10-2012

# Sustainable Water Management on Brownfields Sites

Ryan Fenwick
*University of Louisville*

New England Environmental Finance Center

# Sustainable Water Management on Brownfields Sites

Ryan Fenwick, Graduate Assistant, Environmental Finance Center, University of Louisville, Louisville, KY
Water Infrastructure Capacity Building Team | HUD Capacity Building for Sustainable Communities Program | October 2012

## Background

This practice guide was developed by the Environmental Finance Center Network (EFCN) through the Capacity Building for Sustainable Communities program funded by the US Department of Housing and Urban Development and the US Environmental Protection Agency. Through a cooperative agreement with HUD, EFCN is providing capacity building and technical assistance to recipients of grants from the federal Partnership for Sustainable Communities, an interagency collaboration that aims to help towns, cities, and regions develop in more economically, environmentally, and socially sustainable ways.

## Contents

Introduction ... 2
Brownfields: An Unintended Consequence ... 2
Water Management and Brownfields: New Challenges and First Steps ... 3
Potential for GI and LID on Brownfields Sites ... 4
Funding Sources ... 5
Case Studies ... 7
Additional Resources ... 12
References ... 12

UNIVERSITY OF LOUISVILLE
CENTER FOR ENVIRONMENTAL POLICY & MANAGEMENT

EFCN
environmental finance center network

# Introduction

Managing stormwater is a central concern for municipalities struggling with more intense weather events and increased pressure to develop land that would have previously accommodated stormwater through infiltration. Green infrastructure (GI) and low impact development (LID) are proven methods to manage stormwater more efficiently. GI creates an infrastructure through engineered and natural components that act as a living infrastructure for stormwater management, reducing the need to pump water to centralized water management facilities (Arnold, Norton and Wallen, 2009). LID techniques manage stormwater close to the source in a way that replicates the pre-development management of water on a site (Hawkins et al., 2012). These approaches reduce the need to treat runoff through a combined sewer operation (CSO), a water facility that combines waste water with stormwater runoff and vents excess untreated water during peak flows into water bodies.

Communities are also addressing legacies of shifting economies represented by brownfields. Brownfields are abandoned and under- utilized properties with perceived or real contamination that hinder the redevelopment of the site. They can be large and small, rural and urban and anywhere in-between. Most communities have some level of brownfield redevelopment concerns. GI and LID techniques are not always considered when communities redevelop brownfields because of concerns about addressing soil contamination on those sites. Thus, brownfield are generally not the first sites considered for sustainable water practices.

This practice guide makes the case for using green infrastructure on brownfield sites as a way to offer an environmentally friendly amenity while also meeting cleanup requirements. The guide includes a brief history of brownfields, a description of cleanup practices, examples of potential uses of GI and LID on brownfield sites, a summary of current sources of funding for including GI and LID on a site, followed by case studies of developments that successfully included GI or LID.

# Brownfields: An Unintended Consequence

Generally, former industrial brownfield sites are more accessible than suburban greenfields because of their proximity to urban cores, a result of past infrastructure development patterns in cities (Green, 2003-2004). Today, these sites are ideal places for redevelopment since they are served by existing infrastructure and offer potential for developments that facilitate walking, biking and other types of denser developments close to downtown. Development of brownfields can result in savings on infrastructure spending on new suburban roads and sewer lines (Davis and Sherman, 2010). The estimated 650,000 brownfield sites across the United States are undervalued by $2 trillion because of brownfield designation (Davis and Sherman, 2010).

Industrial practices in the early 20$^{th}$ century left a legacy of potentially hazardous chemicals in many communities. The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) created far-reaching liability for owners of contaminated sites as a way to address this legacy. The unintended consequence of CERCLA was that this potential liability encouraged many owners of brownfield sites to “mothball” their sites, or to leave potentially contaminated sites unused, rather than risking a costly clean-up required by CERCLA (Davis and Sherman, 2010). CERCLA was intended to provide a solution to serious contamination on only a few sites across the country. The legislature did not expect the stultifying effect on development the act would have when it proved to apply to over a thousand sites that met the threshold requirements defining contamination and liability under the act (Green, 2004).

While the CERCLA’s liability provisions created far-reaching concerns for contaminated site owners, sophisticated developers can take advantage of safe harbor provisions of the act to predict costs during development (Davis and Sherman, 2010). These provisions were established in the Superfund Amendment and Reauthorization Act (SERA), which is the 1985 amendment to CERCLA. This act came after recognition by Congress of the chilling effects CERCLA was having on investment in brownfields revitalization (Opp and Hollis, 2005). The Act created an “innocent owner” defense to shield the purchasers of a contaminated property from liability. Moreover, the 2002 Small Business Liability

Relief and Brownfield Revitalization Act exempts small businesses from Superfund liability and promotes voluntary cleanup programs managed by states in cooperation with the U.S. Environmental Protection Agency (EPA). It also strengthens protections for innocent purchasers who did not know a site was contaminated and created additional programs, such as support for education in the process of cleaning up a brownfield site.

