Integrating Remediation and Reuse to Achieve Whole-System Sustainability Benefits

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This perspective article was prepared by members of the Sustainable Remediation Forum (SURF), a professional nonprofit organization seeking to advance the state of sustainable remediation within the broader context of sustainable site reuse. SURF recognizes that remediation and site reuse, including redevelopment activities, are intrinsically linked—even when remediation is subordinate to or sometimes a precursor of reuse. Although the end of the remediation life cycle has traditionally served as the beginning of the site's next life cycle, a disconnect between these two processes remains. SURF recommends a holistic approach that brings together remediation and reuse on a collaborative parallel path and seeks to achieve whole-system sustainability benefits. This article explores the value of integrating remediation into the reuse process to fully exploit synergies and minimize the costs and environmental impacts associated with bringing land back into beneficial use. © 2013 Wiley Periodicals, Inc.

BACKGROUND

The overlap between remediation and reuse can be leveraged to achieve sustainability and can be seen in the definitions of these terms. The Sustainable Remediation Forum (SURF) defines sustainable remediation as a "remedy or combination of remedies whose net benefit on human health and the environment is maximized through the judicious use of limited resources" (US SURF, 2009). Sustainable remediation seeks to balance and maximize the overall environmental, social, and economic benefits of remediation projects while removing or reducing impacts to soil, soil gas, sediment, groundwater, and surface water to ensure protection of human health and the environment. Sustainable reuse can be characterized as the regeneration of abandoned, derelict, underused, and potentially contaminated sites in a way that increases the environmental, economic, and social benefits of a site. Considering the reuse of a site is part of sustainable remediation, such as when the site is a surplus property or an underutilized asset.

In addition, remediation and reuse projects share a largely overlapping pool of stakeholders, including responsible parties, regulators, and communities. Responsible parties and site owners manage remediation costs and the long-term stewardship of property environmental issues. Regulators balance regulatory program requirements with

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sustainable remediation and reuse approaches, and communities seek protection of the environment and economic and quality-of-life improvements.

THE CURRENT DISCONNECT AND RECOMMENDATIONS

Despite similar definitions and common stakeholders, the objectives of remediation and reuse can be very different. The objective of remediation is to treat contaminants at and surrounding a site to protect human health and the environment; conventional site reuse is not always the endpoint. The objective of reuse is to prepare the site for redevelopment in a timely fashion to enhance the potential return on investment. It is clear that these objectives are not always in alignment and may even be in opposition to each other. Common barriers arise because of these differing objectives (see below) and, as a result, whole-system sustainability benefits are not achieved.

SURF believes that one iterative, collaborative process will allow accelerated regulatory site closure, cleanup cost reductions, optimization of the site's natural environmental conditions, local economy gains (e.g., through the creation of local jobs), and greater consideration of the public's needs and concerns.

- All sites are not optimal for conventional redevelopment (e.g., commercial, industrial, or residential use); some require the exploration of innovative reuse opportunities (e.g., interim or ecological land uses).
- Jurisdictional policies can negatively affect development opportunities (e.g., areas requiring unrestricted reuse versus restricted use with institutional controls).
- The environmental protection regulators' role in the remediation process is strictly guided by environmental laws and regulations, not by reuse opportunities.
- The development control regulators' role in the remediation process is strictly guided by land-use and planning laws and policy about reuse opportunities and constraints.
- Responsible parties do not always own the contaminated site and, therefore, do not have control regarding the end use of the site.
- To achieve quick redevelopment, excess material is often handled as waste instead of material that can be beneficially reused. This practice typically results in excavation and landfill disposal.
- Stakeholders involved in a remediation or reuse project do not always have a shared vision for site reuse.

As evidenced by these barriers, two separate processes and the underuse of sites result. SURF believes that one iterative, collaborative process will allow accelerated regulatory site closure, cleanup cost reductions, optimization of the site's natural environmental conditions, local economy gains (e.g., through the creation of local jobs), and greater consideration of the public's needs and concerns.

