2012 GREEN INFRASTRUCTURE TECHNICAL ASSISTANCE PROGRAM
Council for Watershed Health
Los Angeles, CA

Green Infrastructure Opportunities and Barriers in the Greater Los Angeles Region

An Evaluation of State and Regional Regulatory Drivers that Influence the Costs and Benefits of Green Infrastructure

Photo: Elmer Avenue residential stormwater retrofits, Los Angeles, CA

AUGUST 2013
EPA 833-R-13-001

About the Green Infrastructure Technical Assistance Program

Stormwater runoff is a major cause of water pollution in urban areas. When rain falls in undeveloped areas, the water is absorbed and filtered by soil and plants. When rain falls on our roofs, streets, and parking lots, however, the water cannot soak into the ground. In most urban areas, stormwater is drained through engineered collection systems and discharged into nearby waterbodies. The stormwater carries trash, bacteria, heavy metals, and other pollutants from the urban landscape, polluting the receiving waters. Higher flows also can cause erosion and flooding in urban streams, damaging habitat, property, and infrastructure.

Green infrastructure uses vegetation, soils, and natural processes to manage water and create healthier urban environments. At the scale of a city or county, green infrastructure refers to the patchwork of natural areas that provides habitat, flood protection, cleaner air, and cleaner water. At the scale of a neighborhood or site, green infrastructure refers to stormwater management systems that mimic nature by soaking up and storing water. These neighborhood or site-scale green infrastructure approaches are often referred to as *low impact development*.

EPA encourages the use of green infrastructure to help manage stormwater runoff. In April 2011, EPA renewed its commitment to green infrastructure with the release of the *Strategic Agenda to Protect Waters and Build More Livable Communities through Green Infrastructure*. The agenda identifies technical assistance as a key activity that EPA will pursue to accelerate the implementation of green infrastructure.

In February 2012, EPA announced the availability of $950,000 in technical assistance to communities working to overcome common barriers to green infrastructure. EPA received letters of interest from over 150 communities across the country, and selected 17 of these communities to receive technical assistance. Selected communities received assistance with a range of projects aimed at addressing common barriers to green infrastructure, including code review, green infrastructure design, and cost-benefit assessments. The Council for Watershed Health was selected to receive assistance to identify green infrastructure barriers and opportunities in state and regional programs, policies, and regulations and guidance on local code and ordinance evaluations.

For more information, visit *http://water.epa.gov/infrastructure/greeninfrastructure/gi_support.cfm*.

Acknowledgements

Principal USEPA Staff
John Kemmerer, USEPA Region IX
Tamara Mittman, USEPA
Christopher Kloss, USEPA

Community Team
Mike Antos, Council for Watershed Health
Nancy L.C. Steele, Council for Watershed Health
Cathy Chang, Water Replenishment District of Southern California
Michael Gagan, Kindel Gagan
Shelley Luce, Santa Monica Bay Restoration Commission
Caryn Mandelbaum, Environment Now

Consultant Team
Martina Frey, Tetra Tech
Kimberly Brewer, Tetra Tech
Christy Williams, Tetra Tech
Yvana Hrovat, Tetra Tech
Peter Sherman, Tetra Tech

Special thanks to Noah Garrison of the Natural Resources Defense Council for providing comments on the draft report.

Photos used in the report are credited to the U.S. Environmental Protection Agency unless otherwise noted.

This report was developed under EPA Contract No. EP-C-11-009 as part of the 2012 EPA Green Infrastructure Technical Assistance Program.

Contents

Tables

1 Introduction

Green infrastructure can help advance many important environmental and social goals in the Los Angeles Region, including recharging groundwater basins, protecting water quality, greening urban spaces, and mitigating the urban heat island. While many organizations and local governments in the Region share these goals, the adoption of green infrastructure is inhibited by regulatory barriers and by the perception that green infrastructure is less cost effective than *gray infrastructure* (end-of-pipe stormwater treatment systems designed primarily for peak flow reduction and runoff treatment, including ponds, filters, and hydrodynamic devices).

One important regulatory barrier is the inability to receive credit for the groundwater recharge benefits of green infrastructure. In the Los Angeles Region, water rights governing the underlying groundwater basins are tightly controlled through *groundwater adjudications* (court findings that describe the rights and responsibilities of groundwater users). For example, two current adjudications disallow parties who infiltrate stormwater through green infrastructure practices from receiving credit for those inputs and therefore they cannot receive the benefit of increased water supply.

This example adjudication conflicts with the findings of the Los Angeles Basin Water Augmentation Study coordinated by the Council for Watershed Health. The goal of the Los Angeles Basin Water Augmentation Study was to explore the potential to reduce surface water pollution and increase local water supplies through increased urban stormwater infiltration. The early phases of the study monitored the fate and transport of pollutants in runoff by measuring stormwater quality at the surface,

Riverdale Avenue green infrastructure retrofit, Los Angeles, CA as it infiltrates through the soil, and in groundwater. The results of the study showed that stormwater infiltration had no negative impacts on groundwater quality (Los Angeles and San Gabriel Rivers Watershed Council 2010).

Later phases of the study included a feasibility analysis for two groundwater basins in the Water Replenishment District of Southern California to identify the most effective locations for stormwater capture projects to enhance water quality and groundwater recharge. The analysis identified high-priority locations for stormwater capture projects using spatial analyses and several models that considered important siting factors such as geologic conditions, pre-existing contamination, and dewatering, as well as local water quality objectives. This report emphasized the need for a multi-agency approach to water quality and groundwater recharge projects to exploit multiple project benefits and enhance feasibility (Water Replenishment District of Southern California 2012).

To better understand and address the regulatory and perceived cost barriers to green infrastructure, theU.S. Environmental Protection Agency (USEPA) and the Council for Watershed Health conducted a qualitative assessment of state and regional regulations, programs, policies, and plans. This assessment defines the regional regulatory context for green infrastructure by (1) identifying opportunities for meeting multiple regulatory goals and requirements with green infrastructure, and (2) analyzing possible barriers to green infrastructure implementation.

This report is divided into four sections. The first section defines green infrastructure and identifies the most appropriate practices for the Los Angeles Region. The next section discusses the multiple benefits of green infrastructure for water supply, water quality, other environmental benefits, and community livability. The third section presents the results of a review of state and regional regulations, programs, policies, and plans. This section (1) describes how green infrastructure can meet the goals and requirements of multiple state and regional regulations, and (2) analyzes provisions that might complicate green infrastructure implementation. Finally, because the implementation of green infrastructure practices is determined largely by local codes and ordinances, the fourth section describes a process to identify opportunities for and barriers to green infrastructure in local regulations.

2 Green Infrastructure in the Los Angeles Region

Green infrastructure uses vegetation, soils, and natural processes to manage water and create healthier urban environments. At the scale of a city or county, green infrastructure refers to the patchwork of natural areas that provides habitat, flood protection, cleaner air, and cleaner water. At the scale of a neighborhood or site, green infrastructure refers to stormwater management systems that mimic nature by soaking up and storing water. These neighborhood or site-scale green infrastructure approaches are often referred to as *low impact development*.

Most types of green infrastructure that have been implemented nationally are applicable in the Los Angeles Region, assuming modifications based on the local climate. Three local stormwater design manuals were consulted to determine the types of green infrastructure most appropriate for the Los Angeles Region (CASQA 2010; County of Los Angeles Department of Public Works 2009a, 2009b). Based on these manuals, Table 1 lists and defines the green infrastructure practices best suited to the Region. Note that green roofs are not included on the list because many designs would require irrigation to thrive). The USEPA generally does not consider dry wells a green infrastructure practice, but they are included on the list because they offer stormwater volume reduction and groundwater recharge benefits.

Table 1. Green infrastructure practices applicable to the Los Angeles Region

	Green Infrastructure Practice	Description
Vegetated	**Bioretention cells**[a,b]	Also known as rain gardens, bioretention cells are shallow, vegetated basins that collect and absorb runoff from rooftops, sidewalks, and streets. Bioretention mimics natural hydrology by infiltrating and evapotranspiring runoff. Rain gardens are versatile features that can be installed in almost any unpaved space. (Source: USEPA 2012a)
	Bioretention strips/swales[a,b]	Also known as bioswales, bioretention strips are vegetated, mulched, or xeriscaped channels that provide treatment and retention as they move stormwater from one place to another. Vegetated swales slow, infiltrate, and filter stormwater flows. As linear features, vegetated swales are particularly suitable along streets and parking lots. (Source: USEPA 2012a)
	Infiltration basins, swales, and trenches[a,b]	Infiltration trenches are generally larger at their widest surface point than they are deep, and they do not contain any perforated pipes or drain tiles to distribute and/or facilitate subsurface fluid infiltration. (Source: USEPA 2012b)
	Downspout disconnection to a pervious area	Disconnecting downspouts involves rerouting rooftop drainage pipes to drain rainwater to permeable areas instead of the storm sewer, which allows stormwater to infiltrate into the soil. (Source: USEPA 2012a)
	Planter boxes (with infiltration)	Planter boxes are urban rain gardens with vertical walls and open bottoms that collect and absorb runoff from sidewalks, parking lots, and streets. Planter boxes are ideal for space-limited sites in dense urban areas and as a streetscaping element. (Source: USEPA 2012a)
	Constructed wetlands[a,b]	Constructed wetlands use natural processes involving wetland vegetation, soils, and their associated microbial assemblages to assist, at least partially, in treating an effluent or other source water. These systems are engineered and constructed in uplands, outside waters of the United States, unless the water source can serve a significant restoration function to a degraded system. (Source: USEPA 2005)
Non-Vegetated	**Rainwater capture**	Rerouting of rooftop drainage pipes to drain rainwater to rain barrels, cisterns, or underground vaults for storage and reuse. (Source: USEPA 2012a)
	Permeable pavement[b]	Paved surfaces that infiltrate, treat, and/or store rainwater where it falls. Permeable pavements may be constructed from pervious concrete, porous asphalt, permeable interlocking pavers, and several other materials. These pavements are particularly cost effective where land values are high and where flooding is a problem. (Source: USEPA 2012a)
	Dry wells, including underground detention and infiltration facilities/ galleries, and injection wells[b,c]	A well or injection well is a bored, drilled, or driven shaft, or a dug hole, whose depth is greater than its largest surface dimension; an improved sinkhole; or a subsurface fluid distribution system used to discharge fluids underground (40 CFR 144.3). A subset of injection wells are Class V wells, which are typically a shallow on-site disposal system used to place various non-hazardous fluids below the land surface (40 CFR 144.80). A dry well means a well, other than an improved sinkhole or subsurface fluid distribution system, completely above the water table so that its bottom and sides are typically dry except when receiving fluids. (Source: USEPA 2012b)

a. Vegetated with native plant palette including trees, shrubs, and grasses.
b. Includes amended soil where soil is type D.
c. USEPA generally does not consider dry wells a green infrastructure practice. Dry wells are not intended as treatment systems; they reduce stormwater flow rate and volume and help recharge groundwater only.