In addition to these federal laws governing brownfield redevelopment, many states have established mini-CERCLAs. Since the 1960s, states have started to play a greater role in brownfield redevelopment (Opp and Hollis, 2005). The federal government has increasingly allowed states to work with site owners to cooperatively reach a strategy to make the property safe. Many states create safe harbors for developers with voluntary action programs (VAPs) that allow developers and environmental protection regulators to cooperatively determine what remediation is needed for a site. Developers of brownfield sites must comply with applicable state legislation. Ultimately, restoring a brownfield requires cooperation between regulatory authorities and local and state governments; therefore early involvement of all parties is beneficial since it helps guarantee all available funding is found for the site and that the project will meet all applicable standards for making a brownfield property safe.

# Water Management and Brownfields: New Challenges and First Steps

Brownfields are increasingly becoming targets for redevelopment, while at the same time many communities also face novel problems with water management. Aging sewer infrastructure is being pushed past its limits as an unprecedented increase in impervious surface coverage is overwhelming CSOs, causing an increase in volume of untreated water dumped into water bodies. Channelization of streams in combination with the increased rate of runoff from human changes in a sites natural drainage function pose new threats to the health of water bodies stressed by these hydrological changes. More intense storm events and changing weather patterns are likely to exasperate these problems communities are just beginning to address.

In response, Congress has given EPA the mandate to improve water quality in U.S. navigable water through the Clean Water Act. Consequently, some communities find themselves tasked with complying with a consent decree, a court enforced agreement to remediate violations of federal regulations within a period of time or face fines for failure to comply. However, it is not only these communities under consent decrees who must contend with serious water management issues. Flooding and pollutant runoff from pervious surfaces are causing serious issues at the same time water infrastructure across the nation is aging beyond its functional years. Communities across the U.S. are meeting these water challenges by using GI and LID to manage water close to the source. These techniques have proven to be more cost-effective in the long term than traditional “grey” infrastructure, and offer many environmental benefits not delivered by grey infrastructure, such as better maintaining the integrity of existing hydrological functions and aesthetic value.

GI and LID can be incorporated into redevelopment on a brownfield, but measures must be taken to ensure pollutants on site do not spread. There are a wide variety of cleanup and mitigation practices that developers use to remediate brownfields. Listed below are some common approaches to remediation. These should be carefully considered in consultation with state brownfields programs to ensure the most effective and environmentally friendly practice is used for the site. Under the right circumstances, these techniques can be used in combination with GI and LID:

- **Capping** is a strategy for brownfield redevelopment where soil, concrete, or another medium is used to cover contaminants. This preventive measure keeps contaminants from spreading within the soil or leaching into groundwater. This technique is very cost effective since it does not require the removal or treatment of soil. Capping can be creatively integrated into site design; for example, in a park the cap may be a road, parking lot, berm, or tennis court. Capping with a building allows using a green roof to facilitate evapotranspiration. The water is stored in the soil on the roof until it evaporates and so does not carry pollutants into the ground water.

Generally, the downside of capping is that capping increases the amount of impervious surface present on a site, an outcome typically avoided in sites attempting to employ LID practices (De Sousa, 2003).

- **Dig and dump** off-site disposal of pollutants is also used for brownfields cleanup. The contaminated soil, which cannot be treated, is simply removed and taken to a facility certified to receive contaminated soils.
- **Monitoring and isolation** is used where the dangers posed by contaminants are low enough that the contaminants can be left on the site as long as monitoring continues.
- **Bioremediation** improves the ability of natural processes to increase the rate at which natural processes break down contaminants present on site. Depending on the particulars of the site this may be done on-site or the contaminated soil might need to be taken to a different location for remediation (U.S. Environmental Protection Agency [EPA], 2001).
- **X-ray florescent technology** allows contamination to be located on a brownfield (De Sousa, 2002). The technology causes contaminated soil to stand out from clean soil. This is useful to minimize the amount of non-contaminated fill removed by differentiating between clean soil and soil that requires treatment (Martin, 2006).
- **Phytoremediation** uses strategic plantings to remove petroleum hydrocarbons, benzene, and heavy metals, the most common contaminants in urban brownfields. This treatment method is an attractive and cost-effective alternative employing hybrid poplars, willows, grasses, and reeds to deposit plant materials that rebuild soil structure without disturbing the soil. This approach is process based, taking years or decades to completely remove contaminants. Green infrastructure principles can be used with phytoremediation to create the framework for future development on a site. This approach is well-suited for passive recreational uses such as incorporation into a pedestrian system within a city (Sleegers, 2010).

# Potential for GI and LID on Brownfields Sites

The appropriateness of GI or LID practices for a particular brownfield site depends heavily on the level of contamination present (EPA, 2008). Choosing an appropriate technique depends on a thorough site evaluation to determine which contaminants are present and where they are located. Developers should also be cognizant of where their development is located in relation to watersheds. For example, LID practices that allow infiltration should not be used in groundwater recharge areas where chemicals are likely to infiltrate into groundwater. The type of soil present on the site is also relevant to deciding what technique works best. For example, clay soils may mean infiltration techniques are not appropriate and practices that allow evaporation should be used instead.

