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

This section provides examples and tools to help incorporate social and economic factors that will help promote sustainable projects and inform stakeholders. Unlike the environmental prong of sustainability (sometimes referred to as "greening"), regulators, cleanup professionals, and parties responsible for the cleanup often need to convince their stakeholders that these considerations matter. Likewise, community advocates often need to convince regulators or the responsible party that communities need a seat at the decision-making table due to the perception that economic and social concerns are external to cleanup. While this narrow view may have been understandable if not desirable, there are new technologies and sources of information that make it possible to deliver fully sustainable projects. Our intention is to bring these often-overlooked aspects of sustainability onto even footing with the traditional environmental optimization process that dominated early sustainable cleanup planning.

This section is intended for a broad audience:

- regulators or the party responsible for cleanup who may need to convince project proponents of the need to consider these factors or who may need to educate themselves about why these factors matter
- community leaders and advocates who know their concerns matter but may not be able to articulate why or lack the technical expertise necessary to identify cobenefits in the technical language that regulators use
- planners who might appreciate both of those views but lack a holistic framework that reconciles them.

Some of the material in this section may seem repetitious—this is intentional to allow nontechnical audiences and others who do not have the time to read a traditional technical guidance to engage with the subject and become effective participants in cleanup decision making.

5.1 Sustainability Is More Than a Footprint

Sustainability is more than an environmental concept that asks us to be efficient with resources—it requires that projects also consider the communities a cleanup serves and impacts. Sustainable planning and project management involve gathering community data, considering how a site or its cleanup might differently affect different communities, and striking a balance between the three pillars of sustainability -environmental, social, and economic (Purvis, Mao, and Robinson 2019). Meeting this "triple bottom line" seems like it is asking a lot, but doing so can also help you deliver better projects at lower total costs by increasing overall community benefit and ownership.

5.1.1 Sustainability Is Good Business and Good Government

Sustainable design lowers lifetime costs and delivers efficient and optimized projects. While reduced operation and maintenance costs are easy to factor into traditional design, we often struggle to think of the economic context and the social factors in the same way. Holistic planning can lead to direct cost savings and unlock more project options. For example, if mobilization can be coordinated or the need for expensive and time-consuming ground-disturbing operations can be shared to accomplish different goals (cleanup and stormwater improvements, cleanup and utility tunneling, cleanup and creation of green spaces, etc.), then it can be easier to justify those expenses. This document presents case studies that show that authentic community involvement and creative thinking about local needs increase both resources available for completing cleanups and the trust that communities place in you, your company, and your government (see Section 5.4.3).

5.1.2 Sustainability Earns You Valuable Trust

Businesses or industries that act with consideration and respect to local communities typically receive more trust in return. Conversely, cleanups that proceed without considering local communities are more likely to face court challenges, receive negative press attention, or generate political headwinds. Dealing with conflicts after they arise costs money and time and can erode trust. Sustainable projects that account for community needs make it easier for communities to engage with future projects and place their trust in what you say. Investing to earn social license pays dividends on future work.

5.2 Special Considerations for Low-Income and Minority Communities

Project planning and execution do not happen in a vacuum. There are strong and well-known correlations between the locations of environmental contamination and the neighborhoods of people of color and/or low-income residents. Living near environmental contamination creates and perpetuates public health and socioeconomic disparities among these groups.

Toxic Wastes and Race in the United States (UCCCRJ 1987) is a seminal work that documented this relationship almost 30 years ago. Minority, low-income, and indigenous communities are often the most vulnerable and the most overburdened by environmental and public health stressors (USEPA 2016c), and therefore deserve special consideration in this guidance. Even the most well-intentioned cleanup projects can perpetuate these systemic disparities if they fail to address these issues in project planning, execution, or operation.

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For more information, consider reading the Environmental Justice Working Group's appendix to the Minneapolis Climate Action Plan. The appendix was written by local communities and contains their perspectives and suggestions on how to approach climate justice in a proactive manner (MSO 2013).

Project managers must work proactively to overcome these challenges, and the pursuit of environmental justice should be considered an overarching goal for a cleanup project. Robust stakeholder engagement is crucial for achieving meaningful outcomes in environmental justice communities. Project managers should aim to create ongoing, multiple opportunities for two-way dialog and collaboration with stakeholders throughout the project life cycle and beyond. In particular, involving stakeholders in the development and definition of project goals can help to overcome systemic biases and improve the overall sustainability of a given cleanup. The stakeholder engagement resources discussed in Section 5.10.4 provide essential guidance for structuring these processes.

A number of additional tools and resources, such as USEPA's EJ Screen, have been created to support project managers seeking to assess whether or not minority or low-income communities are likely to be impacted by contaminated sites or cleanup decisions. See Section 5.11 for further guidance on identifying vulnerable populations.

5.3 Road Map of Economic and Social Resources

5.3.1 Cleanup Put in Context

In general, Section 5 contextualizes social and economic sustainability as part of the cleanup process (1) in cleanups that are integrated with a larger redevelopment project (such as a brownfields revitalization) and (2) in cleanups that are driven primarily by regulatory responsibilities under a federal or state cleanup program (such as CERCLA or RCRA). Section 6.2.3 explains the role that vulnerability assessments can play in capturing economic and social threats to sites and help you find leverage points for communities and their needs to enter the cleanup process.

5.3.1.1 Cleanup as Part of a Larger Development Project: Integrated Cleanups

Section 5.5 will be familiar to practitioners who work regularly in brownfields development. They bring the brownfield mindset, which combines consideration of social and economic benefits to local communities and the environmental benefits of reusing contaminated spaces.

5.3.2 Promoting a More Sustainable Cleanup

Convincing stakeholders, the public, and project backers to include sustainable and resilient features can be a challenge, but this guidance will help you promote a more sustainable cleanup as a worthwhile investment. This guidance will help you identify and explain the hidden benefits (or hidden costs avoided) associated with taking a greener and more sustainable approach and provide you with the tools and examples you need to streamline these benefits as part of the cleanup process.

5.3.2.1 Planning, Identifying, and Capturing Hidden Benefits of a Sustainable Cleanup

Section 5.4 will cover how to identify and capture the hidden social and economic benefits and possible costs of sustainable and resilient cleanup action. In these pages we demonstrate the importance of stakeholder engagement for eliciting costs and benefits and provide examples of metrics that can be used to capture these additional benefits.

5.3.2.2 Do-It-Yourself: Examples of Green Infrastructure Options, Ecosystem Services, and Co-uses

Sections 5.6 and 5.7 provide background on ecosystem services and green infrastructure, respectively—important concepts that support finding co-uses and overlooked benefits beyond the cleanup itself. In addition to the background, you can find information on specific types of green infrastructure that can support sustainable cleanups and deliver cobenefits. These technologies are included for their ability to significantly shift understanding and characterization of a projects' costs and benefits. These technologies and practices can serve remedial needs (for example, management of stormwater runoff from a cleanup construction site) while providing long-term public benefits (for example, infiltration on nonsite runoff and green spaces for bioswales). These technologies could allow regulators or project proponents to justify more costly alternatives that meet cleanup needs by making clear the additional benefits and offering ways to quantify those benefits.

5.3.2.3 Social and Economic Impact Evaluation

Section 5.9 provides metrics and tools for use in measuring and documenting how economic and social considerations factor into a cleanup project. Evaluation methods and resources include commercial and academic aides that support identification and integration of SRR objectives into decision making. In addition, you can find advice on communications, stakeholder identification, and outreach to make local communities authentic participants in project development.

5.4 Social and Economic Sustainability Through Constructive Change and Protective Remedies

5.4.1 Understanding SRR and Where Additional Environmental, Social, and Economic Benefits Are Derived

Like all remediation and cleanup activities, SRR can deliver easily or commonly recognized public health and environmental benefits associated with cleaning up contaminated land, water, or air (see Jenkins, Kopits, and Simpson 2006). These benefits are primarily associated with the protectiveness of the remedy. But the SRR approach goes a step further, considering additional social, economic, and environmental costs and benefits both within the boundaries of the site or cleanup project, and to surrounding communities or environments. Despite recent attention and guidance (ITRC 2011a), many of these additional benefits remain poorly defined and only vaguely understood by both project managers and stakeholders. This is especially true for benefits that accrue beyond the fence line of a site or cleanup project (such as an improvement in property values in surrounding neighborhoods), or where environmental, economic, and social benefits are derived more from choices made in the process of a cleanup project as distinct from the overall protectiveness of the remedy itself.

These “hidden benefits” of sustainable remediation are the subject of Section 5. Improving understanding of these hidden benefits also offers a basis of support for SRR practices, encouraging project managers and stakeholders to seek solutions that reduce social and economic determinants of risk and vulnerability in nearby communities that are also relevant to social and economic sustainability. This is particularly relevant when SRR planning and project activities move beyond site boundaries to consider wider, cascading impacts, such as when cleanup is part of a wider, transformative, or revitalization-based effort, or when broader consideration of social impacts and ongoing community interaction with sites is included in site assessment and remedy selection processes.

Robust and transparent stakeholder engagement is almost always required to identify specific and meaningful social, environmental, and economic goals for a remediation project, and must be continued to ensure that community expectations are met as cleanup progresses (see Favara et al. 2019). In this way, SRR places as much emphasis on ensuring sustainability in the process of land cleanup as it does in the immediate and long-term impacts or effectiveness of the remedy. This should not be interpreted as a means of justifying a less protective remedial action, but instead as an indication that additional measures of environmental, social, and economic effectiveness should be weighed and pursued at all stages of cleanup and as end-state goals. Some of the additional benefits discussed here could accrue naturally or as a positive externality of standard remediation or cleanup practices, but unless they are intentionally pursued, they do not represent SRR. The intentionality of the SRR approach is its key distinguishing feature, and the approach highlights the need for further guidance on how and where to look for its sometimes-hidden benefits.

▼Read more

More reading on this topic:

The Sustainable Resilient Remediation Evaluation Framework in Section 6 provides an easy visual guide to the full SRR evaluation process.

The Social and Economic Impact Evaluations section contains detailed information about performing economic and social evaluations under each of the SRR pathways described in Figure 6-1.

5.4.1.1 Linking Benefits to Steps in SRR

In 2011, the ITRC produced a GSR document that contains step-by-step guidance for project managers and decision makers involved in SRR (ITRC 2011a). Many of these steps are directly relevant to achieving and documenting the hidden benefits of SRR and reducing unexpected costs. We encourage practitioners to review the steps in SRR and to consider how their project plans can be used to protect and enhance the social and economic benefits of SRR in particular. Stakeholder engagement activities in the remedy evaluation and selection stages can represent especially important keys to unlocking additional benefits.

5.4.2 Hidden Environmental Benefits of SRR

The hidden environmental benefits of SRR accrue primarily at site level and are sometimes referred to as "collateral benefits" of sustainable remediation practices. This term is somewhat unhelpful for SRR, because SRR intentionally pursues as many of these benefits as possible, and therefore treats them not as collateral impacts, but rather as central goals. Characterizing benefits in this goal-based manner also makes it easier for project managers and stakeholders to understand how hidden benefits accrue with the SRR approach, which focuses as much on the sustainability of key components or phases of the cleanup process as the effectiveness of the eventual remedy. Some possible goals that will deliver additional environmental benefits are listed below.

- reduced particulate and GHG emissions through use of cleaner technology and vehicular route planning
- reduced consumables or use of materials with a smaller environmental footprint (such as recycled material)
- reduced energy consumption through use of efficient technology/use of renewable energy
- reduced water use through activities such as reuse of treated water and protection of surface water
- reduced waste by reusing on-site materials where possible or recycling materials back into the site
- reduced truck and traffic noise through vehicular route planning
- reduction in greenfield development (if performed in an urban area) and preservation of land, habitat, and green space
- use of minimally invasive technologies that reduce disturbance to wildlife and wildlife habits
- creation of new habitat
- flood control and flood storage
- environmental renewal (for example, soil and groundwater quality improvements that accrue later)
- helping/promoting novel and effective green remediation technologies become mainstream

Please note that the boundaries between these benefits can overlap; many of these examples could also lead to improvements in other areas (for example, public health or livability). Sections 5.5 (brownfields) and 5.10 (case studies) also delve into many of these concepts in more detail for brownfields cleanup projects.

5.4.3 Hidden Social and Economic Benefits of SRR

As with environmental benefits, the additional social and economic benefits of SRR and potential links to improved community resilience accrue most often through identifying and intentionally pursuing social and economic benefits linked to key components or phases of the cleanup process, although there is potential for longer term impacts as well. As stated previously, many of the benefits discussed here have also been confirmed in prior studies of environmental cleanup, but with SRR they are pursued intentionally as outcomes and/or project process goals where practical. Table 5-1 provides a summary of some of the key benefits and goals that could be pursued in this context. More information on how to pursue and measure progress toward these benefits and goals can be found in Section 5.9. For more specific discussion on how social and economic benefits accrue in an SRR project, see Harclerode et al. (2016).

