Practical Considerations in Sustainability

Richard F. Hoff
Amanda L. Stanonik
John Mahfood
of the Mahfood Group, LLC
and
Coreen M. Casadei, PE
Kathy M. Chavara, PE
Tammi A. Halapin, PE
of Collective Efforts, LLC

ABSTRACT

In 1987, the World Commission on Environment and Development issued a report called "Our Common Future". This report introduced a new concept in environmental and human affairs called *Sustainable Development*. Sustainable development was defined as: "… development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

Implicit in this sustainability concept is that economics and ecology must be completely integrated in decision making and lawmaking processes, not only to protect the environment but, to also promote development. However, more than twenty years later, environmental, engineering and regulatory professionals struggle with this multi-disciplinary and highly complex concept. No category of development is more affected by sustainability than Brownfield development. However, sustainable development rarely extends beyond platitudes offered by those who favor any economically viable reuse at the outset.

For example, the Environmental Protection Agency (EPA) suggests that Brownfield sites are good development locations because they have infrastructure (sewer, water, roads) in place and are more accessible to mass transportation. The reality is that many Brownfield sites contain obsolete and impaired infrastructure that must be upgraded or replaced entirely. EPA also suggests that the most ideal site for a Green building is a Brownfield. However, without green

solutions to exterior “site” problems, conditions existing around the building will eventually become interior problems, no matter how sophisticated the Green building.

This paper evaluates some practical considerations to sustainable development of Brownfield sites with respect to the changing regulatory, economic and social conditions. This paper combines two discussions presented by the Mahfood Group, LLC and Collective Efforts, LLC at the April 16th, 2009 Business of Brownfields Conference in Pittsburgh, Pennsylvania, namely, “Effects of Changing Regulatory Paradigms on Brownfield Viability and Sustainability” and “Practical Considerations in Sustainability”.

Background

From an environmental perspective, sustainability as a policy initiative was specifically addressed by Congress with the passage of the U.S. National Environmental Policy Act (NEPA). NEPA was designed to: "create and maintain conditions under which people and nature can exist in productive harmony, and fulfill the social, economic and other requirements of present and future generations of Americans." No definition of Brownfield sustainability can be complete without including this fundamental policy objective of NEPA. However, it does not completely constitute a comprehensive definition of Brownfield sustainability. Currently, the most widely accepted definition of sustainability is the "Brundtland definition" contained in the 1987 Report of the World Commission on Environment and Development. Brundtland defined sustainability as "meeting the needs of the present without compromising the ability of future generations to meet their own needs” (Brundtland, 1987). Adding language from Bruntland provides greater perspective to the emerging definition. EPA’s Office of Research and Development weighs in on the definition of sustainable development by describing it as: “…as an integration of economic, social, and environmental policies, that cannot be achieved through any single federal agency, because it relies on policy coherence across government agencies.” EPA’s contribution to sustainability is to protect human health and the environment for both this and future generations.

As such, a functional definition of Brownfield sustainability would include considerations for the harmonious existence between human economic activities and the environment that meets current as well as future needs and is ultimately protective of both human health and the environment.

Brownfields are defined as “abandoned, idled or underutilized industrial and commercial facilities where expansion or redevelopment is complicated by real or perceived contamination (Kaiser, 1998). Across the U.S. there are an estimated 500,000 Brownfield sites with uncertain or risky environmental conditions, in terms of known past uses and current status (Norton, 2005). Because Brownfields are in most cases contaminated and pose some level of human health or environmental risks, investigation, assessment and possibly remediation are necessary steps to create congruency between Brownfields and the concept of sustainability. This process begins with risk assessment, statistically representative investigations and a scientific determination of the relationship between the concentrations of contaminants in environmental media or on-site wastes and the potential for adverse human health and environmental effects to occur if no action is taken to remediate the site. Therefore a relatively complete definition of sustainable Brownfield development would include references to not only current uses but all reasonably foreseeable future uses and even changing development practices including green design.