EPA (2008) offers four general guidelines for using GI on brownfield sites:

- Distinguish different groups of contaminants to minimize risks.
- Keep clean stormwater separated from contaminated soils and water so clean water is not contaminated.
- Keep existing trees and use structural practices like swales or sediment basins to prevent erosion with vegetation.
- Use measures to minimize runoff on all new development within and adjacent to a brownfield such as green roofs, green walls, large trees, and rainwater cisterns.

The key to the usage of GI on brownfield sites is the treatment and capture of stormwater rather than allowing the water to infiltrate into the soil as on an uncontaminated site (EPA, 2008). This sometimes means locating vegetated areas above capped contaminated soils to prevent contaminants from being transported by rainwater.

The following are two LID approaches used successfully on brownfield sites:

- Impermeable liners or gravel filter blankets coupled with traditional LID methods, such as a retention pond, are used to allow water to infiltrate without being exposed to contaminated soils. The water infiltrates into the water table without carrying contaminants into the groundwater.
- The potential for rainwater harvesting is present on many sites. It is important to remember on these sites that it is cheaper to start with the system than to retrofit. Tanks, sized to balance supply and demand as estimated for uses of the water, are installed on the site. Water collected from stormwater can be used to water landscaping or

gardens, flush toilets, or other non-potable uses. Water treated with filter strips and ultraviolet lights can be used. Developers earn LEED points for a development that makes use of these techniques.

For some brownfields that are too small to be attractive for redevelopment, a community may decide to turn the brownfield into a public space (Hirschhorn, 2002), such as a pocket park, to create green space in dense areas. These sites are suited for GI with capping and other techniques, perhaps allowing the parks to incorporate recreational areas such as basketball or tennis courts. Federally-funded programs that target projects that promote better health are potential funding sources for these projects. In many cities with waterfronts, brownfield sites that once took advantage of rivers for industrial productivity are being turned into waterfront parks. Many of these larger parks presented the opportunity for a community to improve public amenities and capture potential improvement in water management by including LID or GI components to manage water on site. Examples include using stormwater retention tanks that provide water to sprinklers or rain gardens to handle runoff from hardscaped areas.

For a private developer interested in using GI and LID practices, an initial step would be checking with their local government to see what incentives are offered and ask how to dovetail the incentives. For example, Louisville (KY) Metro Government offers a five-year tax moratorium for redeveloped commercial properties at least 25 years old, favorable loans for façade improvement, and various other incentives that may apply to brownfield redevelopments (Louisville Metro Government, n.d.). New York City, which offered the first local brownfield cleanup program, offers technical assistance and financial incentives including the NYC Brownfield Incentive Grant (NYC Mayor's Office of Environmental Remediation, 2010).

Developers should also check with local sewer district for incentives for the use of GI and LID on site. Many developers will find some effort is being made in their community to support these practices.

# Funding Sources

Funding sources for brownfield redevelopment can be used to supplement typical GI and LID resources. Since development of brownfields may require processes that would not be required for a greenfield site, additional costs may be incurred up front. Because of issues with liability under CERCLA, banks have historically been reluctant to loan money for the development of brownfield sites since this could incur liability for the bank (Davis and Shermann, 2010). However, there are ways a brownfields developer can leverage sources of funding not specifically designed for brownfield redevelopment. These potentials increase when GI or LID becomes a part of the site plan. It is also important to remember that even though a brownfield has difficult issues to address before redevelopment can be a success, development incentives offered by the federal, state, or local government are not precluded by the presence of contamination.

Brownfield financing methods are reviewed in University of Louisville Environmental Finance Center's *Practice Guide #10 Brownfield Redevelopment: Make it Possible!*. These methods include:

- **Tax Increment Financing** (TIF): Cities often use TIF to pay for the development of large projects, but this source of funding is commonly neglected for brownfield sites. This option could be ideal as the presence of a brownfield greatly reduces the land value in the surrounding area. This creates the potential for capturing a large increase in tax revenue to pay back the project (Opp, 2005).
- **Piggybacking** refers to combining brownfield cleanup efforts with other projects, such as a road improvement project near a brownfield site that includes remediation of the brownfield as part of the process. A city official may find opportunities to piggyback by checking with local and state departments to request a copy of their short- and long-term project plans. The drawback of this approach is the time and creativity required to find appropriate opportunities to piggyback (Opp, 2005).
- **Development swap programs** allow developers to receive lesser taxes or special development considerations in exchange for performing a service to the local or state government. A city may bargain with, for example, impact

fees, income taxes, property taxes, or zoning variances. In Cheektowaga, New York, a hotel developer bargained with the city for a break in income tax from a hotel development in exchange for cleaning up an old steel production site (Opp, 2005).

- **Tax credits** may also be applied to brownfield development to provide funds. The federal Low Income Tax Credit (LIHTC) may be useful since many brownfields are ideal locations for housing. The LIHTC Program allows developers and non-profit entities to access a dollar-for-dollar tax credit over a period of 10 years. This might be particularly useful where the developer is contemplating development of loft apartment spaces. Developers may access these tax credits by setting aside a portion of the properties created for loft space.
- **Historic preservation funds** provided through the federal government may be a solution for governmental or non-profit actors. These grants are provided through the federal government through the Federal Historic Preservation Tax Incentives and the Save America's Treasures program. In older cities, brownfield properties are often located in historical neighborhoods and therefore may qualify for these programs.