Table 5-1. Main social and economic goals and broad indicators.
Source: after CL:AIRE (2020), Harclerode et al. (2016)

Health and Safety
• of site workers and the surrounding community including, but not limited to, the alleviation, prevention, or mitigation of contamination risks on site, generation of emissions and dust, and hazards of construction and operation of remedial systems • remediation and restoration options may vary in addition to wider public health benefits., such as public health and well-being benefits that might accrue from exercise and well-being as the surrounding community are more encouraged to be outside in restored/improved environments
Economic Vitality

• by contracting local vendors and resources, developing, and investing in new skilled training and education, and incorporating redevelopment into the remediation strategy selection • internal to the site owner, such as the impacts of remediation costs on debt financing and its ability to allocate resources to its other interests. Other concerns might relate to reputational or brand value, and in some cases fines or punitive damages.
Stakeholder Collaboration
• record the transparency of decisions to local communities and their degree of engagement to identify beneficial and undesirable impacts, to discuss perceived risks, to develop future land use and design, and to aid in assessment goals and indicators to maximize buy-in for the eventually implemented remediation strategy • consideration of the range of interactions, including how remediation might affect local services, community functions and amenities such as improvement of the local landscape and other renovations, including the consequential development of infrastructure such as pathways or roads, and public open space
Benefits to Community at Large
• by promoting the community's quality of life, including increased property value, social and human capital, reuse of treated media/materials to meet community needs, and redevelopment of the property • improvements in the livability of a local area, including removal of invasive vegetation, clearance of vermin, mitigation of odor, or reduction in the informal or antisocial use of the site. Also worthy of consideration is the potential removal of wider risks from sites such as fire or windblown litter
Alleviation of Undesirable Community Impact
• at the neighborhood and locality scale, including noise, traffic, odor, congestion, business disruptions, and compromising local heritage and cultural concerns • integrate resilient adaptation measures to mitigate mobilization of contaminants to receptors during a severe weather event or climate-related impacts and prevent exacerbation of community impacts if such an event were to occur
Social Justice
• consideration of ethics and intergenerational equity and whether the nature or duration of remedial works results in the transfer of contamination impacts and/or their mitigation to future generations; and/or a disproportionate distribution of site revitalization benefits resulting in a greater proportion of adverse impacts to ethnic, vulnerable, disadvantaged (etc.) groups • during urban revitalization, through increased housing availability for all community members, widened access to employment opportunities, and reused brownfields for equitable use throughout the community
Value of Ecosystem Services and Natural Resources Capital
• altered by site activities and consumption, reuse of treated media, and restoration of ecosystems, hydrologic functions, fauna, and indigenous flora habitat, in ways that enhance local quality of life and otherwise address societal challenges • restoration or enhancement of ecosystem services in cleanup and restoration activities, such as green infrastructure and carbon sequestration benefits, as well as mitigation of local and regional impacts to severe weather events and other climate-related impacts
Risk-Based Land Management and Remedial Solutions
• to distribute additional resources (for example, energy, raw materials) in a manner to effectively address the site-specific human health, environmental justice, and community issues associated with contaminated sites • remedial solutions compared with the value of benefit, such as mitigation of liabilities by the risk management achieved, redevelopment potential released for the site, land value enhancement *for the site*

Regional and Global Societal Impacts
• such as long-term, chronic public health impacts and financial implications (for example, mitigating effects of climate change and limited water resources) due to the generation of emissions and consumption of nonrenewable resources • project life span and flexibility via integration of resilience and long-term effectiveness of engineering and institutional controls operating under normal and severe weather event conditions
Contribution to Local and Regional Sustainability & Resilience Policies and Initiatives
• such as renewable energy initiatives, climate change legislation (for example, carbon-trading economy and climate adaptation), eco-job strategies, regional land-use policies, regional and local sustainability objectives (for example, ecological restoration goals, water use), and sustainable resource consumption • site cleanup activities may trigger specific wider investments or developments in an area that were not part of the original project, and not foreseen in the original remediation investment. These may include the treatment of other contaminated land or water in the area. The attraction of new investment and new businesses to an area may be a deliberate strategy for a brownfields restoration initiative, to create new economic clusters.

5.4.4 Documenting Hidden Benefits

One of the most important steps in SRR is documenting the outcomes of the project and measuring progress toward goals. This includes clearly identifying desirable outcomes or benefit categories from the outset and linking them to relevant metrics or progress indicators where possible. Although some of the social and economic benefits of SRR are somewhat qualitative, or site-specific in nature, a number of metrics have been established in recent years for assessing a wide range of social, economic, and environmental benefits from land cleanup. These can be chosen to fit the context of a specific project. Reviewing and choosing metrics at the beginning of a project can also help guide identification of project goals and selection of more diverse benefit categories. Stakeholders should be consulted in the selection of metrics to build consensus and reduce the chance for controversy over SRR outcomes.

In addition to the overview of benefits presented in this document, further guidance on frameworks, performance metrics, and tools for identifying and documenting SRR benefits can be found in (among others) Section 6.1.4.2 of this SRR guidance, the SURF library, frameworks and metric toolboxes, the ASTM guidance on sustainable cleanups (ASTM 2013a, 2015, 2016), the Institute for Sustainable Infrastructure Envision Rating System, or the 2011 ITRC framework and state of the science documents on green and sustainable remediation (ITRC 2011a, b).

5.5 Integrating Sustainability and Resiliency into Brownfields Redevelopment

Whether a contaminated property is urban, suburban, or rural, it often remains abandoned until there is a social or economic reason for cleanup. Brownfields, often located in underserved and highly impacted communities, are one more challenge for achieving social and economic benefits. Brownfields are underused properties whose redevelopment or reuse may be complicated by the presence of contamination. Brownfields redevelopment supports communities by reusing contaminated properties for commercial, residential, or institutional buildings and infrastructure. They can lead to healthier environments when used for parks and open spaces. By incorporating sustainable and resiliency strategies into the cleanup, redevelopment can play an important role in strengthening a community by addressing vulnerabilities and mitigating threats from climate change.

Climate change poses potential threats to the redevelopment of brownfields site from extreme weather (hurricanes, tornadoes, and storm surges), increased precipitation and flooding, decreased precipitation and droughts, wildfires, and warmer temperatures. Incorporating resilience and sustainable practices at brownfield sites is critical for the successful development of contaminated properties and results in many environmental, social, and economic hidden benefits.

By identifying the unique challenges and solutions posed by climate change on brownfield sites, communities can support their redevelopment. The Climate Smart Brownfields Manual (USEPA 2016b) provides a comprehensive approach for communities to think about climate mitigation, adaptation, and resilience for development of brownfield sites. The manual encompasses varied topics, from the role of local communities and the public in land-use planning, zoning, and building codes to support resilient and sustainable redevelopment to the techniques, practices, and adaptive strategies for greener cleanups and resilient land use.

Section 6.2 of this guidance provides more information on site characterization.

An ASTM Phase I Environmental Site Assessment (ESA), or an equivalent investigation, is often conducted to identify the potential risk associated with contamination when a property is being sold or developed. The fundamental objective of an ASTM ESA is to identify the potential for releases of oil or hazardous materials at a property. The Phase I ESA compiles a site history for the property to identify current and historic practices. It relies on a variety of sources, including previous reports prepared for the property, municipal records, historic and geologic maps, interviews with knowledgeable persons, and a site inspection (ASTM 2013b).

Changing climate conditions and risk factors can be included in the Phase I ESA process to identify factors that may need to be incorporated into a brownfield cleanup and reuse. The Phase I ESA can be expanded to identify site vulnerabilities. Authoritative sources such as websites from the U.S. Geological Survey (USGS), National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center, colleges and universities, and state or local resources should be reviewed to identify observed and potential changing climate conditions. Potential risk factors should be classified, such as location (for example, proximity to waterfronts and the ocean; infrastructure vulnerabilities; property affected by a revised FEMA floodplain map; vulnerabilities related to changes in frequency and intensity of precipitation events; vulnerabilities of soil type due to moisture and hydraulic changes; vulnerabilities to wildfires; and ground- and surface drinking water vulnerabilities) (USEPA 2014). During the site visit the practitioner should observe the natural setting and how potential vulnerabilities could impact remedy selection, design, and construction.

Sustainable redevelopment of brownfield sites can start with assessment, reducing the project's environmental footprint from the start. The investigation of contaminated properties may include sampling soil, groundwater, sediment, surface water, and indoor air. Buildings scheduled for demolition may be tested for asbestos, lead paint, polychlorinated biphenyls (PCBs), and other toxic pollutants. Many BMPs can be incorporated in the investigations (ASTM 2016, USEPA 2015a, b).

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Examples of sustainable investigation practices are:

- Use local staff whenever possible to minimize resource consumption.
- Use local analytical laboratories and consolidate delivery schedules.
- Use in situ data loggers and transmit with solar-powered telemetry systems.
- Quickly restore disturbed areas of vegetation serving as stormwater controls.
- Install permanent wells for maximum reuse.
- Use minimally invasive drilling techniques.
- Compress the number of days needed for a given round of sampling.

5.5.1 Sustainable and Resilient Development

According to the Resilient Design Institute (RDI), resilient design is defined as "the intentional design of buildings, landscapes, communities, and regions in response to vulnerabilities to disaster and disruption of normal life." Development on brownfield sites requires attention to this intent.

5.5.1.1 Deconstruction and Demolition

Development of a brownfield site often first entails razing existing structures. Deconstruction involves taking a building apart, piece by piece. Full deconstruction is easier to achieve when incorporated as an intentional design element in the planning phase. This can range from a soft strip, in which only the most high-value and easy-to-extract materials are removed intact, to a full deconstruction, in which the entire structure is "un-built" to maximize reuse of existing materials. Deconstruction can be a good fit for buildings with valuable salvage materials, such as rare wood species or intact bricks. For more reading on this topic check out this helpful RecyclingWorks article. The USEPA Deconstruction Rapid Assessment Tool enables organizations to triage building stock slated for demolition; it assembles data that can help prioritize structures for deconstruction and salvage.

Even if the buildings are not candidates for complete deconstruction, sustainable demolition BMPs may be employed. Predemolition surveys will identify asbestos-containing materials which must be appropriately abated before demolition. PCBs in building materials such as caulk, window glazing, paint, and mastic should be assessed and appropriately disposed. Building products found to contain ≥ 50 ppm PCBs are classified as PCB bulk product waste under federal regulations through the Toxics Substances Control Act (TSCA) found in Chapter 40 of the Code of Federal Regulations (40 CFR 761). Hazardous building materials surveys are often required for state or local government demolition permits.

Asphalt, brick, and concrete (ABC) can be crushed and reused on site to raise site grades or as subgrade materials, or it can be reused off site rather than disposed in a landfill. Reuse of ABC materials may be regulated by local and state authorities and should be done in compliance with these regulations and requirements. Specifications that address many aspects of the demolition, such as waste salvage, hazardous materials, and earthwork, instruct the contractor on specific technical requirements (USEPA 2013c).

5.5.1.2 Greener Cleanups

Green remediation strategies can increase the net benefit of a cleanup, saving project costs and expanding the universe of long-term property use or reuse options without compromising the cleanup goals. USEPA has developed five core elements of a greener cleanup: materials & waste, land & ecosystems, water, air & atmosphere, and energy. The methodology suggests how to reduce the footprint during cleanup selection, design, implementation, and operation (USEPA 2015a). USEPA resources include the Superfund Green Remediation website and CLU-In website.

ASTM has developed Standard E-2893-16 to provide a systematic protocol to identify, prioritize, select, implement, and report on the use of greener cleanup BMPs. The standard includes a wide range of BMPs addressing buildings, materials, site preparation and land restoration, managing surface- and stormwater, and power and fuel (ASTM 2016).

Use of renewable energy resources provides a significant opportunity to reduce the environmental footprint of activities conducted during investigation, remediation, and monitoring of hazardous waste sites. Substitution of energy from fossil fuel resources with energy from renewable resources is a primary approach for addressing energy as one of the five core elements of green remediation strategies. There may be significant life-cycle benefits of local/on-site generation of renewable energy, not only being more cost-efficient over the long term, but also being more resilient by eliminating fuel deliveries. Renewable sources of energy for production of electricity or direct power needed for site cleanup can include the following (USEPA 2011):

- solar resources captured by photovoltaic (PV), solar thermal, and concentrating solar power systems
- wind resources gathered through windmills to generate mechanical power, or turbines of various sizes to generate electricity
- geothermal resources, primarily through geoexchange systems such as geothermal heat pumps or by accessing subsurface reservoirs of hot water
- hydrokinetic and marine resources, through the hydropower of rivers and streams or the tidal and thermal influences of oceans
- biomass such as untreated woody waste, agricultural waste, animal waste, energy crops, landfill gas and wastewater methane, anaerobic digestion, and algae

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The Massachusetts Department of Environmental Protection (MassDEP) issues postclosure use permits for solar and wind installations on closed and capped landfills. To date, the agency has approved more than 100 projects rated more than 220 megawatts. Most of these projects have been completed and are generating nearly 175 megawatts of renewable energy.

Site work during development often can be greener. Techniques include maximizing the reuse of contaminated soil on site, reducing reliance on off-site landfills for disposal and reducing truck trips and associated GHGs. Reuse of contaminated soils may be regulated by local and state authorities and should be done in compliance with these regulations and requirements. Gravel roads, porous pavement, and separated pervious surfaces rather than impermeable materials will maximize infiltration. Planting at the optimum time of the season (for example, late winter/early spring) will minimize irrigation requirements.

5.5.1.3 Resilient Development

Many brownfield sites are along waterfronts, making them susceptible to the impacts of climate change, such as flooding, storm surges, and sea-level rise, or they may be in areas afflicted with extreme heat or wildfires. As brownfield sites are redeveloped, sustainable and resilient principles should be incorporated.

Stabilization along the waterfront, even on contaminated properties, may provide opportunities for incorporating living shorelines made of natural materials such as plants, sand, or rock rather than hard structures such as concrete seawalls or riprap. As described by NOAA, living shorelines provide wildlife habit, as well as natural resilience to communities near the waterfront.

Incorporating resilient design into the built environment, including at brownfield sites, requires rethinking traditional practices to address potential vulnerabilities. RDI has developed many practical approaches to meet the strategic goals for development, such as:

- Design and construct (or renovate) buildings to handle severe storms, flooding, wildfire, and other impacts that are expected to result from a warming climate.
- Locate critical systems to withstand flooding and extreme weather events.
- Model design solutions based on future climatic conditions as much as possible, rather than relying on past data.
- Create buildings that will maintain livable conditions in the event of extended loss of power or heating fuel through energy load reductions and reliance on passive heating and cooling strategies (passive survivability).
- Create durable buildings using such features as rainscreen details, windows that can withstand hurricane winds, and interior finish materials that can dry out if they get wet and not require replacement.
- Optimize the use of on-site renewable energy.
- Carry out water conservation practices and rely on annually replenished water resources, including, potentially, harvested rainwater, as the primary or backup water supply.
- Find opportunities to use gray water, which is domestic wastewater excluding sewage, for plant irrigation, gardening, laundry, and toilet flushing.
- Provide redundant water supplies or water storage for use during emergencies. For deep-well pumps, provide either stand-alone solar electricity or hand-pumping options where possible. Where there is no option for on-site water, consider water storage that can gravity-feed to building.
- Consider an option for human waste disposal in the event of nonoperating municipal wastewater systems. This could include composting toilets and waterless urinals.
- Specify products and materials that will not off-gas or leach hazardous substances in the event of flooding or fire damage.
- Provide redundant electric systems with at least minimal back-up power capacity, such as a fuel-fired electric generator (with adequate fuel storage) or a solar-electric system with islanding capability.