Complications associated with Brownfields result from Federal legislation that stipulates cleanup of hazardous waste sites. The problem created by the comprehensive liability (under the Comprehensive Environmental Response, Compensation and Liability Act of 1980 or CERCLA) is the legal liability issue it raises for any site with relatively small amounts of contamination. Liability associated with contamination is often more daunting than the cleanup or procedural regulations involved (VanLandingham, 1998**)**.

The key legal issues involve “strict” and “joint and several” liability. “Strict” liability does not require the demonstration of any wrong-doing. Even actions that were legal at the time they were taken and created some contamination result in the actors being held accountable for the costs of clean-up and environmental damages. This liability is also retroactive, meaning that it applies even to acts causing pollution years or decades prior to CERCLA passage in 1980. “Joint and several” liability has to do with how this liability is shared among the many parties who could be held responsible for the pollution. CERCLA creates three general classes of “potentially responsible parties” (PRPs): (1) generators of hazardous substances, (2) owners and operators of the site where the contamination is found, and (3) transporters with the authority to decide on the site for disposal of hazardous substances. The “joint and several” language means that one or all PRPs may be held responsible for the entire cost of cleanup, no matter how little pollution they caused. The bottom line has been that local governments or authorities who attempt to redevelop such contaminated properties may end up among the responsible parties, although the establishment of de micromis contributions to site contamination have lessened this risk in recent years.

The potential for assuming liability has created an environment where nearly all previously used industrial and commercial sites require some level of environmental assessment before they can be sold and before redevelopment financing can be obtained. CERCLA has, therefore, made the redevelopment of Brownfield sites: 1) more expensive because of assessment and cleanup costs; 2) riskier because of the possibility of greater contamination than originally conceived; and 3) slower due to the time necessary to assess the levels of contamination, clean the property, and obtain appropriate clearances. Subsequent legislative changes and court decisions regarding CERCLA further complicated the redevelopment of Brownfields by exposing lenders to potential liability (Missimer, 1996), thereby reducing a rather weak demand for any previously developed sites. In addition to these legislative and legal issues, a range of other factors combine to undermine the redevelopment of Brownfield sites including the physical and economic deterioration of older industrial areas; population out-migration from cities; public sector neglect of infrastructure and service delivery in impoverished areas; changes in preferences for production and distribution facilities; and, greater demand for access to the interstate highway system as trucks have replaced river and rail transportation, leading firms to locate in suburban locations near highway interchanges. Access to interstates has lost some influence with the recent spikes in fuel costs and the re-emergence of efficient rail transport of goods.

To address many of the business-related concerns regarding Brownfields redevelopment, Congress passed the Small Business Liability Relief and Brownfields Revitalization Act in 2001.

The Act became law in January 2002 and provided relief from CERCLA liability by clarifying the "innocent landowner" defense and by providing protection from liability for owners of land contaminated by a source on contiguous property. Protections were also extended to prospective purchasers of property that is known to be contaminated (O'Laughlin, 2003).

The Brownfield Law prohibits Federal enforcement actions under CERCLA against a person who is conducting, or has completed a cleanup at an "eligible response site" in compliance with a state response program. The purpose of this law is to assure developers that a Brownfield site, if remediated to the satisfaction of a state with a state response program, the Federal government is highly unlikely to use CERCLA authorities to demand more extensive cleanup. However, EPA retains CERCLA enforcement authority against hazardous substance releases that were not addressed by the cleanup; if the state requests Federal assistance; if hazardous substances migrate across a state line or onto Federally-owned property; if there is an "imminent and substantial endangerment;" or if information that the state was not aware of shows that additional cleanup is required to protect public health or the environment. In the event that any of these aforementioned conditions apply, EPA may commence enforcement actions under CERCLA or statutes other than CERCLA against the owner, developer, or other parties. As such, the most recent Brownfield Law stops short of providing blanket immunity from Federal enforcement action.

Risk Assessment and State Voluntary Compliance Programs

State Voluntary Cleanup Programs (VCPs) were established throughout the 1990s to encourage the environmental remediation and redevelopment of contaminated properties. These programs typically offer liability relief, subsidies and other regulatory incentives in exchange for site cleanup. State VCPs generally involve at least three steps: 1) notice of intent to act, 2) provision of evidence on completed action, and 3) state review of the work completed.