Additionally, funding programs at various federal agencies provide opportunities for implementing green infrastructure techniques on brownfield sites. Table 1 summaries some of these.

**Table 1. Federal funding and assistance programs that can support green infrastructure on brownfields**

| Federal agency | Program | Description / Opportunity |
|---|---|---|
| Appalachian Regional Commission (ARC) | Funding assistance | Funds economic development in Appalachian region from New York to northern Alabama; funds could be used for GI components or as part of a comprehensive revitalization strategy. (Bartsch, 2013) |
| Department of Agriculture (USDA) | Rural Utility Service program | Funds water and wastewater infrastructure projects, which may incorporate green infrastructure components. (Bartsch, 2013) |
| USDA | Community Facilities program | Provides loans, grants, and loan guarantees to support hospitals, health clinics, schools, fire houses, community centers, etc.; GI may be integrated into these projects. |
| USDA | Urban and Community Forestry | Funds urban forestry for climate change mitigation, public health improvement, or economic development. The program encourages intergovernmental cooperation, such as with the EPA, and focuses on the use of urban forests as green infrastructure. |
| USDA | Assistance to small water systems | Rural communities with populations lower than 10,000 can apply for water and waste disposal assistance to develop and repair water, sewer, storm sewer, and solid waste systems. |
| Department of Energy (DOE) | Energy Efficiency program | Provides tax incentives for construction investments to offset costs and increase cash flow; GI could be part of these projects. (Bartsch, 2013) |
| Department of Housing and Urban Development (HUD) | Community Development Block Grant (CDBG) program | Brownfield redevelopment projects are eligible uses of CDBG funds. Within the CDBG program are a number of underused programs such as Section 108 loans, Brownfield Economic Development Initiative (BEDI), and Float loans [1](Opp, 2005). |
| Department of the Interior (DOI) | Technical assistance | Helps communities conserve rivers and open space or developing trails and greenways. Assistance could be |

[1] Float loans can be used to fund alternative activities assuming revenue generated by these activities will generate the funds needed to repay these loans (U.S. Department of Housing and Urban Development 2007).

| | | |
|---|---|---|
| | | used to improve capacity to encourage GI into projects. (Bartsch, 2013) |
| Department of Transportation (DOT) | Federal Highway Enhancement Activities program | Intended to expand transportation choices, including pedestrian, and bicycle facilities. Landscaping, scenic beautification, and environmental mitigation of highway runoff are approved activities for use in projects. GI can be included in projects as the technique for managing runoff. Rain gardens and bioswales could also be part of a project landscaping plan. (Bartsch, 2013) |
| DOT | Weatherization grants | Provides technical assistance and financial support for projects that improve energy efficiency. This program could be used to support GI as part of weatherization, including installing a green roof for building temperature control. |
| DOT | Accountable, Flexible, and Efficient Transportation Act: A Legacy for Users (SAFETEA-LU) | Legislation that can be used to provide state and federal dollars to establish transportation infrastructure for private or public borrowers (Hawkins, 2012). |
| Economic Development Administration (EDA) | Public Works program | Provides grants and support that can be used to facilitate the use of GI in new facility construction or modernization, especially in distressed communities. (Bartsch, 2013) |
| EDA | EDA's Rural Planning grants | Supports community and regional planning activities to promote economic development. GI could be included as a component of a plan. |
| Environmental Protection Agency (EPA) | Green Infrastructure clearinghouse website | Comprehensive source for tools and information on green infrastructure, including up-to-date information about GI financing. |
| National Oceanic and Atmospheric Administration (NOAA) | Habitat conservation, coastal, and wetlands programs | Provides funds and technical assistance that may be used to integrate GI into a project related to wetlands or waterfronts. Communities should stress the importance of GI for preserving and improving waterfronts and the need to encourage inclusion of GI in restoration efforts (Bartsch, 2013). |

For more information about funding GI in a community, see *Tool Box Approach to Wet Growth Module 3: Green Infrastructure*.

# Case Studies

**Cumberland Park, Nashville, TN**

The Nashville Waterfront redevelopment is an example of successful brownfield remediation using GI. The site was left contaminated by a series of heavy industrial uses over the past century. Multiple industries, including barge building, logging, sand companies, and war ship manufacturing left widespread pollutants on the site, including lead and polycyclic aromatic hydrocarbons (PAHs). The city determined to develop the site as a park based on the sense that downtown use of the river as the major site of industry was over. Like other cities, Nashville decided the highest use of the site would be as a 24-hour work, live, and play amenity. This goal became a part of Nashville's master plan to redevelop both sides of the river for public uses, which the city has been working on for the past five years.

The site of Nashville's Cumberland Park was the first proposed in Nashville to take a brownfield site and a four-acre asphalt parking lot and convert it to a park with green infrastructure. The park, which opened in April 2012, has not only reduced the load of on-site pollutants to a safe level for use as a park, but it also offers green infrastructure as an interesting environmental feature. Water runoff from the park site, adjacent football stadium parking lots, and from two adjacent bridges is diverted into a 100,000-gallon holding tank. The water from this tank is captured and re-used for irrigation water for the landscaping, grass and trees in the park. This is estimated to save over a million gallons of water a year. To further the goal of saving water and making the park sustainable, the park is also planted with draught tolerant, non-invasive plants that have some durability in hot southern summers.

