Green Infrastructure for Los Angeles:

Addressing Urban Runoff and Water Supply Through **Low Impact Development**

In memory of Dorothy Green,

whose dedication to creating healthy, sustainable waters for
Los Angeles and the state of California was an inspiration to us all.

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[1] Executive Summary

The purpose of this report is to examine low impact development (LID) for the City of Los Angeles and potential steps for instituting city-wide low impact development programs or projects. It also gathers policy strategies and technical information that could be pertinent to the City's LID efforts.

Part I (Chapters 2–5) describes the importance of low impact development and green infrastructure and highlights existing LID programs throughout the nation and here in Southern California. Part II (Chapters 6–11) explores potential ways to implement LID in Los Angeles and some of the issues that should be considered. It also reviews current policies and regulations (such as stormwater management laws and the City's recent Green Building Ordinance) that intersect with local LID programs. Finally, the appendices contain additional information and resources that may be helpful for developing comprehensive green infrastructure programs and projects for the City of Los Angeles.

Rio Hondo Golf Course parking lot in Downey, CA

What is Low Impact Development?

Stormwater pollution, water shortages, flood control, climate change and the availability of natural green space have all become pressing environmental issues for cities around the nation, including the City of Los Angeles. Fortunately, new strategies for runoff management using low impact development and green infrastructure offer promising solutions to many of these concerns.

Low impact development (LID) is an approach to stormwater management that emphasizes the use of small-scale, natural drainage features integrated throughout the city to slow, clean, infiltrate and capture urban runoff and precipitation, thus reducing water pollution, replenishing local aquifers and increasing water reuse.[1]

Key Principles of Low Impact Development

- Decentralize & manage urban runoff to integrate water management throughout the watershed.
- Preserve or restore the ecosystem's natural hydrological functions and cycles.
- Account for a site's topographic features in its design.
- Reduce impervious ground cover and building footprint.
- Maximize infiltration on-site.
- If infiltration is not possible, then capture water for filtration and/or reuse.

While conventional stormwater controls aim to move water off-site and into the storm drains as quickly as possible, LID seeks to do just the opposite—to keep as much water on-site as possible for absorption and infiltration in order to clean it naturally. LID focuses on controlling urban runoff and pollution at the source of the problem, rather than at the end of the storm drain outlet. A comprehensive approach to LID should include city-wide land development strategies and planning along with the creation of infrastructure for stormwater management.

Green Infrastructure

Green infrastructure refers to an interconnected network of natural features (vegetation, parks, wetlands, etc.) that provide beneficial "ecosystem services" for human populations. The benefits can include functions such as pollution removal, carbon sequestration and groundwater recharge.[2] [3] Low impact development and green infrastructure are often used interchangeably because the terms overlap, but it should be noted that LID focuses specifically on water management issues, while green infrastructure's scope can be broader. Green infrastructure is often used to refer to networks of parks and open lands that preserve habitats and ecosystem functions (usually created or protected by managing land uses), but the term can also encompass small-scale natural features such as trees planted along a city sidewalk. While green infrastructure is often used for water management purposes, it can also be used to tackle other issues such as air pollution, urban heat island effects, wildlife conservation and recreational needs.

Common LID Best Management Practices

A **best management practice (BMP)**[4] is a device or technique used to remove or reduce pollutants found in stormwater runoff, preventing the contamination of receiving waters.[a] It is important to note that LID primarily employs *natural* structural best management practices (such as vegetated swales, retention ponds and green roofs), not mechanical best management practices (such as water treatment facilities and manufactured filtration units). Examples of some of the most common LID best management practices are depicted on the next page; a more extensive selection can be found in Chapter 3. The best management practices generally fall into four categories: landscape BMPs, building BMPs, street and alley BMPs, and site planning BMPs.

Seattle's SEA Street (Street Edge Alternatives) project includes bioswales and permeable pavement.

[a] Receiving waters are lakes, rivers, oceans, and other types of waterways into which stormwater can flow.

Some Common LID Best Management Practices [5]

			
Vegetated Swales / Bioswales	Rain Gardens	Rain Cisterns	Green Roofs

			
Permeable Pavers	Porous Pavement	Curb Bump-Outs	Curb Cuts

The Benefits of LID for Los Angeles

Low impact development offers a wide range of community benefits. It improves flood control, relieves pressure on the sewage treatment system, prevents river and ocean pollution, reduces the demand for water use, augments groundwater aquifers, mitigates climate change, provides natural green space, increases the availability of green jobs, and saves money on the capital costs for stormwater management infrastructure.

The potential benefits of low impact development to help water pollution, water supply and energy usage in Los Angeles County are compelling. A study done by Community Conservancy International in March 2008 found that **nearly 40% of L.A. County's needs for cleaning polluted runoff could be met by implementing low impact development projects on existing public lands.** A net average of 15,000 acres of existing public lands in the county are suitable for LID projects.[6]

In addition, each ¼-acre of hardscape in Los Angeles has the potential to collect 100,000 gallons of rainwater per year.[7] A separate study by the Natural Resource Defense Council from January 2009[8] found that an increased use of LID practices throughout residential and commercial properties in L.A. County would promote groundwater recharge and water capture and reuse, reducing the county's dependence on distant sources of water. This increased use of LID would result in the **savings of 74,600–152,500 acre-feet of imported water** per year by 2030. Based on current per capita water usage in the City of Los Angeles, this is equivalent to the water consumption of 456,300–929,700 people.[9] Moreover,

since L.A. County would be pumping less water from distant locations, **131,700–428,000 MWH of energy would be saved** per year by 2030, which is equivalent to the electricity used by 20,000–64,800 households.[10] Therefore, LID could also mitigate climate change by reducing greenhouse gases.

The following tables highlight some of the advantages that LID has to offer and provide interesting facts about the effectiveness of LID. Additional tables about flood control, wastewater management, water pollution, community improvements, and construction and building costs can be found in Chapter 4.

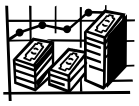
Bioswales at 1100 S. Hope Street in downtown L.A.

Water Supply & Demand

Issues	How LID Helps	Supporting Facts
• The L.A. area regularly faces water shortages and does not generate enough water to sustain itself. • Only 13% of L.A. City's water supply comes from local groundwater.[11] • 48% of L.A. City's water supply originates from the Mono Basin and Owens Valley aqueducts. • At least 30% of all the water used in the City of Los Angeles is used outdoors.[12]	• Decreases Los Angeles' dependence on outside sources of water. • Reduces the demand for irrigation water because rainwater is slowed and captured for infiltration into the ground. Some methods also capture water for reuse. • Increases the supply in the local water table. • Promotes or requires the use of drought-tolerant plants.	• Widespread use of water infiltration, capture and reuse in L.A. County would result in the savings of 74,600–152,500 acre-feet of imported water per year by 2030.[13] (Equivalent to the water consumption of 456,300–929,700 people.) • Each ¼-acre lot in L.A. has the potential to generate100,000 gallons of stormwater annually.[14] • By disconnecting 60,000 gutter downspouts, Portland diverted 1.5 billion gallons of stormwater per year. [15]

Climate Change

Issues	How LID Helps	Supporting Facts
• Fossil fuels are the #1 source of the greenhouse gases that cause climate change. • World temperatures could rise by between 2.0 and 11.5 °F during the 21st century.[16] • Blacktop surfaces can elevate surrounding city temperatures as much as 10°F. [17] • In the summer, central Los Angeles is typically 5°F warmer than surrounding suburban and rural areas due to the heat island effect.[18]	• Increasing the local water supply means that Los Angeles will use less energy pumping water from distant locations. • Trees and landscaping counteract climate change by absorbing excess carbon dioxide. • Shade from trees and evapotranspiration by plants reduce the heat island effect.	• Water systems account for 19% of the electricity used in the state of California.[19] • L.A. County could save 131,700–428,000 mWh of energy per year if less water was transported from Northern California.[20] (Equivalent to electricity use of 20,000–64,800 households.) • Each shade tree in L.A. prevents the combustion of 18kg of carbon annually and sequesters an additional 4.5–11kg of carbon per year. [21]



Green Jobs & Economy

Issues	How LID Helps	Supporting Facts
• The City of Los Angeles would like to encourage the development of "green-collar" jobs.[22] • The current economic recession has resulted in city budget cuts. More revenues are needed to fill the gaps.	• Encourages the growth of the green building industry. • Encourages the landscaping and gardening industry to shift to eco-friendly practices that emphasize native, drought-tolerant plants and rainwater harvesting. • Property drainage evaluations could increase the demand for "green industry" jobs in environmental assessment. • Trees and landscaping and reduced neighborhood flooding can enhance neighborhood property values, thus increasing tax revenues.	• L.A.'s Green Building Ordinance will create an anticipated 500 green-collar, union jobs.[23] • L.A.'s growing green building industry presents workforce development opportunities for auditors and landscapers and gardeners.[24] • Trees in Portland, OR generate approx. $13 million per year in property tax revenues by increasing real estate values.[25]