As part of state VCPs is the practice of risk assessment or the use of media-specific screening criteria to evaluate the potential human health and/or ecological impacts associated with contamination at Brownfield sites. Risk assessment characterizes the nature and magnitude of health risks to humans (e.g., residents, workers, and recreational visitors) and ecological receptors (e.g., birds, fish, and wildlife) from chemical contaminants and other stressors that may be present in the environment. Under many state VCPs, landowners and developers have the choice of conducting a site-specific risk assessment to evaluate the contaminants present at their site and to use risk-based cleanup goals as a means of achieving closure. A major innovation present in many state VCPs is flexibility in the establishment of cleanup standards, with requirements most often based on intended future sites uses. This flexibility permits redevelopment without a complete cleanup. While the ability to leave some contaminants on site can lower project costs, it makes redevelopment decisions more complicated by creating varying remediation strategies for different planned land uses.

To qualify for less burdensome cleanup standards, developers are often required to install engineered controls to limit potential future exposures to contaminants left in place. States vary in the extent to which such controls are recorded or registered and in the procedures they have developed for oversight and to assure that controls are properly maintained over time. Engineered controls are often used with institutional controls. Institutional controls are easements or restrictions that limit what can be done on a site. Institutional controls can take different forms, but in general they are used to provide added assurance that future site uses are consistent with flexible cleanup standards and to assure that engineered controls are maintained over time. The drawback to this cost-first type of approach to Brownfield site redevelopment is the potential that engineered controls will fail, institutional controls will be insufficient to provide adequate protection, and redevelopment projects will inherit long-term consequences of contaminants left in place. This type of approach to Brownfield development, no matter how immediately successful is diametrically opposed to the definition of sustainability.

Just as CERCLA reserves the Federal right to “reopen” any approved cleanup if new dangers arise or risks are discovered, most state VCPs have provisions to reopen sites, particularly when a failure of engineered or institutional controls occurs. For example, the Pennsylvania Land Recycling Program (Act 2) identifies five situations that could lead to reopening a site: 1) fraud in demonstrating attainment; 2) new data indicate that contamination exceeds standards in areas not previously known; 3) remediation fails to meet standards or the level of risk is increased beyond the acceptable risk range at a site due to substantial changes in exposure conditions, such as in a change in land use from nonresidential to a residential use, or new information is obtained about a regulated substance associated with the site which revises exposure assumptions beyond the acceptable range; 4) remediation becomes feasible and only institutional controls were used to meet standards; or 5) institutional controls fail. The existence of reopeners creates inherent uncertainty in the use of site-specific risk assessments and flexible cleanup standards unless sufficient conservatism is used in the establishment of future use scenarios in the site conceptual model.

Changes in Exposure Assumptions and Toxicity Data

The establishment of toxicity values and the practice of risk assessment do not produce absolute results. In fact, the practice of risk assessment is a rather inexact science and uncertainties and their dependencies can greatly influence the outcomes of risk calculations. Uncertainties are inherent in the selection of exposure factors and the extrapolation of toxicity data and recent efforts by EPA have been undertaken to address uncertainties in the development of contaminant screening criteria.

In Spring 2008, a collaborative table of screening values was compiled by Oak Ridge National Laboratory (ORNL) with input and under inter-agency agreement by U.S. EPA Regions 3, 6 and 9. ORNLs *Screening Levels for Chemical Contaminants at Superfund Sites Table* is an attempt at standardizing screening levels across regions and includes the latest toxicity values, default exposure assumptions and physical/chemical properties. A significant component in the development of ORNL screening levels is the introduction of an industrial air scenario and the use of Tier 3 toxicity values including California Environmental Protection Agency (CalEPA) values. The addition of the inhalation pathway to soil screening levels is significant because previously the ingestion pathway was the dominant route of exposure. ORNL values now include dermal and inhalation pathways which, when combined with re-classification of noncarcinogenics as carcinogens can reduce residential screening values by a factor of 410 for a contaminant such as naphthalene (Region III RBC = 1,600 milligrams per kilogram [mg/Kg] versus ORNL = 3.9 mg/Kg) and approximately 1,400 time for ethylbenzene (Region III RBC = 7,800 mg/Kg versus ORNL = 5.7mg/Kg). Naphthalene and ethylbenzene are common contaminants at hazardous waste sites and Brownfield sites (U.S.EPA, 2007) and occur as byproducts or as constituents of commonly used products including fuels, paints and degreasers.