The city used a combination of funds to develop the site. The site was tested for contaminants through a brownfield assessment that was financed by a grant through a partnership of EPA, the U.S. Army Corps of Engineers and the Tennessee Local Department of the Environment and Conservation. As partners, these organizations worked from the onset of the project to determine how to remediate this site. This approach proved more effective than the more traditional after-design review because it allowed all parties to work together on creative ways to design the park to meet both the recreational and remediation project goals and in a way that did not require costly changes after development.


(above) **A view of Cumberland park.** *Photo: Hargreaves Associates*
(below) **Cumberland Park aerial view.** *Photo: Aerial Innovations.*

While no figures are available for calculating exactly what the price differential is between developing the site with grey infrastructure and GI, there is good reason to believe that while some of the environmentally-friendly practices on the site were more costly on the front-end, these features are expected to save money in the long run. Those involved, however, wanted to take the significance of the site into account during the design process. It was important that no toxins on the site seep into the Cumberland River, especially since the river provides drinking water for the city. The developers also wanted to convey the historical significance of the waterfront while offering an attractive park available to everyone. Project planners believe the features offer a net benefit to the city. In fact, Chris Koster, the city project manager for the park, argues that the sorts of environmental features used on the site, such as the water re-use, retention basin, and LED lights, are features people expect to be incorporated into the place where they live and work. As these features become more widely used by the public and private sector, the costs are gradually decreasing (C. Koster, personal communication, November 19, 2012).

Since this was the first of the parks to be developed as part of a riverfront master plan's goal to increase recreational space in Nashville, the city wanted to set a high bar for design standards and a sustainability baseline for future design developments. Koster saw the park as a unique opportunity. It was funded with public money and intended to be a park that is free and open to the public. The intention is to allow people to come and play all year round and enjoy being near the Cumberland River. The park, in addition to its obvious recreational value, tells a story: the site was once a brownfield and impervious asphalt parking lot, but now is a carefully designed public space with features that protect the river while creating a great place for residents of all ages to play. Koster explained, "By taking on such a complex project, and turning it into a beautiful park space, you are demonstrating what is possible. Every time someone visits the park we show what can be done with unused and potentially impacted lands. We can make these sites places that are safe and fun for everyone" (C. Koster, personal communication, November 19, 2012).[2]

**The Green Learning Station at the Civic Garden Center, Cincinnati, OH**

The Green Learning Station (GLS), while on a site never formally designated a brownfield, is carefully designed to allow infiltration without causing contaminants to leech into ground water. GLS is located on the site of a former service station. Leaking gas from large storage tanks removed from the site before redevelopment and spilled oil from the service station resulted in contamination. The area where the tanks had been was refilled with sand and chunks of concrete, resulting in the added expense of rehabilitating the improper fill area to support the Learning Station's foundation.

The Cincinnati Metropolitan Sewer District (MSD), faced with a need to lessen loads on municipal combined sewer operations, partially funded the project both as a way to reduce water directed from the site into the sewer and to educate community members about using GI to reduce infrastructure demands on the city. Since the site had never been officially designated a brownfield, GLS did not work with either state- or federal-level environmental agencies, but instead worked with MSD to develop a cleanup plan. According to GLS project manager Ryan Mooney-Bullock, MSD was "clear and particular" about ways to avoid allowing runoff from the site to infiltrate into groundwater (R. Mooney-Bullock, personal communication, January 22, 2012). Adding to the challenge of keeping contamination out of the water, the soil on the site is heavy clay, which complicates uses of common infiltration practices used more easily on looser soils that drain water more quickly.


**The Green Learning Station**. *Photo: Chuck Lohre*

Runoff at the GLS is managed on-site through six types of pervious pavements, a 2,500 gallon rain harvesting tank, a rain garden, a bioswale at the perimeter of the property, and four types of green roofs on this 18,400 square foot site. Monitoring technology is incorporated into some features to measure water quantity and temperature passing through some of these features. For example, pervious pavers allow infiltration into deep gravel beds lined with a plastic sheet that directs the water through monitoring equipment into a bioswale. This data from GLS monitors is coupled with weather station data to generate information about the dynamics of water-flow through the site. This feature is designed in such a way that in the future, water could be stored in the gravel beds for irrigation use on site.

Mooney-Bullock said that GI is "a more attractive solution for stormwater management and infiltration." She explained that while educating people about GI practices at GLS, the sustainable practices help visitors consider what happens to water after it falls on a developed site, and why it should be a consideration on all sites. Additionally it proves that sustainable water practices can be adapted even to heavy clay soils (R. Mooney-Bullock, personal communication, January 22, 2012).