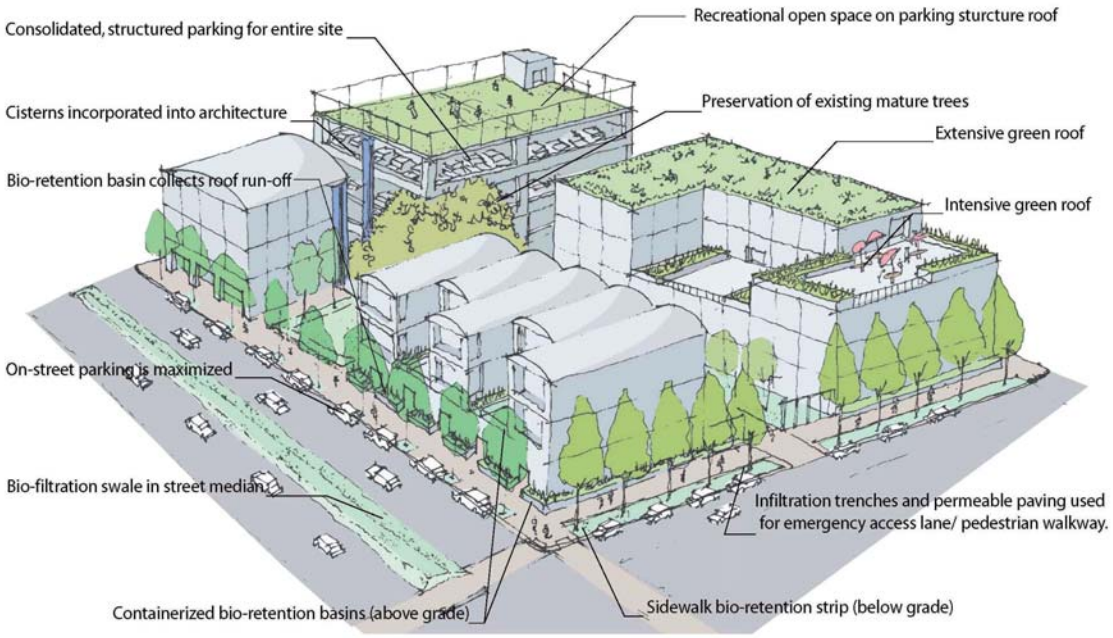


Illustration from the City of Emeryville's *"Stormwater Guidelines for Green, Dense Redevelopment"* manual depicting what LID might look like for a commercial development. *Credit: City of Emeryville / Community, Design + Architecture*

Examples of LID Programs, Projects and Regulations [26]

Many cities and counties across the country already have low impact development regulations, programs and projects underway, often pursued as an extension of a greater stormwater management, landscaping or sustainability program. Some particularly notable examples include the nation's first official LID program in Prince George's County (MD), Seattle's "Street Edge Alternatives" retrofit projects and their Green Factor building code (which requires properties to attain a certain level of permeability), numerous Green Streets projects in Portland (OR), Chicago's Green Alleys program, and Emeryville's program that promotes green, dense redevelopment.

The County of Los Angeles passed its Low Impact Development Ordinance in October 2008, which could offer a template for future LID efforts in the City of Los Angeles. The City of Los Angeles does not yet have a LID ordinance of its own, but it does have a number of pilot programs in place such as the Oros Street stormwater retrofit, Bimini Slough Ecology Park, the Green Streets LA program, and the Downspout Disconnect program. Other examples of LID in Southern California include the City of Ventura's Green Street policy, the City of San Diego's low impact development program, and Santa Monica's green building program.

Oros Street after its "green street" reconstruction (Los Angeles)

Existing Stormwater Regulations & Programs in Los Angeles

There are a number of stormwater regulations and green infrastructure programs originating from the federal, state, county and city levels of government that apply to the City of Los Angeles, providing a solid foundation for future LID efforts. Four key regulations and programs in the City of Los Angeles are the Standard Urban Stormwater Mitigation Plan, the Green Building Ordinance, the Landscape Ordinance and the Green Streets LA program.

The **Standard Urban Stormwater Mitigation Plan (SUSMP)** is part of L.A. County's Municipal Stormwater Permit, which applies to the City and addresses federal water pollution regulations by setting stormwater management requirements. In general, SUSMP applies to new developments and redevelopments of a certain minimum size.[27] It therefore does not apply to a large amount of existing development in Los Angeles. SUSMP best management practices must be able to infiltrate, capture and reuse, or treat all of the runoff from a site during an 85th percentile storm, which is equivalent to a ¾" storm. Although many of Los Angeles' existing low impact development BMPs were installed due to SUSMP requirements, SUSMP's primary goal is to reduce pollution levels; it only incidentally diverts stormwater to groundwater recharge areas. Additionally, the L.A. County Stormwater Permit must be reissued every five years, and its requirements can vary from permit to permit.

A vegetated swale with curb cuts in the parking lot of a shopping center at 8500 Firestone Blvd., Downey, CA.

The City of Los Angeles' **Green Building Ordinance** and **Landscape Ordinance** both have some LID features, but at this time neither addresses low impact development principles.[28] [29] Like SUSMP, they do not deal with existing development, and they do not specifically require significant use of green infrastructure BMPs.

The **Green Streets LA** program was initiated by the City Board of Public Works with the idea that Los Angeles' extensive street network offers an important opportunity to absorb, capture and filter urban runoff, which addresses pollution and groundwater recharge issues.[30] The Green Streets LA program has expanded the City's focus to include a broader array of LID practices. A preliminary set of Green Streets design guidelines were developed in 2008 and other measures are being planned to institutionalize low impact development.

How Much Does Low Impact Development Cost?

Pilot projects have shown that using low impact development techniques instead of conventional stormwater controls can result in considerable capital cost savings. **An analysis of LID projects from across the nation conducted by the U.S. Environmental Protection Agency (EPA) in 2007 found that with just a few exceptions, the capital costs of LID projects were less than conventional water management controls.** As shown in the table below, savings ranged from 15–80%.[31] (Please see Appendix III for a fact sheet about the report.) It is important to note that the EPA's analysis did not account for the value of the environmental, social and community benefits created by the projects.

Project [a]	Estimated Conventional Development Cost	Actual LID Cost	Cost Savings[b]	Percent Savings[b]
2nd Avenue SEA Street (Washington)	$868,803	$651,548	$217,255	25%
Auburn Hills (Wisconsin)	$2,360,385	$1,598,989	$761,396	32%
Bellingham City Hall (Washington)	$27,600	$5,600	$22,000	80%
Bellingham Park (Washington)	$52,800	$12,800	$40,000	76%
Gap Creek (Arkansas)	$4,620,600	$3,942,100	$678,500	15%
Garden Valley (Washington)	$324,400	$260,700	$63,700	20%
Kensington Estates (Washington)	$765,700	$1,502,900	–$737,200	–96%
Laurel Springs (Wisconsin)	$1,654,021	$1,149,552	$504,469	30%
Mill Creek[c] (Illinois)	$12,510	$9,099	$3,411	27%
Prairie Glen (Wisconsin)	$1,004,848	$599,536	$405,312	40%
Somerset (Maryland)	$2,456,843	$1,671,461	$785,382	32%
Tellabs Corporate Campus (Illinois)	$3,162,160	$2,700,650	$461,510	15%

EPA Report:

Cost Comparisons Between Conventional and LID Approaches

Notes:

[a] Some of the case study results do not lend themselves to display in the format of this table (Central Park Commercial Redesigns, Crown St., Poplar Street Apartments, Prairie Crossing, Portland Downspout Disconnection, and Toronto Green Roofs).

[b] Negative values denote increased cost for the LID design over conventional development costs.

[c] Mill Creek costs are reported on a per-lot basis.

Source: "Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices." USEPA, 2007.

Research conducted by the City of Ventura may be helpful in determining the potential costs of implementing low impact development in Los Angeles, as Ventura is also located in Southern California and has a similar climate. A copy of Ventura's "Green Streets Matrix" is included in Appendix II. It contains an analysis of the costs, benefits, challenges and drawbacks for 17 different kinds of LID best management practices. The City of Los Angeles' Green Streets LA program is also in the process of developing its own cost estimates.

Low Impact Development for Los Angeles

Funding and Maintaining a LID Program

In a time of government budget cuts, searching for steady funding to support new public works projects and regular maintenance services has never been more important. Consistent maintenance of low impact development best management practices will ensure that they continuously perform at a high standard. Chapter 6 highlights more than a dozen strategies that could help secure a steady revenue stream for city projects and services. Ideas include municipal bonds, LID in-lieu fees, individualized parcel drainage fees with a rebate program, parking increment financing, using Quimby Fees for LID parks, public-private partnerships, and sales of L.A. City carbon offsets.

Strategies to Codify Low Impact Development

While a number of existing regulations and programs in Los Angeles touch on low impact development principles, the City could benefit from a comprehensive, enforceable ordinance that makes LID a common practice. **The two greatest advantages to enacting a LID ordinance—as opposed to relying exclusively on LID policies—are (1) enforcement, and (2) long-term reliability.** Nonetheless, a few alternative methods for implementing low impact development on a smaller scale include meeting SUSMP requirements using low impact development standards, revising the Landscape Ordinance to include LID standards, or enacting a LID ordinance after a voluntary pilot phase. These alternatives are further described in Chapter 8.

Defining the Scope of a LID Strategy for Los Angeles

Chapter 9 discusses issues that must be considered in order to define the appropriate scope and standards for a low impact development strategy in Los Angeles:

- Determining to whom LID should apply—government buildings, public infrastructure, private residences, commercial properties, industrial land, etc.
- Encompassing new and existing development to ensure that LID is implemented throughout the watershed for maximum results, possibly using a rebate program to encourage existing properties to install LID best management practices.
- Deciding how to safely include brownfields in a LID program.
- Setting new performance standards—should LID vary with soil type and the character of the local water table? Would it benefit L.A. to exceed current SUSMP standards?
- Suggestions for the potential contents of a comprehensive LID ordinance, program and standards manual.

