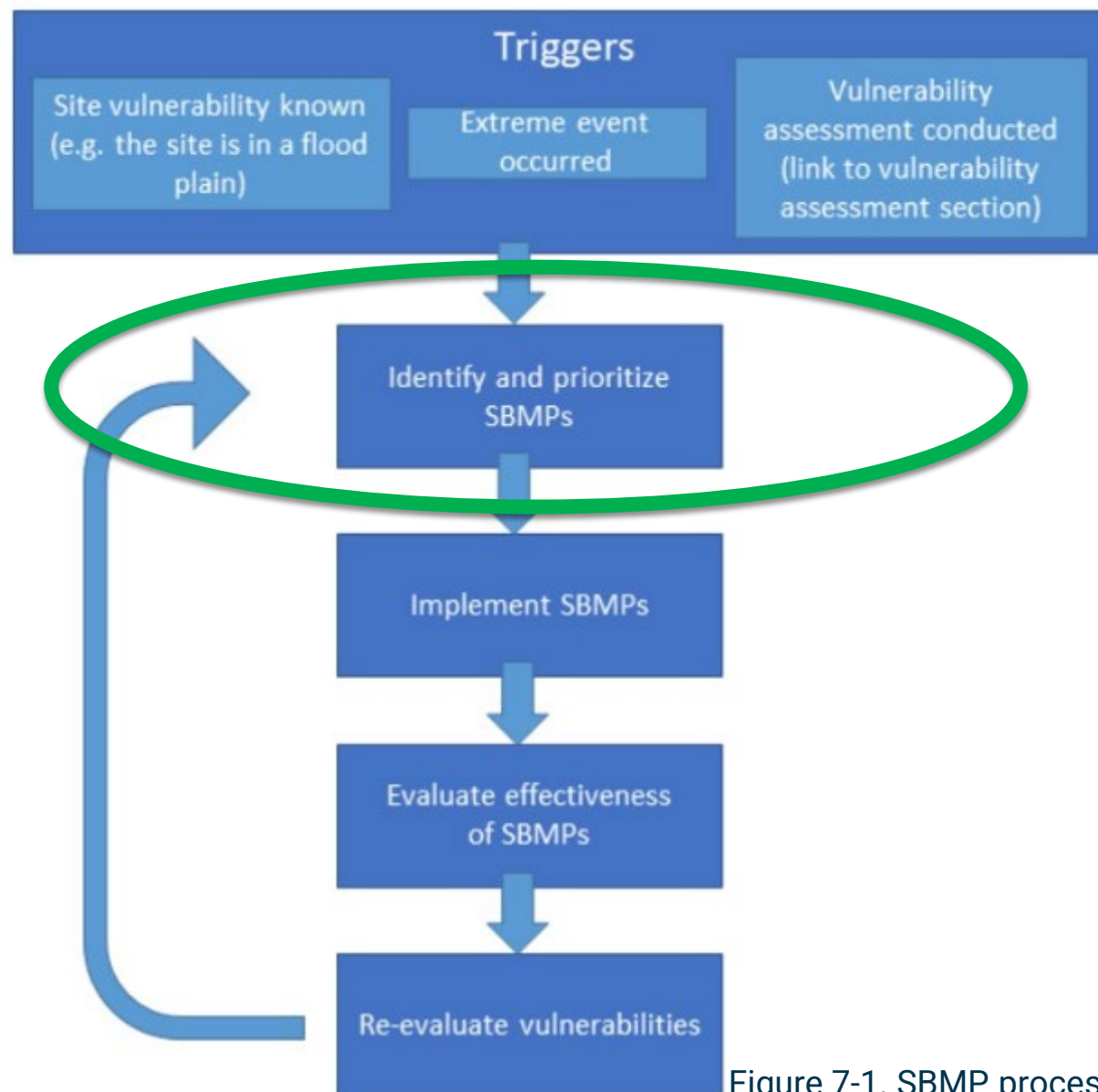


Figure 7-1. SBMP process.