Soil, groundwater, and indoor air contamination may affect the implementation of some of these strategies. When buildings, parking lots, hardscapes, and landscapes are used to encapsulate contaminated soil, they must also be designed to withstand severe flooding and storms. Evaluate when stormwater or wastewaters are recharged on site so that they do not adversely impact the flow of contaminated groundwater. When developing properties contaminated with volatile organic compounds that require vapor mitigation systems, they must be compatible with passive heating and cooling systems and are provided emergency power generation, if required.

5.5.1.4 Green Infrastructure

Green infrastructure is a valuable tool to address many of the impacts of climate change, such as flooding, droughts, urban heat islands, and storm impacts. Infiltration practices can manage flood waters and replenish groundwater. Urban heat islands, which increase temperatures due to dense buildings and pavement, can be mitigated with trees and other vegetation. Energy use can decrease with green infrastructure that reduces rainwater into stormwater or sewer systems, conserves water, and decreases heating and cooling requirements for buildings. More information is available on USEPA's Green Infrastructure for Climate Resiliency website. Sustainability evaluation tools, such as USEPA's Green Infrastructure Wizard, can be used to capture the beneficial externalities of green infrastructure.

5.6 Ecosystem Services

Human populations rely on the many benefits provided by aquatic and terrestrial ecosystems.

Supporting services are those ecosystem services not used directly by people, but which are necessary for all other ecosystem services. They include soil formation, photosynthesis, and nutrient and water cycling.

Provisioning services refer to ecosystem products that are used by or directly impact human populations, including food, fuel, and fresh water.

Regulating services relate to ecosystem process regulation and include air quality, climate, water, and pollination.

Cultural services are the human benefits obtained through ecosystem services, such as cultural diversity, recreational opportunities, or aesthetic amenities.

Figure 5-1 shows how human well-being depends ultimately on renewable and cultivated natural capital. Renewable natural capital refers to well-functioning ecosystems and their living components, that is, native biodiversity. Cultivated natural capital includes traditional crop varieties and livestock races, as well as traditional agroecological knowledge. The internal pyramid conveys the feedback through which increased human well-being has positive benefits that flow back through the system. This suggests that society must support and participate in the restoration of natural capital and thereby reap additional benefit from the full spectrum of enhanced ecosystem services, as well as the inherent value of restored ecosystems.

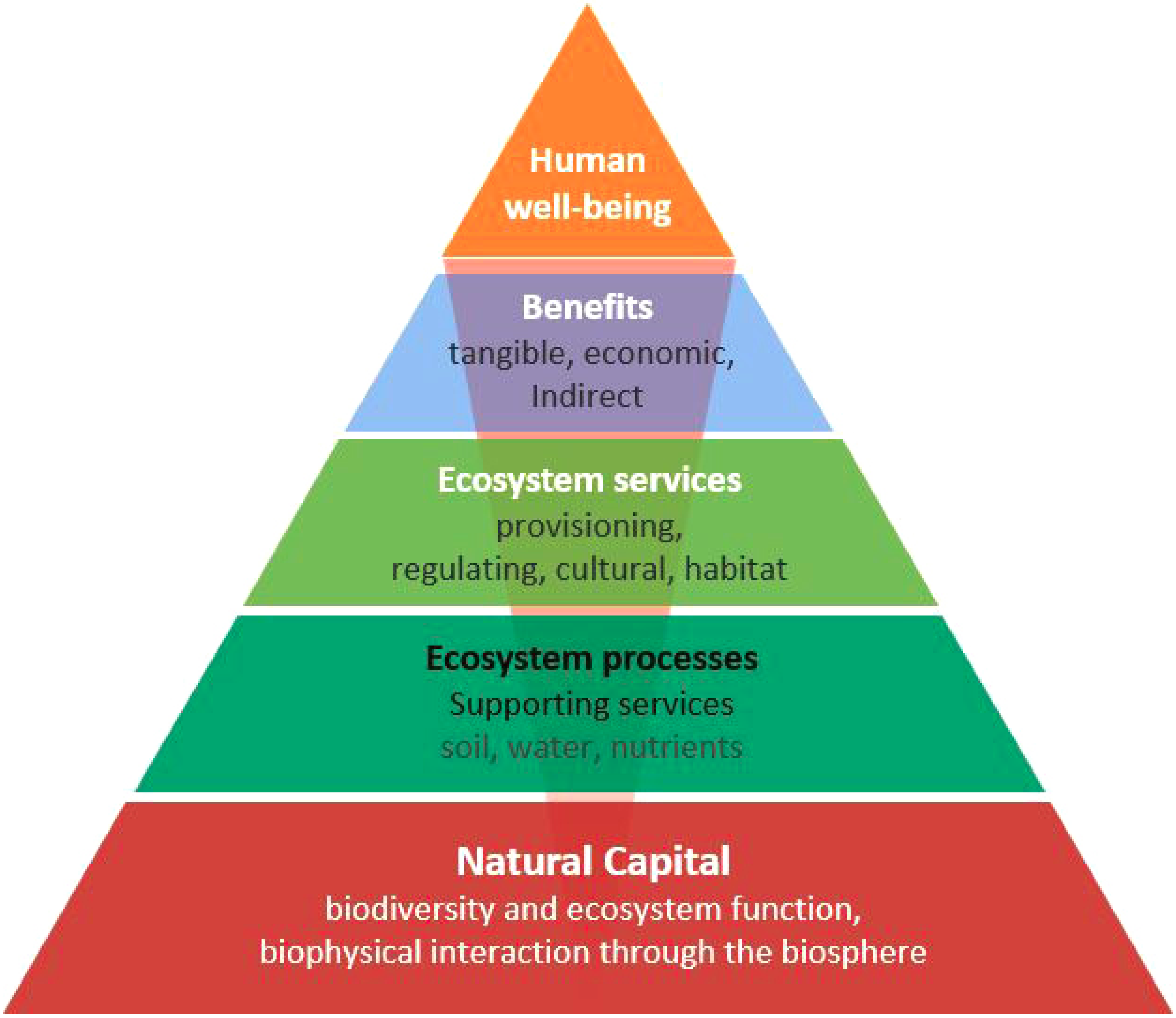

Figure 5-1. Natural capital hierarchy.
Source: Alexander et al. (2016). U

5.6.1 Value of Ecosystem Services

Ecosystem services provide many benefits that have economic value. But because ecosystem services have traditionally been treated as a public good, their actual values are seldom captured in decision-making processes. Assigning value to the range of benefits provided by ecosystems can help decision makers to ensure the values ecosystem services provide are included in site decisions. Forests play a critical role in maintaining water quality. Because healthy forests can reduce the costs of treating drinking water for local governments, it may be cheaper to invest in protection of the watershed than to expend funds in expensive water treatment systems. For example, New York City invested more than $1 billion to protect its primary water supply in the Catskills region of upstate New York and avoided $10 billion to build a water treatment facility and $100 million annually on operations and maintenance costs (Hu 2018).

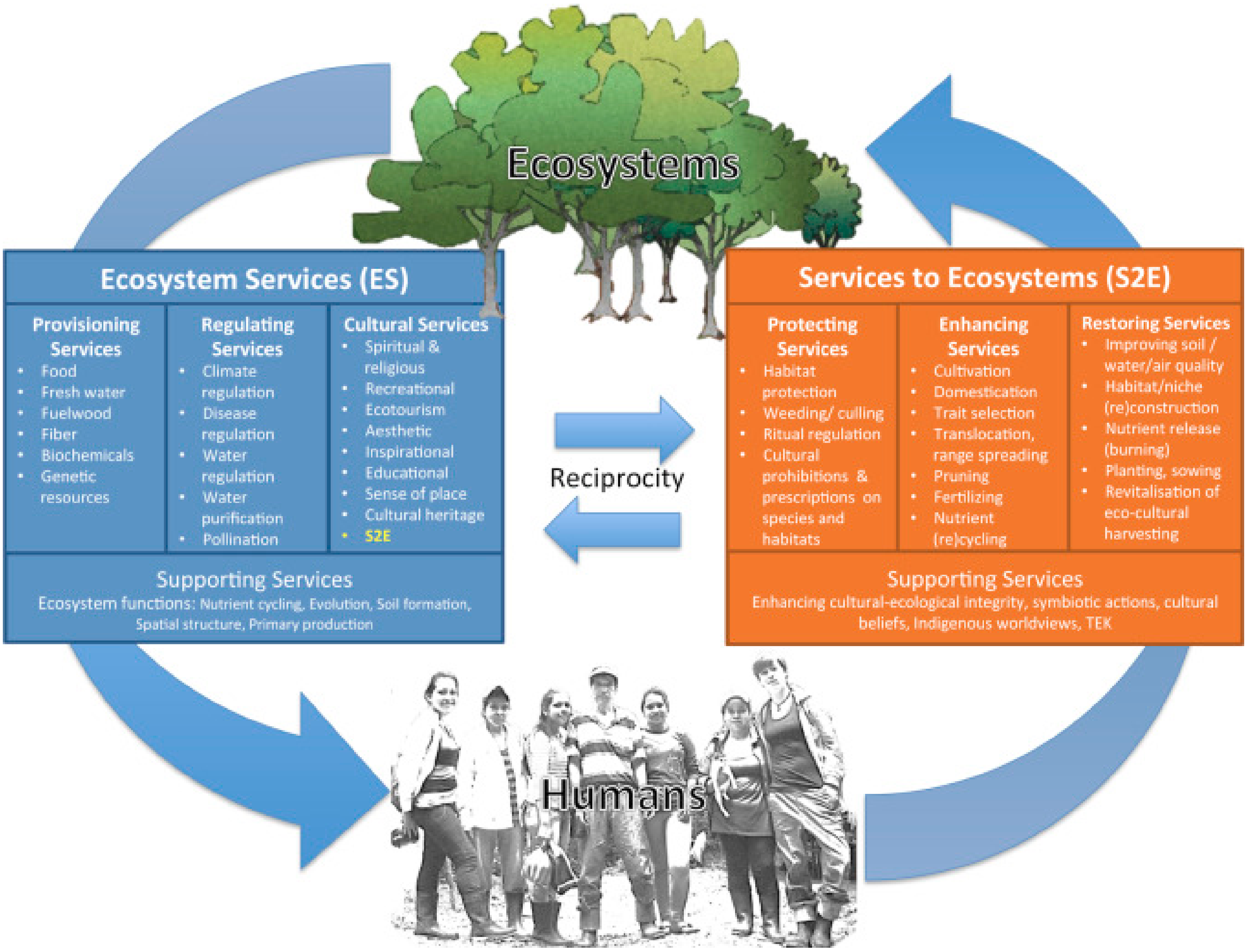

Figure 5-2. Reciprocity between humans and the environment.

Source: Comberti et al. (2015)

Ecosystem services face a range of challenges. Pollution can result in acidification of soil and water sources and can have impacts on plants and wildlife. Land-use changes and urban development can reduce and fragment open space, impacting the viability of ecosystems and their services. Meanwhile, climate changes are fundamentally altering the habitats, fauna, and flora of ecosystems and the services provided by those systems across the globe. These climate impacts will require considerable adaptation for ecosystem services to remain viable or we will suffer a concomitant change in the level of services provided. Ecosystem management and conservation activities are common methods to protect ecosystems and maintain the services they provide, avoiding the need for costly alternative providers of service.

Communities sometimes promote activities to provide the ecosystem services that are in jeopardy. A common practice is “wetlands mitigation”—in which lands are set aside for development of wetlands to compensate for wetlands where disruption or destruction was unavoidable. One concern is that the constructed wetlands may never fully achieve the services that were provided by the original wetland, so it often better and more cost-effective to avoid the damage in the first place.

▼Read more

Tyndall Air Force Base implemented resilience initiatives oriented toward operational recovery and response. Ecosystem services were also employed in these SRR guidance case studies in Appendix A: DeSale; Shark River; Berry Lane; Iron Mountain.

5.6.2 Valuing Ecosystem Services

There are many “tools” used to compare costs and benefits of ecosystem services, including land acquisition and conservation easements, as well as sustainable land management practices that protect important ecosystem services (USEPA 2017b).

There are two main ways to assign value to ecosystem services: avoided costs and replacement costs.

Avoided costs refer to costs that are not incurred because ecosystem services are protected or preserved (see Hu 2018)

Replacement costs are the costs of engineered systems to replace ecosystem services (for example, engineered stormwater systems to replace natural functions; see ITRC's Stormwater Best Management Practices Performance Evaluation guidance (ITRC 2018b).

Each remedial site should not only look to the technical aspects of cleanup, but also to the end use. Regulators are responsible for making a variety of decisions related to community growth and change, and many of these decisions directly affect ecosystem services. For example, decisions concerning the location and design of remediation—including infrastructure facilities and activities—will have significant impacts on the extent to which existing ecosystems will be able to provide services to the community. Markets have emerged to compensate landowners for the ecosystem services their land provides. Through these markets, buyers (governments, nongovernmental organizations, corporations) purchase credits from sellers (landowners), who provide ecosystem services through conservation or sustainable land management practices. Examples of successful markets include those for trading sulfur dioxide emissions and for wetlands mitigation.

New approaches to conservation are emerging that may expand the valuation of ecosystem services. Markets and payments for carbon sequestration, watershed management, ecotourism, and a host of other services may supplement traditional valuations and promote good stewardship, especially when used together with other conservation tools. The US Forest Service (USFS) has published information on valuing ecosystem services.