A curb cut that directs water from the street into a bioswale. 1100 S. Hope Street in downtown Los Angeles.

Considerations for LID Implementation

Low impact development offers promising strategies for the City of Los Angeles to significantly improve stormwater management and increase water supply and green space while simultaneously reducing its impact on climate change and the environment in general. However, the city should consider a number of challenges before developing and implementing a comprehensive LID program. Chapter 10 explores the following issues:

- Defining LID goals and standards that are appropriate for Los Angeles.
- Balancing the City's smart growth and infiltration goals.
- Administrative challenges—which departments will administer LID? Are there any existing regulations that conflict with LID?
- LID readiness and education—do city employees, architects, landscape designers and professional gardeners have the knowledge to properly implement LID techniques?
- LID knowledge, data and evaluation—need to gather more information about the costs and effectiveness of using LID in dry climates.
- Equity issues—how can we ensure that implementing low impact development will not unfairly burden low income communities with a financial obligation that might be difficult to bear without a subsidy?

Recommended Next Steps

Chapter 11 recommends a number of steps that the City of Los Angeles can pursue to implement a more comprehensive low impact development (LID) and green infrastructure program. These recommendations can be summarized as:

1. Internal Review: review low impact development strategy with the City's Green Team, Green Streets Committee and City Council committees.
2. Survey and analyze current policies, ordinances and standards to identify potential conflicts with LID and green infrastructure. Make recommendations for necessary changes. (See Chapters 7 & 10.) Engineering and building & safety standard plans, practices, and ordinances should be a top priority. Also check fire and flood ordinances and insurance maps for conflicts with LID.
3. Integrate LID principles into the Conservation Element of the General Plan.
4. Integrate LID principles into a revised Landscape Ordinance, which the state requires every city to adopt by 2010. (See Chapter 7, page 74.)
5. Determine which groups need to be involved with LID brainstorming, review and feedback: environmental groups, developers, architects, landscape architects, planners, civil engineers, community organizations, gardening industry, etc.
6. Develop a working group to draft a LID ordinance.

Conclusion

Southern California was designed and built mostly in the 20th Century, and the prevailing idea at the time was to move water quickly and directly to the ocean. In the 21st Century, we have learned how to design our streets, sidewalks, and landscaping to soak up runoff through a more natural process, weaving the textures of nature into the fabric of the city. Low impact development is an emerging and important international stormwater management trend. We have begun to capitalize on the valuable services that nature can offer us: capturing, cleaning, and storing stormwater.

Nationwide research has proven that low impact development can be a cost effective solution to pressing problems pertaining to water quality and water supply, as well the other benefits noted in this paper, such as flood control, mitigation of climate change, and creation of more natural spaces. For instance, research conducted in Los Angeles has found that the City can significantly increase its water supply, ameliorate climate change issues, and address of much of the pollution found in urban runoff by converting its paved areas from gray to green. Moreover, implementing low impact development will create new, local "green-collar" jobs through the development of a workforce trained to install and maintain green infrastructure features.

The LID principles become particularly crucial as climate change impacts to our environment produce changing weather patterns that are currently predicted to result in longer term drought conditions throughout California. Harvesting all available rainwater by the various methods shown in this paper is an important means of addressing this looming problem.

The City of Los Angeles is well underway toward implementing the principles of low impact development into its designs for streets, sidewalks and alleys, through its Green Streets and Green Alleys program. With over 6,500 miles of streets and 900 miles of alleys, much could be accomplished by incorporating LID principles into new construction and by phasing in LID conversions for existing infrastructure. However, these paved areas only account for a portion of the hardscape found in Los Angeles, and thus only a portion of the stormwater burden. Implementation of low impact development on a wider and more intensive scale throughout the city is worth consideration, both on public and private property.

Endnotes

[1] Puget Sound Action Team, Washington State University Pierce County Extension. "Low Impact Development: Technical Guidance Manual for Puget Sound," p.1. January 2005. Accessed on 8/5/08, www.psp.wa.gov/downloads/LID/LID_manual2005.pdf

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[4] U.S. Environmental Protection Agency. "Urban Stormwater BMP Performance Monitoring: A Guidance Manual for Meeting the National Stormwater BMP Database Requirements," p.10. April 25, 2002. Accessed on 8/10/08, http://www.epa.gov/guide/stormwater/files/montch1and2.pdf

[5] *Photo credits for Common LID BMPs:* Vegetated swales = Capital Region District, British Columbia. Rain garden = Iowa Natural Resources Conservation Service. Rain cistern = EPA / Abby Hall. Green roof = City of Los Angeles Bureau of Sanitation. Permeable pavers = EPA / Abby Hall. Porous pavement = City of Los Angeles Watershed Protection Division, Planning and Engineering Section. Curb bump-out = EPA / Abby Hall. Curb cuts = Haan-Fawn Chau.

[6] Community Conservancy International. "The Green Solutions Project" report, March 2008. Executive Summary, p.ES-3. The report can be viewed at http://www.ccint.org/greensolution.html

[7] Estimates of potential stormwater runoff assuming an average yearly rainfall in Los Angeles of 15-inches on impervious surfaces. {Potential stormwater from a ¼-acre lot} = (0.25 x 43,560 sq.ft. per acre) x (15" rain per year) / (12" per ft.) x (7.481 gal. per cu.ft.) = 101,835 gallons. An ordinary, 2-lane street is 30 feet wide. {Potential stormwater from a city street, not including sidewalks} = (500 ft. long) x (30 ft. wide) x (15" rain per year) / (12" per ft.) x (7.481 gal. per cu.ft.) = 140,269 gallons. Calculation by the City of Los Angeles Bureau of Sanitation, November 2008.

[8] *First source of information:* Beckman, David S. and Noah Garrison. "NRDC Comment on AB32 Scoping Plan Appendices—Water Sector," August 11, 2008. Natural Resources Defense Council comments sent to the California Air Resources Board. *Second source of information:* Email message from Noah Garrison, Project Attorney at NRDC, on January 21, 2009. "LID Numbers for L.A. County."

[9] This calculation is based on the average daily per capita water use of Los Angeles residents from 2006-2007, which was 146 gallons per person per day. (According to the City of Los Angeles Department of Environmental Affairs website, http://www.lacity.org/EAD/2007environmental%20facts.htm, accessed on 2/22/09.) 146 gallons per day x 365 days per year = 53,290 gallons per person per year = .1635 AF/person/year. Conversion factor: 1 acre foot = 325,851 gallons. 74,600 AF per year saved / .1635 AF per person per year = the water used by 456,269 people. 152,000 AF per year saved / .1635 AF per person per year = the water used by 929,664 people.

[10] This calculation is based on the average monthly electricity use per household in the City of Los Angeles, which is 550 kWh. (According to the C40 Cities website, http://www.c40cities.org/bestpractices/renewables/la_renewable.jsp, accessed on 2/22/09.) 550 kWh per household per month x 12 months = 6,600 kWh = 6.6 mWh per household per year. 131,700 mWh saved per year / 6.6 mWh per household per year = 19,955 households per year. 428,000 mWh saved per year / 6.6 mWh per household per year = 64,848 households per year.

[11] *See Endnote #8.*

[12] Los Angeles Department of Water & Power. "City of Los Angeles Water Supply Action Plan," p.4. May 2008.

[13] *See Endnote #8.*

[14] Estimates of potential stormwater runoff assuming an average yearly rainfall in Los Angeles of 15-inches on impervious surfaces. {Potential stormwater from a ¼-acre lot} = (0.25 x 43,560 sq.ft. per acre) x (15" rain per year) / (12" per ft.) x (7.481 gal. per cu.ft.) = 101,835 gallons. An ordinary, 2-lane street is 30 feet wide. {Potential stormwater from a city street, not including sidewalks} = (500 ft. long) x (30 ft. wide) x (15" rain per year) / (12" per ft.) x (7.481 gal. per cu.ft.) = 140,269 gallons. Calculation by the City of Los Angeles Bureau of Sanitation, November 2008.

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[16] Intergovernmental Panel on Climate Change. "Climate Change 2007: Synthesis Report. Summary for Policy Makers." IPCC Fourth Assesment Report (AR4); Summary for Policy Makers. Accessed on 1/2/09, http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf

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[19] *See Endnote #8*

[20] ibid.

[21] Akbari, H. "Shade Trees Reduce Building Energy Use and CO_2 Emissions From Power Plants." *Environmental Pollution* 116 (2002) S119–S126. Accessed on 1/4/09, http://www.fs.fed.us/psw/programs/cufr/products/12/psw_cufr703_Akbari_Reduce_Energy_Use.pdf

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[25] USDA Forest Service, Pacific Northwest Research Station. *Study shows that street trees increase the value of Portland homes by more than $1 billion*, March 10, 2008. Accessed on 1/3/09, http://www.fs.fed.us/pnw/news/2008/03/trees.shtml

[26] Please see the source citations in Chapter 5 for more information about this section.

[27] State of California, California Regional Water Quality Control Board, Los Angeles Region. "Waste Discharge Requirements for Municipal Storm Water and Urban Runoff Discharges Within the County of Los Angeles, and the Incorporated Cities Therein, Except the City of Long Beach." Order No. 01-182, NPDES Permit No. CAS004001. December 13, 2001.

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Part I:
Understanding Low Impact Development

A multi-family home in Santa Monica that utilizes drought-tolerant landscaping and a rain barrel to capture water for reuse.

[2] What is Low Impact Development?