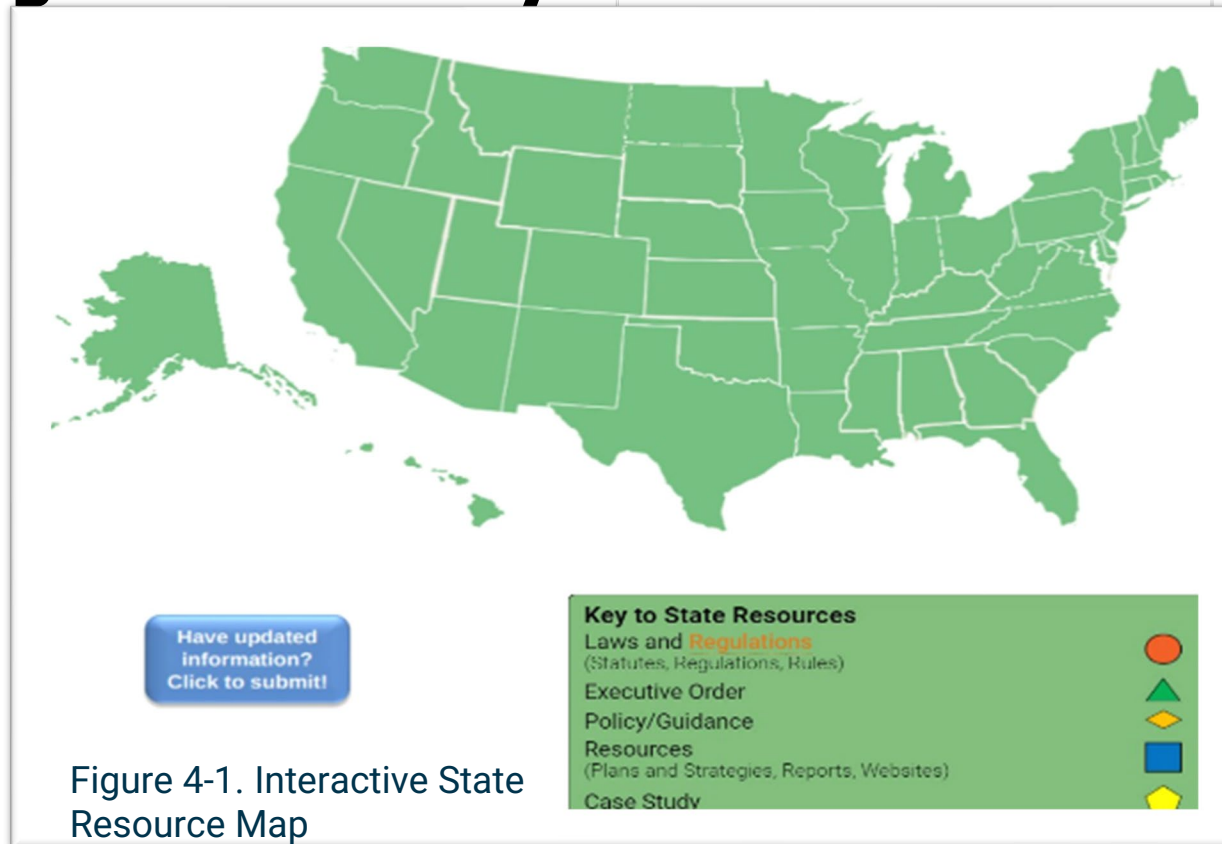
SBMPs by Extreme Event – Appendix D

Appendix D. Sustainable Best Management Practice Checklists

APPLICABLE?		COMPLETE?		Extreme Event or Impact	SBMP	Description
Y	N	Y	N			
				Universal	<p>If an extreme event has already occurred at the site, assume the site is vulnerable to that extreme event.</p> <ul style="list-style-type: none"> oAlso assume the site is vulnerable to associated secondary or cascading events (e.g. an event that may occur as a result of the first event such as flash flooding after a wildfire) identified within the SBMPs. oReview the relevant SBMPs and implement as applicable. oConduct a vulnerability assessment to identify any other extreme events the site may be vulnerable to. Review federal and state resources to identify local vulnerabilities. [Link to Map tool] Review the relevant SBMPs and implement as applicable. 	Assessing Vulnerability
				Universal	<p>If known vulnerabilities exist at the site (e.g. it is in a floodplain or permafrost), assume the site is vulnerable to those extreme events.</p> <ul style="list-style-type: none"> o Also assume the site is vulnerable to associated secondary or cascading events (e.g. an event that may occur as a result of the first event such as flash flooding after a wildfire) identified within the SBMPs oReview the relevant SBMP checklists and implement as applicable. oConduct a vulnerability assessment to identify any other extreme events the site may be vulnerable to experiencing. [Link to Map tool] Review federal and state resources to identify local vulnerabilities. Review the relevant SBMPs and implement as applicable. 	Assessing Vulnerability

Universally Applicable SBMPs for SRR

Assessing Vulnerability



**Review local
vulnerability
information**

Universally Applicable SBMPs for SRR

Planning and Prioritizing



**Seek and Review
Traditional
Ecological
Knowledge (TEK)**



**Integrate into
contracts**



**Predict
Financial Risks**

Universally Applicable SBMPs for SRR

Remedy Design and Implementation



**Use Green
Infrastructure**



**Stormproof
Infrastructure**



Document

Universally Applicable SBMPs for SRR

Operation, Maintenance, and Monitoring (OM&M)