An integrated and comprehensive land remediation and site reuse strategy can result in a positive outcome for all stakeholders. Remediation and reuse costs can decrease and the project can be completed on an accelerated schedule, allowing the site to be more quickly returned to beneficial use. For the public sector, the reuse of these properties can catalyze or complement multiple objectives, such as promoting the use of Brownfield and "greyfield" (i.e., previously developed land) sites, urban in-fill areas, and transit-oriented projects. As a consequence, "greenfields" (i.e., undeveloped land) are protected, jobs and an expanded tax base are created, infrastructure and renewable energy resources are developed, and habitat and other ecosystem services are enhanced. For the community, surrounding land values increase, infrastructure is enhanced, urban blight is reduced, and healthier neighborhoods result.

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SUCCESSFUL PARTNERSHIPS AND OPPORTUNITIES

Sustainable remediation and sustainable reuse are both guided by strategic planning and performance assessment programs with the common goal of improving their respective performance and lessening their respective impacts. Although remediation and reuse objectives are not always aligned, opportunities exist to integrate these processes to obtain the "best practical use" of remediated sites once they have been remediated. Opportunities for successful partnerships between remediation and redevelopment practitioners are described below.

Leadership in Energy and Environmental Design

The United States Green Building Council's (USGBC's) Leadership in Energy and Environmental Design (LEED) program is composed of a suite of rating systems for the design, construction, and operation of high-performance green buildings (e.g., homes, commercial facilities, schools) and neighborhoods. For developments on remediated sites, the goals of LEED and sustainable remediation should overlap significantly. At present, LEED explicitly rewards buildings that are developed on Brownfield sites, although the value of the reward is minor (typically an award of one to two points out of 100 or more available points). The LEED rating system also implicitly rewards Brownfield reuse because more credits are likely to apply to Brownfield sites than "greenfield" sites. For example, Brownfield sites are typically located in urban areas and would therefore tend to fare well in terms of proximity to public transportation, shops, services, housing, and jobs.

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Sustainable Sites Initiative™

The Sustainable Sites Initiative™ (SITES™) is an interdisciplinary effort to create voluntary national guidelines and performance benchmarks for sustainable land design, construction, and maintenance practices. The US Air Force, US Environmental Protection Agency, General Services Administration, National Parks Service, and Office of the Federal Environmental Executive provide input on the direction of the SITES™ program. A prime opportunity exists under this program for incorporation of sustainable remediation practices and explicit rewards for development on Brownfield sites. The program, like LEED, rewards development on Brownfield sites but does not explicitly address the sustainability of the remediation effort on these properties. The USGBC, a stakeholder in SITES™, anticipates incorporating SITES™ guidelines and performance benchmarks into future iterations of the LEED rating system.

The STAR Community Index™

The STAR Community Index™ (STAR™, initiated by ICLEI—Local Governments for Sustainability, a nonprofit organization addressing sustainability issues, in partnership with the USGBC, the Center for American Progress, and the National League of Cities) is a rating system and performance management tool that will offer local governments a roadmap for improving community sustainability. Sustainable remediation shares several common objectives recognized by STAR™, including reducing human health hazards, mitigating greenhouse gases, minimizing waste, and creating compact and complete communities. STAR™ was released in October 2012.

Envision™

The Envision™ rating system, a joint collaboration between the Zofnass Program for Sustainable Infrastructure at the Harvard University Graduate School of Design and the Institute for Sustainable Infrastructure based in Washington, DC, uses a set of objective-based goals focusing on technical solutions that serve broader community interests in the development of all types and sizes of infrastructure projects. Envision™ is intended for infrastructure owners and design teams, as well as community groups, environmental organizations, regulators, and policymakers. Project types include roads and bridges, transit systems, airports, seaports, water and wastewater systems, energy generation and transmission facilities, and other physical facilities. Many Envision™ credits can be applied to sustainable remediation projects.

Sustainable remediation practitioners should strive to work collaboratively with planners and developers of the aforementioned rating systems to incorporate and incentivize sustainable remediation and Brownfield redevelopment into these systems.