Introduction

Stormwater pollution, water shortages, flood control, climate change and the availability of natural green space have all become pressing environmental issues for cities around the nation, including the City of Los Angeles. These concerns affect not only the city's environmental quality, but also our long-term quality of life. **This report takes a look at how a low impact development program in the City of Los Angeles could offer promising solutions to many of the city's environmental concerns, especially those related to water management.**

Rio Hondo Golf Course parking lot in Downey, CA

Low impact development (LID), as defined by Washington State University's Puget Sound Action Team, "is a stormwater management strategy that emphasizes conservation and the use of existing natural site features integrated with distributed, small-scale stormwater controls to more closely mimic natural hydrologic patterns in residential, commercial and industrial settings."[1]

Low impact development takes a very different approach to water management as compared to conventional stormwater strategies. Conventional methods aim to move water off-site and into the storm drains as quickly as possible, while LID seeks to do just the opposite—keep as much water on-site as possible for absorption and infiltration. Instead of large, centralized treatment plants and water storage facilities, LID emphasizes local, decentralized solutions that capitalize on the beneficial services that natural ecosystem functions can provide. LID also focuses on controlling urban runoff and pollution right at the source, rather than at the end of the storm drain outlet. For example, a landscaped area may rely on natural soils to simultaneously absorb stormwater, filter out contaminants, and recharge the groundwater supply.

A comprehensive approach to LID should include city-wide land development strategies and planning along with the creation of infrastructure for stormwater management. As discussed in greater detail in Chapter 4, low impact development is most effective when it is applied on a wide scale. Additionally, it is important to note that LID encompasses much more than just water infiltration—it slows down water velocities (preventing floods downstream), filters out pollutants, and captures and stores water for later reuse.

Key Principles of Low Impact Development

A number of key principles characterize the goals of low impact development: [2] [3]

- Decentralize and micromanage urban runoff to integrate water management throughout the watershed.
- Preserve or restore the ecosystem's natural hydrological functions and cycles.
- Emphasize a distributed (not concentrated) control of stormwater.
- Account for a site's topographic features in its design.
- Reduce impervious ground cover and building footprint.
- Maximize infiltration on-site.
- If infiltration is not possible, then capture water for filtration and/or reuse.

At its most basic level, low impact development strives to slow, clean, infiltrate and capture urban runoff and precipitation through natural processes in order to increase groundwater recharge and water reuse.

Best Management Practices & Green Infrastructure

Best Management Practices (BMPs)

A wide array of techniques and features can be used to design a low impact development project. LID sites rely heavily on natural, small-scale structural best management practices to achieve their water management goals. According to the U.S. Environmental Protection Agency, a **best management practice (BMP)** is a device or technique used to remove or reduce pollutants found in stormwater runoff, preventing the contamination of receiving waters.[4] It is important to note that LID primarily employs *natural* structural BMPs (such as vegetated swales, retention ponds, green roofs), not mechanical BMPs (such as water treatment facilities and manufactured filtration units).

Key Terms

Low Impact Development (LID)

"A stormwater management strategy that emphasizes conservation and the use of existing natural site features integrated with small-scale stormwater controls to mimic natural hydrologic patterns." *(Puget Sound Action Team 2005)*

Best Management Practice (BMP)

A device or technique used to remove or reduce pollutants found in stormwater runoff, preventing the contamination of receiving waters. *(EPA 2002)*

Green Infrastructure

[1] "An interconnected network of green space that conserves natural ecosystem values and functions and provides associated benefits to human populations." *(The Conservation Fund)*

[2] Large scale and small-scale stormwater "management approaches and technologies that infiltrate, evapotranspire, capture and reuse stormwater to maintain or restore natural hydrologies." *(EPA)*

LID is Not LEED

Low impact development (LID) should not be confused with LEED, which stands for "Leadership in Energy and Environmental Design." LEED is a program run by the U.S. Green Building Council and is used to certify eco-friendly buildings and construction practices. While some features of LEED green buildings (green roofs, pervious pavement, etc.) fulfill the goals of low impact development, the two terms are not synonymous.

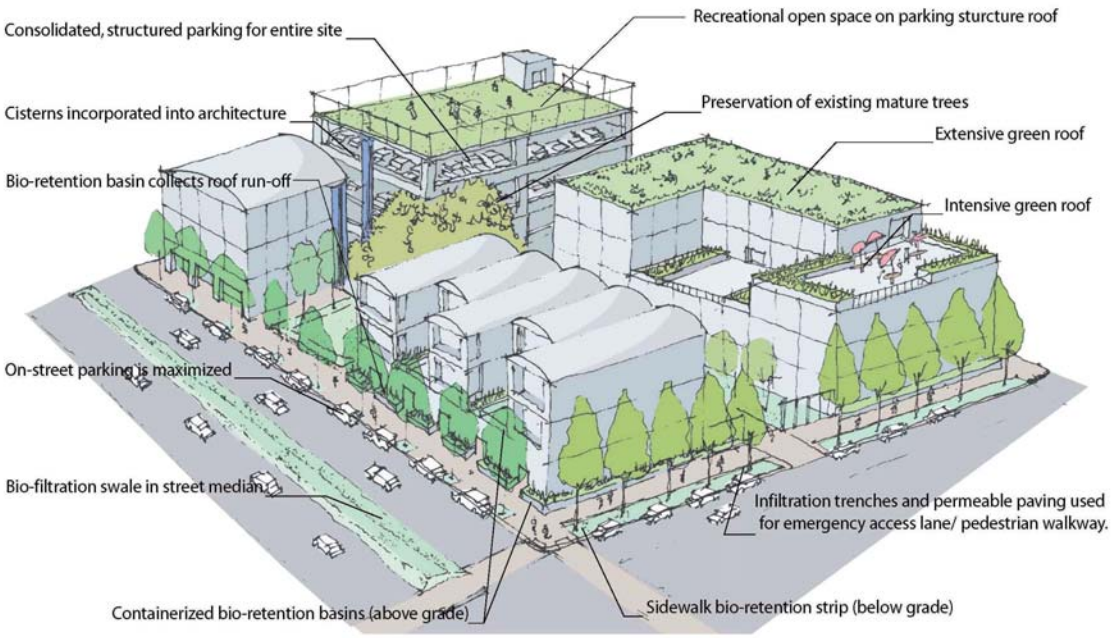


Illustration from the City of Emeryville's *"Stormwater Guidelines for Green, Dense Redevelopment"* manual depicting what LID might look like for a commercial development. *Credit: City of Emeryville / Community, Design + Architecture*

Green Infrastructure

In recent years, "green infrastructure" has become an important concept in the field of urban sustainability. Like many new terms, there is not yet one standard definition, but there is agreement on the principles. The Conservation Fund in Washington, DC states that "green infrastructure is defined as an interconnected network of green space that conserves natural ecosystem values and functions and provides associated benefits to human populations."[5]

The EPA defines green infrastructure as a stormwater management strategy that is closely intertwined with natural BMPs. The EPA website says that green infrastructure uses stormwater "management approaches and technologies to infiltrate, evapotranspire,[a] capture and reuse stormwater to maintain or restore natural hydrologies. At the largest scale, the preservation and restoration of natural landscape features (such as forests, floodplains and wetlands) are critical components of green stormwater infrastructure. On a smaller scale, green infrastructure practices include rain gardens, porous pavements, green roofs, infiltration planters, trees and tree boxes, and rainwater harvesting for non-potable uses such as toilet flushing and landscape irrigation." [6]

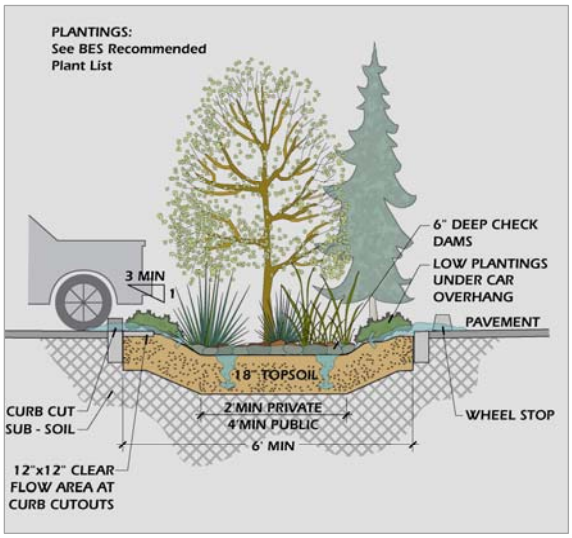
In either case, a city with a robust green infrastructure system can reap multiple benefits from the increased services that nature provides, especially with regards to stormwater management, increased

[a] Evapotranspire refers to the processes of evaporation and transpiration carried out by plants and trees.

local water supply, and pollution control. It should be noted that "low impact development" and "green infrastructure" are often used interchangeably because the terms overlap, but LID focuses specifically on water management issues, while green infrastructure's scope is broader. Green infrastructure can be used to tackle other issues besides stormwater management, such as air pollution, urban heat island effects, wildlife conservation and recreational needs.