**Update
Vulnerability
Assessment**



**Review CSM
(on defined and
regular basis)**



**Evaluate
Performance**

Universally Applicable SBMPs for SRR

Crisis Management



**Reevaluate site
boundaries and
pathways**



**Reassess
monitoring
and sampling**

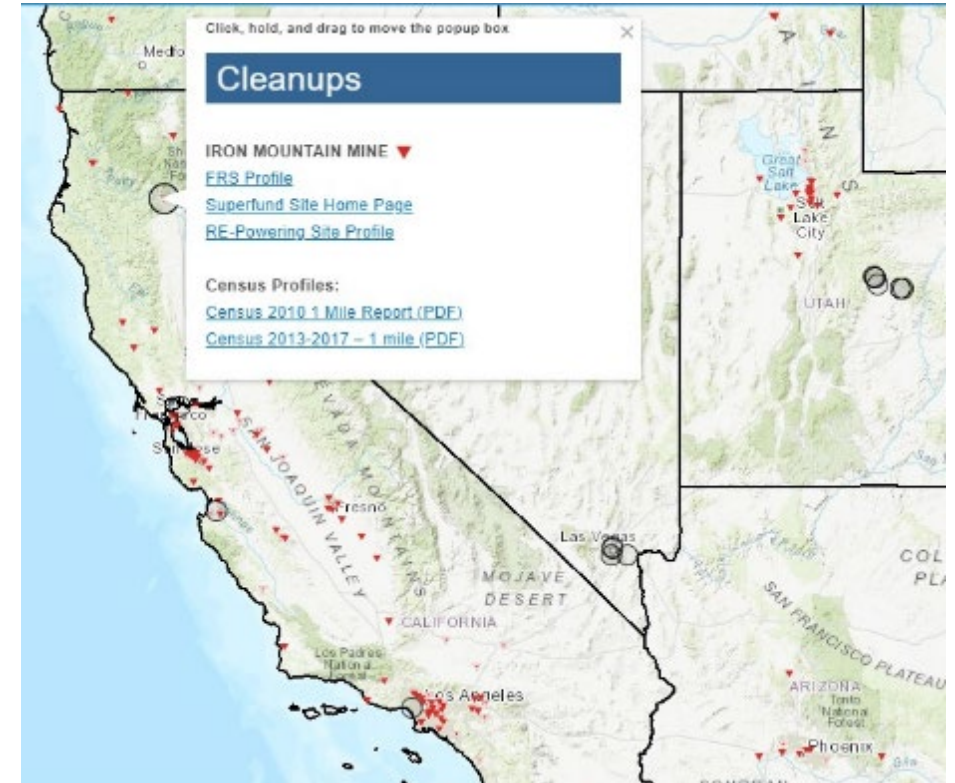


**Revise safety
procedures**

SBMP Integration: Case Study

Iron Mountain Mine, Shasta County, CA

- ▶ **Site Description:** 4,400-acre site with historic acid mine drainage discharges to multiple waterways, including a source of drinking water.
- ▶ **Remedial action objective:** eliminate the mine discharges that are harmful to the environment.
- ▶ **Interim Remedies:**
 - Source Control
 - AMD collection and treatment
 - Water management



US EPA, Cleanups in My Community

SBMP Integration: Iron Mountain Mine Case Study

Step 1: What trigger brought the cleanup into the climate resilient SBMP process

- ☑ Extreme events have occurred
 - Wildfires
 - Severe Storms

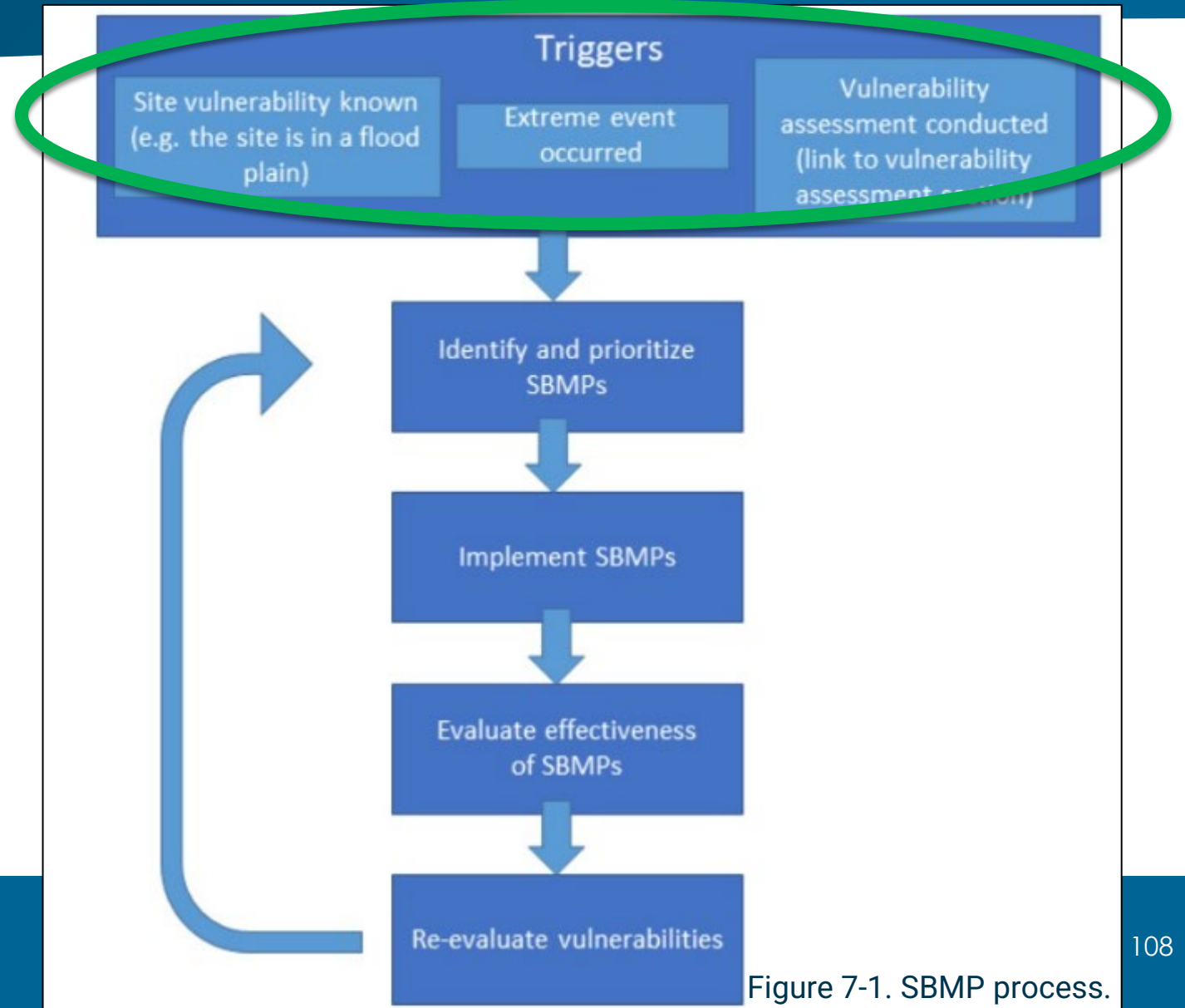


Figure 7-1. SBMP process.