Building Research Establishment Environmental Assessment Method

Building Research Establishment Environmental Assessment Method (BREEAM®) was established in the United Kingdom by the Building Research Establishment and is an environmental assessment method and rating system for buildings. The assessment compares recognized measures of performance with established benchmarks to evaluate the specification, design, construction, and use of a building. The performance measures represent a broad range of categories and criteria, ranging from aspects related to energy and water use, health and well-being, pollution, transport, materials, waste, ecology, and management processes. Since its launch in 1990, about one million buildings have been assessed and 200,000 have received certification.

Sustainable remediation practitioners should strive to work collaboratively with planners and developers of the aforementioned rating systems to incorporate and incentivize sustainable remediation and Brownfield redevelopment into these systems. There are no explicit incentives for the sustainable remediation of Brownfield sites under these programs; therefore, a prime opportunity exists to award additional credits for sustainable remediation and incorporate sustainable remediation performance benchmarks in these guidelines and rating systems.

US Federal Government Initiatives

Numerous US federal government initiatives provide opportunities for remediation and reuse practitioners to collaborate for mutual benefit. Under the umbrella of Executive Orders (EO) 13423 and 13514, which set sustainability requirements in several areas, federal agencies are continually searching for innovative ways to achieve long-term savings, improve efficiency, reduce pollution, and eliminate waste. EO 13423, signed in January 2007, sets energy and environmental management system (EMS) requirements in areas such as reducing energy and water intensity, increasing renewable energy use, and designing and operating sustainable buildings. An EMS is a widely embraced management tool that allows an organization to strategically and comprehensively address its environmental issues and related health and safety matters. The EMS should cover all

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environmental activities and programs within an organization, including remediation activities. Integrating an organization's remediation program with its EMS provides an opportunity to manage a remediation program more holistically and ensure that remediation and asset management are considered as a single, interlinked process, not as independent activities. EO 13514, signed in October 2009, expands on the energy reduction and environmental performance requirements already in place. It sets energy requirements in areas such as strategic sustainability performance planning, greenhouse gas management, sustainable buildings and communities, water efficiency, and pollution prevention and waste reduction. In addition to the EMS, the incorporation of sustainable remediation practices and metrics in the initiatives that follow could begin to meet the mandates of EOs 13514 and 13423. It is important to note that the list that follows provides some examples and is not intended to be all inclusive.

- **EPA Land Revitalization Program.** A far-reaching goal of the EPA Land Revitalization Program (which encompasses the Brownfields Program) is to realize a new paradigm of sustainable approaches to remediation and revitalization. To achieve this objective, the program aims to incorporate sustainable cleanup and development techniques into policy, guidance, ordinances, and laws at all levels of government. The program acknowledges that Brownfield reuse and redevelopment provides significant environmental benefits compared to "greenfield" development scenarios. Through the Brownfields Sustainability Pilots program, efforts are being made to promote greener assessment, cleanup, and redevelopment in Brownfield projects. Currently, the EPA's support focuses on the reuse and recycling of construction and demolition materials, green building and infrastructure design, energy efficiency, water conservation, renewable energy development, and native landscaping. To improve on these benefits and move toward mainstream acceptance of sustainable remediation and revitalization, the EPA's Greener Cleanup principles could be expanded to incorporate societal and economic metrics, and goals for sustainable remediation practices combined with site reuse could be integrated into the grant applications for EPA-funded Brownfield projects.
- **Partnership for Sustainable Communities.** Supported by the Department of Housing and Urban Development (HUD), Department of Transportation (DOT), and EPA, the Partnership for Sustainable Communities is a program through which communities can receive direct technical assistance from the EPA on a number of sustainability issues for redevelopment plans. Sustainable remediation practices and benchmarks could be integrated with the grant applications and performance goals under this program to enhance revitalization efforts by lessening Brownfield redevelopment impacts, especially in vulnerable and underserved communities.
- **Base Realignment and Closure Program.** The Department of Defense (DOD) Base Realignment and Closure (BRAC) program facilitates the transition of surplus military property to civilian use. With systems-based planning and strategy, the BRAC program has the ability to address numerous economic, social, and environmental sustainability metrics applicable to both remediation and site reuse. The application of sustainable remediation prior to property transfer may provide additional economic, social, and environmental benefits to the military and civilian communities involved with BRAC projects.