5.6.3 Involve Community Stakeholders

Community stakeholders can be engaged in the valuation process to identify the best method to use to determine the values (see Section 5.9.1.5). Stakeholders should remain involved and informed throughout the analysis to ensure that the process remains transparent. At the beginning of the process, key stakeholders should be identified for involvement. Stakeholder groups to be considered would include community members, interest groups, agencies, and elected officials.

Community members should be engaged to develop a common vocabulary on ecosystem services and identify broader community goals. Discussions with stakeholders should be held in order to find out what have historically been issues in the community. They may have anecdotal information that could lead to discovering other issues. It is helpful to establish relationships and solicit inputs from interest groups that will benefit from the ecosystem services, such as agriculture, recreation, and ecotourism, to help fine-tune needs and project requirements.

Stakeholders can be enlisted to help with the inventory of ecosystem resources. Activities conducted with stakeholders should be consistent with plans that are in place. Partnering with local government officials can help to identify mechanisms in place that are impeding any natural resources functions.

Meetings with the public should be conducted to discuss outcomes and products of the ecosystem inventory and associated issues. The focus of the meeting should be on ecosystem service benefits, and costs incurred if those benefits are decreased. Open communication in these meetings is encouraged in order to allow for questions and comments and an openness to change. The goal is for stakeholders to "own" part of the process and the outcome along with the project leaders.

Stakeholder involvement in alternatives analyses is encouraged in order to identify scenarios that address the community needs or issues. Any actions taken should be consistent with existing planning and implementation mechanisms.

5.6.4 Expert Help to Protect Ecosystem Services

Sustainable land management practices promote ongoing sustainable management of resources for productive use. There are governmental programs and funding to protect land and their associated ecosystems. For example, the USFS Forest Stewardship program assists landowners through the state and private forestry programs to promote land stewardship and agroforestry practices that will result in long-term sustainability of forest resources and landscapes. The U.S. Department of Agriculture (USDA) can provide technical support through extension offices situated in many counties and universities throughout the nation. Also, nongovernmental agencies and conservation groups can provide technical expertise and volunteers to help transform remedial sites into areas that return ecological services to nature and the community.

5.7 Green Infrastructure and Resiliency

Green infrastructure refers to ecological systems, either natural or engineered, that use or mimic natural processes to sequester, infiltrate, evaporate, transpire, or reuse stormwater. Green infrastructure helps manage destructive precipitation and can help mitigate potential flooding in communities. These ecological systems provide a service in terms of sustainability and resiliency. Green infrastructure also has preferable attributes such as lower maintenance and cost, and improved access. Some green systems are resilient with respect to flooding, drought, wildfire, temperature extremes, and salt-water intrusion.

Green infrastructure provides many benefits by reducing capital investment in built (gray) infrastructure for stormwater control and management, thereby slowing erosion, improving aquifer recharge, and lowering energy use. When effectively managed, human health benefits are improved from reduced pollution and heat stress, as well as cultural, societal, and aesthetic benefits from access to safe, green space. Green infrastructure projects may provide refuge for threatened and endangered species, provide a safe space for pollinators, and help sequester GHGs. But green infrastructure projects may be limited by restrictive land-use regulations, by access issues, or by the available diversity of plants and/or animals. These projects may also create adverse site characteristics due to changes in climate, soils, and/or habitat, which may cause an increase in nuisance plants or animals. Adverse changes to green infrastructure can often affect the chance or intensity of wildfires and flooding.

Sociocultural changes, specifically reliance on controlled-temperature interiors, tend to limit usefulness of some green infrastructure measures. Green roofing allows buildings to naturally regulate their thermal environment by:

- Retaining heat during the cool period by insulating the building
- Deflecting heat during the warm period by reflecting solar radiation and absorbing solar radiation through photosynthesis and evapotranspiration of the vegetation.

Extreme temperatures may bring the building interior beyond comfortable levels and require the ongoing use of heating and cooling systems (for example, HVAC, furnace, air conditioners).

More and more communities are employing green infrastructure and conservation of surrounding watersheds to improve resilience to changing climates (Cassin 2019). For instance, increased development around Boston, Massachusetts, during past decades eliminated many wetlands and increased roadways, parking lots, and other impervious surfaces. A series of dams along the Charles River historically controlled flooding, but these dams had insufficient capacity for large precipitation events, which have become more common. Rather than build more dams at great environmental, social, and economic costs, the U.S. Army Corps of Engineers, the city, and surrounding communities agreed to set aside from development and protect the remaining wetlands by creating the Charles River Natural Valley Storage area. These wetlands provide critical green infrastructure and flood resilience to the city, and expand recreational amenities for the entire region.

5.7.1 Opportunities for Green Infrastructure in Site Remediation

During the past 25 years, the ITRC has focused on cleanup and has produced many documents related to technologies. Many of these technologies (linked below) may also have a green infrastructure and/or sustainable option that may help reduce costs, improve cleanup efficiencies, and expand community acceptance.

- In Situ Bioremediation – The In Situ Bioremediation (ISB) documents address the systematic characterization, evaluation, and appropriate design and testing of ISB for biotreatable contaminants.
- Bioremediation of Dense Non-Aqueous Phase Liquids (DNAPLs) – These documents address the selection and design of ISB systems for chlorinated ethene DNAPL source zones, as well as technical and related regulatory considerations (ITRC 2005, 2007, 2008b).
- Enhanced Attenuation: Chlorinated Organics – The Enhanced Attenuation (EA): Chlorinated Organics document provides direction to regulators and practitioners on integrating EA into remedial decision making for a smooth transition between aggressive remediation and monitored natural attenuation (ITRC 2008a).
- Enhanced In Situ Biodenitrification – This document addresses nitrate-contaminated groundwater, which is associated with environmental and health problems, and an emerging technology for remediating and protecting public and domestic supply wells (ITRC 2000).
- Natural Attenuation – The Natural Attenuation documents provide a framework for thinking about natural attenuation based on science, focusing on the basic information needed to determine and document the conditions necessary for natural processes to be an effective part of remediating contaminants in groundwater.
- Phytotechnologies – These documents provide practical information on the process and protocol for selecting and applying various plant-based technologies to remediate contaminated soil, groundwater, surface water, and sediments (ITRC 2009).
- Stormwater – This guidance is intended to provide a nationwide perspective on the challenges facing the stormwater industry in evaluating the performance of postconstruction BMPs throughout a project life cycle. The guidance describes historic, existing, and developing postconstruction BMP performance verification and certification programs and captures existing program data in a new BMP screening tool to assist practitioners during the design of projects (ITRC 2018b).

5.7.2 Brownfield Sites

Cities are redeveloping brownfield sites, properties where the presence (or likely presence) of contaminants could complicate redevelopment or reuse (see Section 5.5). Integrating green infrastructure into these sites can benefit the environment and the community. But implementing infiltration-based stormwater management practices must be done carefully, so contaminants in the soil are not mobilized, increasing the risk of groundwater contamination.

It is important to perform site analysis and planning during the design and planning stages of any remedial project. In 2013, the USEPA released Implementing Stormwater Infiltration Practices at Vacant Parcels and Brownfield Sites (USEPA 2013b). This document guides decision makers through a series of questions to determine whether infiltration or other stormwater management approaches are appropriate for a specific brownfield property.

The creation of public green space on a brownfield site is considered a "soft reuse," where the soil remains unsealed, versus a "hard reuse," where the soil is covered by "built" structures or infrastructure. It may be difficult to monetize benefits of soft reuse (sustainable) services for the restoration of brownfields. A brownfield opportunity matrix is proposed to compare soft- versus hard-reuse options through sustainability linkages (Bardos et al. 2016). The CSM can provide the linkages between the services provided by the green infrastructure (ecosystem) and the overall costs for the restoration project (Bardos et al. 2016).

Demonstrating the economic merits of green infrastructure practices is integral to acceptance, funding, and implementation. A robust comparison of sustainable alternatives will help communities decide where, when, and to what extent green infrastructure practices should become part of future planning, development, and redevelopment. A recent guide provides methodology and considerations for detailed calculations of most ecosystem services provided by green infrastructure alternatives and across regions (CNT 2011).

Incorporating green infrastructure into a site remedy can reduce overall costs and improve sustainability if the project uses renewable resources (wholly or mainly), and green infrastructure provides habitat and promotes a varied ecosystem. If businesses in the surrounding community are hired to supply materials, plants, and labor for building green infrastructure projects, then the local economy and community will also benefit from the project.

5.7.3 Flooding Resilience for Green Infrastructure

Resilience may be a concern for sites and facilities that rely on infrastructure and/or utilities to maintain operations. During extreme climate scenarios, even green infrastructure may not be sufficiently resilient to withstand weather extremes. While smart landscaping or other, common sense measures can slow a small or slow-moving fire, long periods of hot, dry weather combined with winds can create firestorms that can leap over these preventive measures. Most floods can be managed by floodplain or building restrictions and improved infiltration measures; however, extreme flooding can overwhelm the capacity of even large acres of floodplains and wetlands. While resilient to most weather conditions, even green infrastructure may be burned or washed away during extreme events. Selecting native plants for bioretention structures will ensure the plants can tolerate typical temperature and precipitation ranges experienced in their habitat, without relying on lawncare and climate control measures to thrive. This practice allows the designed and constructed green infrastructure to be more resilient to climatic fluctuations.

Figure 5-3. Examples of green infrastructure (left: retention basin; right: permeable pavement) that mitigates flooding and high temperatures while allowing infiltration to help replenish the local groundwater system during drought conditions.

Sources: Klausing Group. Unilock Turfstone. Used with permission.

In some instances, green infrastructure is more resilient than engineered landscapes to cope with increased risk of floods and droughts. One community (Napa, California) solved flooding problems by restoring the Napa River's natural channel and wetlands (that is, allowing floodplains and infiltration to mitigate flooding) instead of lining the river with concrete. The natural landscaping also benefits the local community by providing new parks and open space (Figure 5-4). The consequences of drought can be mitigated by installing green infrastructure; during infrequent rainfall events, rainwater has time to infiltrate where it lands instead of contributing to a flash flood. Local infiltration benefits the wider ecosystem as the rainwater replenishes groundwater stores, maintains baseflow toward local rivers and streams, and can be used during times of surface-water shortage.

Figure 5-4. Examples of green infrastructure installed to mitigate the effects of and be resilient in the face of flooding (Napa, CA). Flood terrace restoration near the confluence of Sulfur Creek (left) and regraded bank with a wider setback and gravel/cobble bar (right) in St. Helena, CA.
Source: Napa County Stream Maintenance Manual. Used with permission.

Top-down and stakeholder-supported considerations are needed to mitigate deleterious and costly effects from uncontrolled or unmanaged volume and movement of water across the landscape, and to speed recovery from damaging events. USEPA's Community Flood Resilience checklist provides an excellent summary of issues.

5.7.4 Wildfire Resilience for Green Infrastructure

Green infrastructure and the ecosystem services it provides are typically devastated by wildfires. Loss of fauna, flora, clean water, and habitat is often sudden, catastrophic, and may take many years to recover in a manner that will support a wide diversity of plants and animals (see Section 7.7).

Post-wildfire concerns include flooding and mudflows. Depending on the loss or accumulation of soils from flooding or mudflow, the vegetation will experience drastic changes. Invasive plants—often nonnatives—will grow, which will significantly change the soil structure and associated animal species (see Section 7.8).

New contaminants may be introduced into the environment, raising health and safety concerns after a wildfire, either by short-term exposure to water or inhalation or other factors such as things burned (that is, building materials, vehicles) or by dispersal of contaminated surface soils by winds or floods. Long-term, residual contamination of soils from wildfires can cause persistent exposure hazards to humans and wildlife.

Green infrastructure projects and measures can speed the recovery process by controlling erosion, protecting surface waters, restoring nutrient cycling, and rebuilding the area's to support plants and animals, including those used for agriculture (USAID 2017).

Several tools exist to determine whether a site or community is prepared for wildfire events, such as the Fire-Adapted Network's community assessment tool.

5.8 Selecting Sustainable and Resilient Passive or Low-Energy Remediation Technologies

When considering a remediation technology, it is a good practice to first identify the remediation concerns for the site. This will aid in establishing the remediation goals and determining the remediation cleanup objectives. More information about identifying concerns, establishing remediation goals, and determining remediation cleanup objectives is found in ITRC's Light Non-Aqueous Phase Liquid Site Management Guidance (ITRC 2018a).

In addition to meeting the cleanup objectives, technologies with sustainable practices that help the environmental, economic, and social benefits of the cleanup can be considered (Section 6.3.5.2). Sustainable resilient remediation technologies (Section 6.3) use natural resources and energy efficiently, reduce negative impacts on the environment, minimize or eliminate pollution, and reduce waste to the greatest extent possible (USEPA 2008). Sustainable and resilient cleanup technologies can be evaluated once the investigation portion of the conceptual site model (CSM) has been built. The next step is to build or update the remedy selection and remedy design portion of the CSM. Sections 6 and 7 of this guidance, along with ITRC's Green and Sustainable Remediation: A Practical Framework (ITRC 2011a) and Green and Sustainable Remediation: State of the Science and Practice (ITRC 2011b) are good resources for approaches and BMPs that should be considered when building the CSM.

5.8.1 Characterizing the Site

When determining which remediation system to select for cleanup at a site, it is important to first characterize the nature and extent of the contamination and its relation to the site setting and hydrogeology. This is a critical step for cleanup decision making. It is also critical to gather information and considerations specific to the contamination relating to the risks of the contaminant source, exposure pathways, and receptors. This information should be shared with the community and stakeholders to enlist their perspective and concerns.

For example, some of the questions to fully consider before selecting a remediation system at the site are:

- Does the contamination pose a risk to human health or the environment?
- Is the contamination migrating?
- Will the remediation technology address the regulatory requirements?
- How resilient are the technologies to future impacts due to climate change?
- What is the future use planned for the site?
- What are the concerns of the stakeholders or community?