Downspout disconnection at the High Point development, Seattle, WA

It may not be possible to implement green infrastructure on every parcel due to constraints that may be present on the site. Final Order (R4-2012-0175, NPDES Permit CAS004001), hereafter referred to as the Municipal Stormwater Permit, and related local ordinances and guidelines describe development site characteristics that increase the likelihood that specific green infrastructure techniques may be technically infeasible. According to the Municipal Stormwater Permit, the potential limitations to certain types of green infrastructure, primarily infiltration best management practices (BMPs), include (LARWQCB 2012):

- Infiltration rate of saturated in-situ soils is less than 0.3 inch/hour and it is not feasible to amend the in-situ soils to attain an infiltration rate necessary to achieve reliable performance of infiltration or bioretention BMPs;
- Seasonal high groundwater is within 5–10 feet of the surface;
- Sites within 100 feet of a groundwater well used for drinking water;
- Brownfield development sites where infiltration poses a risk of causing pollutant mobilization;
- Other locations where pollutant mobilization is a documented concern, i.e., at or near properties that are contaminated or store hazardous substances underground;
- Sites with potential geotechnical hazards; and

- Smart growth and infill or redevelopment locations where the density and/or nature of the project would create significant difficulty with complying with the on-site volume retention requirement.

The City of Los Angeles (2012) LID ordinance includes similar potential limitations as those included in the Municipal Stormwater Permit, with an additional requirement to place infiltration BMPs at least 10–25 feet away from buildings and avoiding placement of infiltration BMPs on or near steep slopes.

Detailed geotechnical investigations to confirm infiltration rates or geotechnical hazards can be performed to address potential localized soils issues. If, upon detailed investigation, soils are confirmed to have low infiltration rates, engineered soil can be used with or without underdrains, though an additional volume of stormwater must be treated if underdrains are employed.

Where groundwater contamination is known to occur or for projects near brownfield sites, green infrastructure facilities can be equipped with liners to ensure that localized contamination will not be transported further. This principle can also be applied to sites that are in proximity to a groundwater well. An analysis of the remediated site can identify areas where soil is uncontaminated or contains pollutants that do not pose a risk to groundwater via infiltration; if the site layout is flexible, these areas can be set aside preferentially for green infrastructure practices.

Green streets in Portland, OR (Photo credit: M. Frey)

3 Green Infrastructure Costs and Benefits

Developers and local agencies must balance gray and green infrastructure when developing or redeveloping a property or when installing or replacing stormwater and drainage infrastructure. Traditionally engineered gray infrastructure had been the default choice for decades before low impact development and green infrastructure came to prominence. Now that green technologies have been tested and shown to be successful in a variety of settings both nationally and internationally, developers and agencies are weighing the costs, benefits, and applicability of green infrastructure replacing or supplementing gray infrastructure to determine the best choices for each project. There is a perception that green infrastructure is not as cost-effective as gray infrastructure. If lifecycle costs and the multiple benefits of green infrastructure are considered, however, green infrastructure can be shown to provide more value than gray infrastructure at comparable cost.

Green infrastructure has been shown to be cost-effective when compared with traditional gray infrastructure approaches (see inset box, this page), though it can have higher installation costs for some projects, including potentially in redevelopment and retrofit settings common to the Los Angeles Region. (This is not always the case because of the site-specific nature of infrastructure opportunities and constraints; retrofitting gray infrastructure can also be costly.) Green infrastructure can be integrated into other infrastructure improvement projects to help mitigate costs.

From a life cycle perspective, it is important to compare the long-term costs of maintenance and replacement between green and gray infrastructure. The vegetation characteristic of many green infrastructure practices becomes enhanced as it grows over time, whereas gray infrastructure's engineered materials only deteriorate over the long term. The maintenance required for green infrastructure practices typically does not require heavy equipment or specialized expertise, whereas maintaining gray infrastructure's pipes, forebays, basins, and embankments can be more costly.

Regarding performance, green infrastructure's mix of physical and biological processes can achieve better water quality and quantity management than more traditional stormwater technology provides. These practices restore the hydrologic function of the urban landscape, managing stormwater at its source and reducing or eliminating the need for gray infrastructure. An important objective of green infrastructure is to reduce stormwater runoff volume, which improves water quality by reducing pollutant loads, erosion, and sedimentation; these benefits are well-documented (Table 2). When green infrastructure is employed as part of a larger-scale stormwater management system (i.e., the green infrastructure practices do not retain all of the stormwater generated on site), it reduces the volume of stormwater that requires conveyance and treatment through conventional means (e.g., detention ponds).

Green infrastructure practices can be integrated into existing features of the built environment, including streets, parking lots, and landscaped areas. In terms of accommodating site constraints, green infrastructure can be practical at scales both small (individual parcel) and large (neighborhood/landscape/regional), whereas gray

Resource for Valuing Green Infrastructure Benefits

The Center for Neighborhood Technology's ***The Value of Green Infrastructure: A Guide to Recognizing its Economic, Environmental, and Social Benefits*** provides local municipalities with tool for determining the economic value of green infrastructure by quantifying and determining the value for each green infrastructure benefit (CNT 2010). *http://www.cnt.org/repository/gi-values-guide.pdf* infrastructure is most practical at large scales (ECONorthwest 2011). Site-dispersed green infrastructure practices can be the best option for achieving a minimum level of stormwater management performance in highly urbanized and infill situations where development density is desired and offsite mitigation is not a preferred alternative.

Table 2. Relative water quality improvement, volume reduction, and recharge performance of green infrastructure practices

	Stormwater Quality/Quantity Benefit[a]										
Green Infrastructure Practice	**Bacteria**	**Metals**	**Organics**	**Sediment**	**Pesticides**	**Nutrients**	**Oil and Grease**	**Trash**	**Flow rate**	**Volume reduction**	**Groundwater recharge**
Bioretention cells	●	◗	◗	●	◗	●	◗	●	●	●	●
Bioretention strips/swales	●	◗	◗	●	◗	●	◗	●	●	●	●
Infiltration basins/swales/trenches	●	◗	◗	●	◗	●	◗	●	●	●	●
Planter boxes	●	◗	◗	●	◗	●	◗	●	◗	◗	◗
Constructed wetlands	●	◗	◗	●	◗	◗	●	◗	●	◗	◗
Rainwater capture	◗	◗	◗	●	◗	◗	◗	◗	●	●	●
Permeable pavement	●	◗	◗	●	◗	●	○	○	●	●	●
Dry wells[b]	○	○	○	○	○	○	○	○	●	●	●

a. ● – primary benefit; ◗ – secondary benefit; ○ – little or no benefit

b. USEPA generally does not consider dry wells a green infrastructure practice. Dry wells are not intended as treatment systems; they reduce stormwater flow rate and volume and help recharge groundwater only.

Ancillary to the direct water pollution benefits of green infrastructure, green infrastructure incrementally reduces the cost of TMDL implementation (see Section 4.2.3 for a discussion of Los Angeles Region TMDLs). Where stormwater fees are levied, green infrastructure can reduce the cost to implement the stormwater management program because the amount of stormwater needing treatment regionally is reduced; green infrastructure also reduces pollutant loads in runoff.

The visible, above-ground and accessible qualities of green infrastructure, as opposed to gray infrastructure, provide other benefits, including creating habitat for wildlife, improving air quality, improving aesthetics, and offering recreational opportunities. Table 3 describes some additional benefits of green infrastructure.

Table 3. Additional green infrastructure benefits

Benefit	Description
Reduce irrigation	Green infrastructure in Los Angeles will use native plant species, which will reduce the need for irrigation. This reduces demand for potable and recycled water and the energy consumption and CO_2 emissions associated with treatment and delivery of the water.
Reduce flood risk	Los Angeles has a history of major flood events that have caused significant property damage. Green infrastructure can decrease the severity of flooding by reducing stormwater volume and delaying peak flows.
Improve air quality	Green infrastructure improves air quality by increasing vegetation, specifically trees, that absorb air pollutants, including carbon dioxide (CO_2), nitrogen dioxide (NO_2), ground-level ozone (O_3), sulfur dioxide (SO_2), and particulate matter that is 10 µm or smaller (PM_{10}). In a modeling study, Nowak et al. (2006) estimated total annual removal of those pollutants by U.S. urban trees at 711,000 metric tons, valued at $3.8 billion. Reduced air pollution benefits human health through lowered incidence and severity of respiratory ailments and reduces costs associated with air quality regulation compliance (ECONorthwest 2011).
Reduce greenhouse gases	Green infrastructure's ability to sequester carbon in vegetation can help to meet greenhouse gas emission goals by contributing to a carbon sink.
Mitigate urban heat island	Green infrastructure practices that include trees and other vegetation can reduce the urban heat island effect, which is the phenomenon of urban area temperatures that are several degrees higher than surrounding rural land uses. USEPA (2012) indicates that annual mean air temperature can be 1.8 °F to 5.4 °F higher in urban centers, or up to 22 °F higher in the evening. Tree cover reduces temperatures through shading and evapotranspiration. Reducing urban heat islands through tree planting achieves energy reduction (reduced electricity demand, air pollution emissions from electricity generation) and can reduce the incidence and severity of heat-related illnesses.
Improve property aesthetics	Green infrastructure that includes attractive vegetation can improve property aesthetics, which can translate into increased property values.
Provide habitat for urban wildlife	Vegetated green infrastructure can provide habitat for urban wildlife, particularly birds and insects, even at small scales of implementation.
Offer recreational opportunities	Larger-scale green infrastructure facilities that include public access, such as constructed wetlands, offer recreational opportunities (e.g., fishing, bird-watching).
Improve public health	Some evidence exists that residents' health and well-being are improved by the presence of larger-scale green space that offers recreational opportunities (Stratus Consulting 2009). Riparian area improvements that enhance stream stability can include recreational trails for walking, running, and biking (e.g., the Tujunga Wash Greenway project in Los Angeles). Also, creation of parks, green space, and plaza space into which green infrastructure can be integrated can create gathering spaces for local residents, which fosters social connections.
Improve public safety	Green infrastructure can be used in concert with public safety measures to enhance walkability. Green streets that include curb bump-outs at pedestrian crossings improve pedestrian safety by slowing traffic and decreasing the distance that pedestrians must travel in the roadway.
Educate the public	The visible nature of green infrastructure offers enhanced public education opportunities, especially when signage is used to inform viewers of the features and functions of the various types of facilities (e.g., sign describing the function of a bioretention practice).

Stream stabilization and recreation at the Tujunga Wash Greenway, Los Angeles, CA
(Photo credit: Los Angeles County Department of Public Works)

Signage describes the purpose and functions of a bioretention area, Portland, OR (Photo credit: M. Frey)

4 Defining the Regional Regulatory Context for Green Infrastructure

Green infrastructure and its associated benefits provide opportunities to meet many regulatory objectives that focus on environmental protection and resource conservation. To better understand the regulatory benefits of green infrastructure, a set of state and regional regulations was selected by the project partners for review to determine if green infrastructure met one or more goals or requirements. These regulations also were analyzed to determine whether they posed any limitations or barriers to green infrastructure implementation. Each review below includes a summary of the relevant parts of the regulation and a discussion of green infrastructure considerations.