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- **Sustainable Communities Program.** The Sustainable Communities Program is funded by the Environmental Security Technology Certification Program, an Office of the Secretary of Defense's research and development program, and is led by the Air Force Civil Engineer Center. The program is rooted in EMS and establishes a voluntary methodology to assess the sustainability and continuous improvement of an installation using the framework of the DOD's Strategic Sustainability Performance Plan (SSPP). Sustainable Communities provides tactical and operational-level guidance to installations and allows installations to apportion agency SSPP goals to installation-level goals. Sustainable Communities also enables installations to achieve strategic goals such as Net Zero and Energy Security by providing strategies to achieve those goals as well as a standardized methodology for tracking progress. The incorporation of sustainable remediation planning within larger, overall facility-level sustainability effort provides additional mechanisms to achieve federally mandated goals.

ACHIEVING "BEST PRACTICAL USE"

The integration of remediation and site reuse is one of the fundamental value propositions for sustainable remediation. In real estate, the fundamental value proposition for site reuse is based on "highest and best use" economics: cost-benefit analysis, timely return on investment, and higher-value use. The activities are market-driven instead of regulation-driven, as is the case with most remediation projects. The "highest and best use" for a Brownfield site is to develop it sustainably as opposed to leaving the site underused and an ongoing liability to its owners. In locations with a strong market demand, contamination is less of an impediment to reuse because high land values reduce the relative cost of cleanup compared to total acquisition and redevelopment expenses. But in locations with a limited market demand, project margins are lowered further by fixed contamination costs and the certainty of development success diminishes as a consequence.

While some reuse options are assisted through government funds or civic commitment, those commitments are limited in scope, assets, and duration. It has been estimated that approximately 80 percent of all Brownfield sites in the United States are not economically viable for redevelopment[1] either because environmental liabilities are too great, they are located in areas with little demand or low population density, or they have functionally obsolete structures. Furthermore, of the remaining 20 percent that are viable, 5 percent will be developed by the market with no government assistance as long as a state voluntary cleanup or Brownfield program is in place that provides clarity about the remaining liability. The remaining 15 percent of sites require some level of government assistance or financial incentives to transform them into economically viable redevelopments.

Many site owners often value "currencies" other than direct cost. While remediation may be driven by regulation, many site owners also value liability reduction, stakeholder acceptance, corporate reputation, environmental stewardship, and decreased custodial care that may also entail a higher-value, more productive future use of the site. The resulting value of the transformed site may or may not be commensurate with the cost of cleanup for that new use. The challenge for sustainable remediation is to remediate to a future use that provides sufficient incremental value to move properties from the "15 percent" category to the "5 percent" category. Therefore, it is clear that sustainable

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remediation can deliver value. Indeed, SURF's framework for sustainable remediation (Holland et al., 2011) emphasizes the importance of considering potential future use early (and often) in the remediation life cycle.

Currently, no viable economic credits, such as carbon markets or transactional efficiencies, exist that can be claimed for sustainable reuse. The economic benefits of remediation are achieved when the site is transformed into a suitable, beneficial, increased value asset rather than a more costly, multi-functional unrestricted future use. Thus, applying sustainable practices to a remediation project does not always result in an increase in costs. Rather, sustainable remediation increases value when coupled with viable reuse—while protecting human health and the environment.

Sustainable remediation in the context of site reuse involves finding the best balance between remediation and reuse options. Successfully integrating remediation and reuse to determine the most protective and cost-effective future use of a site requires collaboration with knowledgeable real estate professionals, responsible parties and site owners, remediation professionals, and government agencies. Defining a viable future use creates clarity in terms of the real estate market, and clarity brings value. The real estate concept of "highest and best use" to determine the best redevelopment opportunity considers many factors that have more to do with markets, infrastructure, and development opportunities than remediation requirements.