5.8.2 Transitioning to Sustainable and Resilient Remedial Technologies

To continue to make progress in the cleanup, many sites will require adaptive strategies. Typically, this may include transitioning to different remediation technologies over time. This will be necessary to achieve the remediation cleanup goals and address the contamination concerns at the site. Over the time span of the cleanup, remediation technologies will likely need to be transitioned when the remediation technology has reached its technological endpoint or when site conditions and contamination levels change. These transitions are opportune times to look at sustainable and resilient cleanup technologies and practices. While transitioning remedies to a passive or low-energy remedial technology is also an excellent time to engage or reengage the stakeholders and community on any social and economic values (including costs).

5.8.3 Selecting Goals

Remediation technologies can be selected that can be adapted to the site conditions or adapted to the needs or reuse requirements of the site or community concerns. In addition to transitioning remediation technologies to meet cleanup and risk goals, economic and social needs for the site and surrounding community should be evaluated and achieved. Examples of characteristics for more sustainable remediation technologies include:

- remediation technologies that are adapted to the desires of stakeholders and the community where the remediation or reuse is occurring
- sustainable and resilient remedies that will be less impacted by extreme weather, flooding, wildfires, and power outages
- remediation technologies that are adapted to fit within the needs of community development and social needs
- remediation technologies that use less energy, are less noisy, and are less disruptive to the stakeholders and community
- remediation technologies that have a smaller carbon footprint and are more cost-effective and adaptive to the social and economic conditions of the site or the community where the remediation is occurring

If exposure to the contamination and risk to human health and the environment are under control, transitioning to a passive or low-energy remediation technology can be considered. Passive technologies often use less energy and can be more resilient to extreme weather. Depending on site conditions, some of these technologies can be powered by wind or solar energy. Some of the technologies require no external energy source. This would reduce the carbon footprint of the remediation technology compared to a technology that uses large amounts of energy.

5.8.4 Passive or Low-Energy Remediation Technologies

Table 5-2 lists examples of several passive or low-energy remediation technologies that can be considered for light nonaqueous phase liquid (LNAPL).

Table 5-2. Passive or low-energy remediation technologies to treat LNAPL (ITRC 2018a).

Technology	Description
Biosparging/bioventing	This process is similar to air sparging/soil vapor extraction, except air/oxygen is injected more slowly with the main goal being stimulation of aerobic biological degradation of organic contamination (such as LNAPL) in the saturated and unsaturated zones. Various configurations are possible, including inducing airflow into the unsaturated zone by extraction of soil vapors.
Enhanced anaerobic biodegradation	Enhanced anaerobic biodegradation involves supplying electron acceptors other than oxygen (e.g., nitrate and sulfate). Anaerobic biodegradation can also be achieved by increasing the subsurface temperature to increase the natural biodegradation rates.
Natural source zone depletion	LNAPL is degraded via naturally occurring processes of biodegradation, volatilization, and dissolution. The predominant process is biodegradation, including direct LNAPL-contact biodegradation. LNAPL constituents dissolve, biodegrade, volatilize, solubilize in soil moisture, and also subsequently biodegrade further in the vadose zone. Biodegradation produces gaseous products, such as methane and carbon dioxide, and ultimately completely mineralizes the LNAPL.
Phytotechnology	Phytotechnologies use plants to remediate or contain contaminants in the soil, groundwater, surface water, or sediments. Phytoremediation is generally considered a phase-change technology, enhancing subsurface biodegradation, but, to a lesser extent, can also be considered mass control technology if designed for hydraulic control.

In addition to LNAPL technologies, USEPA's green remediation primer (USEPA 2008) provides a discussion of how energy-intensive remedies can be transitioned to more natural, low-energy treatment processes such as enhanced aerobic bioremediation, permeable reactive barrier walls, engineered wetlands, and monitored natural attenuation (ITRC 2011a). For more examples of passive or low-energy remediation technologies, please refer to other ITRC documents below.

- LNAPL Site Management: LCSM Evolution, Decision Process, and Remedial Technologies (ITRC 2018a)
- Remediation Management of Complex Sites (ITRC 2017)
- A Systematic Approach to In Situ Bioremediation in Groundwater, Including Decision Trees on In Situ Bioremediation for Nitrates, Carbon Tetrachloride, and Perchlorate (ITRC 2002)
- Remediation Process Optimization: Identifying Opportunities for Enhanced and More Efficient Site Remediation (ITRC 2004)
- Optimizing In Situ Remediation Performance and Injection Strategies (ITRC 2020a)

Other GSR and infrastructure examples can be found in Section 5.5.1.4. Information and examples using passive ecosystem services and infrastructure for remediation can be found in Section 5.6.

Transitioning to a passive remediation technology can be sustainable and resilient if it addresses the cleanup goals and site conditions, is protective of human health and the environment, meets regulatory requirements, and addresses the concerns of the community and stakeholders.

5.9 Social and Economic Impact Evaluations

This section provides an overview of the process, indicators, and tools to evaluate social and economic impacts from cleanup activities and subsequent land revitalization. The identification and selection of sustainable resilient indicators and tools to be applied should be informed by the CSM, stakeholder needs and concerns, risk management strategies, and future use scenarios. Applicable metrics and tools to evaluate project specific sustainable resilient indicators will likely evolve throughout project planning and implementation of cleanup activities. We recommend that you develop sustainable resilient objectives to guide the formulation of project specific SMART (that is, **s**pecific, **m**easurable, **a**ttainable, **r**elevant, and **t**imely) goals focused on SRR process implementation to help attain those objectives. Once developed, the goals and objectives must be regularly revisited and revised as needed to ensure appropriate project progress. Note that conducting a stakeholder engagement session with a community is not the same as consideration and assessment of the impacts on social, economic, and environmental factors of a project. The latter is a process to evaluate sustainability impacts, which may include stakeholder engagement activities to obtain input.

Social and economic factors can be represented as indicators of either beneficial or unintended impacts of cleanup and restoration activities. These indicators are helpful when articulating what socioeconomic impacts mean in the context of the project, and in measurable ways to define and evaluate a project's broader sustainable and resilient risk management goals. Using these indicators to communicate with stakeholders is also beneficial to support project decision-making rationale and evaluate the SRR return on investment (S-ROI). Table 5-1 provides ten main social and economic goals and broad indicators. These indicators and related impacts may be applicable in a short-term, interim, and/or long-term context.

Examples of SRR goals applicable to the remedy implementation stage are:

- consideration of site worker and community health and safety during operation under normal and severe weather event conditions
- mitigation of unintended community impacts due to cleanup activities
- stimulation of the local economy

Examples of SRR goals applicable to the land restoration/revitalization stage are:

- maximization of S-ROI of cleanup activities, such as mitigation of community displacement and other social justice concerns due to revitalization
- restoration of ecosystem services for wildlife habitat, recreational use, and/or storm-surge protection
- implementation of risk-based land management to facilitate property reuse in a timely manner

The social dimension of SRR includes consideration of stakeholder concerns and needs. In this context, multiple stakeholder values inform site-specific objectives, goals, and processes of an SRR assessment (Cundy et al. 2013). Stakeholder identification is an important part of the engagement process (Ridsdale and Noble 2016). Different stakeholder groups need different levels of engagement at different stages of the project life cycle—for example, those directly affected and those indirectly affected. Research has shown that when communities are consulted adequately, perceptions of sustainability are increased (Fidler 2010), and acceptance of project decisions and outcomes is easier (Greenberg and Lewis 2000). Alternatively, when communities are not consulted, they feel more distrust and are less agreeable to final outcomes (Letang 2017). The next section will provide an overview of stakeholder engagement methodologies. Additional resources can be found in Section 6.1.2, Stakeholder Engagement.

5.9.1 Select Metrics, SRR Evaluation Level, and Boundaries

ITRC has developed a three-level approach to conducting GSR evaluations as described in the GSR-2 technical and regulatory guidance document (ITRC 2011a). This approach provides different levels of detail for GSR evaluations and embraces the concept that GSR evaluations are scalable to any type of project or site. Level 1 evaluation can be achieved for all project types by implementing SBMPs to maximize relatively easy sustainability gains from site activities. Levels 2 and 3 evaluations consist of Level 1 BMPs and either a "simple" or "complex" value assessment. The results of SRR evaluations and assessments provide optimization opportunities that can benefit projects by comparing remedial solutions for their social, economic, and environmental values (benefits and costs).

The ITRC GSR three-level evaluation approach includes consideration and assessment of social, economic, and environmental indicators of SRR. Subsequent information presented herein provides a compilation of resources, methods, and tools to support an SRR evaluation in the context of social and economic indicators. This compilation is comprehensive but not necessarily all encompassing, as additional indicators, metrics, and tools may be applicable and pertinent. To learn more about how to apply the GSR three-level evaluation to project planning, see Section 6.1.5.2, Determine SRR Evaluation Level. We recommend that you engage an SRR subject matter expert to support determination of the level of evaluation that is in alignment with site-specific objectives and goals.

5.9.1.1 ITRC GSR Level 1 – Best Management Practices

The objective of the ITRC GSR Level 1 approach is to adopt BMPs based on common sense to promote resource conservation and process efficiency (ITRC 2011a, b). This objective can be expanded upon to adopt BMPs to promote quality of life improvements and mitigate unintended impacts that directly affect the community and indirectly affect broader society.

Table 5-3 presents a resource summary to help practitioners identify, prioritize, track, evaluate, and report social and economic BMPs and related indicators that best represent their project. The GSR Level 1 approach is a basic desktop analysis of these resources and subsequent implementation of BMPs.

More information on the process of BMP identification, selection, implementation, and tracking can be found in ASTM E2876 – 13 Standard Guide for Integrating Sustainable Objectives into Cleanup (ASTM 2013a) and the ITRC GSR-2 Guidance (ITRC 2011a).

Table 5-3. Level 1 social and economic BMP resources.

Social and Economic BMPs Resource	Resource Summary
ASTM E2876 – 13 Standard Guide for Integrating Sustainable Objectives into Cleanup (ASTM 2013a)	Appendix X1 presents a comprehensive sustainable remediation BMPs list to serve as a starting point for practitioners. This list may be added to or modified based on additional resources and site-specific factors.
USEPA 542-R-17-004 Ecosystem Services at Contaminated Site Cleanup (USEPA 2017b)	This document provides examples of greener cleanup BMPs that address ecosystem services.
Institute for Sustainable Infrastructure Envision Pre-Assessment Checklist	This simple self-assessment preplanning checklist evaluates project sustainability by increasing awareness of issues, including quality of life, leadership, resource allocation, natural world, and climate and risk.
Section 5.4, Social and Economic Sustainability Through Constructive Change and Protective Remedies	Section 5.4 of this document discusses consideration of social and economic indicators, including ecosystem services, quality of life, and mitigation of climate change impacts.
U.S. NOAA, Fisheries Community Social Vulnerability Indicators (CSVIs)	The CSVIs data series from 2009 to 2016 consists of a suite of indicators that describes and evaluates a coastal community's ability to respond to changing social, economic, and environmental conditions.
Sustainable Remediation Forum – United Kingdom (SuRF-UK)	Supplementary Report 1 of the SuRF-UK Framework: A general approach to sustainability assessment for use in achieving sustainable remediation Supplementary Report 2 of the SuRF-UK Framework: Selection of indicators/criteria for use in sustainability assessment for achieving sustainable remediation Both available (free) from https://www.claire.co.uk/projects-and-initiatives/surf-uk

5.9.1.2 ITRC GSR Level 2 – BMPs and a Simple Evaluation

The ITRC GSR Level 2 evaluation approach combines the selection and implementation of BMPs with some degree of qualitative and/or approximate quantitative evaluation (ITRC 2011a, b). This level of evaluation assesses how site cleanup and restoration activities may result in beneficial or unintended social, economic, and environmental impacts. The ten main social and economic goals and broad indicators presented in Table 5-1 provide a foundation to identify and select metrics that can be evaluated qualitatively or semi-quantitatively. Identified stakeholder concerns and needs should also be considered in the assessment. Table 5-4 summarizes methods and tools to perform an approximate quantitative evaluation of social and economic impacts. Table 5-5 provides market and nonmarket inputs for an enhanced cost-benefit analysis.

Table 5-4. Level 2 social and economic impact evaluation methods.

Method	Method Summary

Rating and Scoring System (Harclerode et al. 2015)	This is a technique used to summarize and communicate information crucial to the decision-making process. This method includes a rating metric and an aggregation rule that combine individual ratings into a single overall score. Remediation decision makers are then able to draw conclusions based on the results of the scoring.
Social Sustainability Evaluation Matrix (SSEM) Tool (Reddy, Sadasivam, and Adams 2014), *a rating and scoring system*	This Excel-based tool evaluates impacts across the four key social dimensions: (1) social-individual; (2) socio-institutional; (3) socioeconomic; and (4) socio-environmental. A series of key measures (i.e., impact indicators) is listed for each dimension.
Institute for Sustainable Infrastructure EnvisionOnline Scoresheet, *a rating and scoring system*	This system provides an online scoresheet for rating achievement toward sustainability credits encompassing quality of life, leadership, resource allocation, and natural world, as well as climate and risk sustainable and resilient metrics.
Ecosystem Services at Contaminated Site Cleanup (USEPA 2017b)	Appendix A presents a compilation of evaluation tools that have been developed for different ecosystems, levels of technical expertise, management questions, and anticipated outputs. Types of tools include maps and spreadsheet kits.
Enhanced Cost-Benefit Analysis (CBA) (Favara et al. 2019, Harclerode et al. 2015)	A CBA accounts for and compares all the benefits and costs of particular courses of action. Recently, the cost analysis of remedial activities has been extended to include socioeconomic factors, resulting in a CBA focused on social feasibility. This enhanced CBA evaluates whether the monetized benefits to society exceed the monetized costs to society of undertaking particular courses of action. At the Level 2 GSR evaluation, market and nonmarket inputs are assessed by a semiqualitative/semiquantitative approach using publicly available information. Integration of cost metrics can help practitioners normalize disparate sustainability metrics into one unit for ease of comparison. These market and nonmarket inputs can also serve as indicators or metrics for project decision making even if a CBA is not performed.
Social Science Methodologies to Support Qualitative Assessment (Harclerode et al. 2015, Ridsdale and Harclerode 2019)	1) *Surveys* are an inexpensive method that allows the remediation practitioner to evaluate generalizable social impact indicators, perceived local economic benefits, and community well-being. Surveys can be transparent communication tools, as there is negligible subjectivity in compiling answers, and the community can fully participate in the review of survey results, which can be used to address community concerns and identify areas where knowledge transfer to the community is needed. 2) *A design charette*is a collaborative platform during which stakeholders can sketch designs to explore and share a broad diversity of site restoration and redevelopment ideas. 3) *Social network analysis* is a complex method recently introduced in environmental management. For sustainable remediation, the method appears to be promising, as it can offer valuable insights into how stakeholders are involved in remediation processes rather than how remediation practitioners choose to involve them.
Multi-Criteria Decision Analysis (MCDA) (Favara et al. 2019, Harclerode et al. 2015)	MCDA is a tool used to evaluate multiple site-specific cleanup criteria, including SRR indicators. For example, stakeholder input presents their level of preference on criteria used to select a proposed project, remediation alternative, or preferred land-use scenario.