SBMP Integration: Iron Mountain Mine Case Study

Step 2: Identify and prioritize the SBMPs

- ✓ Review Wind, Pre-Wildfire, Post-Wildfire and Universally Applicable SBMPs
- ✓ Review the secondary and cascading extreme event SBMPs identified in the primary extreme event SBMPs

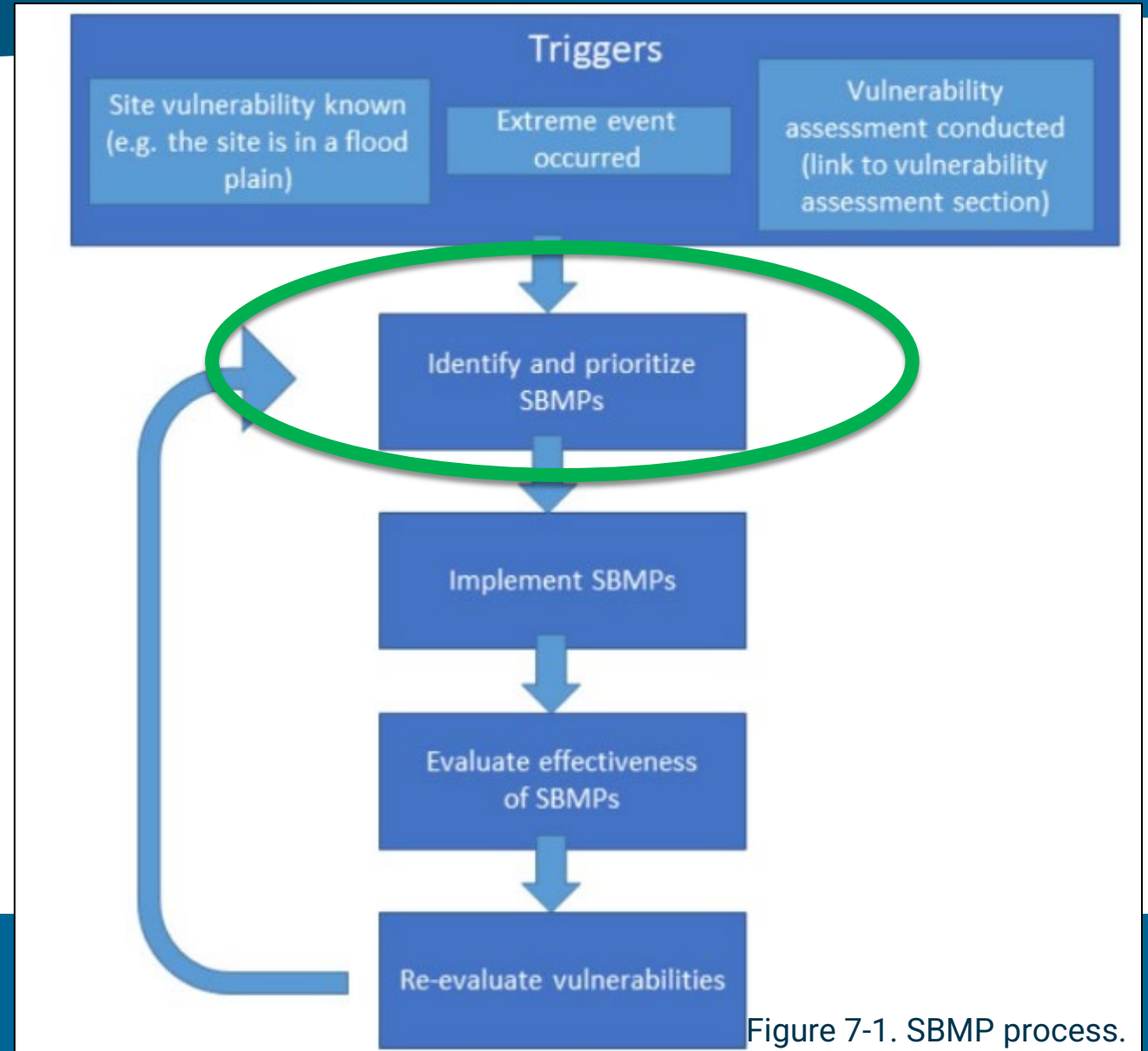


Figure 7-1. SBMP process.