However, including remediation requirements and costs when determining the value of the site can result in a more sustainable outcome. By identifying the "best practical use," market efficiencies (i.e., the project is completed in a timely manner) and execution efficiencies (i.e., remediation and reuse features are combined) are created. Remediating a site to allow redevelopment to a future industrial or commercial use (e.g., with a hypothetical cost of \$20 to \$50/square foot) may be more cost-effective than remediating to a future residential use (e.g., with a hypothetical cost of \$100 to \$200/square foot) while providing additional benefits to the community (e.g., having access to a local workplace and shops, and occupying the space at a lower cost).

To determine the "best practical use" for a property being remediated, a comparison of the direct and external costs and values for future use options should be prepared and revisited throughout the remediation life cycle. Where the value of site reuse exceeds costs, remediation to enable those future uses is favored. At this point, the site owner and community noncapital values, such as those described earlier, should also be applied to determine the relative merits of the most favored options.

With a clear reuse plan, the total costs of a project can be reduced. Several examples of potential cost-saving measures are as follows:

- A site owner decides not to backfill an excavation because reuse requires regrading to accommodate future improvements.
- A site owner is not required to remove or treat low-level concentrations of residual hydrocarbons because reuse involves capping the areas as parking lots, thereby eliminating potential exposure.
- A site owner segregates waste to reuse suitable material for fill where future exposure is precluded.
- A site owner incorporates the site's natural environmental conditions (e.g., wetlands, drainage) into the remedy to accommodate site end use while reducing remediation costs.

- A site owner preserves ecological assets to provide offsets for resource damages at other sites.

The integration of remediation and reuse tips the balance to facilitate the beneficial regeneration of contaminated properties.

CASE STUDIES

The integration of remediation and reuse tips the balance to facilitate the beneficial regeneration of contaminated properties.

The integration of remediation and reuse to achieve whole-system sustainability is applicable to a range of sites, from residential redevelopment sites to landfills. Examples include designing and constructing sustainable buildings and infrastructure, conserving water and energy, reusing construction and demolition materials, and incorporating native landscaping and open space into site reuse. Opportunities may also be available to integrate a site's use into a broader community vision for improved economic prosperity, community vitality, and recreation. Large military and industrial case studies are highlighted in this section because these examples clearly demonstrate the value of integrating remediation with reuse.

Former Carswell Air Force Base, Texas

The Former Carswell Air Force Base is located approximately eight miles from downtown Fort Worth, Texas in an area that is heavily developed and significantly growing in population and land use. The base was established in the 1940s as part of the US World War II military buildup. In 1992, the base was transferred to the US Navy under the BRAC program and renamed Joint Base Fort Worth. Four hundred acres were identified as surplus and were planned to be transferred to the private sector. Over 400 Air Force housing units, a school, golf course, and recreation area were located on the property identified for privatization. Due to historical operations, a chlorinated solvent plume had migrated under the golf course and was at the edge of the Air Force property boundary. Concerned that the privatization would translate into lost business and jobs, local communities established the Westworth Redevelopment Authority (WRA). The WRA worked with the Air Force Real Property Agency to develop an Economic Development Conveyance Agreement (EDCA) for the transfer of the property. The EDCA sustainable reuse plan called for mixed-use redevelopment with a strong emphasis on job creation. Sustainable remediation of the chlorinated solvent plume was integrated into the plan, resulting in direct positive economic and social impacts while protecting human health and the environment.

The sustainable aspects of this project began after the Air Force implemented a pump-and-treat system as an interim remedial measure to remediate the plume. The system pumped 200 to 300 gallons of contaminated groundwater a minute from the plume, treated it, and discharged it to the local publicly owned treatment works. After an inquiry from the golf course operator, the Air Force worked with the Texas Commission on Environmental Quality to develop a discharge monitoring program that allowed the discharge water to be used for golf course irrigation water. Sustainability was integrated into the long-term remedial approach as well. A 1,400-foot long passive permeable reactive barrier stopped the migration of the plume, allowing the energy-intensive pump-and-treat system to be shut off. With plume migration stopped, the Air Force was

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able to transfer ownership of the golf course to a private owner who implemented significant improvements. A former landfill located in the property transfer area was partially covered by the golf course improvements.