Additional resources: (CRCCARE 2018, Harclerode et al. 2015)

Table 5-5. Enhanced cost-benefit analysis market and nonmarket inputs.

Market Inputs	**Nonmarket Inputs**

• Capital costs • Operation and maintenance costs • Decommissioning costs • Redevelopment costs • Property value increase (benefits) • Employment opportunities (benefits) • Local business stimulation/revenue (benefits) • Local business interference/loss of revenue (costs)	• Relative societal externalities associated with emissions generation and natural resource consumption (costs) • Value of natural resources protected (benefits)/damaged (cost) • Value of ecosystem services enhanced or restored (benefits) • Improvement in quality of life from remediation/redevelopment (benefits)

5.9.1.3 ITRC GSR Level 3 – BMPs and Advanced Evaluation

The ITRC GSR Level 3 evaluation approach combines the selection and implementation of BMPs with a rigorous quantitative evaluation (ITRC 2011a, b). This level of evaluation assesses how site cleanup and restoration activities may result in beneficial or unintended social, economic, and environmental impacts. The ten main social and economic goals and broad indicators listed in Table 5-1 provide a foundation to identify and select metrics that can be evaluated quantitatively. Identified stakeholder concerns and needs should also be considered in the assessment. Table 5-6 summarizes methods and tools that can supplement those presented in Table 5-4 to perform a quantitative evaluation of social and economic impacts.

Table 5-6. Level 3 social and economic impact evaluation methods.

Method	**Method Summary**
Institute for Sustainable Infrastructure Envision Framework	This is an in-depth guidance and rating system used to assess and improve the sustainability aspects of all types and sizes of infrastructure projects. A site can be Envision-verified by the Institute for Sustainable Infrastructure.
Ecosystem Services at Contaminated Site Cleanups (USEPA 2017b)	Appendix A provides a compilation of evaluation tools that have been developed for different ecosystems, levels of technical expertise, management questions, and anticipated outputs. Types of tools include software models.
Economic Valuation Techniques to Support Enhanced CBA (Harclerode et al. 2015, Favara et al. 2019)	Willingness to pay is the maximum amount an individual is willing to sacrifice to procure a good (such as a regional groundwater management program) or avoid something undesirable (such as contaminant mobilization due to a severe weather event). Opportunity cost is the loss of a potential benefit from other cleanup alternatives not applicable to the selected alternative. For example, the implementation cost of treated groundwater reuse for Alternatives A and C represents the opportunity cost for not implementing this sustainable practice under Alternative B.
Cost-Benefit and Sustainability Analysis (CRCCARE 2018)	Cost-benefit and sustainability analysis is an economic evaluation technique that combines elements of enhanced CBA and MCDA evaluation. Impacts that can be readily monetized are assessed as part of the enhanced CBA, while those impacts that can only be quantified are assessed as part of a standard MCDA. The results of the CBA and MCDA are then combined and assessed to maximize the sustainable and resilient outcome of cleanup and restoration activities.

5.9.1.4 Community Involvement and Stakeholder Engagement

Community involvement and engagement of other stakeholders can play an essential role in identifying inadvertent or unintended impacts felt by community members. The social and economic impact evaluation methods presented in Section 5.9.1.3 can be performed with community members and other stakeholders as an engagement activity, in-person, virtually or web-based. The overall objective of community involvement in an SRR context is to gain deeper insight into community concerns and values throughout the project life cycle to inform decision makers and practitioners on cleanup activities and future use (see Section 5.9.1.5). Different levels of engagement are needed for various stakeholder groups (for example, those directly affected vs. indirectly affected), and those stakeholder groups may change during the project life cycle. Refer to the Read More below for community involvement resources and tools.

▼Read more

Community engagement resources:

- ATSDR Principles of Community Engagement (ATSDR 2011)
- International Association of Public Participation spectrum of public involvement
- USEPA Superfund Community Involvement Handbook (USEPA 2020a)
- USEPA Risk Communication in Action: The Risk Communication Workbook (USEPA 2007)

The success of stakeholder engagement relies on identifying the appropriate stakeholders and knowing how and when to engage them most effectively. The ITRC Risk Communication Toolkit provides guidance and resources to perform stakeholder identification and assessment (ITRC 2020b). During community involvement and/or stakeholder engagement activities, the decision makers will learn who will be most affected by the site activities and their level of interest, knowledge, and concern. Don't assume that the lead organization and other decision makers understand the concerns of the people in the surrounding community. Recognize that people may be skeptical that the lead organization is telling the truth, cares about them, and is willing to work with them. Research the full range of opinions and concerns, including general attitude, knowledge, and perceptions about the cleanup activities. This can be accomplished by regularly asking community leaders and the stakeholders you are working with if there are other groups of individuals who are missing from the outreach and who should be involved. One of the best ways for regulators and responsible parties to reach stakeholders is to identify members of the stakeholder groups who are willing to act as liaisons between the community and the regulators (ITRC 2020).

Engaging the community and other stakeholders on community impacts from site activities can be controversial. This is understandable as issues of health and safety are of deep importance to communities. How a community and the stakeholders within that community view risk management efforts proposed or being performed will depend on myriad factors, including the community's and other stakeholders' trust in the agency or lead organization, the nature of the hazard itself, and a range of stakeholder characteristics, such as numeracy and scientific literacy. Therefore, early and effective stakeholder engagement is important. Community involvement and other forms of stakeholder engagement should emphasize timely access to data, transparency, and responsiveness to stakeholder questions and concerns (ITRC 2020b). Furthermore, it is beneficial to consider whether certain members of a community might bear a disproportionate burden of exposure to contaminants or unintended impacts from site activities.

▼Read more

USEPA's Superfund Community Involvement Toolkit is a comprehensive, complementary resource to the Community Involvement Handbook that provides detailed information and recommendations about specific aspects of the community involvement process, such as how to develop a community involvement plan, conduct community interviews, create a community profile, prepare fact sheets, and perform many other activities.

5.9.1.5 Conceptual Stakeholder Assessment Road Map

Stakeholder engagement will assist practitioners in defining site-specific sustainability and resiliency objectives and goals, identifying indicators and metrics, and obtaining data to implement methods and tools to evaluate environmental, social, and economic impacts. The purpose and process of stakeholder engagement evolves throughout the project life cycle. During project planning, we recommended development of a site-specific stakeholder assessment road map to define the purpose and process of engagement, and most importantly the difference between the two. More specifically:

- Purpose: define level of stakeholder engagement versus outreach; discuss the reason(s) for engagement project
- Process: develop stakeholder engagement and outreach SMART goals; identify methods and tools to support stakeholder engagement and outreach activities in alignment with SMART goals; determine if regulatory authority risk communication and/or community involvement processes are applicable

▼Read more

SURF's Sustainable Remediation Framework calls for "a systematic, process-based, iterative, holistic approach beginning with the site end use in mind" (Holland et al. 2011, page 10). "This holistic approach can incorporate planning for uncertainty, reducing the rate and extent of local, regional, and global climate change impacts, and address social impacts, equity concerns, and opportunities. Setting criteria and indicators for measuring progress provide for more transparency and can gain stakeholder support" (Maco et al. 2018, page 10).

The purpose of the road map is to provide a simplified framework to assess the site-specific role of stakeholder engagement and to aid in engagement planning and execution. During project planning we recommend identifying stakeholder groups and defining their role and influence on decision-making milestones and development of SRR goals and objectives. Figure 5-5 presents a conceptual stakeholder assessment road map with the purpose of identifying and integrating stakeholder sustainability and resiliency values throughout the cleanup project life cycle (Favara et al. 2019, Ridsdale and Harclerode 2019). The process of stakeholder engagement is continuous and should be a means of partnership and information exchange. The conceptual road map shown defines four stages of stakeholder engagement summarized in Table 5-7. Ridsdale and Harclerode (2019) are currently developing the conceptual stakeholder assessment road map to facilitate SRR.

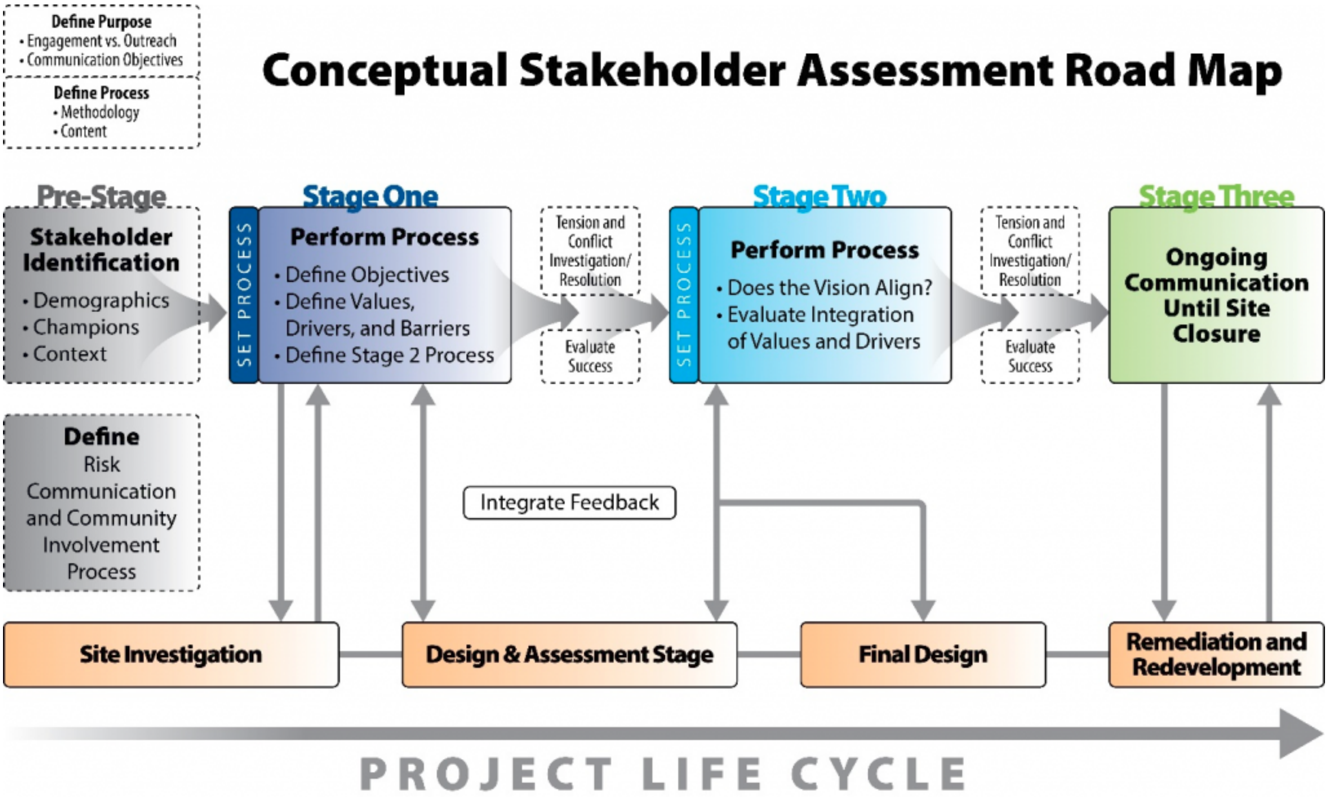

Figure 5-5. Conceptual stakeholder assessment road map.

Source: Ridsdale and Harclerode (2019). Used with permission.

Table 5-7. Conceptual stakeholder assessment road map objectives and implementation phase.

Road Map Stage	Objectives	Project Life-Cycle Phase
Pre-Stage	• Define the purpose of stakeholder assessment for each site-specific project with project team • Identify stakeholders, context, and values • Define risk communication and community involvement strategies	Section 6.1, Project planning
Stage 1	• Define the purpose and level of stakeholder engagement for site-specific project with ongoing stakeholder input • Define SRR objectives • Engage stakeholders and identify values • Identify SRR drivers and barriers* • Define Stage 2 process with information gathered during engagement activities • Resolve conflict, as applicable	Section 6.2, Site characterization Section 6.3, Remedy planning

Stage 2	• Confirm SRR objectives were met or document justification for not meeting • Evaluate and debrief on integration of stakeholder values • Identify new or changed SRR objectives and stakeholder values • Resolve conflict, as applicable	Section 6.3, Remedy planning
Stage 3	• Perform ongoing communication on the status of cleanup and restoration activities • Identify and adapt to new or changed SSR objectives, stakeholder values, drivers, and barriers • Resolve conflict, as applicable	Section 6.4, Remedy execution Section 6.6, Site closeout

*see Harclerode et al. (2016)

Before undertaking any communication or planning with stakeholders, the core project team should have a discussion on what the known or anticipated SRR stakeholder values are for the project, in the context of the remediation site and the affected community. A desktop review of community demographic data and applicable news and social media can help a project team preliminarily assess stakeholder needs and concerns. This is considered “Pre-Stage” (see Table 5-7). Not all projects require the same level of engagement. Determination on the level of engagement and who should be engaged should be made during project planning and revisited as new stakeholder concerns and needs arise. Furthermore, individual stakeholders’ interest in and influence on a project may change over time, prompting a revised or more comprehensive engagement strategy. Additional information on levels of engagement is provided in Section 5.9.1.4.