SBMPs by Extreme Event – Appendix D

Appendix D. Sustainable Best Management Practice Checklists

APPLICABLE?		COMPLETE?		Extreme Event or Impact	SBMP	Description
Y	N	Y	N			
				<div><div>Search</div><div><div><input checked="" type="checkbox"/> Storm Surge</div><div><input checked="" type="checkbox"/> Bank and Shoreline Erosion</div><div><input checked="" type="checkbox"/> Evapotranspiration</div><div><input checked="" type="checkbox"/> Flooding</div><div><input checked="" type="checkbox"/> Fluctuating Groundwater Elevation</div><div><input checked="" type="checkbox"/> Permafrost Thaw</div><div><input checked="" type="checkbox"/> Post Wildfires</div><div><input checked="" type="checkbox"/> Pre-Wildfire</div></div><div>OKCancel</div></div>	<p>has already occurred at the site, assume the site is vulnerable to that extreme</p> <p>site is vulnerable to associated secondary or cascading events (e.g. an event as a result of the first event such as flash flooding after a wildfire) identified within</p> <p>SBMPs and implement as applicable.</p> <p>ability assessment to identify any other extreme events the site may be</p> <p>review federal and state resources to identify local vulnerabilities. [Link to Map</p> <p>relevant SBMPs and implement as applicable.</p>	Assessing Vulnerability
					<p>ities exist at the site (e.g. it is in a floodplain or permafrost), assume the site is</p> <p>extreme events.</p> <p>site is vulnerable to associated secondary or cascading events (e.g. an event as a result of the first event such as flash flooding after a wildfire) identified within</p> <p>SBMP checklists and implement as applicable.</p> <p>Conduct a vulnerability assessment to identify any other extreme events the site may be vulnerable to experiencing. [Link to Map tool] Review federal and state resources to identify local vulnerabilities. Review the relevant SBMPs and implement as applicable.</p>	Assessing Vulnerability

SBMPs by Extreme Event – Appendix D

Appendix D. Sustainable Best Management Practice Checklists

APPLICABLE?		COMPLETE?		Extreme Event or Impact	SBMP	Description
Y	N	Y	N			
				Universal	If an extreme event has already occurred at the site, assume the site is vulnerable to that event. oAlso assume the site is vulnerable to associated secondary or cascading events (e.g. an event that may occur as a result of the first event such as flash flooding after a wildfire) identified in the SBMPs. oReview the relevant SBMPs and implement as applicable. oConduct a vulnerability assessment to identify any other extreme events the site may be vulnerable to. Review federal and state resources to identify local vulnerabilities. [Link to Map tool] Review the relevant SBMPs and implement as applicable.	<div> <div>Search</div> <div> <input checked="" type="checkbox"/> (Select All) <input checked="" type="checkbox"/> Assessing Vulnerability <input checked="" type="checkbox"/> Crisis Management <input checked="" type="checkbox"/> General <input checked="" type="checkbox"/> Operation, Maintenance & Monitoring <input checked="" type="checkbox"/> Planning and Prioritizing <input checked="" type="checkbox"/> Remedy Design and Implementation </div> <div>OKCancel</div> </div>
				Universal	If known vulnerabilities exist at the site (e.g. it is in a floodplain or permafrost), assume the site is vulnerable to those extreme events. o Also assume the site is vulnerable to associated secondary or cascading events (e.g. an event that may occur as a result of the first event such as flash flooding after a wildfire) identified in the SBMPs oReview the relevant SBMP checklists and implement as applicable. oConduct a vulnerability assessment to identify any other extreme events the site may be vulnerable to experiencing. [Link to Map tool] Review federal and state resources to identify local vulnerabilities. Review the relevant SBMPs and implement as applicable.	

SBMPs by Extreme Event

Appendix D. Sustainable Best Management Practice Checklists

A		B		C		D		E		F		G	
APPLICABLE?		COMPLETE?						Extreme Event or Impact		SBMP		Description	
Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
Y								Universal		Whenever possible use green infrastructure and natural solutions such as native plantings over impervious, man-made solutions. Green infrastructure and natural solutions are typically more resilient. Native plantings should be native to the existing climate with tolerances for the types of climate events the site is likely to experience in the near future.		Remedy Design and Implementation	
Y								Universal		Generate primary or secondary power from on-site renewable resources independent of the utility grid. It is important to note that during extreme climate scenarios, even green infrastructure may not be sufficiently resilient to withstand weather extremes.		Remedy Design and Implementation	
	N							Universal		Integrate electronic devices for remote control of equipment during extreme weather or wildfires.		Remedy Design and Implementation	
	N							Universal		Integrate sensors linked to electronic control devices to trigger either shutdown of equipment or an alarm to alert workers to shut down equipment.		Remedy Design and Implementation	
	N							Universal		Move or locate remedy components away from potential danger zones (USEPA 2013).		Remedy Design and Implementation	
Y								Universal		Stormproof infrastructure by repairing, retrofitting, or relocating facilities and equipment to prevent damage and disruptions during extreme weather or wildfire events.		Remedy Design and Implementation	
Y								Universal		Document SBMPs implemented in completion reports.		Remedy Design and Implementation	
Y								Universal		Evaluate the performance of the SBMPs in place following an extreme event		Operation, Maintenance & Monitoring	
Y								Universal		Include maintenance of the SBMPs in the site OM&M Plan and evaluate that the SBMPs are properly maintained		Operation, Maintenance & Monitoring	
Y								Universal		Regularly update the vulnerability assessment and adapt SBMP implementation to match any changing site conditions		Operation, Maintenance & Monitoring	
Y								Universal		Review the CSM on a defined and regular basis to determine if adaptations to remedy design and		Operation, Maintenance & Monitoring	