The indoor inhalation pathway is particularly intriguing for these common contaminants and intrusion from vapors emanating from subsurface and shallow groundwater must be seriously considered with respect to changing toxicity designations. For example, the Johnson and Ettinger vapor intrusion screening model suggests that the presence of naphthalene in groundwater at concentrations 10 times greater than benzene will produce vapor concentrations approximately half that of benzene. CalEPA has designated naphthalene as a probable carcinogen and has assigned a unit risk factor of 3.4x10-5 cubic meters per microgram (m^3/µg), similar to the unit risk factor of 2.9x10-5 m^3/µg established by EPA for benzene. This suggests that under certain conditions, cancer risks from naphthalene in environmental media may be as significant as those of benzene. In soil gas, naphthalene can dominate noncarcinogenic hazard indices because of the significantly lower reference concentration (RfC) (Christopher, 2005).

It is important to note that EPA does not consider naphthalene or ethylbenzene to be B2 – probable human carcinogens. It is likely that at some point in the future, other states may take CalEPA's position and it is not beyond the realm of possibility that EPA may also reclassify these contaminants in the future. If Brownfield site redevelopment is to achieve a modicum of sustainability, it is vitally important to consider state-of-the-art science and subsequent influences on public policy during the development of the site conceptual model.

Emerging Contaminants

The concept of sustainability at Brownfields and other hazardous waste sites will be challenged by our ability to sample, concentrate and analyze contaminants that occur in the environment. These contaminants are generally referred to as emerging contaminants and they comprise new contaminants as well as classical environmental contaminants that may occur as a result of new uses or sources of release.

Emerging contaminants include antidepressants, antibiotics, fungicides, veterinary drugs, natural and synthetic hormones, detergent metabolites, plasticizers, insecticides, surfactants and fire retardants. These contaminants have been detected at relatively low levels (parts per billion [ppb]) in both aqueous samples (surface water and ground water) as well as soil and sediment samples. Many of the emerging contaminants are known or suspected to be hormonally or pharmaceutically active. However, little is known about the potential health effects to humans or aquatic organisms exposed to low levels of these chemicals.

The ability to analyze and detect these contaminants in environmental samples is critically important in the development of treatment processes and policy development. Novel methods of extraction including Solid Phase Extraction (SPE) and Accelerated Solvent Extraction (ASE) methods are allowing the scientific community to evaluate the presence of emerging contaminants at relatively low concentrations. The use of high-performance liquid chromatography–electrospray ionization mass spectrometry (LC/ESI/MS) and LC/MS/MS analytical methods are improving and may soon become sufficiently affordable for commercial analytical laboratories.

While analytical techniques continue to improve, legislative efforts are underway to address potential chemical impacts on human health and the environment. The Chemical Assessment and Management Program (ChAMP) is broadening EPA's efforts to ensure the safety of existing chemicals. The program is developing screening-level hazard, exposure, and risk characterizations for an estimated 6,750 chemicals produced or imported in quantities of 25,000 pounds or greater per year. Many of these are considered to be emerging contaminants. EPA is currently developing prioritization protocols for individual chemicals or a group of chemicals that are structurally or physically similar. EPA will develop screening-level information to characterize hazard, exposure and potential risks via risk-based prioritization (RBP) or hazard-based prioritization (HBP). These assessments include EPA prioritization of chemicals for follow-up data collection or management actions based upon their potential to cause adverse ecological and or human risks. While these prioritizations will not establish definitive determinations regarding hazard or risk or the sufficiency of available information for any regulatory purpose, they will serve as initial evaluations of data and understanding currently available to EPA in a rapidly changing regulatory environment (U.S.EPA, 2009). ChAMP was created to implement commitments that the United States made at the Security and Prosperity Partnership of North America (SPP) Leaders Summit, in Montebello, Canada in August 2007. SPP was launched in March of 2005 as a trilateral effort to increase security and enhance prosperity among the United States, Canada and Mexico through greater cooperation and information sharing. As such ChAMP is an outgrowth of international treaty – a vast departure from regulatory frameworks that have defined past environmental regulations.