**<u>Rome, NY</u>**

Rome, New York, a city with a population of 35,000 people, is turning 500 acres of abandoned brownfield properties into an opportunity to reconnect the downtown with the Eerie Canal (Mercurio, 2013). This area had been abandoned since the 1950s, when industrial activity moved away from the canal as trucks replaced the canal for cargo transit (Spiotta, 2011). A key parcel in the redevelopment effort is former General Cable Complex, a wire rope manufacturing plant

---

2 *Chris Koster is the Special Projects Manager for Riverfront, City of Nashville, TN. To contact, email him at Chris.Koster@Nashville.gov.*

occupying 17 acres.  The site included several abandoned buildings, extensive impervious cover, and a high level of hazardous material contamination.  Today, the site is occupied by American Alloy Steel, which operates a 58,000 square foot, clean manufacturing facility.  100 percent of the site's stormwater is safely filtered and managed by green infrastructure practices without adding water to combined sewer overflow facilities.

Transformation of the site began in 1996, when Rome was awarded a US EPA Brownfield Pilot Program grant.  Initial site investigation revealed contamination needing remediation.  Initially the city used some limited remedial measures of heavily contaminated soil in hot spots.  It then joined the New York Department of Environmental Conservation Voluntary Clean-up Program, which lasted several years and involved the remediation of some point sources of pollution as well as the removal of storage tanks from the site.  Hot spots of contamination were further remediated.  Through cooperation with the NY Voluntary Clean-up Program, current and future site owners were indemnified from liability.  A 2007 New York State Economic Development grant was used to remove a significant amount of infrastructure left from previous uses. This allowed American Allow Steal to begin operations on site.

Attention shifted in 2010 to another portion of the site where dilapidated buildings were torn down for sub-structure investigation.   Seventeen acres of concrete, as deep as six feet in places, had to be removed.  Hundreds of thousands of pounds of soil had to be removed from the site that had been previously overlooked for contaminants.  This excavation process is an important part of run-off mitigation since all the water on site was previously straight piped directly into the canal.

In total, 150,000 gallons of above ground storage tanks were removed from the site.  Asbestos contamination was abated, an oil sump was cleaned out, and storm drains were remediated.  Seven thousand gallons of petroleum-impacted wastewater was removed from aboveground storage tanks and over two thousand tons of petroleum-impacted soil, dug to a depth of 20 feet in places, was dumped off-site.  Seven acres of concrete was crushed to make foundations for buildings.  Site cleanup took a total of fifteen years.

Chris Mercurio, Deputy Director of City of Rome Community and Economic Development Department, says that the cleanup and redevelopment process depended on hard work from many partners, all of whom were critical to the success of the project.  These key partners included US EPA, NY Department of Environmental Conservation, the Environmental Facilities Corporation (which typically finances sewer water, clean water, and drinking water infrastructure and sets aside a certain amount of money for innovative projects downtown), the New York State Canal Corporation, and the New York Department of State.  Mercurio calls the project a “study in partnerships" and credits the cooperation between organizations with making the project a success.  Three agencies and public bonding provided the $1.5 million in financing needed for the undertaking.

Throughout the cleanup and redevelopment process, concerted effort was made to manage all the water falling on the site.  Green infrastructure works side-by-side with traditional site design to maintain the site in compliance with brownfields regulation.  Structures, driving lanes, and parking are placed over portions of the site that are potentially contaminated hot spots.  These structures direct runoff to an extensive network of bioswales landscaped with plant species that help sequester contaminants.  Even with extensive remediation of the site, it is still encumbered with institutional controls.  The site may only be used for industrial and commercial uses.  Groundwater may not be pumped. Engineering controls require existing 6-12 inch concrete caps.  For a city that wants to make the waterfront more accessible, ensuring that water pumped into the canal is clean is a major priority.

As part of the US EPA Brownfield Opportunity Area Program, the project is designed to extend the focus of redevelopment beyond the site to the entire area it impacts.  Redevelopment of the site is the first step in Rome's larger plan to spark development in the economically challenged surrounding area, which links the Eerie Canal to downtown. Using innovative controls on the site are important to encourage surrounding land owners to develop their properties with similar practices.

This plan has already shown evidence of success.  A company that manufactures nuclear power plant cooling systems was recruited and located on a site across the canal.  It includes a 22,000 square foot facility with a campus that is also installing green infrastructure features.  Mercurio says, “Just the idea of this happening has already generated momentum.”  He points out that green infrastructure principles have significantly changed how people think about green development.  Mercurio challenges other communities, pointing out that with 30,000 people and a median income of $38,000, Rome's efforts at the former General Cable Complex is proof that green infrastructure is a worthwhile investment.

**Genetta Stream Restoration, Montgomery, AL**

Montgomery, Alabama, has restored miles of an urban stream and turned an industrial eyesore into an attractive environmental amenity (Langham and Wilkerson, 2013). Genetta Stream travels about five miles from downtown Montgomery to Catoma Creek located at the intersection of US HWY 80 and Interstate 65. In 1978, roughly half a mile of the stream's length was converted into a concrete channel when Interstate 65 was constructed. The negative effects of stream channelization are well documented and include increased flooding downstream of the channel, impaired water quality, reduced stream biodiversity, and reduced groundwater recharge (US E.P.A. Region 7, 2005).