Stage 1 is identified as the first official stage of the engagement process and involves engaging stakeholders to define early SRR objectives and values. Stage 2 involves evaluating if remedial actions are in line with the stakeholders’ needs and concerns, and if any conflicts arise, developing a plan to address them. This “conflict check in” is suggested to avoid a prolonged conflict, which may lead to project delays, uncertainties in public acceptance, or unwanted negative press. Stage 3 of the road map takes place during the remediation activities and involves continued communication with the stakeholders on progress, updates, and early identification of conflicts that may arise.

5.10 Case Studies

5.10.1 Phoenix Park, Camden, New Jersey

Phoenix Park (Figure 5-6) represents an example of how cleanup can support redevelopment, provide important local services, and build bridges with communities. Camden is an urban area in southern New Jersey that has a history of early industrial activity followed by a decline that has left the city with abandoned parcels that require cleanup. Camden County’s Municipal Utility Authority (MUA), New Jersey Department of Environmental Protection (NJDEP), and the Camden Redevelopment Authority worked together with local community groups to turn a vacant riverside plot into much needed open space and stormwater management capacity that improved functioning of the city’s water treatment system (Figure 5-7). Partnering with the local community and visioning uses that support environmental and social goals has turned this brownfield redevelopment into a shared resource that enjoys broad community support.

Figure 5-6. The location of Phoenix Park, in Camden, New Jersey, was an abandoned riverside industrial area that has been transformed into a walkable park that provides much needed stormwater management for this dense urban area.

Source: Photos courtesy of Camden County Municipal Utility Authority

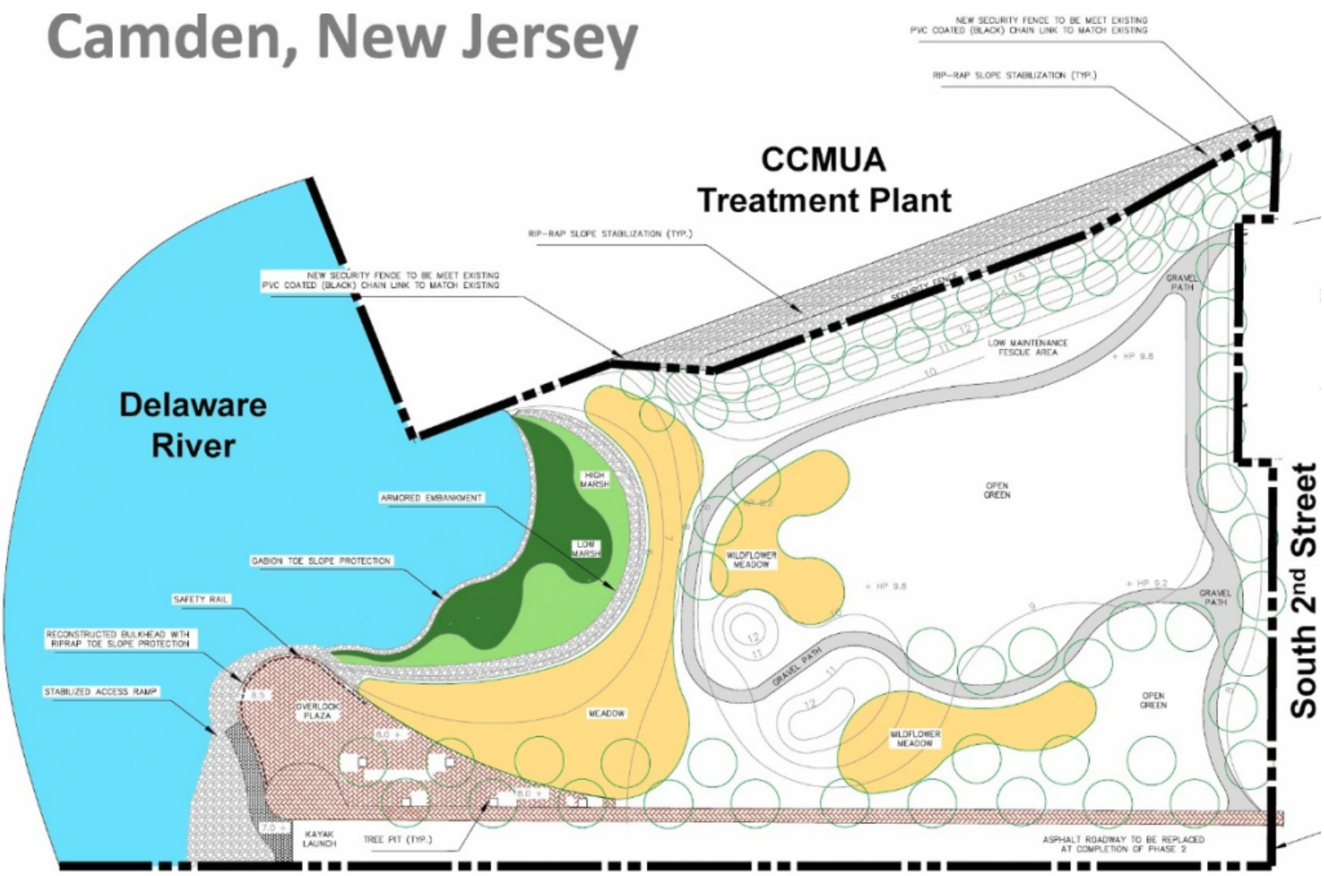

Figure 5-7. Site reuse plans show the ecosystem services and park spaces in this new open space.
Source: Photos courtesy of Camden County Municipal Utility Authority

Camden is a city in southern New Jersey, across the Delaware River from Philadelphia, with a population of almost 74,000. Historically, Camden was one of the major industrial centers of the Atlantic Coast, with a strong role in shipbuilding and metals processing. It was the home of Campbell's Soup and RCA Victor, a pioneer in phonograph production. Those industries largely abandoned Camden in the mid-20th century but left behind a legacy of environmental contamination that the city still struggles with to this day. With the flight of capital, the city has lacked the resources it needed to tackle both cleanup and infrastructure development.

The development adjacent to the Delaware River grew out of a partnership between Camden County's MUA, NJDEP, the Camden Redevelopment Authority, the City of Camden, Cooper's Ferry Partnership, Rutgers Cooperative Extension Water Resources Program, New Jersey Tree Foundation, and the Nature Conservancy. This strong partnership and a commitment to serve the needs of the communities who lived with the low-level radioactive waste contamination for decades resulted in green spaces and infrastructure.

The park occupies a 5-acre riverfront space next to Camden County's MUA wastewater treatment plant that was formerly occupied by a site known as American Minerals Industrial. Discussions with the community revealed a real need for green space in an urban environment that was mostly concrete and abandoned buildings. At the same time, the neighboring treatment plant was interested in separating the flows from a combined sewer system to focus on treating residential wastewater while diverting stormwater. To separate flows, the impervious surfaces that made up the vast majority of the site were removed. This allowed the stormwater to infiltrate into the ground surface, eliminating the need for storm sewer inlets, significantly reducing the stormwater flow into the combined sewers.

Listening to and involving local representatives throughout the process means that local communities feel connected to this park and have a sense of ownership. This collaboration helped rebuild trust between the community and government agencies, something that cannot be taken for granted when working with historically disadvantaged communities.

5.10.2 Senator Joseph Finnegan Park at Port Norfolk, Boston, Massachusetts

After more than 30 years, since residents first locked arms to block toxic dumping, the Shaffer Paper site in Dorchester, a neighborhood of Boston, Massachusetts, has been transformed into the Senator Joseph Finnegan Park at Port Norfolk (see Figure 5-8).

Figure 5-8. Senator Joseph Finnegan Park, an urban oasis along the Neponset River in Boston, Massachusetts. *Source: Photo by Halvorson Design. Used with permission.*

This 12-acre waterfront park along the Neponset River is the last link of the 5-mile Neponset River Greenway, which provides a variety of scenery from urban wilderness through a mill village to a salt marsh at the mouth of the Neponset River. Located in Port Norfolk, a quiet, lovely historic neighborhood cut off from the rest of Dorchester by the interstate highway, the park was formerly a lumberyard, a commercial flounder fishing pier, and then an industrial area, which led to hazardous waste contamination by heavy metals and polychlorinated biphenyls (PCBs).

To ensure that site cleanup would result in a beautiful passive park for all to enjoy, while being protective of both human health and the environment, the Massachusetts Department of Conservation and Recreation engaged an integrated and collaborative team of an environmental consultant, landscape architect, and permitting specialist from the earliest planning stages through construction that executed the project within the allotted budget and time frame.

The park was designed to sit lightly on the land and blend with the coastal environment. A site-specific risk assessment identified the areas of contaminated soils that required excavation and off-site disposal. A dilapidated sheet pile seawall was demolished and replaced with a living shoreline. Native saltmarshes were preserved and expanded, including transplanting a salt marsh which had grown on top of asphalt to a new location on a formerly rubble-strewn part of the bank. Park elements include paths, lawns, salvaged granite seat stones, and new trees and shrubs. Lawns were planted with native grass and wildflower species chosen to be wildlife-friendly, low maintenance, and drought-resistant. Structures were deliberately excluded from the park. The design incorporated greenspaces capable of absorbing floodwaters and rising water levels.

5.10.3 Harrison Avenue Landfill/Cramer Hill Waterfront Park Project

The Harrison Avenue Landfill is a former 86-acre municipal landfill in the Cramer Hill neighborhood of Camden, at the intersection of Harrison Avenue and East State Street, where the Cooper River flows into the Delaware River. The Harrison Avenue Landfill has been converted into a community center and public park under the cooperative work of the City of Camden, NJDEP, the Camden Redevelopment Agency, the Salvation Army, Coopers Ferry Partnership, and the residents of the Cramer Hill neighborhood.

Figure 5-9. Conceptual graphic of the waterfront park (left) and an aerial photo of the Salvation Army Ray and Joan Kroc Corps Community Center (right).

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

The City of Camden operated the former landfill as an unregulated municipal landfill from 1952 to 1971, but it was never capped or officially closed, which left the site subject to unauthorized dumping in subsequent years. In 2006, the Salvation Army applied monies it received from the estate of Ray and Joan Kroc to construct the Salvation Army Ray and Joan Kroc Corps Community Center on 24 acres of the landfill in partnership with the City of Camden, the Camden Redevelopment Agency, and the NJDEP. The Kroc Community Center opened in 2014 and serves over 8,000 residents of the Cramer Hill neighborhood and the surrounding communities with educational, recreational, social service, fitness, art, and worship programs and early childhood care center amenities.

The remaining 62 acres of the landfill is in the process of being redeveloped as open space, involving the restoration and creation of freshwater tidal wetlands, a living shoreline, an endangered species habitat, and a tidally fed fishing pond.

Project challenges include federal and state regulations impacting development of the waterfront, bald eagle endangered species foraging area, wetlands, cross-jurisdictional state regulatory authority regarding the closure of the unregulated landfill, and the associated environmental cleanup and redevelopment of the property.

5.10.3.1 Restoration Summary

The 62-acre restoration project and creation of the Cramer Hill Waterfront Park has four main components: (1) shoreline protection; (2) landfill closure; (3) natural resource restoration; and (4) park construction.

The shoreline protection involves regrading and stabilizing over 3,000 feet of shoreline on the Delaware River where municipal solid waste and soil contamination, including pesticides and PCBs, are exposed on the surface of the unstable, steep slopes in this area of the landfill.

The landfill closure includes excavating and redistributing approximately 375,000 cubic yards of solid waste and soil onto the interior of the landfill, installing a passive gas venting system, and constructing a 0.6-m thick semipermeable cap of clean fill material and vegetation.

Natural resource restoration consists of enhancing and expanding the existing freshwater wetlands by constructing approximately 7 acres of tidal freshwater wetlands on the Cooper and Delaware Rivers, creating 450 feet of living shoreline in areas along the back channel of the Delaware River, preserving areas of existing trees as bald eagle forage habitat, replanting trees within the remainder of the bald eagle forage habitat, including an area where large specimen trees will be planted. Over 375,000 plantings are included as part of the site restoration. The tidal freshwater wetland on the Cooper

River will connect to a fishing pond that will also be a prominent feature of the waterfront park.

The waterfront park will include features for use by the community, such as an amphitheater, an entry plaza, exercise stations, a fishing plaza, hiking/biking paths and trails, historic/educational signage, a kayak launch, a picnic area, a playground, a sensory garden, shoreline observation areas, and a summit vista with panoramic views of downtown Camden, the Camden Waterfront, the Delaware River, Petty Island, the Benjamin Franklin Bridge, and the City of Philadelphia.

Figure 5-10. Cramer Hill Waterfront Park ongoing development facing west (May 2020).
Source: www.nj.gov/dep/nrr/cramer-hill-gallery.htm

Figure 5-11. Cramer Hill Waterfront Park ongoing development facing east (May 2020).
Source: www.nj.gov/dep/nrr/cramer-hill-gallery.htm

5.10.4 Bellingham Waterfront, Bellingham, Washington

Figure 5-12. Aerial picture of Bellingham Bay.
Source: Photo courtesy of Nick Kelly / Public Domain.

Bellingham Bay's cleanup and redevelopment is a prime example of what can be accomplished when multiple agencies and organizations work together to plan cleanups that meet the needs of local communities using principles of integrated project planning and public participation in decision making. Bellingham Bay has an industrial history as a key port for lumber processing, creation of paper goods, and other maritime trades. As with many industries, advances in technology and a changing local economy have led to some of those businesses closing doors or leaving town for other locations. When businesses leave, they do not always take all their hazardous waste with them. In Bellingham, that meant waterfront lots with easy access to infrastructure were being left idle—an opportunity to get prime land at a cost even a government can afford—if they could find ways to build public support for a potentially costly cleanup.