4.1 State Regulations and Programs

We reviewed four state regulations and initiatives: the Global Warming Solutions Act of 2006 (Assembly Bill 32), Sustainable Communities and Climate Protection Act of 2008 (Senate Bill 375), Water Conservation Act of 2009 (Senate Bill x7-7), and Water Efficient Landscape Ordinance (Assembly Bill 1881).

4.1.1 Global Warming Solutions Act of 2006 (AB 32)

With the Global Warming Solutions Act of 2006,[1] the State requires reporting and verification of statewide greenhouse gas emissions, including setting emission limits to 1990 levels by 2020. The goal of the bill is to reduce global warming impacts (air quality, decreased water supply from reduced snowpack in the Sierra Nevada Mountains, rising sea level, damage to marine ecosystems, and human health impacts—specifically heat-related illness). The focus of AB 32 is to reduce greenhouse gas emissions, to which green infrastructure can contribute through tree planting (shading, evapotranspiration, reducing the urban heat island). Vegetated practices are capable of sequestering more carbon than gray infrastructure through photosynthesis. AB 32 (§ 38561.f) does not require carbon sequestration projects, but such projects are considered voluntary efforts to contribute to the overall greenhouse gas reduction goals of the bill. The bill does not provide a provision for reimbursement by the state to local agencies and school districts for costs associated with implementation, so it is important that greenhouse gas emission reduction efforts provide multiple benefits as part of a larger strategy of environmental improvement. AB 32 does not pose any barriers to green infrastructure, nor does it specifically encourage installation of green infrastructure. A community could implement a city-wide program of urban greening that includes planting trees and installing a network of vegetated stormwater features that would remove carbon dioxide from the atmosphere and have additional ground-level air quality benefits. Additionally, recharging the region's aquifers with treated stormwater would reduce the demand for energy-intensive imported water.

4.1.2 Sustainable Communities and Climate Protection Act of 2008 (SB 375)

The Sustainable Communities and Climate Protection Act of 2008[2] focuses mainly on transit planning, with goals of reducing greenhouse gases and traffic and addressing access to affordable housing. SB 375 neither encourages nor poses barriers to green infrastructure, but it does present opportunities for green infrastructure projects to be integrated into transit and affordable housing projects undertaken to meet the requirements of SB 375. In general, green infrastructure can be incorporated into such

[1] California Health and Safety Code §§38500–38599

[2] California Health and Safety Code §65080, §65400, §65583, §65584, §65587, §65588, §14522, §21061, and §21159

Streetscape improvements that include porous pavement and bioretention, Hermosa Beach, CA

projects without adversely affecting their feasibility or practicality, and they can enhance water quality performance, aesthetics, and livability at the same time.

Section 1(g) mentions walkability as a policy emphasis that could affect transit choices. There are a number of ways that walkability can be improved for new developments, but in the already urbanized setting of the Los Angeles Region, retrofits to existing streetscapes would be necessary to improve pedestrian access and safety. For example, walkability can be improved with streetscape retrofits that widen sidewalks and reduce the distance pedestrians have to travel to cross the street (e.g., curb bumpouts). These types of street improvements can accommodate small-scale green infrastructure practices, specifically tree planter boxes, bioretention areas with low-profile vegetation, permeable pavement, or a combination of the three. The Hermosa Beach Pier Avenue Streetscape Improvement Project is an excellent example of green infrastructure incorporated into a public safety and beautification project.

4.1.3 Water Conservation Act of 2009 (SBx7-7)

The Water Conservation Act of 2009[3] focuses on urban and agricultural water conservation through increased water use efficiency and advancements in overall regional water management. For urban water use, the act specifically requires that water suppliers achieve increases in per capita water use efficiency (but not total water use). Section 10608.16(a) sets forth that "The state shall achieve a 20-percent reduction in urban per capita water use in California on or before December 31, 2020," with an interim target of 10-percent reduction by December 31, 2015. The act references the Water Efficient Landscape Ordinance (see Section 4.1.4) as the water efficiency performance standard that urban water suppliers should assume for irrigated urban landscapes to determine per capita targets (other assumptions are made for indoor water use and non-residential use).

Water conservation requirements would tend to favor drought-tolerant plant palettes for vegetated green infrastructure practices to reduce watering requirements during the establishment period and during periods of excessive heat or extended drought. This could be achieved by choosing native or climate-adapted vegetation for stormwater BMPs that could be sustained without supplemental water.

Bioretention area with low-maintenance plantings and hardscape (Photo credit: M. Frey)

[3] California Water Code §10608 and §§10800–10853

The use of non-vegetated green infrastructure, specifically permeable pavement and downspout disconnection, would not require watering. These practices, in fact, would augment supply compared to the same area of impervious surface because infiltration of stormwater would replenish the groundwater supply.

Rainwater capture in rain barrels, cisterns, and vaults would provide an on-site supply of water for residential or commercial reuse, such as supplemental landscape watering, toilet flushing, or cooling system makeup, which could reduce the demand for potable or recycled water. Rainwater harvesting can be an effective means of reducing water demand even if the amount of stored rainfall meets only a portion of the user's water needs in periods of no or low rainfall.

4.1.4 Water Efficient Landscape Ordinance (AB 1881)

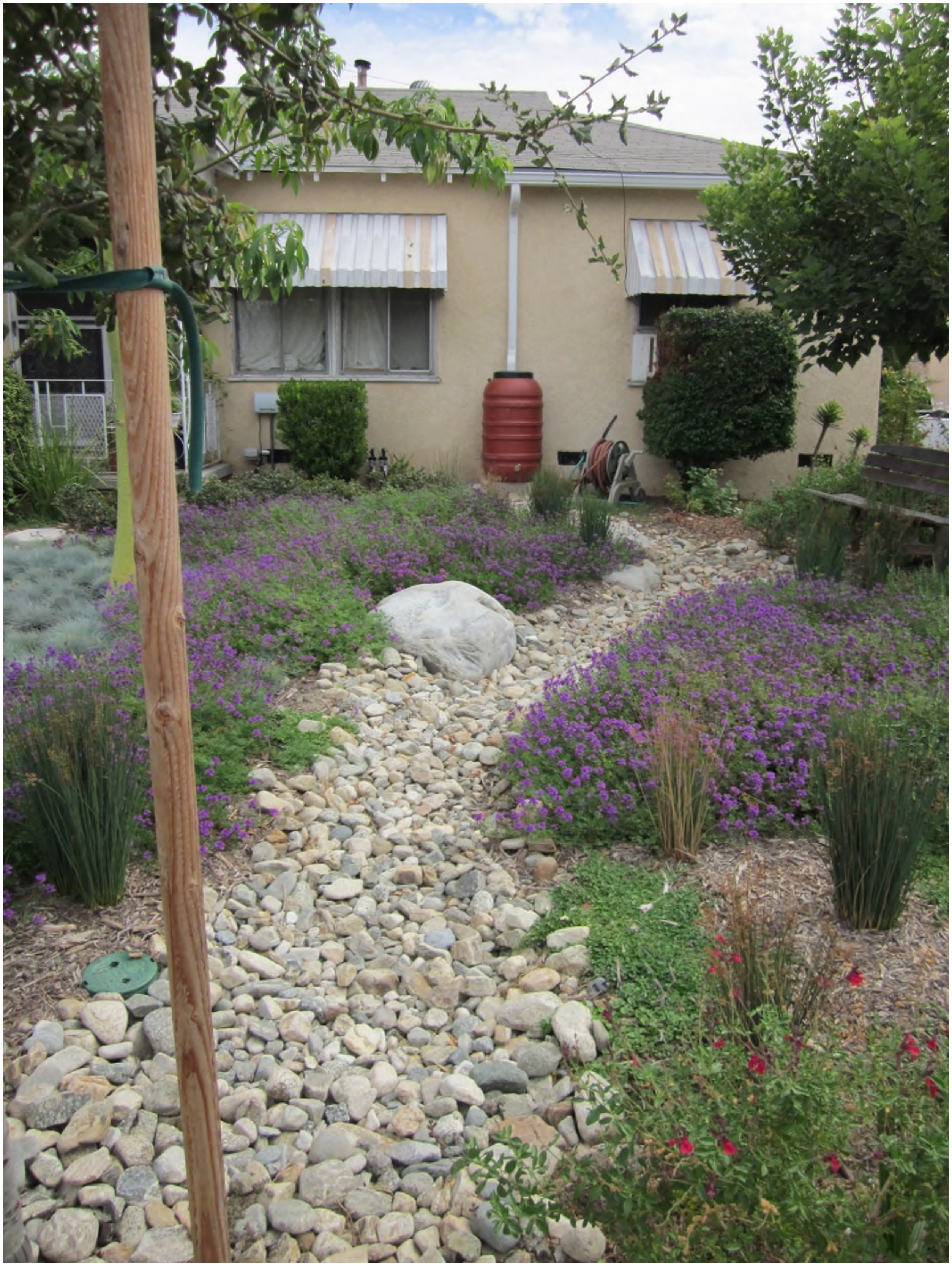
Assembly Bill (AB) 1881, the Water Conservation in Landscaping Act of 2006,[4] required local agencies to adopt the Model Water Efficient Landscape Ordinance developed by the California Department of Water Resources, or a comparable local ordinance, by 2010. This measure is aimed at achieving potentially significant water savings by improving irrigation systems and water use behavior under the premise that existing water-saving irrigation technology combined with current best practices for system design, installation, and maintenance can reduce residential and commercial water use. Selection of water-efficient, drought-tolerant plants for landscaping is another key component of the model ordinance.

For new or rehabilitated landscapes 2,500 square feet or greater, the ordinance requires completion of a landscape documentation package and water efficient landscape worksheet to document landscape plans and develop water budgets, irrigation scheduling, maintenance schedules, and irrigation audits. For existing landscapes larger than one acre, irrigation surveys and audits are required to evaluate water use and provide recommendations to prevent water waste. For metered landscapes, water use needs to be reduced below the Maximum Applied Water Allowance according to the formula provided in the Model Ordinance. Local agencies are required to prevent runoff from irrigation overspray or drainage issues.

The model ordinance language explicitly encourages and recommends stormwater features integrated into the landscape (§ 492.15) and does not consider nonirrigated stormwater facilities to be "water features" that need to be included in the water budget calculation. The ordinance lists the following practices (§ 492.6):

- Infiltration beds, swales, and basins that allow water to collect and soak into the ground;
- Constructed wetlands and retention ponds that retain water, handle excess flow, and filter pollutants; and
- Pervious or porous surfaces (e.g., permeable pavers or blocks, pervious or porous concrete, etc.) that minimize runoff.

[4] California Civil Code §1353.8, California Government Code §65591, California Public Resources Code §25401.9, and California Water Code §535



Xeriscape and rain barrel, Elmer Avenue, Los Angeles, CA

Successful establishment of vegetated green infrastructure practices, such as bioretention and stormwater planters, require irrigation initially to develop deep plant root systems. The language of the model ordinance acknowledges a plant establishment period, typically one to two years, during which plants are vulnerable to low moisture conditions and should be irrigated during dry periods. Proper selection of climate-adapted plants can eliminate the need to irrigate beyond the plant establishment period and can minimize the amount of water needed in the first two years. Additionally, the use of drip or microspray irrigation systems and soil moisture sensors can minimize water inputs while meeting the plants' moisture needs.