The Air Force worked with the WRA throughout the remediation process to minimize the impacts of site cleanup and expedite restoration and reuse, which resulted in economic and social benefits. The remediation paved the way for redevelopment, which created jobs, restored the tax base, and made land available in a high-growth area. The 400 acres that were set aside have been redeveloped with 80 private homes; an apartment housing complex; a military recruiting center; commercial, retail, restaurant, and service businesses; and recreational facilities. A Walmart/Sam's Club store was built and acts as a successful magnet for numerous small businesses located in the same complex. With the addition of the Walmart and the small businesses, it is expected that over 1,200 local jobs will be created; already these stores have contributed $900,000 a year in local sales taxes alone. In addition to the surface development, over $4 million of infrastructure improvements have been made to date, with much of the funding collected by the WRA. For the 10 years prior to the property transfer, local private investment within two miles of the redeveloped acreage totaled less than $20 million. Since the property transfer in 1992, over $280 million has been invested in the area, including $84 million on the redeveloped acreage.

Former Petroleum Refinery and Chemical Plant

An 800-acre refinery and chemical plant was constructed in 1907 and provided the foundation of a midwestern US city. More than half of the city's tax base came from employment at the plant, and a local high school mascot continues to be named for the plant. The refinery closed in the 1980s, and the chemical plant closed in the mid-1990s. Widespread soil and groundwater contamination from refined petroleum and fuel additives were present as a result of former facility operations. After 20 years of slow and/or no cleanup progress under the Resource Conservation and Recovery Act (RCRA), the owner considered redevelopment in 1998, which prompted a sustainable approach to remediation at the site. A master plan for commercial, industrial, and riverfront recreational redevelopment was created based on input from the regulatory agency and community.

The master plan was designed to extinguish environmental concerns, restore the economic contribution of the former plant to the community, reduce remediation cost, and provide a social contribution to the community. Prior to redevelopment, hydrocarbons in groundwater were hydraulically controlled and recovered using two separate pump-and-treat systems. Removing and disposing of contaminated soil was cost-prohibitive, and alternative methods of addressing soil cleanup had not yet been developed. On-site remedies for soil and material disposal were employed to reduce energy use and transportation impacts (i.e., emissions and vehicle miles). For example, on-site screening, site-specific risk-based cleanup objectives, and engineered barriers—some already in place—were used to leave impacted soil in place, and select concrete foundations that were removed were crushed and reused on-site. Alternative energy applications are currently being considered in the remedial alternatives analysis for soil. For example, the feasibility of micro-turbine electricity generation using soil vapor extraction effluent as fuel has been considered. In addition, on-site materials such as discharge water from the pump-and-treat system are being recycled.

The approach was not without its challenges. The owner's concerns about the property transfer, long-term liability management, and acceptance of an *in situ* remedy were addressed through open communication and discussion of successful case examples. Although regulatory agency leadership was promoting closure and sustainability, case managers and staff initially focused on a narrower implementation of regulatory program requirements. By communicating openly, presenting successful case examples, and developing trust, the agencies involved agreed that the sustainable approaches met regulatory objectives.

Remediation and site reuse should be considered as a single, interlinked process, not as independent activities. As such, remediation and reuse practitioners should work together, establishing partnerships to share knowledge and resources.