Low Impact Development for Los Angeles

Many other municipalities have already embarked on the road to implementing low impact development and have found that stormwater improvements can even be made to large, built-out cities like Los Angeles. A number of cities, counties, federal agencies, and national and local nonprofit organizations have conducted research and published documents on LID and green infrastructure. Additionally, there are existing local LID pilot projects such as Oros Street and Elmer Avenue along the Los Angeles River. **Together, these regulations, programs, technical manuals, pilot projects and research reports offer a wealth of existing information and resources from which the City of Los Angeles could model its own low impact development ordinance and programs.**



Cross section design for a vegetated swale in a parking lot.
Bureau of Environmental Services, Portland, OR / Tom Liptan

Because Los Angeles has significant amounts of water runoff even during dry weather, low impact development can benefit the city year-round, not just during the rainy season. However, not all sites will be able to achieve every goal that LID sets forth for water management (slowing, cleaning, infiltration, capture, groundwater recharge, and reuse). Some sites may only achieve one outcome, while others may fulfill all six. For instance, near the Los Angeles River, infiltration and groundwater recharge can be difficult because the ground is composed of impenetrable clay. There, it would be best to place emphasis on slowing and cleaning water flows before they reach the river.

A curb cut and bioswale at 1100 S. Hope Street
in downtown Los Angeles.

The Purpose of This Report

The purpose of this report is to examine low impact development (LID) for the City of Los Angeles and potential steps for instituting city-wide low impact development programs or projects. It also gathers policy strategies and technical information that could be pertinent to the City's LID efforts. Part I (Chapters 2–5) describes the importance of low impact development and green infrastructure and highlights existing LID programs throughout the nation and here in Southern California. Part II (Chapters 6–11) explores potential ways to implement LID in Los Angeles and some of the issues that should be considered. It also reviews current policies and regulations (such as stormwater management laws and the City's recent Green Building Ordinance) that intersect with local LID programs. Finally, the appendices contain additional information and resources that may be helpful for developing comprehensive green infrastructure programs and projects for the City of Los Angeles.

Green roof on top of Chicago City Hall.
Dept. of Energy, NREL / Katrin Scholz-Barth

Endnotes

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[3] Common LID Best Management Practices

Despite its semi-arid climate, the City of Los Angeles has the potential to generate a remarkable amount of stormwater over the course of a year. **Each ¼-acre of hardscape has the potential to generate 100,000 gallons of stormwater runoff annually, and a 500-foot long residential street in Los Angeles could generate 140,000 gallons of stormwater.**[a] This chapter highlights a wide array of low impact development (LID) best management practices (BMPs) that are available to capture, treat, infiltrate and reuse potential water resources. Many BMPs, such as bioswales, can be applied to streets, houses, commercial development, and even industrial sites, while other BMPs (such as rain barrels for single-family homes) tend to have a narrower range of use. Projects may combine several BMPs that work together to slow down stormwater flow and infiltrate it into the ground. For instance, a single "green street" can utilize porous pavement, bioswales, bump-outs, and curb cuts all together.

Property owners can select the most appropriate BMPs to accomplish infiltration, water reuse or runoff control at their particular location. In keeping with LID principles, it is important to evaluate what existing resources on-site can be retained and reused to promote groundwater infiltration, such as top soil, established trees or natural topographic features. The suitability of soil conditions to support vegetation or infiltration can help narrow the number of BMPs to be considered. The long-term maintainability of any BMP must be factored into all decisions as an underlying driver for sustainability. Consideration of all these factors can reduce monetary costs for the owner as well as reduce "external" costs for the city overall (conserving water, reducing amount of soil sent to landfills, etc.).

Fundamental LID Objectives

Low impact development strives to **slow, clean, infiltrate and capture** urban runoff and precipitation in order to increase groundwater recharge and water reuse.

Types of LID Best Management Practices

1. Landscape BMPs
2. Building BMPs
3. Street and alley BMPs
4. Site Planning BMPs


Capital Region District, BC

[a] Estimates of potential stormwater runoff assuming an average yearly rainfall in Los Angeles of 15-inches on impervious surfaces. {Potential stormwater from a ¼-acre lot} = (0.25 x 43,560 sq.ft. per acre) x (15" rain per year) / (12" per ft.) x (7.481 gal. per cu.ft.) = 101,835 gallons. An ordinary, 2-lane street is 30 feet wide. {Potential stormwater from a city street, not including sidewalks} = (500 ft. long) x (30 ft. wide) x (15" rain per year) / (12" per ft.) x (7.481 gal. per cu.ft.) = 140,269 gallons. Calculation by the City of Los Angeles Bureau of Sanitation, November 2008.

Landscape BMPs

Landscape-based BMPs that use runoff to support vegetation are particularly effective in satisfying the City's LID goals. For instance, the City's million trees initiative (Million Trees LA) directly recognizes the important role of trees in the capture and reuse of water, plus the additional benefits they provide by absorbing CO_2 (a greenhouse gas) and shading city streets to reduce the urban "heat island effect." Native trees are well-suited as landscape BMPs because of their ability to use large amounts of water when available, but can still withstand long periods of reduced soil moisture. Overall, integrating trees throughout the city could result in cooler temperatures, improved aesthetics, improved water quality, and enhanced property values.

Past development practices often employed engineered solutions to stormwater management instead of preserving a site's original soil conditions and natural drainage patterns. Unfortunately, the impact of these many small decisions has resulted in the loss of the Los Angeles region's ability to infiltrate groundwater, an increase in local temperatures and a negative impact to water quality. Over time, landscape practices based on low impact development can mitigate many of the unfavorable impacts of prior development and change Los Angeles into a city that has more sustainable water management practices.

Vegetated Swales

A vegetated swale is a broad, shallow channel with a dense stand of vegetation covering the side slopes and the bottom. Swales can be natural or manmade, and are designed to trap particulate pollutants (suspended solids, trace metals), promote infiltration, and reduce flow velocity from stormwater runoff.[1]

Photo credit: Capital Region District, British Columbia

Bioswales

Bioswales are landscape elements, very similar to vegetated swales, designed to remove silt and pollution from surface runoff water. They direct drainage with gently sloped sides (less than 6%) and are filled with vegetation, compost and/or rip rap. The water's flow path is designed to maximize the time water spends in the swale.[2]

Photo: Westchester/Imperial Highway Infiltration Swale Project
Credit: LA BOS

Rain Gardens

A rain garden, created in a low spot on a property, captures rain and excess irrigation water from roofs, driveways and yards. Runoff is directed into the rain garden to support landscapes and for infiltration to ground water. In a sense, a rain garden is a "mini-bioretention" swale that can be particularly well-suited for residential properties. Supplemental irrigation may be required during the dry season in Los Angeles.

Photo credit: Iowa Natural Resources Conservation Service, http://www.ia.nrcs.usda.gov/features/raingardens.html

Infiltration Swales / Basins / Trenches

Infiltration swales are designed for conveyance and infiltration, with less emphasis on growing vegetation.[3] They are depressions created by excavation, berms, or small dams placed in a channel intended to infiltrate the storm runoff from impervious surfaces.

Infiltration basins and trenches serve similar purposes as swales, but the tops may be hidden with covers that could range from landscaping to a porous material, such as decomposed granite.

Photo: Pavers and infiltration swale at Taylor Yard near Elysian Valley
Credit: LA BOS

Riparian Buffers

Riparian buffers are strips of vegetated land adjacent to a river or stream. In addition to providing wildlife habitat, the grasses, shrubs and trees along stream banks capture sediments and pollutants and prevent erosion. They also slow down flow velocities, allowing more water to percolate into the ground.[4]

Photo: Los Angeles River near Atwater Village
Credit: LA BOS

Open Space & Parks

Open space and parks provide large, vegetated areas especially well suited for infiltrating runoff on a regional scale. Additional benefits include increased wildlife habitat and recreation opportunities.

Photo: Sepulveda Basin Wildlife Refuge in the Encino area of L.A
Credit: LA BOS

Building BMPs

Building-based low impact development BMPs often focus on directly capturing and storing stormwater, but they can also be designed to slow and filter runoff, and reduce the sediments flowing into various water bodies. Building BMPs also improve water quality, reduce the heating and cooling requirements of buildings, and improve aesthetics. Capturing runoff from buildings or other impermeable surfaces for reuse can be done on different scales, ranging from small rain barrels to the construction of large underground cisterns. Even though Los Angeles is considered a dry climate because rainfall occurs during a relatively short season, there is still considerable potential to capture significant amounts of water.

Green roofs are especially innovative building BMPs. Both locally and around the country, green roofs (sometimes called "living roofs") have been installed to reduce runoff and provide attractive open spaces in unexpected locations. Green roof BMPs have most often been used in areas where rainfall is distributed more evenly throughout the year when compared to Los Angeles. However, in combination with other collection-oriented BMPs, green roofs cannot be ruled out for Los Angeles, especially when value is placed on potential energy savings and microclimate improvements. Green roof concepts will need to be adapted to the unique microclimates found in Los Angeles.

	**Green Roofs** Placement of rooftop planting system that allows for sustained presence of live plants covering a significant portion of a building's roof. Green roofs can provide a range of environmental (stormwater runoff reduction, energy savings), economic, and social benefits.[5] *Photo: Vista Hermosa Park, Santa Monica Mountains Conservatory, Los Angeles Credit: LABOS*
	**Cisterns** Reservoirs, tanks, or containers can be used to store stormwater for non-potable reuse (such as landscape irrigation). Cisterns are usually placed underground, but can also sit above ground. The cistern system on the left directs rainfall from the roof through a sand pit to filter out impurities; it then collects the water in an underground cistern. Cisterns can vary in size from smaller household units to large underground storage areas beneath outdoor playing fields. These features can also be made into attractive architectural elements. A pump may be required to harvest the water for reuse. *Photo: Cistern in Chicago. Credit: EPA / Abby Hall*

Rain Barrels

Rain barrels are used to store rainwater for later reuse. Gutters and downspouts direct rainfall from rooftops into the barrels. Rain barrels are smaller and less expensive than cisterns, making them more appropriate for residential buildings. Most barrels have spigots so that the water can be easily accessed for irrigation. Rain barrels are made from a variety of materials and can be an attractive landscape feature. They commonly have provisions to prevent mosquitoes from breeding.