To summarize, the Model Water Efficient Landscape Ordinance does not deter the use of green infrastructure and in fact specifically recommends the use of green infrastructure-type practices, given that the stormwater features employ the same principles as water-efficient landscaping (i.e., selecting locally adapted plants or xeriscape and maximizing water use efficiency).

4.2 Regional Regulations and Programs

The following section summarizes five regional regulations selected by the project partners for review. A synopsis is presented of how green infrastructure can be used to meet related requirements and how each might pose a barrier to green infrastructure implementation. Each summary concludes with recommendations on how these barriers could be overcome, as applicable.

4.2.1 Final Waste Discharge Requirements for Municipal Separate Storm Sewer System (MS4) Discharges within the Coastal Watersheds of Los Angeles County, Except Those Discharges Originating from the City of Long Beach MS4

The Los Angeles Regional Water Quality Control Board (Board) issued a Municipal Stormwater Permit (Final Order R4-2012-0175, NPDES Permit CAS004001) for Municipal Separate Storm Sewer System (MS4) discharges originating from the Coastal Watersheds of Los Angeles County (County), with the exception of the City of Long Beach. The Municipal Stormwater Permit was signed November 8, 2012.

The overall goal of the Municipal Stormwater Permit is to regulate surface runoff conveyed through MS4s with the intent of restoring impaired waters and preventing further impairments caused by this runoff. As part of this goal, one of the key elements of the Municipal Stormwater Permit is to encourage the use of green infrastructure and low impact development design principles for new and redevelopment projects throughout the County.

The Municipal Stormwater Permit's provisions require green infrastructure as a means to achieve on-site retention of the Stormwater Quality Design Volume (SWQDv), which is defined as "runoff from (a) the 0.75-inch, 24-hour rain event or (b) the 85th percentile, 24-hour rain event, as determined from the Los Angeles County 85th percentile precipitation isohyetal map, whichever is greater." The Municipal Stormwater Permit encourages green infrastructure by:

- Requiring post-construction BMPs for certain categories of new and redevelopment projects;
- Requiring certain new development street and roadway projects to follow USEPA guidance regarding Managing Wet Weather with Green Infrastructure: Green Streets to the maximum extent practicable;
- Listing infiltration, bioretention and rainfall harvest (all considered green infrastructure components) as high priority post-construction BMPs;

- Including strict hydromodification management criteria that require maintaining pre-project hydrology for certain categories of new and redevelopment projects;
- Recommending impervious surface be minimized for new and redevelopment projects by minimizing soil compaction, employing LID, and mimicking the predevelopment water balance through infiltration, evaporation, and rainfall harvesting;
- Requiring that each permittee develop an inventory of retrofit opportunities within the public right-of-way to address stormwater impacts and in coordination with Total Maximum Daily Load (TMDL) implementation plans; and
- Outlining TMDL provisions and related waste load allocations for permittees.

The Municipal Stormwater Permit outlines a set of alternative compliance strategies that can be used in instances where retention of the full SWQDv cannot be achieved on site. These include achieving equivalent stormwater treatment using:

- Biofiltration (bioretention that allows for discharge of runoff to an underdrain and requires treatment of 1.5 times the SWQDv that is not retained on site);
- Offsite infiltration (using infiltration or bioretention facilities to intercept the balance of the SWQDv that is not retained on site); or
- Regional groundwater replenishment projects (pollutant reduction and infiltration of the balance of the SWQDv that is not retained on site to replenish groundwater supplies that have a designated beneficial use).

The two types of offsite projects need to be located in the same subwatershed as the development or redevelopment site.

The alternative compliance options offer flexibility to allow for higher density development as part of transit-oriented, Smart Growth, or economic development strategies, and they recognize that development might occur in areas unsuitable for stormwater infiltration. The Municipal Stormwater Permit's performance standards and alternative compliance options seek to achieve multiple regional water management objectives for water quality protection, stormwater volume reduction, and groundwater recharge for beneficial use through a combination of green infrastructure practices and other stormwater management strategies.

Bioretention sidewalk retrofits in Santa Monica, CA

4.2.2 Water Quality Control Plan for the Los Angeles Region: Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties

The *Water Quality Control Plan for the Los Angeles Region: Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties* (Basin Plan) was adopted by the Los Angeles Regional Water Quality Control Board in 1994 to preserve and enhance water quality and protect the beneficial uses of all regional waters. The Basin Plan does so through designation of beneficial uses for surface waters and groundwater and setting of quantitative and qualitative objectives along with implementation programs designed to protect these uses.

The Basin Plan recognizes nonpoint source pollution's role in the degradation of California's waterbodies and sets numeric and narrative water quality objectives for surface waters and groundwater. Green infrastructure is further encouraged directly and indirectly in the Basin Plan through:

- Outlining numeric objectives for surface waters and groundwater for the region's constituents of concern;
- Providing narrative objectives for hydrology and habitat;
- Requiring that all cities and counties in the region develop and implement comprehensive urban runoff control programs that focus on water quality improvement through the implementation of BMPs, including post-construction BMPs; and
- Requiring the California Department of Transportation (Caltrans) to participate in a program similar to the comprehensive urban runoff control programs outlined above and specifically calling out reduction of direct discharges and runoff velocity, use of grassed channels, curb elimination, infiltration practices, and detention/retention practices as desired outcomes of the program.

In addition to outlining water quality objectives and beneficial uses, the Basin Plan also describes the characteristics of surface waters and groundwater basins in the region. Seawater intrusion is listed as an issue specific to the Central and West Coast groundwater basins. This issue is being dealt with through artificial recharge systems, spreading basins, and injection wells.

The Basin Plan further describes the lower aquifers of the Central and West coast basins as consisting generally of good quality water but explains that large plumes of saline water have been trapped behind the barrier of injection wells in the West Coast basin, resulting in high concentrations of chloride. Additionally, quality of water in parts of the upper aquifers of both basins is degraded by organic and inorganic pollutants.

The Basin Plan, similar to the IRWMP, recognizes the important role that green infrastructure plays in providing water quality improvements, groundwater recharge and reduction of seawater intrusion impacts. The Basin Plan's discussion of groundwater quality emphasizes the importance of proper planning, siting, and design of green infrastructure practices to prevent pollutants from being mobilized to groundwater supplies.

Residential downspout disconnection in Seattle, WA

4.2.3 TMDL Implementation Plans

A number of TMDL implementation plans were prepared throughout the region to provide a comprehensive, phased approach of BMP implementation to meet water quality goals. For the purposes of this project, the Multi-Pollutant TMDL Implementation Plans for the Unincorporated County Areas of the Los Angeles River Watershed and Ballona Creek (October 2010) and the Santa Monica Bay Beaches Bacteria (SMBBB) TMDL Implementation Plan (July 2005) were reviewed and summarized as examples.

Each of the plans reviewed promote the implementation of green infrastructure to address stringent numeric requirements as part of local TMDLs for a number of pollutants of concern. Specifically, green infrastructure is encouraged through:

- Promoting recharge of groundwater and development of local water supplies (all three plans);
- Describing captured runoff as by far the largest component of active recharge (LA River and Ballona Creek Plans);
- Listing structural BMPs encouraged for use (all 3 plans) including bioretention, porous pavement, swales, vegetated filter strips, water harvesting systems, and infiltration facilities;
- Outlining numerous LID projects that are underway or proposed for implementation throughout the region (all three plans);

- Explaining the importance of numerous proposed projects (e.g., Obregon County Park, Crescenta Valley County Park and Tujunga Wash Greenway projects) that replenish groundwater and recharge aquifers;
- Calling out infiltration as one of the more simple and inexpensive approaches to beneficial reuse of runoff and recharge of groundwater basins (all three plans);
- Encouraging integrated water resources management focusing on the re-use of stormwater and groundwater infiltration throughout the watershed (SMBBB TMDL Plan), and
- Describing potential West Coast basin benefits from recharge via re-used stormwater runoff (SMBBB TMDL Plan).

The plans outline watershed-specific goals for BMP implementation, specifically LID and green infrastructure BMPs, and therefore are strong drivers of green infrastructure implementation in the region. Modeling efforts associated with TMDLs can help to quantify the benefits of the BMPs in terms of stormwater volume and pollutant load reduction and groundwater recharge. These results can help inform future green infrastructure planning.

4.2.4 Greater Los Angeles County Region Integrated Regional Water Management Plan

To define a clear direction for the sustainable management of water resources for the next 20 years in the Greater Los Angeles Region, a Leadership Committee of key stakeholders formed in 2006 and prepared an Integrated Regional Water Management Plan (IRWMP). The IRWMP provides a comprehensive set of solutions and associated costs to address water supply needs, treatment of local groundwater and stormwater, in-stream water quality, and habitat improvement.

The IRWMP is intended to improve the sustainability of water resources and ecological health of local watersheds in conjunction with assisting local jurisdictions in complying with regulatory mandates such as TMDLs. The IRWMP includes quantitative goals for measurable progress and accountability, further ensuring that water quality improvement and water resources sustainability measures are implemented. The IRWMP encourages green infrastructure through:

- Objectives to protect, restore, and enhance natural processes and habitats, including identifying planning targets for restoration of riparian and wetland habitats;
- An objective to sustain infrastructure for local communities, encouraging replacement of aging systems with more integrated flood management and green infrastructure systems; and
- Water quality improvement objectives that:
    - Recommend achieving compliance with TMDLs through a combination of runoff volume reduction and capturing and treating runoff from developed areas;
    - Call for the reduction and reuse of 150,000 acre-feet/year (approximately 40 percent) of dry weather urban runoff and capture and treatment of an additional 170,000 acre-feet/year (approximately 50 percent);
    - Call for the reduction and reuse of 220,000 acre-feet/year (approximately 40 percent) of stormwater runoff from developed areas, and capture and treatment of an additional 270,000 acre-feet/year (approximately 50 percent);

- Highlight LID BMPs for their stormwater capture, pollutant reduction, and groundwater recharge benefits to meet the above goals, and
- Recommend the reduction of stormwater runoff volumes through impervious surface reduction, swales, cisterns, and other on-site BMPs that capture and/or infiltrate runoff, identifying how important these measures are to augment local water supplies through natural recharge.

- Identification of more than 1,500 stakeholder projects and project concepts, many of which involve green infrastructure elements, to help achieve IRWMP objectives throughout the region.

The IRWMP provides more general recommendations encouraging the use of green infrastructure and establishes a framework for implementation of such measures through a series of qualitative and quantitative objectives. As such, specific barriers and limitations to green infrastructure measures are not explicitly called out in the IRWMP.

Because one of the key goals of the IRWMP is groundwater replenishment, groundwater quality issues throughout the IRWMP region should be considered when siting green infrastructure projects. The IRWMP indicates that groundwater quality in some portions of the region has been degraded by elevated levels of nitrates and plumes of volatile organic compounds (VOCs). Groundwater contamination has also occurred in some locations from the historic use of methyl tertiary butyl ether (MTBE). For instance, MTBE was discovered in groundwater wells in the City of Santa Monica in 2003

Porous pavement and xeriscape in Los Angeles, CA and VOCs have been detected at 1,000 times above the established maximum contaminant levels in the Baldwin Park area. Groundwater clean-up efforts are being coordinated by various agencies and cities throughout the region.