After 50 years of stream degradation, the City of Montgomery established a project to daylight Genetta stream, which was formerly known by the city as Genetta Ditch, and restore hydrological functions as much as possible after recommendations from Judd Langham and Bob Wikerson, architects at 2D Studio, LLC who played a major role as project consultants. It would not be an easy project, in part because it was discovered early in the project that the stream flowed through a site heavily contaminated by a former windshield manufacturing plant. Nevertheless, local leaders felt this represented an ideal opportunity to launch a broader beautification effort in this historically significant area. The stream lies in the path of the Selma-to-Montgomery Civil Rights March and is located near Rosa Park's residence, St. Jude Educational Institute, and Mt. Zion Church, the last camp site for the 1965 Voter's Rights March. The impoverished area suffered from years of neglect and had long been overlooked for development. Restoring Genetta Stream would demonstrate the city's commitment to revitalizing this neighborhood. In addition to restoring the waterway, project leaders were committed to reducing non-point source pollutants through green infrastructure improvements. This element was important to Montgomery, due to a growing interest within the city to advance sustainability.

The first stage of the project was the construction of a wetland. This was done by retrofitting a portion of the existing box culvert system, consisting of three side-by-side, 14-by-14 foot culverts; this allows the first flush of storm water from a 10-year rain event to be diverted. This had to be carefully designed since the 4-acre site would have to handle very large amounts of stormwater during larger rain events. Hardy drought resistant plants were selected to withstand both standing water during heavy rains and little water during the hot, dry summer months. These plants were also chosen for their ability to absorb pollutants from diverted water.

Significant remediation of the site had to be done before construction could begin, because of brownfield contamination. The abandoned windshield manufacturing plant left behind petroleum, hydraulic fuels, and asphalt parking lots that covered a large portion of the site. Initial plans called for reuse of onsite concrete, but levels of contamination from the brownfield meant most of the materials slated for reuse could not be used. As the concept evolved, a third of the existing wetland on the site had to be excavated to remediate pollutants.

Another design constraint was the limited area available for wetland restoration. Land used for residential development and the interstate left just over an acre for wetland construction. This small parcel would have to accommodate the base flow from a 10-year storm event without flooding into other areas. This was achieved by the creation of weirs and pools. Weirs, much like dams, restrict the flow of stormwater. As the water level rises, water flows through a series of pools, in a process similar to a natural stream meander system that would maximize water retention time. Since completion, wildlife has already been seen on the site including a native crane species and a fish that already lives in the wetland.

Phase two of the project – currently underway – is a green infrastructure demonstration project. In this phase, an outdoor educational facility is planned to provide an opportunity for local schools to hold outside educational programs and for other groups to host events on the site. The design calls for permeable surfaces with water infiltrated through various planters. During this phase, a smaller version of the phase one wetland will be constructed. These highly visible features demonstrate the usage of green infrastructure in a dense urban setting while also providing a much needed park amenity for neighborhood residents. The park will also connect the downtown to neighborhoods with a future greenway slated to be built through the park.

Phase three will naturalize the half-mile of culverted stream downstream from the park area. This process originally called for restoration of the natural meandering process. The idea behind this was to restore the natural ability of the stream to dissipate runoff energy and attenuate pollution to the greatest degree possible. Naturalization also restores connection to the floodplain to increase groundwater recharge. Designers planned this phase of the project to demonstrate design and construction techniques applicable to other urban stormwater systems.

The project extends into several smaller streams that enter the main channel, all of which are also conveyed through concrete channels. Water samples from these smaller streams indicate high fecal counts, suggesting problems with sanitary systems along the course of the stream system. At the end of the main branch of the stream, the increased velocity of the stream has resulted in three feet of entrenchment where the concrete meets the natural stream bed. In total, the watershed draining into the stream is seven to eight acres of highly developed urban land with significant nonpoint source pollution runoff and frequent flash floods. The major design constraint was the necessity of moving water away from these highly developed areas without causing flooding.

Designers conducted extensive modeling of the stream's hydrology to meet this challenge. They discovered during this process that the original concept calling for the creation of a meander system to control the water was not practical. The final design instead spreads the three feet of elevation change over the entire length of the project and creates a series of cesspools. Water is diverted through a series of cross-veins to create a flow that is similar to a meander system. The design will also open up a floodplain to the east. These designs allow for more natural hydrological functions which in turn reduces flood risk. Models demonstrate the project will result in a sustainable habitat for indicator species in the stream.

The final phase will mitigate the downstream impact of the modified steam on unmodified portion of the channel. This phase makes use of abandoned water treatment lagoons along the unmodified portion to create wetlands complexes to connect the stream with the floodplain. Eventually, a greenway will be placed through the restored system to further increase educational opportunities.

Over two million dollars was secured to fund the project through the Alabama Department of Environmental Management Section 319 Stream Restoration Program. Alabama's Clean Water State Revolving Fund contributed a grant to the city from unused 2012 funding. The project was carried out as a partnership between the City of Montgomery, Alabama Department of Environmental Management, the Alabama Clean Water Partnership, Alabama Department of Transportation, the U.S. Environmental Protection Agency, the U.S. Army Corps of Engineers, and community based organization All Collaborating to Succeed Community Development Corporation.