Building public support has been a group effort. The Bellingham Bay cleanup effort began as the Bellingham Bay Demonstration Pilot Project in 1996, comanaged by Washington Department of Ecology (Ecology) and the Port of Bellingham. This baywide effort included 12 agencies from federal, tribal, state, and local governments, and the former paper mill. The goal of the project was to coordinate sediment cleanup, control pollution sources to sediment, and restore habitat, with consideration for land and water uses. In 2000, the Bellingham Bay Comprehensive Strategy was finalized and still guides current cleanup efforts. Today, this group is called the Bellingham Bay Action Team. It has a slightly different composition and is mainly led by Ecology. Local environmental protection nonprofits, like RE Sources, also join in the group efforts through their environmental education supported by one of Ecology's Public Participation Grants. Public support for outreach, visioning, and communication continues to be critical to getting a diverse group of stakeholders on the same page about a future for the bay.

Today on the Bellingham Waterfront, there are new infrastructure improvements; community amenities, including a park and kayak launch; social support, including a public meeting space and job training center; restoration of critical habitat; and places for local businesses. By taking the time to identify all these co-uses and learn what the community needed, this project has turned into a win for everyone involved. This vibrant waterfront brings people together, includes plans to provide affordable housing, provides rental income to the Port and tax income to the city, and improves the health of residents and that of the natural environment.

(1) Eldridge Municipal Landfill Contaminated soil due to former municipal landfilling activities.
(2) Weldcraft Steel & Marine Contaminated soil, sediment, and groundwater associated with former shipyard practices.
(3) Marine Services NW Contaminated sediment associated with past boatyard practices.
(4) I & J Waterway Contaminated sediment associated with former industrial practices.
(5) Central Waterfront Contaminated soil and groundwater associated with former municipal landfilling and industrial activities.
(6) Holly Street Landfill Contaminated soil due to former municipal landfilling activities.

(7) Whatcom Waterway Contaminated sediment associated with past pulping operations.
(8) Georgia Pacific West Contaminated soil and groundwater associated with former industrial operations.
(9) R.G. Haley Contaminated soil, groundwater, and sediment associated with former wood treatment facility.
(10) Cornwall Avenue Landfill Contaminated soil, groundwater, and sediment associated with past municipal landfilling activities.
(11) South State St. Manufactured Gas Plant Contaminated soil, groundwater, and sediment associated with a former gas manufacturing facility.
(12) Harris Avenue Shipyard Contaminated soil, groundwater, and sediment associated with former industrial activities at an active shipyard.

Figure 5-13. A map showing the cleanup sites associated with Bellingham Bay and a table describing their contaminants.

Source: Washington State Department of Ecology

▼Read more

For more reading on the Bellingham Bay cleanups, check out these resources:

- Washington Department of Ecology Port of Bellingham page
- Bellingham Bay Cleanup Fact Sheet
- Port of Bellingham Environmental Cleanup page

5.11 How to Identify Potential Site or Cleanup Impacts on Highly Impacted or Socioeconomically Vulnerable Communities

This section is intended to support people in scoping and identifying a project's impacts to highly impacted or otherwise vulnerable communities. Project planners can use information in this section as SBMPs to improve project outcomes. State agencies can use information in this section as SBMPs to improve project outcomes, to identify communities for communication needs, to prioritize use of limited resources where they might do the most good, and to plan initiatives or grant programs to redress negative social impacts of cleanups.

5.11.1 Background

Understanding the characteristics of people who will be affected by cleanup sites and cleanup activities is a necessary first step in planning and carrying out cleanups that avoid, mitigate, or redress disproportionate impacts to communities. While cleanups, by their nature, provide long-term environmental improvements, cleanups can directly affect communities with short-term impacts such as air pollution, traffic, noise, and accident risk, or indirectly affect communities with gentrification and displacement. Understanding the affected population can also provide project proponents with a way to identify potential recipients of project cobenefits identified in other portions of this report (for example, improved green infrastructure, Section 5.7). Planning projects that avoid impacts and provide benefits to affected communities is central to integration of economic and social considerations in the sustainability framework (Section 5.9) and can provide real benefits to project proponents (Section 5.4).

5.11.2 Key Practices

The following information is provided in steps that can help you structure your identification and consideration of highly impacted communities and potential cumulative impacts.

- **Identify.** Use publicly available map tools (for example, EJScreen from USEPA) to understand impacted communities and identify potentially highly impacted communities.

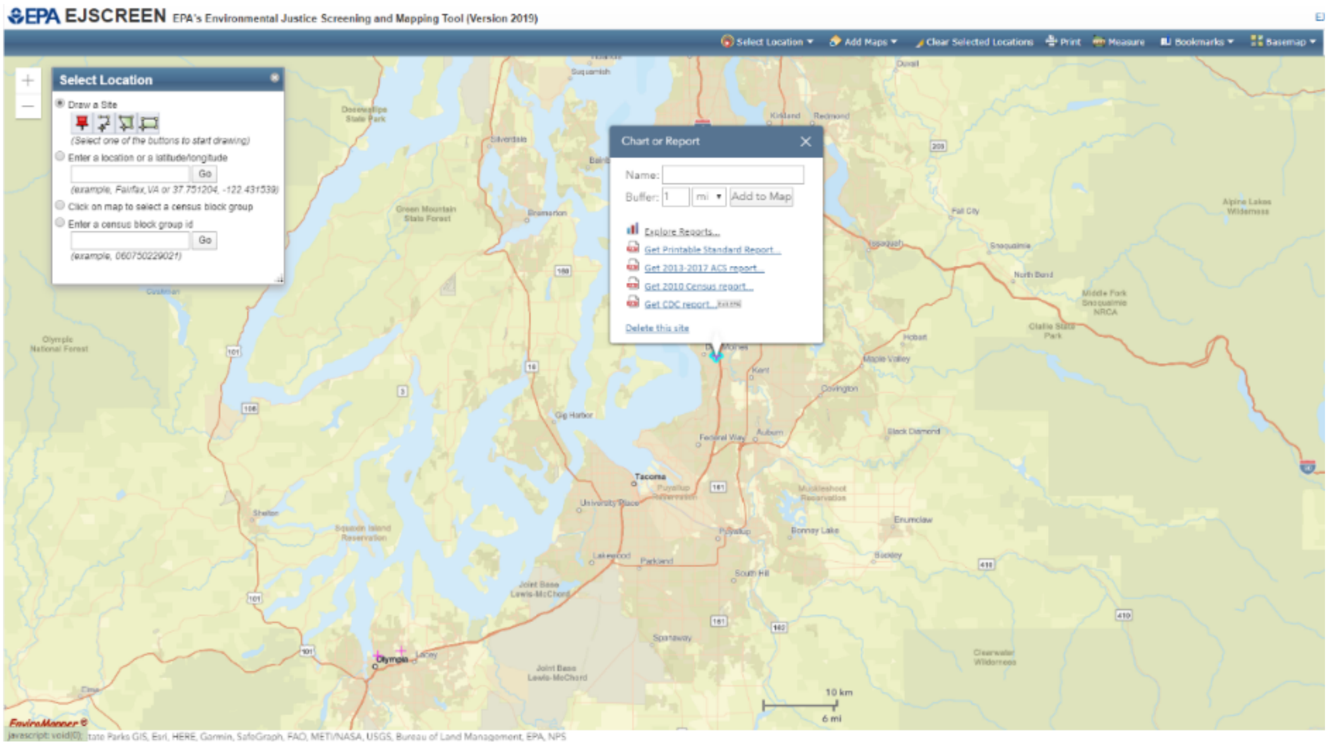

Figure 5-14. Screenshot of USEPA's EJScreen map tool.

Source: U.S. Environmental Protection Agency, EJScreen website.

- **Define.** Highly impacted communities might be defined by your local or state government but are generally understood as groups/communities that have historically faced economic or political barriers to participation in environmental decision making. For example, Executive Order 12898 (NARA 1994) originally instructed federal agencies to look at how projects impact people of color and low-income people, but has been understood by USEPA to include national origin. Look to your state's equity and environmental justice regulations and use your existing local knowledge to define who your project might highly impact.
- **Screen.** Use the data or maps to screen according to a consistent metric for potential to affect highly impacted groups. For example, many federal and state projects look for impacts to communities above the 80th percentile to understand the most highly impacted groups. If a location is above the 80th percentile for a particular environmental harm, consider how your project or project activity might contribute to impacts to the community.

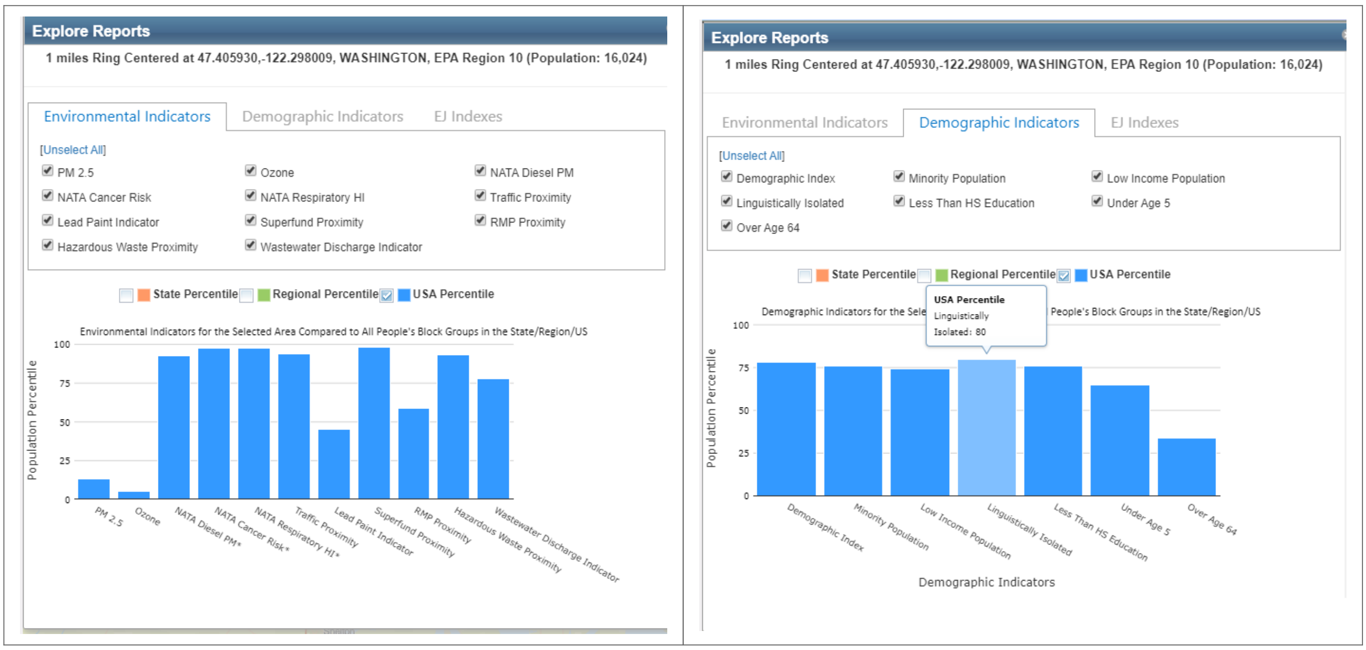

Figure 5-15. Screenshots showing the types of impacts and community characteristics you could consider for

this analysis.
Source: U.S. Environmental Protection Agency, EJScreen website.

- **Avoid.** Consider ways to avoid the particular impact, or, if it cannot be avoided without compromising the project, consider ways to offset or mitigate the impact. Examples of changes to a project include:
  - changing the timeline to allow seasonal use of important cultural or recreational resources
  - choosing on-site power generation that avoids diesel emissions in areas that are already heavily impacted by particulate matter or have a large number of children
  - planning more robust site management and emergency planning options in densely populated areas with vulnerable communities.
- **Mitigate.** Offsets and mitigation steps can be tailored to the impacted group through consultation with elected officials and community groups or that meets needs identified in public planning or community visioning documents/meetings.
- **Communicate.** Make the results of your analysis part of your existing communication plans and include in reporting on corporate social responsibility or equity and inclusion targets.

5.11.3 Additional Resources

5.11.3.1 State Resources

Some states have their own map tools available to assist with identification of highly impacted or vulnerable communities and to assess cumulative environmental risks. For more resources, please see:

- 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

5.11.3.2 Federal Resources

If your state does not have its own resources available, you can find data using the following federal resources:

- EJScreen, USEPA
- American Community Survey, Census Bureau

5.11.3.3 Nonprofit Resources

You can also find related information on this topic through nonprofit organizations that provide guidance or scoring metrics for the reporting of social responsibility. Some examples include:

- ISO 26000, Social Responsibility, International Standards Organization (ISO) (2010)— ISO publishes internationally recognized standards that facilitate cross-border recognition for following recommended practices or using standardized scoring metrics. ISO 26000 supports Social Responsibility reporting and contains information that will allow you to measure and report consideration of social and economic factors at the organizational level.
- Envision Certification, Institute for Sustainable Infrastructure—This is an accreditation nonprofit that has developed and administers Envision, which is a tool for planning, executing, and documenting sustainable infrastructure development. Envision provides tools for practitioners to follow its guidelines and has options for third-party verification and awards for levels of project accomplishment. Envision includes social and economic considerations in its framework and in many cases its highest levels of achievement require local cobenefits.
- FAC Self-Assessment Tool, Fire Adapted Communities Learning Network—This tool is provided to allow communities at risk from wildfire and other sources of fire to conduct a self-assessment. The tool provides steps for identifying who in the community is at most risk and what valuable community resources could be impacted. It also provides advice on planning and organizing responses around fire risks.

Many organizations centered on specific impacts (for example, wildfire, coastal flooding, earthquake, etc.) provide tools for assessing risk to communities. If you know your site is in an area prone to one of these risks, these toolkits (while not designed around remediation) can provide frameworks that benefit your project and impacted communities.