The authors of the IRWMP recognize the importance of green infrastructure in improving groundwater quality and replenishing local supplies. When siting potential green infrastructure projects, careful attention should be paid to areas with contaminated groundwater. This can be achieved through GIS mapping of these areas and either re-siting, use of green infrastructure BMPs that are not infiltration-based, or use of liners and underdrains for infiltration BMPs to avoid mobilizing contaminants.

The IRWMP also specifies that projects aimed at reducing runoff via on-site BMPs also preserve or enhance flood protection levels. Thus, careful attention should be paid to designing such BMPs for both water quality enhancement and flood protection purposes as much as feasible.

4.2.5 Groundwater Adjudications in the Central and West Coast Basins

Additional regional regulatory[5] drivers that potentially affect the use of green infrastructure in the Los Angeles Region include two groundwater adjudications that address the Central and West Coast Basins. The discussion below examines whether the court judgments resulting from these groundwater adjudications pose barriers to the implementation of green infrastructure stormwater infiltration projects in those areas and how ongoing litigation to amend those judgments could potentially address these issues.

In most areas of California, overlying land owners may extract percolating groundwater and put it to beneficial use without approval from the State Board or a court. California does not have a permit process for the regulation of groundwater use (excluding subterranean streams). In several basins,[6] however, groundwater use is subject to regulation in accordance with court decrees adjudicating the groundwater rights within each basin. These groundwater adjudications establish specifically who is entitled to extract groundwater and how much each entitled party may extract annually. The court typically appoints a Watermaster to report on annual extractions and to enforce the judgments to ensure, for example, that a party does not extract more than its entitled extraction rights.

Two specific groundwater adjudications apply to the Central and West Coast Basins. These basins underlie a 420-square mile area of the Los Angeles Coastal Plain and include all or parts of 43 cities with a population of 4 million people. Groundwater supplies 40% of the water demand in the area. The adjudications fix extraction rights in the West Coast Basin at 64,468 acre-feet and in the Central Basin at 217,367 acre-feet. The extraction rights are roughly double the *natural safe yield* in each basin as defined in the early 1960s. Both judgments presuppose artificial replenishment will occur to make up the difference between the amount of water naturally replenished by storm water and underflow and the amount of groundwater extracted under the judgments.

Artificial replenishment is provided by the Water Replenishment District. The District charges a Replenishment Assessment on each acre-foot of groundwater extracted in order to buy or produce the

[5] *Regulatory* here is used in the broad sense of legal structures and decisions.

[6] There are approximately 22 adjudicated groundwater basins in California. http://www.water.ca.gov/groundwater/gwmanagement/court_adjudications.cfm. Other means of regulating groundwater in the State include: overlying property rights; statutory authority; groundwater management districts or agencies; groundwater management plans; and city and county ordinances.

Porous pavement parking stalls and bioretention at the Los Angeles Zoo (Photo credit: Tetra Tech)

imported water, recycled water and conserved stormwater necessary to replenish the groundwater extracted. The 2012–2013 Replenishment Assessment is $244 per acre-foot.

Central and West Coast Basin Groundwater Judgments

The adjudication of groundwater extraction rights in the West Coast Basin was concluded in 1961 (*California Water Service Company, et al. vs. City of Compton, et al., C506806*). Judgment in the Central Basin case was entered in 1965 (*Central and West Basin Water Replenishment District, et al. vs. Charles E. Adams, et al., C786,656*).[7]

While the judgments make provision for groundwater extraction rights, they do not provide for groundwater storage and the extraction of stored water. As a result, municipalities and others with groundwater extraction rights may not extract stored water over and above their respective extraction rights and they may not extract stored water without paying the Replenishment Assessment.

[7] http://www.water.ca.gov/watermaster/centralbasin_judgment/index.cfm

Potential Barriers/Disincentives to Green Infrastructure Projects Posed By Groundwater Adjudications

The judgments thus provide no incentive, and in fact are barriers, to municipalities with extraction rights that might otherwise invest in green infrastructure stormwater infiltration projects to meet TMDL requirements and to enhance their groundwater supply.

Conditions that would promote the implementation of green infrastructure projects that could supplement groundwater recharge include the allowance for groundwater recharge projects by parties to the judgments (e.g., stormwater infiltration), flexibility to use the Central and West Basins for the storage of captured water, and the ability to extract or gain credit for such captured and stored groundwater as long as it could be demonstrated that the infiltrated water reached the usable groundwater basins and increased the natural supply above previously determined amounts. Equitable and clear rules, rights, and processes regarding these areas will promote the implementation of green infrastructure.

Potential Effect of Ongoing Litigation

In May 2009, petitions to amend both judgments were filed by the Water Replenishment District and parties representing a majority of extraction rights in both basins. The amendments would create a legally-certain framework for individual and regional storage projects. They would permit parties to take advantage of the 450,000 acre-feet of available storage capacity in the two basins (120,000 acre-feet in the West Coast Basin and 330,000 acre-feet in the Central Basin). Most importantly, would permit a party to extract water it stores without that extraction counting against its judgment extraction rights and without paying a Replenishment Assessment on the extraction of the water it stores.

The judgment amendment motions before the court note that the work to allow for groundwater storage has been a long-term, professionally facilitated effort and that the proposed amendments are supported by the parties holding well over fifty percent of the water rights in both Basins, as well as the Watermaster, and the Water Replenishment District of Southern California, the local agency responsible for groundwater replenishment.

The motions indicate that the amendments will provide the region with essential opportunities to satisfy water demands, that the amendments provide the legal certainty needed to encourage basin users to optimize their use of the basins by taking advantage of available storage capacity and investing in water augmentation projects and projects to increase the use of recycled water. The motions assert that by making the water supply more reliable and by opening access to lower-cost supplies, these improvements to the judgments will provide significant benefits to the people who depend upon the basins and that, as a result, the basins' water users and the region as a whole will be more self-sufficient now and into the future. The motions further assert that the economic value of these benefits to the region is more than $500,000,000, and that the amendments will encourage economic benefits including:

- Increased local supply through increased storage;
- Increased reliability of supply, especially during a drought or imported supply restriction;
- Increased use and development of recycled water;
- Increased efficiency in the capture of storm flow and other local supplies; and
- Increased use of now-underutilized groundwater pumping rights.

Bioretention with xeriscape incorporated into the right-of-way, Los Angeles, CA
(Photo credit: Tetra Tech)

Overall, the proposed amendments to the Central and West Coast Basin groundwater adjudications would appear to address existing provisions that discourage investment in green infrastructure. A trial in connection with the proposed judgment amendments is scheduled for January 2014. There is no way of knowing, of course, whether these motions will be adopted and the judgments amended to explicitly provide for groundwater storage. Based on available information, however, it is clear that the proposed amendments reflect significant work to facilitate groundwater recharge, storage and use in these basins and it appears they would provide a clear and workable framework that will, if adopted, support the potential for increased use of certain types of green infrastructure projects.

In summary, the amendments would recognize groundwater storage as supporting beneficial use, provide available resources in the respective basins for such storage, and put in place specific processes and requirements that address groundwater storage and use in the Central and West Coast Basins in an equitable manner and in a manner that does not disrupt groundwater rights held under the existing judgments.

They would provide clarity that is much needed if entities are expected to invest in improving local groundwater resources. Under the amendments, water augmentation projects could be developed and potentially used to increase the yield of the basins. Again, under the amendments, no replenishment fee would be assessed against the extraction of augmented water. In this way an entity that contributes to the costs of a water augmentation project could benefit from the project without being penalized by an assessment on water that it in whole or in part contributed.

5 Overcoming Barriers to Green Infrastructure at the Local Level

As discussed previously, state and regional policies and programs can drive green infrastructure implementation. At the local level, municipal codes and ordinances,[8] policies, and guidance documents also can create barriers to or encourage green infrastructure implementation. Such barriers vary from one municipality to the next and can create an uneven regulatory landscape that developers need to navigate to implement green infrastructure in the region. Within a single municipality, different neighborhoods might have different zoning rules governing density, infrastructure features, and other requirements that can affect how green infrastructure can be incorporated into development projects.

To identify municipal code obstacles, a local government must conduct an audit of applicable documents. An audit involves coordinating with and educating staff in relevant municipal service areas, reviewing documents that guide municipal activities, and interpreting and prioritizing findings. The following sections describe a process by which a local government can assess its codes, ordinances, policies, and guidance to remove barriers to green infrastructure and strengthen language that would encourage or require green infrastructure implementation. A *Green Infrastructure Identification of Barriers and Opportunities Checklist Tool*, which was adapted for the local development conditions and resource protection priorities of the Los Angeles Region, is provided in Appendix A to facilitate the audit.

[8] Municipal codes and ordinances refer to laws that are enacted and enforced by a village, town, city or county government.

Code and Ordinance Review Resources

The Center for Watershed Protection's (1998) ***Better Site Design: A Handbook for Changing Development Rules in Your Community***, available at *www.cwp.org*, outlines 22 guidelines for better developments and provides a detailed rationale for each principle. Better Site Design also examines current practices in local communities, details the economic and environmental benefits of better site designs, and presents case studies from around the country.

USEPA's (2009) ***Water Quality Scorecard: Incorporating Green Infrastructure Practices At Municipal, Neighborhood, and Site Scales***, guides municipal staff through a review of relevant local codes and ordinances across multiple municipal departments to ensure that these codes work together to support a green infrastructure approach. It can be downloaded at *www.epa.gov/dced/pdf/2009_1208_wq_scorecard.pdf*.

5.1 Municipal Service Areas and Associated Codes, Ordinances, Policies, and Guidance

The first step in conducting an audit is to identify all of the appropriate municipal service areas whose regulations or policies in some way impact the implementation of green infrastructure. Note that many of the common green infrastructure barriers exist in regulations not immediately associated with water quality or environmental issues. The following is a list of the service areas that should be included in a green infrastructure audit that focuses on the Los Angeles Region's key issues of infill development; redevelopment; and water conservation, reuse, and recharge:

- Public works
- Planning
- Public health and safety
- Economic development
- Legal/municipal attorney

The following are descriptions of each service area's potential green infrastructure interactions. The codes,[9] ordinances, policies, and guidance documents associated with each service area are presented in Table 4.

Public Works

The public works service area typically encompasses street design, asset maintenance, and engineering. Green infrastructure implementation can be supported or inhibited through street and right-of-way design, paving requirements, and infrastructure design, such as requirements for curb and gutter and stringent pavement requirements that do not allow the use of permeable materials. Further, if green infrastructure practices are publicly owned or maintained, public works maintenance staff will be charged with the inspection and maintenance of the facilities. Finally, the public works service area

[9] Where specific standards are referenced, probable code location(s) are also listed.

could impact green infrastructure implementation through the development and application of post-construction BMP performance standards for treatment, channel protection, and flood control to protect infrastructure and receiving streams.