States have also begun to take actions to address possible regulatory strategies for emerging contaminants. In July 2006, Massachusetts became the first state in the nation to promulgate drinking water and waste site cleanup standards for perchlorate, a contaminant that was unregulated by any state or the Federal government. Massachusetts Department of Environmental Protection (MassDEP) established a standard of 2 parts per billion for this emerging contaminant and by doing so, established a model for how the agency will address other emerging contaminants that may not be adequately regulated. The Mass DEP Perchlorate Work Group became the Emerging Contaminant Workgroup in early 2008 and is charged with identifying new potential public health and environmental problems and MassDEP can or should address them. The Workgroup has defined emerging contaminants as hazardous materials or mixtures comprised of naturally occurring or manmade chemical, microbial or radiological substances that are characterized by having 1) a perceived or real threat to human health, public safety or the environment; 2) no published health standards or guidelines; 3) insufficient or limited available toxicological information or toxicity information that is evolving or being re-evaluated; or 4) significant new source, pathway, or detection limit information. MassDEPs Workgroup has developed a preliminary list of approximately 80 emerging contaminants and has established a framework to screen and prioritize these contaminants. Thirty of these contaminants have been placed on a watch list which will be updated every 6 months as new information becomes available. Future work will involve developing recommended strategies for contaminants nominated for additional action (MassDEP, 2009). It is reasonable to expect that health-based criteria will soon be available for many of these emerging contaminants and this will have industry-wide impacts that will also affect closure and relief from liability at Brownfield sites.

Green Design Considerations

In 1998, the U.S. Green Building Council developed the LEED (Leadership in Energy and Environmental Design) Green Building Rating System. This system is a benchmark used for Green Design. It provides a suite of standards for environmentally sustainable construction. LEED promotes a whole-building approach to sustainability by recognizing performance in key categories such as sustainable sites, water efficiency, energy, materials and resources, indoor environmental quality, and location. Choosing a building's site and managing the site during the construction activities are important considerations for a project's sustainability. The LEED sustainable sites category encourages development on previously developed land (such as brownfields), regionally appropriate landscaping, stormwater runoff control, and the reduction of erosion (U.S. Green Building Council, 2009). The 2009 version of LEED for New Construction and Major Renovations gives preference to Brownfield sites.

LEED encourages the development on Brownfields and considers the reuse of existing infrastructure as a benefit. In Allegheny County and other areas throughout Pennsylvania, the existing sanitary sewer lines and storm sewer lines are significantly old and in dire need of upgrading or replacement. Therefore, the re-use of these lines is typically not recommended at Brownfield sites with on-site contamination. The leaking sewer lines can serve as potential migration pathways for the contamination remaining at the site.

Stormwater Management Considerations

Stormwater management must be considered for a Brownfield site. Any land development that changes the surface features of land at a site impacts stormwater runoff. It is important to manage and control discharges of any potential pollutants from a site to eliminate the potential for pollution to surface waters and groundwater. The Pennsylvania Stormwater Best

Management Practices (BMPs) Manual prepared by the Pennsylvania Department of Environmental Protection (PADEP) provides guidance and tools that can be used to protect water quality, enhance water availability and reduce flooding potential (PADEP, 2006). The BMP Manual lists various BMPs and design standards which are acceptable in Pennsylvania to manage stormwater and prevent pollution of the waters of the Commonwealth. The BMP Manual also contains a section on Special Management Areas that includes Brownfields. This section reinforces the need for communication between the site remediation and the site redevelopment stages. This section also discusses the need to limit or focus infiltration to areas where soil contaminants have been removed or where only non-soluble contaminants remain on site.