Photo Credit: http://www.greenerbuilding.org/

Rain Chains

A rain chain is a creative and attractive form of water diversion from rain gutters to the collection system; it is an alternative to the more utilitarian downspout. Rain chains consist of metal cups or chains linked to direct and slow rooftop runoff to a desired catchment area. Architect Frank Lloyd Wright often used these as an architectural element; the concept originated in Japan centuries ago where they are known as "kusari doi."[6]

Photo: A home in West Los Angeles
Credit: Haan-Fawn Chau

Street and Alley BMPs

The 6,500 miles of streets[7] and 914 miles[8] of alleys in the City of Los Angeles have tremendous potential for reducing the velocity of water flows, decreasing polluted runoff and augmenting water infiltration. In general, Los Angeles is highly urbanized, and the ability to apply relevant street and alley BMPs is mostly a function of redevelopment opportunities. For instance, city roadwork projects can be used to "green" city streets and sidewalks with porous pavement, curb cuts and bioswales. The successful application of these BMPs will also depend upon the development of standards acceptable to the City (to reduce liability) and the development of financial and aesthetic incentives. Additional benefits common to most of these BMPs are aesthetic improvements to the local neighborhood.

<table>
<tr>
<td> 
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<td>Porous Pavement & Sidewalks
Porous/permeable/pervious pavement and sidewalks absorb water, allowing infiltration into the soil layer below. They are especially appropriate for highly urbanized areas where open space is scarce. Porous pavement usually needs to be vacuum swept periodically to keep pores unclogged. Side benefits: (1) reduces danger of hydroplaning for cars, (2) some porous pavements absorb and store less heat, so they can help reduce temperatures in an urban environment.[9]

Photo credit: City of Los Angeles Watershed Protection Division, Planning and Engineering Section</td>
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<td>Permeable Pavers
Permeable pavers allow water to percolate through crevices between paving blocks. They come in a variety of styles, shapes and sizes. Cobblestones are a popular example.

Photo Credit: Permeable Pavers, EPA / Abby Hall</td>
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<td>  </td>
<td>Vegetated Pavers / "Grasscrete"
This well-established BMP can be met with numerous commercial products. Vegetated pavers help natural infiltration by reducing the overall imperviousness of otherwise paved areas. They can be used for sidewalks, driveways, and parking lots. They address stormwater through small, cost-effective, attractive landscape features located at the lot level. They may be suitable for emergency access where other BMPs may not.
Photo credit: Haan-Fawn Chau</td>
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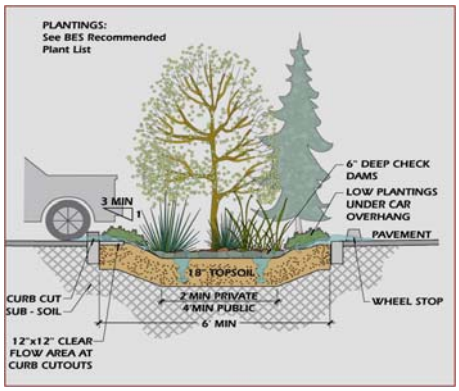
	**Bump-Outs** "Bump-Outs" are small vegetated swales that can be used in well-established neighborhoods where other options for infiltration may be limited. Not only can they be functional for reducing runoff, but they can also provide an attractive focal point for a street and can be used to slow traffic to improve pedestrian safety. *Photo: Portland, OR. Credit: EPA / Abby Hall*
	**Curb Cuts** Curb cuts can be used to direct runoff from paved areas into infiltration zones such as bioswales. They allow stormwater runoff to enter a vegetated area and infiltrate the underlying root system or soil medium. *Photo: Hope Street, downtown Los Angeles. Credit: Haan-Fawn Chau*
	**Tree Wells** Tree wells can be installed upstream of a catch basin to intercept urban runoff from a gutter (up to a certain volume). The runoff is used to irrigate the tree and local landscaping, and provides infiltration. During heavy rains, the excess water beyond the capacity of the tree well flows into the catch basin. Tree wells are placed below grade so trash is also intercepted, which is then manually removed on a periodic basis. *Photo: Hope Street, downtown Los Angeles. Credit: Haan-Fawn Chau*

Site Planning BMPs

The most important low impact development BMPs often occur during a project's planning phase, well before any "green infrastructure" features are installed. Properly planning the layout of a site to enhance natural drainage patterns and developing a strategy to preserve the infiltration capacity of the existing soil during construction can make an significant difference in the success of a LID project.



Site Evaluation and Planning
During the design phase, property owners and designers should evaluate the topographic and hydrologic features of their site and minimize the amount of impervious surfaces. Soil characteristics determine whether the site is best suited for water capture or infiltration. Low impact development BMPs should be placed in locations that will maximize infiltration and minimize runoff.

Photo credit: Tom Liptan, Bureau of Engineering / Portland, OR

Retaining Existing Trees and Large Vegetation
Retaining existing trees and large vegetation that has well-developed root systems can help improve the infiltration capacity of a low impact development site.

Photo credit: Haan-Fawn Chau

Proper Site Grading
LID sites can be graded to enhance natural drainage patterns by directing water towards rain gardens and infiltration zones. Flat or shallow slopes reduce the velocity of stormwater runoff, allowing for greater infiltration. Moreover, carefully planned grading practices can help preserve valuable topsoil.

Photo credit: Haan-Fawn Chau

Preserving Top Soil and Preventing Soil Compaction
Healthy top soil can be a major asset to a LID site because it absorbs water quickly and the vegetation and microbes help filter out pollutants from urban runoff. Compaction can greatly reduce the infiltration capacity of soil. Therefore, strategies should be developed to preserve topsoil and to prevent soil compaction, especially during the construction phase of any LID project.

Photo: Compacted soil vs. healthy soil. Credit: Haan-Fawn Chau

Prioritizing LID Best Management Practices

Not all low impact development BMPs are equally effective, so municipalities could establish guidelines that place a greater priority on the installation of BMPs that fulfill goals for water infiltration, cleaning, velocity control, capture and reuse. On July 9, 2008 the City of Los Angeles adopted simple guidelines[10] to prioritize the installation of stormwater BMPs to fulfill the County's Standard Urban Stormwater Mitigation Plan (SUSMP). (Read more about SUSMP in Chapter 7.) The order of preference for the selection of appropriate BMPs is as follows: (1) infiltration systems, (2) biofiltration/retention systems, (3) stormwater capture and reuse, (4) mechanical/hydrodynamic units, and (5) a combination of any of the above.

In 2006, the County released a guidance manual called *Los Angeles County-Wide Structural BMP Prioritization Methodology*.[11] [12] The guidelines also apply to the City of Los Angeles because the City falls under the County's Standard Urban Stormwater Mitigation Plan. The County developed its Prioritization Methodology as a "systematic way of prioritizing structural BMP projects within Los Angeles County watersheds to optimize pollutant reductions in a cost-effective manner."[13] The County also notes that "the strength of the Methodology is its ability to systematically process multiple factors that affect BMP placement and effectiveness."[14]

Endnotes

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[4] Benefits of Low Impact Development

The potential benefits of low impact development for water pollution, water supply and energy usage in Los Angeles County are compelling. A study conducted by Community Conservancy International (CCI) in March 2008 found that **nearly 40% of L.A. County's needs for cleaning polluted runoff could be met by implementing low impact development (LID) projects on existing public lands.** CCI calculated that there is a net average of 15,000 acres of existing public lands in the county suitable for LID projects.[1]

Additionally, a study completed by the Natural Resources Defense Council (NRDC) in January 2009[2] found that an increased use of LID practices throughout residential and commercial properties in L.A. County would promote groundwater recharge and water capture and reuse, reducing the county's dependence on distant sources of water. This increased use of LID would result in the **savings of 74,600–152,500 acre-feet of imported water** per year by 2030. Based on current per capita water usage in the City of Los Angeles, this is equivalent to the water consumption of 456,300–929,700 people.[3] Moreover, since L.A. County would be pumping less water from distant locations, **131,700–428,000 MWH of energy would be saved** per year by 2030, which is equivalent to the electricity used by 20,000–64,800 households.[4] Therefore, LID could also mitigate climate change by reducing greenhouse gases.

Both the CCI and NRDC studies illustrate the significant benefits that broad implementation of low impact development strategies can have for the Los Angeles region. However, in order for Los Angeles to fully realize these benefits, LID would need to become a common, widespread practice for both new and existing land uses, not just an occasional innovation.