SBMP Integration: Iron Mountain Mine Case Study

Step 3: Implement the applicable and prioritized SBMPs

- ✓ Replace portions of the treatment system with nonflammable stainless steel
- ✓ Add redundancies in the treatment system
- ✓ Develop vegetation management especially with plants that effectively spread fires
- ✓ Continue and increase coordination with local emergency responders
- Update the Emergency Preparedness Plan
- Update the Asset Management Plan

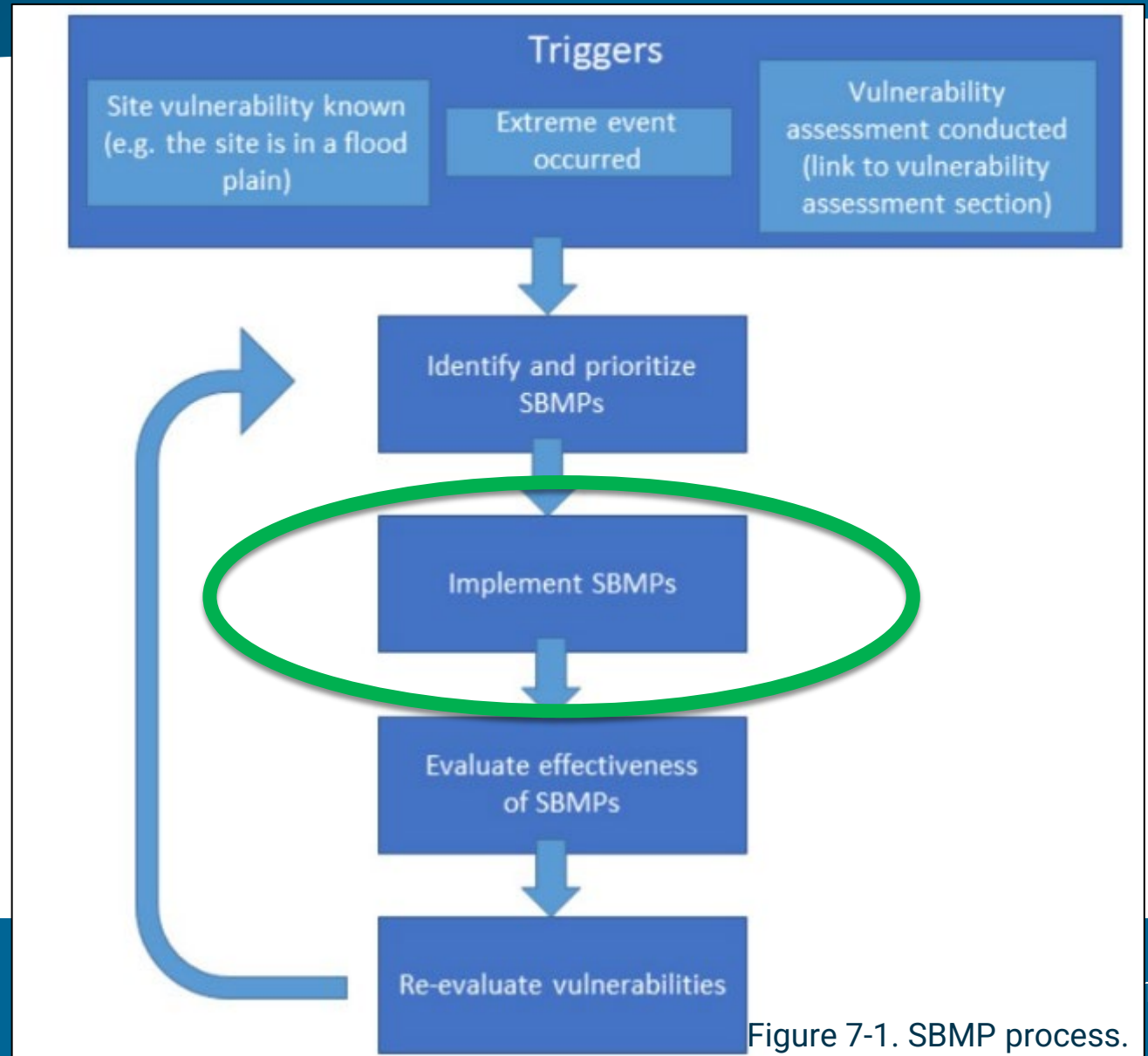


Figure 7-1. SBMP process.

SBMP Integration: Iron Mountain Mine Case Study

Step 4: Evaluate the effectiveness of the SBMPs

- ✓ Cal Fire on-site visits to advise on fire prevention measures
- 5-year review assessments