Planning

The planning service area includes site plan review, building inspections, zoning, code enforcement and perhaps a green building program. It is imperative that green infrastructure practices be considered and incorporated early in the site planning process—with regard to parking lot and building requirements—and then implementation confirmed throughout all development phases and post-construction. Planning codes need to be evaluated for requirements that oversupply impervious surfaces (e.g., roads, driveways, sidewalks, parking) and discourage Smart Growth.

Public Health and Safety

Allowances for and obstacles to rainwater harvesting and water conservation are typically found in codes, policies and guidance implemented by departments that deal with public health issues. In addition, fire codes should also be evaluated to determine if they prohibit narrow streets, curb bumpouts, alternative cul-de-sac designs, and other modifications to street design.

Economic Development

The economic development service area may include incentives to develop within brownfield areas that would encourage redevelopment in lieu of greenfield development. Further, the creation of tax incremental financing districts can stimulate new private investment and enhance real estate values in urban areas that are unlikely to attract development otherwise. Incentivizing redevelopment can reduce the demand for greenfield development and focus development in areas with existing infrastructure.

Legal/Municipal Attorney

The legal department should be involved in any discussions that may involve code changes to evaluate ramifications and help craft specific code language. Education of legal staff regarding the science of green infrastructure and its importance and multiple benefits should occur early in the audit process.

Table 4. Codes, ordinances, policies, and guidance documents related to municipal service areas

Service Area/Topic	Location
Public Works	
Street and sidewalk design standards	Municipal Code: Streets and Sidewalks, Zoning – All Zones; Complete/Smart Streets Guidelines
Curb and gutter design standards	Municipal Code: Streets and Sidewalks, Zoning – All Zones
Paving standards	Municipal Code: Streets and Sidewalks
Public post-construction stormwater BMP inspection standard operating procedures	Stormwater manual or internal operating procedure documents
Post-construction BMP performance standards	Municipal Code: Drainage, Stormwater, Development/Subdivision; Local Stormwater Design Guidance

Service Area/Topic	Location
Planning	
Density allowances	Municipal Code: Zoning – All Zones
Transit or existing infrastructure development incentives	Municipal Code: Zoning, Transit Overlay Zone, Tax Incremental Financing (TIF) Zone; Local or Regional Transportation Plan(s); Downtown/Neighborhood Development Plans; TIF Design Guidelines
Off-street parking requirements	Municipal Code: Zoning – All Zones; Off-Street Parking; Parking Overlay Zone
Landscaping requirements	Municipal Code: Zoning – All Zones, Landscaping, Tree Protection
Setback requirements	Municipal Code: Zoning – All Zones
Open space requirements	Municipal Code: Zoning – All Zones
Driveway, alley, garage requirements	Municipal Code: Zoning – All Zones
Greenfield or infill development Incentives	Municipal Code: Mixed Use Development Zones, Agricultural Zones, Open Space Zones; Downtown/Neighborhood Development Plans; Capital Improvement Plan
Critical area, wetland or waterway protection	Municipal Code: Zoning, Drainage, Flood Zone, Sensitive Area Protection Zone; Watershed Plan
Buffer requirements	Municipal Code: Zoning, Drainage, Flood Zone, Sensitive Area Protection Zone; Watershed Plan
Off-site mitigation allowances	Municipal Code: Drainage, Stormwater, Development/Subdivision; Local Stormwater Design Guidance
Tree protection standards	Municipal Code: Zoning – All Zones, Landscaping, Tree Protection; Urban Forestry Guidance
Private post-construction stormwater BMP inspection authority	Municipal Code: Drainage, Stormwater, Public Nuisance
Private post-construction stormwater BMP inspection standard operating procedures	Stormwater manual or internal operating procedure documents
Maintenance and private inspection agreement requirements	Municipal Code: Drainage, Stormwater, Development/Subdivision; Local Stormwater Design Guidance
Green building requirements	Municipal Code: Green Buildings
Public Health and Safety	
Cistern and rain barrel requirements	Municipal Code: Zoning, Plumbing, Building, Water Conservation
Maintenance and private inspection agreement requirements	Municipal Code: Drainage, Stormwater, Development/Subdivision; Local Stormwater Design Guidance
Gutter disconnection allowances	Municipal Code: Plumbing, Building
Rainwater reuse allowances	Municipal Code: Plumbing, Building, Health
Emergency vehicle street requirements	Municipal Code: Fire, Streets and Sidewalks
Economic Development	
Tax incremental financing districts	Municipal Code: TIF District Zones
Brownfield incentives	Municipal Code: Zoning

5.2 Education of Staff

Many aspects of municipal management can support or inhibit the implementation of green infrastructure practices, and some are more straightforward to understand than others. Municipal staff might not understand their role in preventing green infrastructure or how their work could be altered to instead promote it. Staff are charged by the governing body of their municipality with achieving a certain level of service to residents with regard to their particular service area, i.e., transportation planners plan and design safe and efficient streets. Achieving this level of service is their primary concern and objective, so it might require some education to inform them of the purpose and importance of changes needed to remove high-priority obstacles to green infrastructure. In addition, staff have detailed knowledge of the codes, policies and guidance documents that guide their work and therefore may be of great help in identifying barriers during the audit process.

It is likely that municipal staff will have concerns about green infrastructure related to safety, access, and maintenance. For example, in an attempt to minimize impervious area, green infrastructure principles recommend narrower streets and cul-de-sacs and smaller parking areas. Often, fire departments and public works departments express concerns regarding safety and access, engineering departments object because of conflicts with the State Streets and Highway Code, and engineering and public works departments have concerns about maintenance of distributed BMPs, especially on private land and in the public right-of way.

The easiest and fastest way to educate staff may be to convene a round table meeting of all appropriate staff. The meeting would include a brief training regarding the benefits of green infrastructure (see Section 3) and each service area's role in promoting or inhibiting green infrastructure. After this training, a moderated discussion regarding which particular codes, policies, or guidance documents should be audited would be helpful to ensure nothing is overlooked at the onset of the process. The suggested documents in Table 4 could be used to initiate discussion and a blank copy of the *Green Infrastructure Identification of Barriers and Opportunities Checklist Tool* (Attachment A) could be distributed to elicit additional input or ideas. The meeting should also be used to request the documents discussed if they are not readily available to audit staff. The documents being reviewed should be in an electronic format that is easily searchable, if possible. Participants in this round table meeting would be considered green infrastructure contacts for future questions regarding the audit process.

5.3 Conducting the Review

There are multiple approaches to conducting an audit of local codes, policies, and guidance documents, but one of the most straightforward is to treat the exercise as a targeted keyword search to locate the answers to each of the questions included in the Tool. The first step should be to generally become familiar with a key part of the municipal code, namely the zoning code. The specific contents of the zoning regulations may vary, however generally housing unit density, setbacks, off-street parking space requirements, lot size minimums and maximums can be found in the zoning regulations. Many municipal codes will have a section describing landscaping requirements for off-street parking and screening between land uses, but this also might be defined specific to certain zones. Some municipal codes will have an off-street parking section of the code as well that define landscaping requirements, pavement type, and other requirements, while other municipal codes may refer to different sections of the code that focus on these items.

The auditor can save time during the audit process by briefly reviewing these sections in advance to become familiar with the location of particular information. In addition, the auditor should consider each question in the Tool and search for certain key words that can help to identify green infrastructure obstacles. The following key words should be searched and associated text evaluated for green infrastructure implications:

- Pervious
- Bioretention
- Driveways
- Greenfield
- Wetland
- Rain barrel
- Sensitive area
- Infiltration
- Outfall
- Riparian
- Island
- Impervious
- Infill
- Alley
- Buffer
- Cistern
- Stormwater
- Retention
- Water quality
- Channel
- Banking
- Mature tree
- Permeable
- Transit
- Open space
- Swales
- Graywater
- Rain
- Detention
- Flood
- Mitigation
- Curb and gutter
- Context-sensitive design

When completing the Tool, when the answer to a question is *no*, be sure to indicate the section or sections of the code, policy, or guidance document where barriers exist. It is helpful to include the exact language from the reference document and any recommendations for removing the barrier for future reference when prioritizing barriers and developing an action plan. For example:

GOAL #1 KEY QUESTIONS	IMPORTANCE	COMMENTS
• Does the code definition of impervious area distinguish between impervious area connected to the storm drain system (effective impervious area) and disconnected impervious area?	◑	NO – The only specific definition of impervious area is the square footage of a lot multiplied by its runoff coefficient (Sec. 2-168). Code also refers to "impermeable surface" (Sec. 51A-8.611(c)(1)(B)(i)), which is not defined, and "nonpermeable coverage," (Sec. 51A-10.101(19)) defined as "coverage with any pavement that is not "permeable pavement." **Recommendation:** Provide specific definition distinguishing connected and disconnected impervious area and revise Sec. 51A definition to include rooftops and other nonpermeable surfaces.

5.4 Common Barriers and Issues

Generally, the issues and barriers found during audits include the following:

- Setbacks that specify minimum distances, necessitating more impervious cover associated with driveways and walkways.
- The recommendation for 18 to 22 feet streets widths (for low-volume traffic) often conflicts with state minimum road and street design requirements, which are in turn adopted and required by local governments before accepting a street for public maintenance.
- Curb and gutter requirements that prevent infiltration of road runoff into vegetated features.
- Cul-de-sac design specifications that require a large radius or that specify impervious cover rather than functional landscaping.
- Parking standards that specify a minimum number of spaces rather than a maximum number, set minimums based on peak use rather than typical use, and do not allow for flexible layouts that would allow functional landscaping.
- Prescriptive requirements for paved surface materials that preclude the use of permeable pavement options in low-traffic areas.
- Restrictions for the use of public right-of-way for stormwater control or BMP maintenance access.
- Prescriptive planting requirements that can sometimes be at odds with requirements for stormwater BMPs.
- Open space requirements that prevent the use of green space for stormwater treatment.
- Requirements for ownership and maintenance of BMPs that might prevent or complicate installation of BMPs on private property.

5.5 Developing an Action Plan

Once the audit is complete, the next step is to develop an action plan to address the highest priority obstacles. Each key question of the Tool includes the following symbols that indicate the level of importance that particular issue plays in removing obstacles to green infrastructure.

● Essential ◑ Very important ○ Important

The Tool questions for which a *No* answer is provided that are considered *Essential* should be considered the highest priority. Issues and priorities that are unique to a locality may result in assignment of priorities for individual questions and topics that are different than those provided in the Tool.

Similar to the first step in the audit process—gathering applicable documents—it is helpful to pull together all green infrastructure contacts to disseminate the results of the audit and develop an action plan for eliminating obstacles. A moderated, charrette-style discussion could be helpful to ensure that all parties' views, opinions and ideas are documented.