Quantifying LID Benefits

Quantifying the benefits of low impact development in monetary terms is dependent on the still-emerging field of placing economic

Major Benefits of LID for L.A. County

Polluted Urban Runoff

Nearly 40% of the county's needs for cleaning polluted runoff could be met by LID projects on existing public lands.[a]

Water Supply

By 2020, LID projects could save L.A. County 41,000–83,000 AF/yr of imported water through groundwater recharge and water capture & reuse.[b]

Energy Use & Climate Change

Greater reliance on local water supply instead of pumping from distant locations would save 72,000–233,500 MWH of energy per year.[c]

Additional LID Benefits

- Better flood control
- Reduced need for wastewater treatment
- Money saved on water management infrastructure
- Increased green space and wildlife habitat
- Reduced urban heat island effect
- Community beautification
- Emphasis on green jobs and economy

Sources: a) Community Conservancy International 2008, b) NRDC 2008, c) NRDC 2008

values on nature's services. While the initial efforts to determine environmental benefits may be challenging to undertake, recent studies specific to the Los Angeles area have made significant headway in providing data that can be used to calculate the benefits of LID projects. For instance, the Center for Urban Forest Research found that in Los Angeles, one million trees can remove 2.24 million pounds of air pollutants and capture 1.9 billion gallons of stormwater per year.[5] Also, the Los Angeles & San Gabriel Rivers Watershed Council has developed a Groundwater Augmentation Model that can estimate a low impact development BMP's potential for infiltration, water capture, and groundwater recharge.[6]

Low impact development is best known for helping to resolve stormwater issues, but will also have value in terms of reduction of the urban heat island effect, carbon sequestration, and groundwater recharge, as mentioned above. Further, unlike the typical mechanical methods of stormwater management (such as treatment plants) LID techniques often have significant and multiple community benefits that can simultaneously address a wide range of City concerns with one project. The following tables highlight some of the advantages that LID has to offer.

Flood Control & Wastewater Management

Issues	How LID Helps	Supporting Facts
• Heavy rains can cause flooding. "On a typical dry summer day, an average of about 24 million gallons per day (mgd) flows through the storm drain system into the Santa Monica Bay. In a heavy rain storm, this flow can increase to over one billion gallons per day."[7] • Stormwater often leaks into aging sewage pipes, straining the capacity of our treatment facilities. During a storm, the flow into the Hyperion Sewage Treatment Plant can double.[8] • The entire City of Los Angeles is approximately 47% impervious surfaces.[9]	• Reduces the quantity of urban runoff and prevents flooding. • Provides natural plants and soil which absorb excess stormwater. • Relieves pressure placed on sewage treatment plant during rain events because less stormwater seeps into the sewage system.	• Planted drainage swales in Seattle's "SEA Streets" project reduced runoff volume by 99%[10] and cost 25% less than conventional street designs.[11] • Simulated tests of curb bump-outs installed on Siskiyou Street in Portland, OR found that the vegetated swales absorbed enough water (85%) to prevent neighborhood basements from flooding.[12] • Rain gardens in Burnsville, MN retained 90% of storm runoff, even when rain was greater than the targeted 0.9-inch storm.[13]

River & Ocean Pollution

Issues	How LID Helps	Supporting Facts
• In Los Angeles, the primary source of pollution in oceans and rivers is urban runoff.[14] • The City's 34,000 catch basins carry trash and contaminants from the streets straight out to the ocean, with no treatment.[15] • Five of the 10 most polluted beaches in California are in L.A. County.[16]	• Stormwater retention basins and rainwater catchment systems reduce the volume of contaminated water headed for creeks, rivers and the ocean. • Biological filtration by plants and soils can remove pollutants and sediments from urban runoff.	• Nearly 40% of polluted runoff needs in L.A. County could be met by implementing "Green Solution" projects on existing public lands.[17] • In Seattle, a green street using a series of waterfall-like bioretention features captured up to 92% of pollutants through infiltration and plant uptake.[18] • Heritage Park in Minneapolis uses filtration basins and ponds to remove 70-80% of total phosphorous and 85% of sediment from local runoff.[19]

Water Supply & Demand

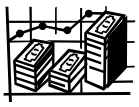
Issues	How LID Helps	Supporting Facts
• The L.A. area regularly faces water shortages and does not generate enough water to sustain itself. • Only 13% of L.A. City's water supply comes from local groundwater.[20] • 48% of L.A. City's water supply originates from the Mono Basin and Owens Valley aqueducts. • At least 30% of all the water used in the City of Los Angeles is used outdoors.[21]	• Decreases Los Angeles' dependence on outside sources of water. • Reduces the demand for irrigation water because rainwater is slowed and captured for infiltration into the ground. Some methods also capture water for reuse. • Increases the supply in the local water table. • Promotes or requires the use of drought-tolerant plants.	• Widespread use of water infiltration, capture and reuse in L.A. County would result in the savings of 74,600–152,500 acre-feet of imported water per year by 2030.[22] (Equivalent to the water consumption of 456,300–929,700 people.) • Each ¼-acre lot in L.A. has the potential to generate100,000 gallons of stormwater annually.[23] • By disconnecting 60,000 gutter downspouts, Portland diverted 1.5 billion gallons of stormwater per year. [24]

Climate Change

Issues	How LID Helps	Supporting Facts
• Fossil fuels are the #1 source of the greenhouse gases that cause climate change. • World temperatures could rise by between 2.0 and 11.5 °F during the 21st century.[25] • Blacktop surfaces can elevate surrounding city temperatures as much as 10°F. [26] • In the summer, central Los Angeles is typically 5°F warmer than surrounding suburban and rural areas due to the heat island effect.[27]	• Increasing the local water supply means that Los Angeles will use less energy pumping water from distant locations. • Trees and landscaping counteract climate change by absorbing excess carbon dioxide. • Shade from trees and evapotranspiration by plants reduce the heat island effect.	• Water systems account for 19% of the electricity used in the state of California.[28] • L.A. County could save 131,700–428,000 mWh of energy per year if less water was transported from Northern California.[29] (Equivalent to electricity use of 20,000–64,800 households.) • Each shade tree in L.A. prevents the combustion of 18kg of carbon annually and sequesters an additional 4.5–11kg of carbon per year. [30]

Green Space & Community Improvements

Issues	How LID Helps	Supporting Facts
• Los Angeles ranks last among major cities in per capita open space. The National Recreation and Parks Association recommends 10 acres of park space per 1,000 residents. L.A. barely reaches 10% of this national standard with a mere 1.107 acres per 1,000 residents.[31] • Many L.A. neighborhoods do not have any substantial trees or street landscaping. Acccording to a canopy analysis prepared for the City in 2006, L.A. has an average of only 21% canopy cover; in some districts, the canopy cover is as low as 7%.[32]	• Increases parks, open space and landscaping. • Complements the goals of the city's Million Trees LA Campaign. • Adds more wildlife habitat and enhances wetlands vegetation. • Many LID measures, such as increased landscaping, are aesthetically pleasing and help to beautify communities and make the city more pedestrian-friendly.	• L.A.'s Sepulveda Basin Wildlife Refuge is used to control major floods. It also provides 225 acres of wildlife habitat and recreation opportunities.[33] • Tree-lined streets are more walkable because they provide shade and some separation between cars and pedestrians.[34] • Attractive landscaping and plantings can increase property values by 15%.[35] • Trees and well-maintained grassy areas create a welcoming neighborhood atmosphere. Studies show this promotes social health and reduces crime and violent behavior.[36] [37]



Green Jobs & Economy

Issues	How LID Helps	Supporting Facts
• The City of Los Angeles would like to encourage the development of "green-collar" jobs.[38] • The current economic recession has resulted in city budget cuts. More revenues are needed to fill the gaps.	• Encourages the growth of the green building industry. • Encourages the landscaping and gardening industry to shift to eco-friendly practices that emphasize native, drought-tolerant plants and rainwater harvesting. • Property drainage evaluations could increase the demand for "green industry" jobs in environmental assessment. • Trees and landscaping and reduced neighborhood flooding can enhance neighborhood property values, thus increasing tax revenues.	• L.A.'s Green Building Ordinance will create an anticipated 500 green-collar, union jobs.[39] • L.A.'s growing green building industry presents workforce development opportunities for auditors and landscapers and gardeners.[40] • Trees in Portland, OR generate approx. $13 million per year in property tax revenues by increasing real estate values.[41]

Construction & Building Costs

Issues	How LID Helps	Supporting Facts
• To maximize profits, developers usually select the most cost-efficient building and landscaping options. • To conserve funds, the City of L.A. makes it a priority to keep construction costs low for City projects.	• LID projects use less concrete & asphalt, and reduce the need for pipes and other stormwater control devices. As a result, site development and maintenance costs can be lowered. [42] • LID best management practices can eliminate the need for expensive curbs and gutters (catch basins). [43] • LID projects involve minimal clearing and grading, thus reducing the need for costly earth-moving equipment. [44]	• An EPA analysis of 17 LID projects from across the nation found that all but a few projects cost less than conventional water management controls. Savings ranged from 15–80%.[45] • Seattle's first green street (SEA Street #1) cost 25% less than conventional street designs. [46] • Extensive use of swales and rain gardens for a new subdivision in Somerset, MD cost 32% less than it would have for conventional stormwater controls.[47]

Endnotes

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[4] This calculation is based on the average monthly electricity use per household in the City of Los Angeles, which is 550 kWh. (According to the C40 Cities website, http://www.c40cities.org/bestpractices/renewables/la_renewable.jsp, accessed on 2/22/09.) 550 kWh per household per month x 12 months = 6,600 kWh = 6.6 mWh per household per year. 131,700 mWh saved per year / 6.6 mWh per household per year = 19,955 households per year. 428,000 mWh saved per year / 6.6 mWh per household per year = 64,848 households per year.

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[20] *First source of information:* Beckman, David S. and Noah Garrison. "NRDC Comment on AB32 Scoping Plan Appendices—Water Sector," August 11, 2008. Natural Resources Defense Council comments sent to the California Air Resources Board. *Second source of information:* Email message from Noah Garrison, Project Attorney at NRDC, on January 21, 2009. "LID Numbers for L.A. County."