The ongoing success of this project is demonstrated by the resulting environmental, economic, and social benefits. The environmental concerns at the site were addressed in significantly reduced time. Little progress occurred over the six years prior to considering redevelopment. After the master plan was developed, the first soil closure was achieved within one year. The redevelopment created economic benefits for the site owner and community; the owner contributed relatively devalued land and the community provided financial backing and acceptance. A market analysis estimates 800,000 square feet of commercial and industrial development potential for the property, which would create about 2,000 jobs. In addition, liability and remediation costs were reduced for the site owner, and the prospective developer saved money by reusing on-site materials. Alternative energy opportunities, including wind or solar power for systems and the use of petroleum-related contaminants as fuel for power, are also providing opportunities for cost savings. These alternative energy considerations provide additional land-use opportunities for redevelopment. For example, the availability of large land tracts that have environmental and geotechnical use restrictions can be considered for wind or solar generation. Finally, social benefits, including the removal and reduction of urban blight, were achieved. Tank berms were removed along the site boundaries and, where there was once soil and stone blocking the view of the site, vistas were created across the site and communities were reconnected. Wildlife habitats were restored, bringing recreation (i.e., wildlife viewing area) and wildlife and urban agriculture educational opportunities. By recycling the land, the existing infrastructure was able to be put back in service. The owner also benefits from recognition for its corporate social responsibility in a "win-win" partnership with the regulatory agency for achieving greener solutions.

RECOMMENDATIONS

Although remediation and reuse objectives are not always aligned, it is clear that remediated sites should be reused in a way that best serves the community, local and broader economy, and environment. SURF recommends the following to help practitioners more effectively integrate remediation and reuse:

- Remediation and site reuse should be considered as a single, interlinked process, not as independent activities. As such, remediation and reuse practitioners should work together, establishing partnerships to share knowledge and resources.
- A framework for the effective integration of remediation and reuse should be developed that describes a "cradle-to-grave" process to ensure the "best practical use" throughout the project (remediation and reuse) life cycle.

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- All remediation and reuse stakeholders should be involved at the beginning of the remediation process where feasible. In particular, remediation practitioners should apply the partnering concept used by the redevelopment industry to determine how the remediation of the site can deliver value.
- Developers should implement innovative development opportunities and consider sustainable remediation as a means of converting historically dormant sites to beneficial reuse.
- Stakeholders, from remediation practitioners to developers and from the local community to financers, should receive guidance on the value proposition associated with the highest and best reuse of a site. Measures undertaken to minimize risk to human health and the environment during site remediation and reuse should also be appropriately communicated to these stakeholders.
- Sustainable remediation practitioners should work more collaboratively with planners and the developers of LEED, SITES™, STAR™, Envision™, and BREEAM® so that:

    - Sustainable remediation and Brownfield redevelopment can be incorporated and incentivized into existing guidelines and rating systems.
    - Explicit incentives for the sustainable remediation of Brownfield sites can be developed and included in these initiatives.
    - Credit can be awarded for sustainable remediation.
    - Sustainable remediation performance benchmarks can be incorporated in the guidelines and rating systems associated with these programs.

DISCLAIMER

This document was produced by the Sustainable Remediation Forum, which is a New Jersey nonprofit corporation with broad membership. The views and opinions expressed in this document are solely those of SURF and do not reflect the policies or positions of any organization with which SURF members are otherwise associated.

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NOTE

1. Estimated percentages were provided by Robert Colangelo, executive director of the National Brownfield Association. Colangelo acknowledges that it is very difficult to count the number of Brownfield properties in the United States because sites are rarely advertised as "Brownfields" on a "For Sale" sign. Furthermore, there is a lack of consistency between public- and private-sector organizations as to the definition of a "Brownfield."

REFERENCES

Holland, K., Lewis, R., Tipton, K., Karnis, S., Dona, C., Petrovskis, E., Bull, L., Taege, D., & Hook, C. (2011). Framework for integrating sustainability into remediation projects. Remediation, 21(3), 7–38.

US Sustainable Remediation Forum (US SURF). (2009). Integrating sustainable principles, practices, and metrics into remediation projects. Remediation, 19(3), 5–114.

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Rick Wice, P.G., is a senior project manager and geologist at Tetra Tech. Wice is involved in developing and implementing green and sustainable remediation (GSR) approaches for government and commercial site restoration projects. As a lecturer at Carnegie Mellon University, he incorporates GSR practices and principles in the graduate remediation engineering course.

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