The location of the project plays a major role in demonstrating the benefits of green infrastructure as an alternative to traditional hard-engineered stormwater systems. Project leaders hope that visitors to Alabama's state capital will see the project and take its innovative green design ideas back to communities in the rest of the state.

# Additional Resources

Case studies focusing on the use of GI on compacted or contaminated soils: http://www.epa.gov/brownfields/tools/swcs0408.pdf.

Resources on a wide range of stormwater management practices: http://louisville.edu/cepm/hud-sustainable-communities-capacity-building.html.

Resources on sustainable brownfield remediation: http://www.epa.gov/brownfields/.

Local regulations to increase GI usage: *Tool-Box Approach to Wet Growth: Module 3, Green Infrastructure.*

# References

Arnold, C. A., Norton, C. & Wallen, D. (2009). *Kentucky Wet Growth Guide.* Retrieved January 22, 2013 from http://louisville.edu/landuse/healthy watersheds-land-use-initiative.html

Bartsch, C. 2013. *Green Infrastructure on Brownfields 2-20-13* [recorded webinar]. Retrieved 2/28/2013 from http://vimeo.com/60246205.

Davis, T.S, & Sherman, S. A. (2010). *Brownfields: A Comprehensive Guide to Redeveloping Contaminated Property* (3rd ed.) Chicago, IL: ABA Publishing.

De Sousa, C. (2003). Turning brownfields into green space in the City of Toronto. *Landscape and Urban Planning*, 62, 181-198.

Green, E. A. (2003-2004). The rustbelt and the revitalization of Detroit: a commentary and criticism of Michigan brownfield development legislation. *Journal of Law in Society*, 5, 572-615.

Hawkins, A., Myers, D., Eberenz, J., Smith, J., Quinn, J., Calvo, L. … Fenwick, R. (2012). *Tool-Box Approach to Wet Growth.* Retrieved February 18, 2013 from http://louisville.edu/cepm/hud-sustainable-communities-capacity-building.html

Hirschhorn, J.S. (2002). Brownfields Projects to Improve Human Health. Retrieved March 1, 2013 from http://www.nga.org/files/live/sites/NGA/files/pdf/1102BROWNFIELDS.pdf

Louisville Metro Government. (n.d.). Retrieved January 10, 2013 from http://www.louisvilleky.gov/economicdevelopment/businessdevelopment/LoanPrograms.htm.

Martin, J. (2006). XFR marks the spot. *Environmental Protection*. Retrieved February 18, 2013 from http://eponline.com/articles/2006/03/01/xrf-marks-the-spot.aspx

Langham, J and Wilkerson, B. *Green Infrastructure on Brownfields 2-20-13* [recorded webinar]. Retrieved 2/28/2013 from http://vimeo.com/60246205.

Mercurio, C. *Green Infrastructure on Brownfields 2-20-13* [recorded webinar]. Retrieved 2/28/2013 from http://vimeo.com/60246205.

New York Mayor's Office of Environmental Remediation. (2010). New York City Brownfield Cleanup Program: Information for Brownfield Site Owners and Developers. Retrieved February 5, 2013 from http://www.nyc.gov/html/oer/downloads/pdf/NYCBCP/NYC_BCP_Report.pdf.

Opp, S. (2005). *Practice Guide #10 Brownfield Redevelopment: Make it Possible!* Retrieved January 22, 2013 from http://tinyurl.com/cuatxgm .

Opp, S. & Hollis, S. (2005). *Practice Guide #9 Contaminated Properties: History, Regulation, and Resources for Community Members*. Retrieved March 1, 2013 from http://tinyurl.com/cr2pqn4 .

Sleegers, F. (2010) Phytoremediation as green infrastructure and a landscape of experiences. *Proceedings of the Annual International Conference on Soils, Sediments, Water and Energy*, 15 13, 132-140. Available at http://scholarworks.umass.edu/soilsproceedings/vol15/iss1/13

Spiotta, D. (2011). Going for broken. *New York Times* 10 June 2011. Retrieved June 14, 2013 from http://www.nytimes.com/2011/06/12/magazine/the-glorious-ruins-of-the-erie-canal.html?pagewanted=all&_r=0.

U.S. Environmental Protection Agency. (2001). A citizen's guide to bioremediation. Retrieved January 13, 2013from http://www.epa.gov/tio/download/citizens/bioremediation.pdf.

U.S. Environmental Protection Agency Region 7. (2005). Stream channelization. Retrieved April 13, 2013 from http://www.epa.gov/region07/wetlands/pdf/ChannelizationFS04-Final.pdf.

U.S. Environmental Protection Agency. (2008). Design principles for stormwater management on compacted, contaminated soils in dense urban areas. Retrieved March 10, 2013 from http://www.epa.gov/brownfields/tools/swdp0408.pdf.

U.S. Environmental Protection Agency. (2010). Green remediation best practices: bioremediation. Retrieved January 21, 2013 from http://www.clu-in.org/greenremediation/docs/GR_factsheet_biorem_32410.pdf

U.S. Department of Housing and Urban Development (HUD). (2007). Basically CDBG. Retrieved March 26, 2013 from http://portal.hud.gov/hudportal/documents/huddoc?id=DOC_16480.pdf .