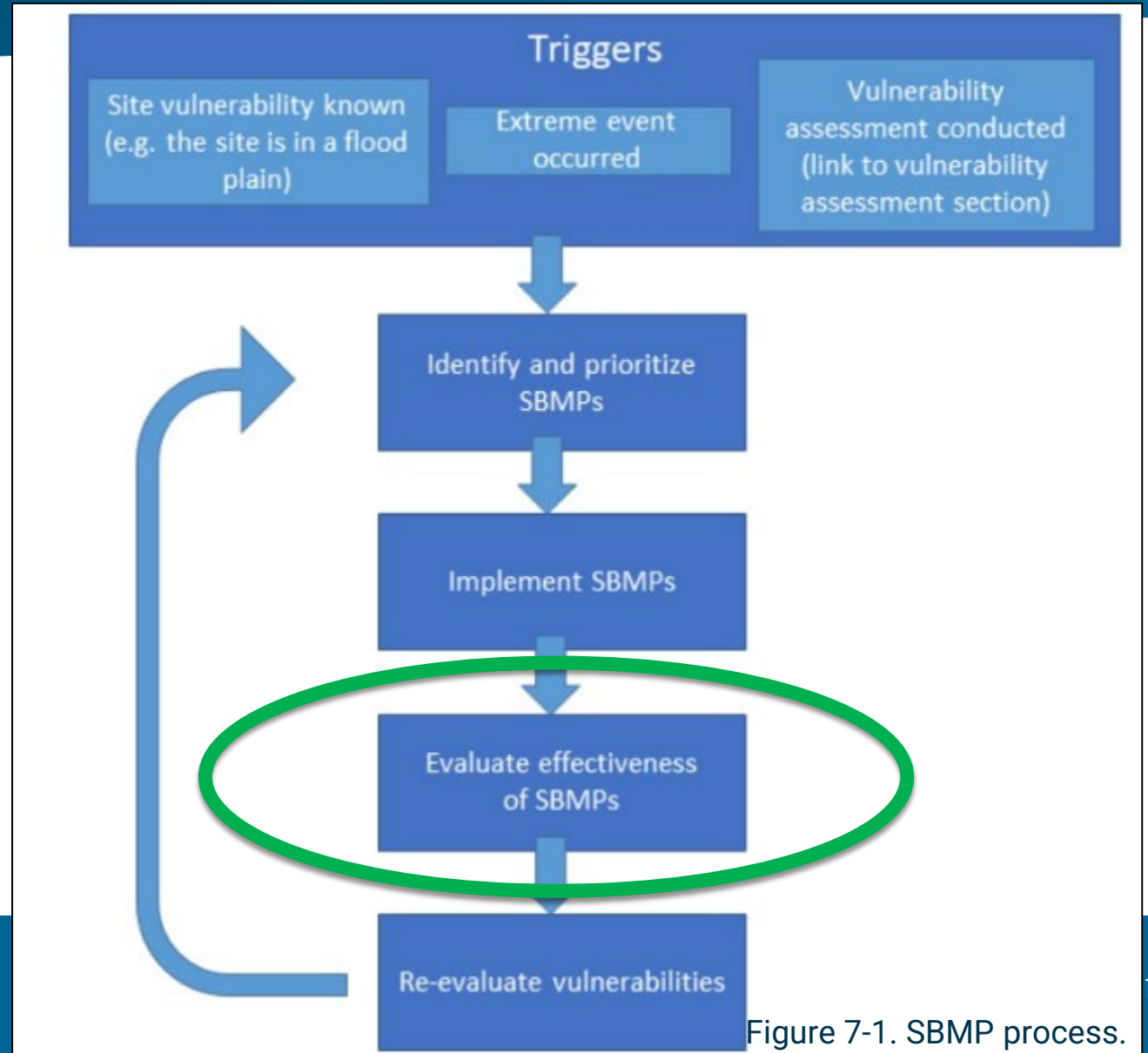


Figure 7-1. SBMP process.

SBMP Integration: Iron Mountain Mine Case Study

Step 5: Re-evaluate vulnerabilities

- ❑ Consideration of climate change in the final sitewide RI/FS is being assisted by running climate change scenarios in the Water Quality Model.
- ❑ 5-year review