Some of the most challenging issues to reach consensus include:

- **Residential street and road widths.** The recommendation for 18 to 22 feet streets widths (for low volume traffic) often conflicts with state minimum road and street design requirements, which are in turn adopted and required by local governments before accepting a street for public maintenance. Fire departments also object to the narrower streets because they believe they are not wide enough for fire trucks to navigate.
- **Culs-de-sac.** The recommendation that a cul-de-sac have a radius of 35 feet or less can conflict with state DOT standards. This standard is related to transport of liquid fuels.
- **Use of grass swales and bioretention areas rather than curb and gutter.** The major objection to this recommendation comes from local engineering and public works departments that are concerned about the maintenance of the swales and street edges and the use of swales on steeply sloped areas.
- **Use of one sidewalk rather than two.** Planning departments often object to this ordinance revision because they believe it conflicts with their goal of providing walkable communities.
- **Reducing residential setback and frontage requirements to encourage cluster development.** Planning staff are concerned that the reduced setback/frontage requirements would be incompatible with existing neighborhoods built under traditional subdivision requirements.

In most cases, the resistance to ordinance changes arises from competing local government service area objectives and concerns. For example, the planning, public works, and fire departments may have to resolve internal issues to determine the extent to which street widths can be reduced in a subdivision. For each issue, it will be important to show how other communities have overcome barriers through creative design, construction standards, and approval process requirements, among other strategies.

Prior to the conclusion of the charrette, it is important to assign a department responsible for implementing the recommended actions. The action items and parties responsible should be summarized and distributed after the meeting.

Code/Ordinance Audit Process

1. Notify service area coordinators of the pending audit.
2. Request copies of codes, ordinances, policies or guidance documents thought to be applicable to GI implementation.
3. Organize roundtable meeting of service area coordinators to discuss GI benefits and roles and establish GI contacts for future efforts.
4. Request additional documents identified during the roundtable meeting.
5. Review development code and conduct a keyword and topic search to answer the questions contained in the Tool.
6. For each barrier identified, note the applicable documents (e.g., code section, technical manual) and include the language that poses a barrier.
7. Using the relative importance symbols in the Tool, develop a prioritized list of barriers to be addressed in the short versus long term.
8. Hold a moderated meeting with GI contacts to address high priority barriers, develop action items, and identify responsible parties.

6 Summary and Conclusions

Stormwater has been identified as a valuable and reliable resource for groundwater augmentation to help ensure long-term regional water self-reliance for Southern California and reduce the region's reliance on imported water (Natural Resources Defense Council 2009; Los Angeles and San Gabriel Rivers Watershed Council 2010; Water Replenishment District of Southern California 2012). Regional groundwater recharge projects are planned or underway to implement this strategy. Smaller-scale green infrastructure projects have the potential, when considered collectively, to contribute to groundwater supplies while meeting other objectives, specifically water quality improvement and other environmental and community benefits.

Green infrastructure in the Los Angeles Region must reflect local development opportunities and environmental constraints. In the already developed, highly urbanized areas of Los Angeles County, green infrastructure will mostly be implemented as retrofits or infill redevelopment, which can constrain the footprint of stormwater facilities and require creative site designs. Green infrastructure designs must also meet water conservation goals, which can be achieved by selecting native and locally adapted plants and using permeable hardscape, as exemplified by the Elmer Avenue Neighborhood Retrofit Project's functional landscaping.

From a regulatory perspective, there are numerous drivers that encourage the use of green infrastructure, particularly those with goals geared toward water quality improvement (e.g., the Municipal Stormwater Permit, Integrated Regional Water Management Plan, Basin Plan, and TMDL implementation plans). These regulations strongly encourage or specifically require the use of green infrastructure to meet hydrologic and water quality objectives. Other regulations create opportunities for green infrastructure implementation as part of other projects that aim to create more sustainable, livable communities, such as the Sustainable Communities and Climate Protection Act's transportation and affordable housing requirements. Green infrastructure can be used as a strategy to meet climate change goals (e.g., those set forth in the Global Warming Solutions Act) by incrementally increasing vegetative cover that can serve as a carbon sink, reducing other air pollutants, offsetting imported water needs, and reducing building energy cooling.

The current status of water rights in the Central and West Coast Groundwater Basins, governed by the Central and West Coast Basin Judgments, creates potential disincentives for the entities considering implementing water capture, recharge, and storage because the judgments lack a system to account for, credit, or pay for that water, and users would be charged a replenishment fee to extract the water they stored. Ongoing litigation seeks to address these shortcomings by amending the judgments to establish a system that accounts for additional water storage and eliminates replenishment fees on extraction of stored water.

The next challenge facing Los Angeles communities is to incorporate green infrastructure standards and requirements into local codes and ordinances so that it becomes *business as usual* for most or all permitted development projects. An audit of relevant codes and ordinances is an important first step to identify and remove barriers to green infrastructure. Subsequently, communities can begin creating incentives for voluntary green infrastructure implementation, if desired and feasible. Constraints related to funding for green infrastructure can pose challenges, but grant opportunities, such as California's Proposition 84 for flood control and water supply improvements, can help to promote green infrastructure. Eventually, the aim is for green infrastructure to become *business as usual* for developers and municipalities while contributing to local and regional water quality and hydrologic objectives, achieving water replenishment goals, and improving community livability and quality of life.


Bioretention in a plaza gathering space in Portland, OR (Photo credit: M. Frey)

7 References

California Regional Water Quality Control Board, Los Angeles Region (LARWQCB). 2012. Order No. R4-2012-0175, NPDES Permit No. CAS004001. Waste Discharge Requirements for Municipal Separate Storm Sewer System (Ms4) Discharges within the Coastal Watersheds of Los Angeles County, Except Those Discharges Originating from the City of Long Beach MS4. http://www.swrcb.ca.gov/rwqcb4/water_issues/programs/stormwater/municipal/la_ms4/2012/Order%20R4-2012-0175%20-%20A%20Final%20Order%20revised.pdf. Accessed March 5, 2013.

California Stormwater Quality Association (CASQA). 2010. *Low Impact Development Manual for Southern California: Technical Guidance and Site Planning Strategies*. http://www.casqa.org/LID/SoCalLID/tabid/218/Default.aspx. Last updated April 2012. Accessed November 23, 2012.

Center for Neighborhood Technology (CNT). 2010. *The Value of Green Infrastructure: A Guide to Recognizing its Economic, Environmental, and Social Benefits*. http://www.cnt.org/repository/gi-values-guide.pdf. Accessed November 23, 2012.

Center for Watershed Protection. 1998. *Better Site Design: A Handbook for Changing Development Rules in Your Community*. Center for Watershed Protection, Ellicott City, MD.

City of Los Angeles. 2012. Ordinance No. 181899. http://www.lastormwater.org/wp-content/files_mf/finallidordinance181899.pdf. Accessed March 5, 2013.

County of Los Angeles Department of Public Works. 2009a. *Low Impact Development Standards Manual*. http://dpw.lacounty.gov/wmd/LA_County_LID_Manual.pdf. Last updated January 2009. Accessed November 23, 2012.

County of Los Angeles Department of Public Works. 2009b. *Stormwater Best Management Practice Design and Maintenance Manual for Publicly Maintained Storm Drain Systems*. http://dpw.lacounty.gov/ldd/publications/Stormwater%20BMP%20Design%20and%20Maintenance%20Manual.pdf. Last updated May 2009. Accessed November 23, 2012.

ECONorthwest. 2011. *Economic Benefits of Green Infrastructure: Chesapeake Bay Region*. ECONorthwest, Eugene, OR.

Los Angeles and San Gabriel Rivers Watershed Council. 2010. *Water Augmentation Study: Research, Strategy, and Implementation Report*. Los Angeles and San Gabriel Rivers Watershed Council, Los Angeles, CA.

Natural Resources Defense Council. 2009. *A Clear Blue Future: How Greening California Cities Can Address Water Resources and Climate Challenges in the 21st Century*. http://www.nrdc.org/water/lid/files/lid_hi.pdf. Accessed May 9, 2013.

Nowak, D.J., D.E. Crane, and J.C. Stevens. 2006. Air pollution removal by urban trees and shrubs in the United States. *Urban Forestry & Urban Greening* 4: 115–123.

Stratus Consulting. 2009. *A Triple Bottom Line Assessment of Traditional and Green Infrastructure Options for Controlling CSO Events in Philadelphia's Watersheds*. Office of Watersheds, City of Philadelphia Water Department. Philadelphia, PA.

USEPA. 2005. *National Management Measures to Protect and Restore Wetlands and Riparian Areas for the Abatement of Nonpoint Source Pollution*. http://water.epa.gov/polwaste/nps/wetmeasures/upload/2005_08_19_NPS_wetmeasures_ch2.pdf. Last updated July 2005. Accessed November 23, 2012.

USEPA. 2009. *Water Quality Scorecard: Incorporating Green Infrastructure Practices At Municipal, Neighborhood, and Site Scales*. http://www.epa.gov/dced/pdf/2009_1208_wq_scorecard.pdf. Accessed February 27, 2013.

USEPA. 2012a. *What is Green Infrastructure?* http://water.epa.gov/infrastructure/greeninfrastructure/gi_what.cfm. Last updated March 21, 2012. Accessed November 23, 2012.

USEPA. 2012b. *Storm Water Drainage Wells*. http://water.epa.gov/type/groundwater/uic/class5/types_stormwater.cfm. Last updated September 28, 2012. Accessed November 23, 2012.

Water Replenishment District of Southern California. 2012. *Stormwater Recharge Feasibility and Pilot Project Development Study*. Prepared for the Water Replenishment District of Southern California, Lakewood, CA, by the Council for Watershed Health, Geosyntec Consultants, and the Santa Monica Bay Restoration Commission.

This page is intentionally blank.

Attachment A:

Green Infrastructure Identification of Barriers and Opportunities Checklist Tool

Photo: Elmer Avenue residential stormwater retrofits, Los Angeles, CA

Parking lot bioretention, Wilsonville, OR
(Photo credit: M. Frey)

The *Green Infrastructure Identification of Barriers and Opportunities Checklist Tool* is tailored to the Los Angeles Region's key priorities of infill development, redevelopment, and water conservation/reuse/recharge. The checklist was developed originally to perform audits of local codes and ordinances for local government clients based on experience with other checklists, such as the Center for Watershed Protection's *Codes and Ordinances Worksheet* and EPA's *Water Quality Scorecard*.

This tool is intended to be used by local governments in the Los Angeles region to determine whether their codes and ordinances pose barriers to green infrastructure practices and to highlight opportunities for green infrastructure to be encouraged or required in codes. For additional guidance on the code review process for local governments, see Section 5 of this report and the Center for Watershed Protection's *Better Site Design: A Handbook for Changing Development Rules in Your Community* (1998), which contains the Codes and Ordinances Worksheet mentioned above (see www.cwp.org for details).

The process of changing codes to encourage green infrastructure is not without challenges, most of which can be overcome through education and negotiations with other departments. It is very likely that municipal staff will have concerns about green infrastructure related to safety, access, and maintenance. For example, in an attempt to minimize impervious area, green infrastructure principles recommend narrower streets and cul-de-sacs and smaller parking areas. Often, fire departments and public works departments express concerns regarding safety and access, engineering departments object because of conflicts with the State Streets and Highway Code, and engineering and public works departments have concerns about maintenance of distributed BMPs, especially on private land and in public right-of way. Developers often have concerns about feasibility of green infrastructure BMPs if there is inflexibility in other code requirements.