For stormwater management on traditional sites, the Manual discusses two types of BMPs: non-structural and structural. Non-structural BMPs are sometimes referred to as low impact development or conservation design techniques. They take the form of broader planning and design approaches. Non-structural BMPs prevent stormwater generation and not just mitigate stormwater-related impacts once problems have been generated. Major areas of preventive non-structural BMPs include:

- Protect and conserve sensitive areas
- Cluster and concentrate
- Minimize disturbance and maintenance
- Reduce impervious cover
- Disconnect/distribute/de-centralize

Non-structural BMPs can preserve open space, protect natural systems and incorporation existing site features such as wetlands and stream corridors to manage stormwater at its source. Some BMPS focus on clustering development, minimizing disturbed areas and reducing the size of impervious areas. The incorporation of these practices into development plans such as for Brownfields can contribute to desirability of a community, environmental health and quality of life.

The BMP Manual identifies 21 structural BMPs, many of which are natural system-based structures and include vegetation and soils mechanisms as part of their functioning. Some of the structural BMPs include:

- Pervious Pavement
- Infiltration Structures
- Rain Garden/Bioretention
- Dry Well
- Vegetated Swale/Filter Strip
- Green Roof
- Runoff Capture and Reuse
- Constructed Wetland
- Retention/Detention Pond
- Water Quality Filters

All structural BMPs may not be applicable to a Brownfield site. At Greenfield sites, the preferred method of stormwater management is infiltration. But at Brownfield sites, this may be a limited recommendation. Significant consideration must be given to the extent and type of contamination remaining at a site. Contaminated soil might remain at the site under a cap where stormwater should not infiltrate and cause contaminant migration. During the site redevelopment stage of a Brownfield site, it is imperative that the project does not disturb any completed work from the site remediation stage. Most conflicts could occur during foundation and utility work by creating new pathways for contaminants to migrate. BMPS that reduce the volume of stormwater runoff without infiltration methods such as green roofs will most likely be the acceptable structural BMPs for these sites.

Conclusions

By definition, Brownfield sites are not sustainable because the presence of contamination precludes their unrestricted current or future redevelopment with some level of remediation. Contamination greatly complicates the reuse of Brownfield sites and despite legislative efforts to provide relief from liability. The general perception is that involvement with these sites is more costly and complicated than development efforts involving Greenfields.

Reuse is further complicated by the changing regulatory environment. The results of site-specific risk assessment are not absolute. For example, changes in how certain contaminants are evaluated from an exposure as well as a toxicological perspective (e.g., ethylbenzene and naphthalene) will result in changes to risk-based attainment criteria. These changes will ultimately impact risk-based attainment criteria promulgated under state VCPs.

Another complication is the growing focus on emerging contaminants. Emerging contaminants are defined as synthetic or naturally occurring chemicals or microorganisms that are not commonly monitored in the environment but have the potential to enter the environment and cause known or suspected adverse ecological and human health effects. EPA ChAMP and state programs are underway to address the presence of emerging contaminants in environmental media and subsequent environmental and human health effects. As regulatory frameworks evolve, emerging contaminants may broaden the spectrum of contaminants and stressors that must be addressed to ensure sustainability.

There are various methods to evaluate how “green” a project is. The LEED Green Building Rating System is a commonly used method. LEED encourages the development on Brownfields and considers the reuse of existing infrastructure as a benefit. The existing infrastructure must be reviewed to check for deterioration, capacity, and contaminant migration along existing pipelines. The locating of buildings on Brownfield sites must be done with consideration to areas that have been capped or are to remain undisturbed, areas where paving might be used as part of a remedial action, and clean areas that could be left open for stormwater management structures.

Stormwater management options can be limited when pursuing re-development of Brownfield sites. Many states have developed post-construction stormwater management manuals or guidance that recommend or require infiltration as the primary method of stormwater management. Infiltration may not be an option for sites where soil contaminants have been left in-situ. Careful design consideration must be given to try to meet the requirements of on-site stormwater management while not spreading any residual contaminants remaining on site. Several methods of stormwater management do lend themselves to Brownfield applications, including lined bio-retention swales, green roofs, and cisterns.