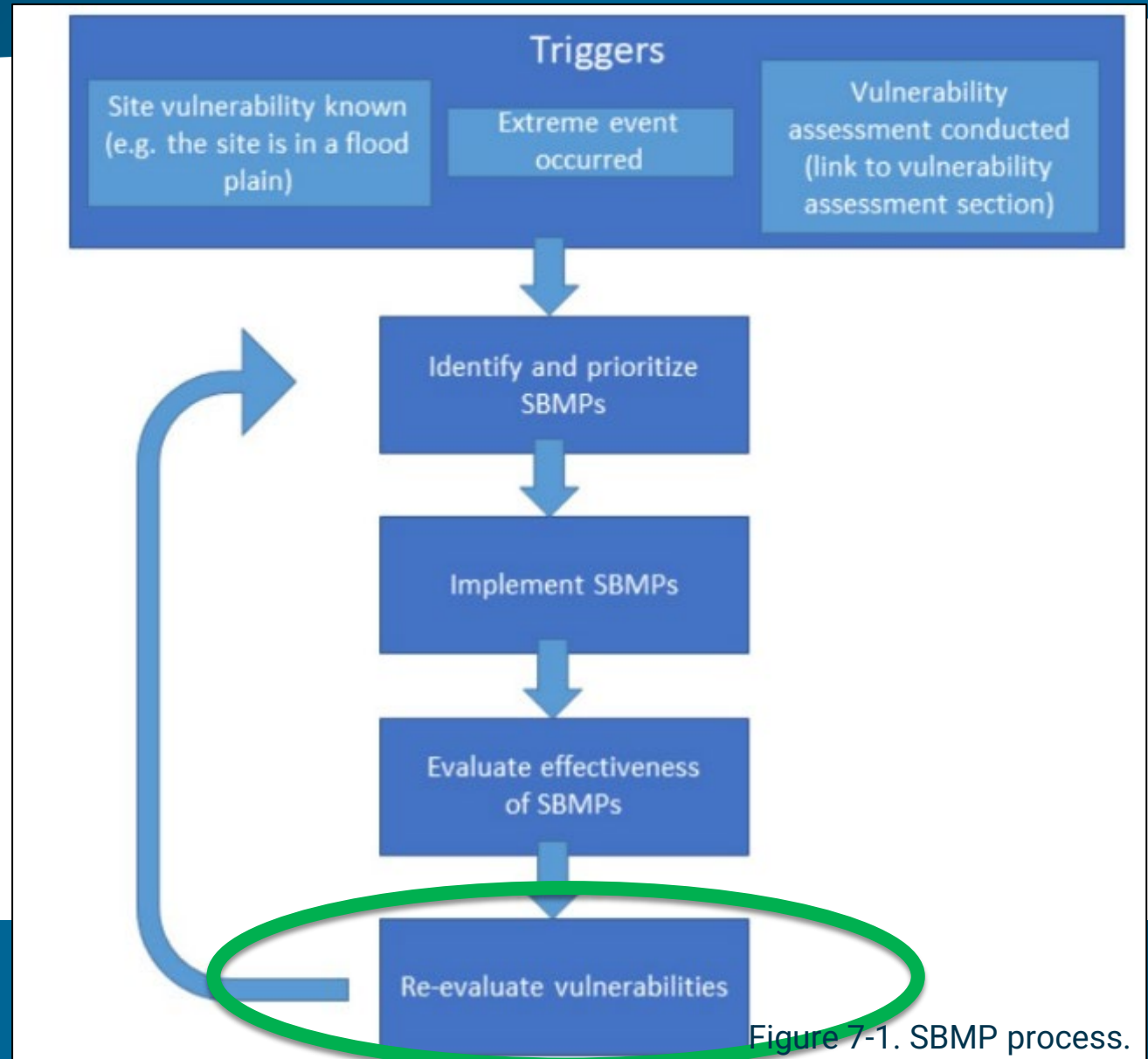


Figure 7-1. SBMP process.

SBMP Conclusion



Flexible

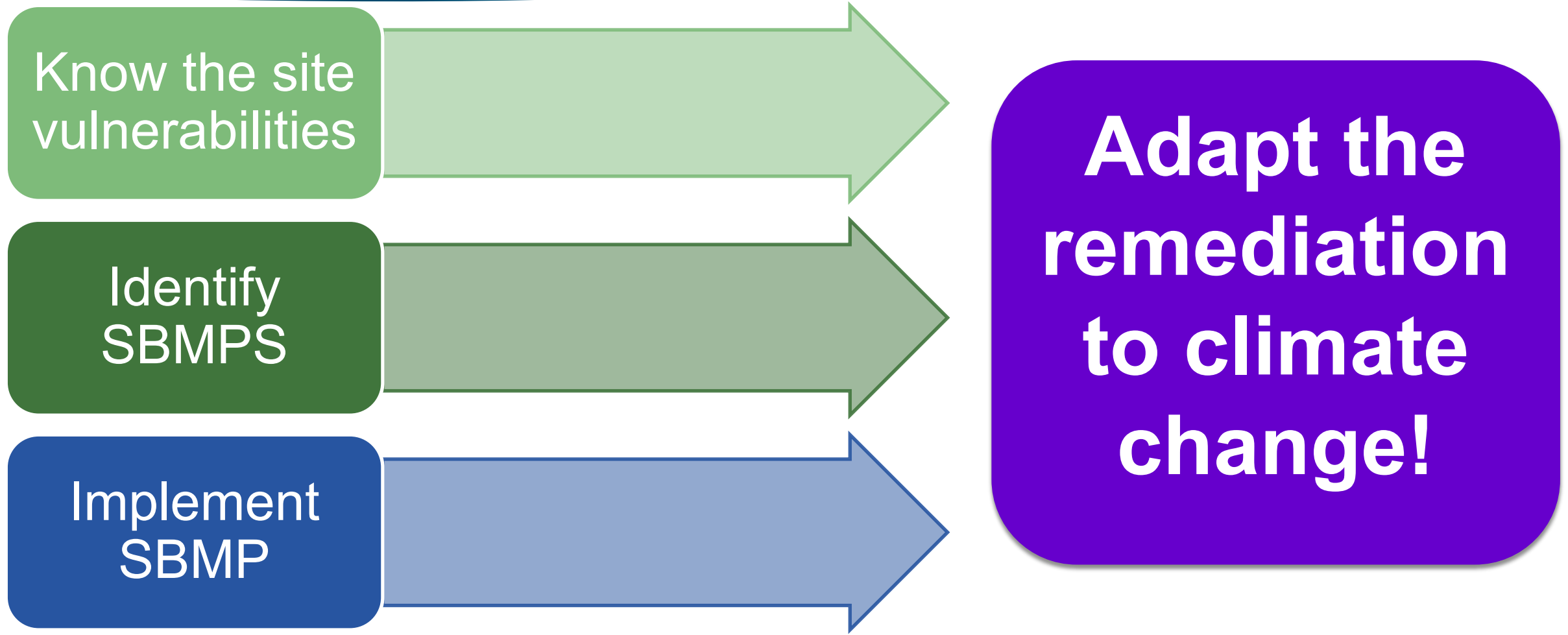


Comprehensive



Easy

SBMP Summary



Thank you for attending!

Questions

- ▶ Email further questions on today's session to: training@itrcweb.org
- ▶ Sustainable Resilient Remediation Training & Feedback Form & Certificate of Completion: <https://clu-in.org/conf/itrc/srr>

