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Sustainable Water Management on Brownfields Sites

by

Ryan Fenwick

University of Louisville

Center for Environmental Policy and Management

Environmental Finance Center: Serving EPA Region 4

University of Louisville

Department of Sociology

Louisville, KY 40292

502-852-8042

http://louisville.edu/cepm

UNIVERSITY OF LOUISVILLE

CENTER FOR ENVIRONMENTAL POLICY & MANAGEMENT

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Contents

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 vent 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 20th 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 their potentially contaminated site 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 brownfields 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 contaminates. This preventive measure keeps contaminates 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 contaminates 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:

1. Distinguish different groups of contaminants to minimize risks.
2. Keep clean stormwater separated from contaminated soils and water so clean water is not contaminated.
3. Keep existing trees and use structural practices like swales or sediment basins to prevent erosion with vegetation.
4. 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 contaminates 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.

Sources of Funding

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.

There are many methods to finance brownfields and some of these are discussed in *Practice Guide* *#10 Brownfield Redevelopment: Make it Possible!* For example, cities often use Tax Increment Financing (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', in the context of brownfields development, 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).

The U.S. Department of Housing and Urban Development (HUD) Community Development Block Grants (CDBG) may provide a useful source of funds as 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).

The U.S. Department of Agriculture (USDA) offers the Rural Utility Service program for water infrastructure and waste projects (Bartsch, 2013). GI may be included as a component of a utility project. USDA also offers the

[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 (HUD), 2007)

Community Facilities program, another source of funding targeting rural communities (U.S. Department of Agriculture [USDA], 2013). Projects funded through Community Facilities loans, grants, and loan guarantees include hospitals, health clinics, schools, fire houses, and community centers.

GI could be incorporated as part of project development (Bartsch, 2013). Urban and Community Forestry is a matching grant program offered by USDA to encourage 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. Rural communities with populations lower than 10,000 can apply for Water and Waste Disposal to develop and repair water, sewer, storm sewer, and solid waste systems.

The Department of Transportation (DOT) Federal Highway Enhancement Activities program is intended to expand transportation choices including pedestrian, and bicycle facilities (Bartsch, 2013). 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 be part of a project landscaping plan. A DOT Weatherization Grant 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.

The U.S. Department of Energy gives tax incentives through the Energy Efficiency program to construction investments to offset costs and increase cash flow (Bartsch, 2013). GI could be used as a part of a larger project receiving these incentives.

The U.S. 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 (Bartsch, 2013). The program targets distressed communities. EDA's Rural Planning grant supports community and regional planning activities to promote economic development. This could be used to promote the use of GI as a component of a plan.

The Appalachian Regional Commission (ARC) 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).

The National Oceanic and Atmospheric Administration (NOAA) funds or technical assistance may help integrate GI into a project related to wetlands or waterfronts through their habitat conservation, coastal, or wetlands programs.

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).

The Department of the Interior offers technical assistance to communities interested in conserving rivers and open space or developing trails and greenways. Assistance could be used to improve capacity to encourage GI into projects (Bartsch, 2013).

A *development swap program* allows a developer 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. For a more detailed description of these financing methods, see *Practice Guide #10 Brownfield Redevelopment: Make it Possible!*

For communities interested in instituting LID on brownfield sites there is a wide range of possibilities. The DOT's Safe, Accountable, Flexible, and Efficient Transportation Act: A Legacy for Users (SAFETEA-LU) can be used to provide state and federal dollars to establish transportation infrastructure for private or public borrowers (Hawkins, 2012). EPA maintains dedicated centers for assisting in the process of finding funding needed for a GI project and up-to-date information about GI financing data and tools. Bonds may be sold for the instillation of GI in much the same way as used for traditional infrastructure projects (Sheesley, 2012). Additionally, EPA offers a variety of loans for rural, urban and tribal governing bodies including the Revolving Loan Fund. EPA may fund or assist a brownfield site assessment, a cleanup. For more information about financing GI within a community see *Tool Box Approach to Wet Growth Module 3: Green Infrastructure*.

Case Studies

Nashville Waterfront 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. Elevated levels of lead and polycyclic aromatic hydrocarbons (PAH's) were found. The city was 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.

Cumberland Park aerial view. *Photo: Aerial Innovations.*

The site of Nashville's waterfront park, now called 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. Today, 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 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.

A view of Cumberland park. *Photo: Hargreaves Associates*

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]

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

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 Green Learning Station. *Photo: Chuck Lohre*

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.

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).

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/.

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

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