An emphasis on the site conceptual model, quantitative uncertainty analysis and the acceptance of risk assessment as a strategic and operational element of site redevelopment combined with best engineering practices will provide practical approaches for the sustainable redevelopment of Brownfield sites now and in the future.

References

Bruntland, G. H. (1987). Report of the World Commission on Environment and Development: Our Common Future. Transmitted to the General Assembly as an Annex to document A/42/427 - Development and International Co-operation: Environment. March 20, 1987.

Christopher, J. P., Davis, B. K., Polisini, J. M., Wade, M. J. (2005). Designation of Naphthalene as a Carcinogen: Risk Assessment for Inhalation Exposure Pathways at Hazardous Waste Sites. Presented at the 44th Annual Meeting of the Society of Toxicology. New Orleans, Louisiana. March 10, 2005.

Kaiser, S-E. (1998). Commentary: Brownfield National Partnership. *Public Works Management and Policy* 3(2), 196–201. January, 1998.

Massachusetts Department of Environmental Protection [MassDEP]. (2009). Toxics and Hazards: Emerging Contaminants. Retrieved April 2009, from http:// www.mass.gov/dep/toxics/stypes/emercfs.htm

Missimer, T. (1996). A Lenders Guide to Environmental Liability Management. Boca Raton, FL: CRC Press.

Norton, C. (2005). Brownfields: Historic Preservation as a Redevelopment Option. Practice Guide #8, Spring 2005. Southeast Regional Environmental Finance Center, EPA Region 4. University of Louisville, Louisville, KY.

O' Laughlin, J. (2003). Superfund Liability Reform in 2002. College of Natural Resources Policy Analysis Group, University of Idaho. Issue Brief No. 3, September 2003.

Pennsylvania Department of Environmental Protection [PADEP], Bureau of Watershed Management. (2006). Pennsylvania Stormwater Best Management Practices Manual. #363-0300-002. 642 pages. December 30, 2006.

United States Environmental Protection Agency [U.S.EPA]. (2009). Chemical Assessment and Management Program (ChAMP). Methodology for Risk-Based Prioritization under ChAMP. Office of Pollution Prevention & Toxics. Retrieved April 2009 from http://www.epa.gov/champ/pubs/hpv/abouthpv.html.

U.S.EPA. (2008). Mid-Atlantic Risk Assessment - Screening Levels for Chemical Contaminants at Superfund Sites. Retrieved April 2009 from http:// www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm

U.S.EPA. (2007). Toxics Release Inventory Database. 2007 Public Data Release. Section E - The 20 Chemicals with Largest Total Recycling On-site and Off-site, 2007: Petroleum. Retrieved April 2009 from http://www.epa.gov/tri/tridata/tri07/index.htm.

U.S.EPA. (2007). Sustainability Research Strategy. 600/S 07/001. October 2007. Retrieved April 2009 from http:// *www.epa.gov/sustainability*.

U.S. Green Building Council. (2009). What is LEED. Retrieved in May 2009 from http:// www.usgbc/org.

VanLandingham, H.W., & Meyer, P.B. (1998). Council for Urban Economic Development. Brownfields Redevelopment Manual. Washington, DC.

The Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA or Superfund). 42 U.S.C 9601-9675 consists of Public Law 95-510 (December 11, 1980) and the amendments by subsequent enactments.

The Pennsylvania Land Recycling and Environmental Remediation Standards Act. 35 P.S. 6026.101 – 6026.909, May 19, 1995.

The National Environmental Policy Act of 1969 (NEPA), As amended (Pubic Law 91-190, 42 U.S.C. 4321-4347, January 1, 1970, as amended by Pubic Law 94-52, July 3, 1975, Public Law 94-83, August 9, 1975, and Public Law 97-258, § 4(b), September 13, 1982).

The Small Business Liability Relief and Brownfields Revitalization Act of 2002. Public Law 107-118. January 11, 2002.