GOAL #1: MINIMIZE EFFECTIVE OR CONNECTED IMPERVIOUS AREA

Objective: Minimize impervious area associated with streets, parking, driveways, and sidewalks; cluster development; and incorporate sustainable hydrology practices into urban redevelopment.

GOAL #1 KEY QUESTIONS	IMPORTANCE[10]	COMMENTS[11]
Effective Impervious Area		
1. Does the code distinguish between pervious paved areas and impervious paved areas in the determination of onsite stormwater requirements?	◑	
2. Does the code definition of impervious area distinguish between impervious area connected to the storm drain system (effective impervious area) and disconnected impervious area?	◑	
Streets		
1. For residential development and redevelopment, are the street pavement widths allowed to be between 18 to 22 feet, with curb pullouts for passing of large vehicles?	●	
2. Are travel lanes allowed to be from 12 to 10 feet (or less), with curb pullouts for passing of large vehicles?	●	
3. Are curb bumpouts/extensions allowed near intersections and mid-block for traffic-calming and bioretention opportunities?	◑	
4. Is pervious paving allowed for on-street parking and alleyways?	◑	
5. Are grass swales or bioretention swales allowed instead of curb and gutter or with curb cuts (where slopes allow)?	◑	
6. Are bioretention areas, swales, and other green infrastructure techniques allowed to replace the required “grass strip” or “parkway area” between the sidewalk and curb?	●	
7. If there are cul-de-sacs, is the radius required to be 35 feet or less?	○	
8. If there are cul-de-sacs or roundabouts, are landscaped islands or bioretention islands allowed or encouraged?	○	
9. Are site designs for development and redevelopment required to promote the most efficient street layout to reduce overall street length?	○	

[10] Degree of Importance Key to Symbols: ● Essential ◑ Very important ○ Important

[11] Indicate ordinance findings “yes” or “no.” When “no,” note specific location of barrier in code.

GOAL #1 KEY QUESTIONS	IMPORTANCE[10]	COMMENTS[11]
Parking		
1. Is the minimum stall width for a standard parking space 9 ft. or less?	●	
2. Are parking stall lengths allowed to be 15 ft.?	●	
3. Are parking lot drive aisles allowed to be 22 ft.?	◑	
4. Are bioretention cells allowed in parking medians?	●	
5. Are consolidated travel lanes and on-street parking allowed to create space for bioretention?	○	
6. Are pervious surfaces such as paver stones, porous pavement, or other pervious pavers allowed for on-street parking?	◑	
7. For office buildings, is the required parking ratio 3.0 spaces per 1,000 sq. ft. of gross floor area or less?	◑	
8. For commercial centers, is the required parking ratio 2 to 4.5 spaces per 1,000 sq. ft. of gross floor area or less?	◑	
9. Are proposed developments and redevelopment areas allowed to take advantage of opportunities for shared parking?	◑	
10. Are proposed developments and redevelopment allowed to have parking stalls under the second floor podium?	○	
Buildings		
1. Do requirements for rooftop structures and materials allow or encourage cisterns?	◑	
2. Are buildings allowed to have bioretention areas, swales, and other Green Infrastructure practices near the foundation if properly designed?	◑	
Driveways/Sidewalks		
1. Are driveway standards 9 feet or less in width?	◑	
2. Are shared driveways allowed?	●	
3. If sidewalks are required, are they required to be designed to the narrowest allowable width (e.g., 4 ft.)?	○	
4. Are sidewalks allowed to be on one side of the street only?	○	

GOAL #1 KEY QUESTIONS	IMPORTANCE[10]	COMMENTS[11]
Clustering Development		
1. Is redevelopment encouraged in lieu of greenfield development through site performance standards?	●	
2. Is Conservation or Open Space Design an option, particularly for development in environmentally sensitive areas?	●	
3. To encourage clustering and open space design, are setbacks minimized (e.g., for residential lots that are ½-acre or less in size, is the front set back 20 feet or less, the rear setback 25 feet or less, and the side setback 8 feet or less?)	●	
4. Are site designs required to have development focused on areas of lesser slopes and farther from watercourses?	◑	
5. Are policies effective in encouraging new higher density development and redevelopment to be centered around transportation corridors?	●	

GOAL #2: PRESERVE AND ENHANCE THE HYDROLOGIC FUNCTION OF UNPAVED AREAS

Objectives: Minimize building footprint/envelope area and preserve topsoil structure, sensitive wetlands and washes, sensitive soils, and sensitive stream buffers.

GOAL #2 KEY QUESTIONS	IMPORTANCE[12]	COMMENTS[13]
Topsoil Structure & Building Footprint		
1. Is disturbance of vegetated areas required to be phased?	●	
2. Is disturbance of vegetated areas and riparian areas required to be minimized?	◑	
3. Are building envelopes required/encouraged to avoid sensitive environmental areas such as riparian areas, wetlands, high infiltration soils, and steep slopes?	◑	
Wetlands		
1. Are site designs required to minimize hydrologic alteration to existing wetlands?	◑	
Sensitive Soils		
1. Are building footprints required/encouraged to avoid highly erodible soils?	◑	
2. Are building footprints required/encouraged to avoid soils with high permeability (e.g., Hydrologic Soil Group A and B)?	◑	
Stream Buffers		
3. Is a 50- to 75-foot stream buffer required/encouraged for new development and redevelopment?	○	
4. Are stream buffers for new development and redevelopment required to remain in a natural state?	◑	
5. Are site designs required to preserve existing runoff pathways to adequately support existing wetlands?	◑	
6. Is a 50-foot wetland buffer required/encouraged?	○	

[12] Degree of Importance Key to Symbols: ● Essential ◑ Very important ○ Important

[13] Indicate ordinance findings "yes" or "no." When "no," note specific location of barrier in code.

GOAL #3: HAVEST RAINWATER TO ENHANCE POTABLE & NONPOTABLE WATER SUPPLY

Objectives: Through plumbing code provisions, enhance rainwater harvesting and water conservation. Through the building and zoning code, allow the use of rooftop runoff disconnection and rainwater harvesting by routing rainwater to natural and landscape areas throughout the site.

GOAL #3 KEY QUESTIONS	IMPORTANCE[14]	COMMENTS[15]
Plumbing Code		
1. Are interior or exterior cisterns allowed?	●	
2. Is a BMP maintenance plan required?	●	
3. Is harvested rainwater allowed to be used for nonpotable interior uses such as toilet flushing?	○	
4. Are personal treatment systems allowed to be used for potable water supply?	○	
Building and Zoning Code		
1. Can rooftop runoff be disconnected and distributed throughout the site via contours and drainageways to discharge into natural areas or landscape areas?	●	
2. Are interior or exterior cisterns allowed?	●	
3. Can rain barrels be placed within standard zoning setback areas for new development and redevelopment?	●	
4. Do zoning and building provisions allow cisterns to be placed on rooftops to harvest rainwater?	◑	
5. Is a BMP maintenance plan required?	◑	

[14] Degree of Importance Key to Symbols: ● Essential ◑ Very important ○ Important

[15] Indicate ordinance findings "yes" or "no." When "no," note specific location of barrier in code.

GOAL #4: ALLOW AND ENCOURAGE MULTI-USE STORMWATER CONTROLS

Objectives: Allow and encourage stormwater controls as multiple use in open space areas and landscaped areas.

GOAL #4 KEY QUESTIONS	IMPORTANCE[16]	COMMENTS[17]
Landscaped Areas		
1. Does the code and zoning ordinance allow or promote development of an urban tree canopy?	●	
2. Are bioretention areas allowed to be constructed in the development's designated landscape areas, if properly designed?	●	
3. Are bioretention areas given "credit" as landscape area to count as a percent of the required landscaping?	●	
4. Are landscaping plans required to consider less water-intensive, native vegetation?	●	
5. Do landscaping requirements allow plantings conducive to bioretention, bioswales, rain gardens, and other Green Infrastructure BMPs?	●	
6. Do tree planting requirements allow use of rain gardens, tree boxes, and other Green Infrastructure BMPs?	●	
7. If irrigation is required, are weather-based or moisture-based irrigation controls required?	◑	
Open Space Areas		
1. Are there open space preservation requirements or incentives for new development and redevelopment?	○	
2. Is preserved open space required to be managed in a natural condition?	◑	
3. Are Green Infrastructure structural techniques such as constructed wetlands, swales, and bioretention areas allowed to be constructed in a development's designated open space, if properly designed?	●	
4. Are Green Infrastructure structural techniques such as constructed wetlands, swales, and bioretention areas given "credit" as open space to count as a percent of the required open space area, if properly designed?	●	
5. Does protection of sensitive, natural areas and habitat qualify as credit for local open space dedication?	●	

[16] Degree of Importance Key to Symbols: ● Essential ◑ Very important ○ Important

[17] Indicate ordinance findings "yes" or "no." When "no," note specific location of barrier in code.

GOAL #5: MANAGE STORMWATER TO SUSTAIN STREAM FUNCTIONS

Objectives: Replicate the predevelopment hydrology of the site, to the extent practicable, maintain water quality functions of the watershed, minimize channel erosion and flooding impacts, inspect BMPs to ensure proper construction and design, and ensure long-term maintenance.

GOAL #5 KEY QUESTIONS	IMPORTANCE[18]	COMMENTS[19]
Performance Standards		
1. Is stormwater required to be retained/infiltrated onsite (through bioretention, natural areas, and swale infiltration) where possible (e.g., Hydrologic Soil Group A and B)?	●	
2. Do stormwater management practice standards and sizing provide sufficient storage volume?	●	
3. Are water quality treatment performance standards adequate?	●	
4. Are channel protection performance standards adequate?	●	
5. Are flood control performance standards adequate?	●	
6. Are thresholds of applicability adequate (e.g. land disturbance greater than 5,000 sq. ft.)?	●	
7. Are outfalls required to be stabilized to reduce erosion?	●	
Inspections		
1. Are inspections required during construction and routinely after construction (i.e. for post construction BMPs)?	●	
2. Are inspectors required to be trained and certified?	●	
Maintenance		
1. Are maintenance agreements required?	●	
2. Is maintenance required to be performed by a certified professional?	●	

[18] Degree of Importance Key to Symbols: ● Essential ◑ Very important ○ Important

[19] Indicate ordinance findings "yes" or "no." When "no," note specific location of barrier in code.

GOAL #5 KEY QUESTIONS	IMPORTANCE[18]	COMMENTS[19]
Off-Site Mitigation		
3. Is offsite mitigation required when on-site management does not meet the performance criteria (unless there is proof of no adverse impact)?	●	
4. Is offsite mitigation for forested area conservation allowed in the same named watershed? Is the replacement ratio at least 1:1?	●	
5. Is offsite mitigation for riparian area conservation allowed in the same named watershed? Is the replacement ratio at least 1:1?	●	
6. Is offsite mitigation for BMP retrofit allowed in the same named watershed?	●	
7. Is nutrient banking or the equivalent land banking allowed in the same named watershed? Is redevelopment encouraged in lieu of greenfield development?	◑	