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[22] *First source of information:* Beckman, David S. and Noah Garrison. "NRDC Comment on AB32 Scoping Plan Appendices—Water Sector," August 11, 2008. Natural Resources Defense Council comments sent to the California Air Resources Board. *Second source of information:* Email message from Noah Garrison, Project Attorney at NRDC, on January 21, 2009. "LID Numbers for L.A. County."

[23] Estimates of potential stormwater runoff assuming an average yearly rainfall in Los Angeles of 15-inches on impervious surfaces. {Potential stormwater from a ¼-acre lot} = (0.25 x 43,560 sq.ft. per acre) x (15" rain per year) / (12" per ft.) x (7.481 gal. per cu.ft.) = 101,835 gallons. An ordinary, 2-lane street is 30 feet wide. {Potential stormwater from a city street, not including sidewalks} = (500 ft. long) x (30 ft. wide) x (15" rain per year) / (12" per ft.) x (7.481 gal. per cu.ft.) = 140,269 gallons. Calculation by the City of Los Angeles Bureau of Sanitation, November 2008.

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[5] Examples of LID Programs & Projects

Many cities across the country already have low impact development (LID) regulations, programs and projects underway, often pursued as an extension of a greater stormwater management, landscaping or sustainability program. This chapter describes a variety of LID efforts in the United States, with some specific focuses on local examples from Los Angeles and Southern California. This review is intended to be selective and not exhaustive. For more information on nationwide LID practices, please see the resources listed in Appendix I.

Maryland— LID Programs and Stormwater Regulations

Prince George's County: LID Urban Retrofit Program

In 1999, the Environmental Services Division of Prince George's County, Maryland, pioneered a radically different approach to stormwater management with the introduction of their manual titled, "Low Impact Development Design Strategies: An Integrated Design Approach."[1] This document has since become a leading reference guide on low impact development in the United States. By the end of 2006, Prince George's County had completed a number of projects to demonstrate the feasibility of incorporating LID principles into the urban landscape.

Highway divider strip before and after the retrofit of an infiltration swale.

Credit: Final Technical Report – Pilot Projects for LID Urban Retrofit Program in the Anacostia River

The pilot projects in the Anacostia River Watershed focused on infiltration and bio-retention BMPs to manage urban runoff, while keeping an eye on the overall landscaping aesthetics.[2] These projects incorporate key LID elements: conservation of existing natural and topographical features, emphasis on retrofitting as opposed to clearing new land, increased detention times over existing conditions, and the integration of small source-control projects into existing landscaping to improve local water quality.

Maryland Stormwater Act of 2007

Governor Martin O'Malley signed the Maryland Stormwater Act into law in 2007.[3] This act aims to maintain predevelopment runoff characteristics as nearly as possible by implementing "environmental site design" (ESD). ESD includes the conservation of natural features, minimizing use of impervious surfaces, slowing runoff, and preferentially using nonstructural practices or innovative stormwater management practices. Because of the Stormwater Act, the Maryland Stormwater Design Manual (originally released in 2000) has been revised to promote ESD as much as possible.[4]

Seattle— SEA Streets and Green Factor

SEA Streets Project

In 2001, Seattle completed its pilot "Street Edge Alternatives" Project (SEA Streets).[5] The city redesigned residential streets to reflect natural drainage patterns using swales and the addition of over 100 evergreen trees and 1100 shrubs. To support LID goals, the SEA Streets had 11% less impervious surfaces than a conventional street. Two years of monitoring has found that the SEA Streets have reduced the total volume of stormwater leaving the street by 99%.

Seattle's SEA Street (Street Edge Alternatives) project includes bioswales and permeable pavement.

Seattle Green Factor

In 2006, the City of Seattle revised its building codes for business and commercial areas. A part of the revision included an innovative system called the Seattle Green Factor, which places an environmental value on virtually every exterior element of a property.[6] The Seattle Green Factor promotes LID principles using flexible requirements, which allows developers to select the most appropriate landscaping and building elements for their site. The Green Factor aims to increase the quantity and quality of natural drainage and landscaping elements. While layering vegetation and public visibility are prominent objectives, the Green Factor also promotes rainwater harvesting and the use of plants with low water requirements.

Seattle Green Factor Scoring Parameters

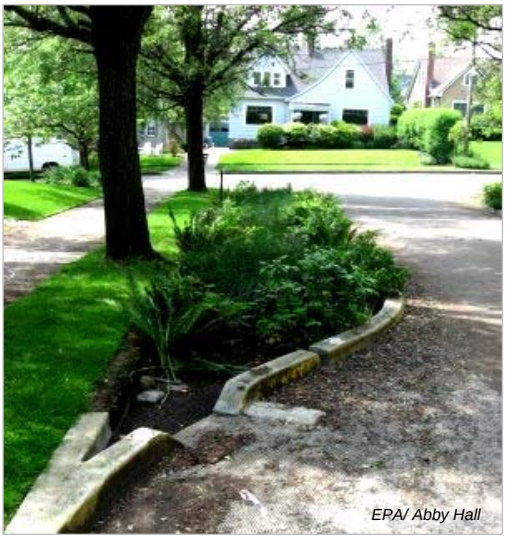
Element	Multiplier
Vegetated walls	0.7
Rain garden	0.7
Lawn – deep	0.7
Green roofs	0.7
Permeable pavement	0.6
Exceptional trees	0.5
Bigger trees	0.4
Smaller trees	0.3
Shrubs-deep	0.3
Shrubs – shallow	0.3
Lawn – shallow	0.2
Visibility (aesthetics) - bonus	0.1
Drought tolerant - bonus	0.1
Conventional pavement	0.0

As of January 2007, Seattle requires new developments in neighborhood business districts to achieve a final Green Factor score of 0.30 or higher. A "Green Factor Worksheet" lists various landscaping options along with their corresponding multipliers. The multipliers, which weigh the elements in proportion to their desirability and environmental effectiveness, are used with square footage measurements to calculate the total Green Factor value of a property. For example, asphalt, concrete and conventional pavement have low green factors of 0.0, but LID practices such as permeable paving (0.6) and green roofs (0.7) have much higher values.

Portland— Green Street Retrofits & Stormwater Management Program

Siskiyou Green Street Project

Portland, Oregon's first green street project on NE Siskiyou Street was completed in just two weeks during 2003.[7] Siskiyou Street was selected for the pilot project because the local homes would experience basement flooding during major storms.[8] Two stormwater curb extensions ("bump-outs") with attractive landscaping were added to this residential street for $17,000.[9] Strategically-placed curb cuts in the bump-outs allow street runoff to flow into the bioswales, where the water is then filtered and infiltrated into the ground. A flow test conducted in 2004 determined that the bump-outs would capture 85% of the runoff generated by a 25-year storm and delay the peak flow by twenty minutes.[10] Besides the major stormwater management benefits, the Siskiyou Street project also makes the street more attractive, filters out water pollutants and increases street safety by reducing the speed of cars.



Curb bump-outs on NE Siskiyou Street in Portland, OR.

Portland's Stormwater Management Manual

The City of Portland has a comprehensive approach to stormwater management that emphasizes the use of vegetated surfaces to treat and infiltrate stormwater on the property where the stormwater runoff originates. The Stormwater Management Manual (SWMM), developed by the Portland Bureau of Environmental Services in 1999 and most recently revised in July 2008, outlines the stormwater management requirements that apply to development and redevelopment on private and public properties.[11] The SWMM illustrates methods for infiltration and discharge, flow control, pollution reduction, operations and maintenance, and source control. The city promotes the use of vegetated surface infiltration facilities for meeting multiple requirements. SWMM provides design criteria for these vegetated facilities, many of which are LID-based.

Portland's Office for Sustainable Development also provides guidelines and practical solutions for designing and building of LID practices such as eco-roofs, rainwater harvesting, green streets, and water conservation.[12] This office uses a combination of technical assistance (including workshops for homeowners and businesses), outreach, research and policy development.

Chicago— Green Infrastructure

Water Agenda & Green Building Agenda

Chicago's green roof on City Hall
Photo: http://www.asla.org/meetings/awards/awds02/chicagocityhall.html

The City of Chicago published its "Water Agenda" in 2003 as a strategy for protecting its water resources by conserving water, protecting water quality, managing stormwater and providing outreach and encouraging mobilization—all focusing on "green" infrastructure as opposed to conventional "built" infrastructure.[13] The stormwater component of this plan relies on creating green infrastructure for City projects as well as private developments. Examples of low impact development (LID) practices include rooftop gardens, permeable alleys, rain gardens, green design and infrastructure requirements for developers' site plans, and wetlands rehabilitation. Building on experience, Chicago started a new green building program, "Chicago's Green Building Agenda 2005," with goals that include reduced operation and maintenance costs, conservation of natural resources, and the improvement of health and productivity. Ultimately, Chicago expects to create a "Green Building Code" to utilize green building technologies and strategies.

Green Alley Program

Chicago's "Green Alley" program, developed by their Department of Transportation, has completed projects that use permeable pavement to increase rainwater infiltration, recycled concrete, and surfaces that have a high solar reflectance (high albedo) to reduce the heat island effect.[14] "The Chicago Green Alley Handbook"[15] recently won the 2007 American Society of Landscape Architects award for Communications Honors[16] for its simple and easy-to-understand graphics explaining possible BMPs. Other cities (including Seattle, Baltimore and Vancouver) also have innovative programs to convert, sometimes unattractive, alleys into green spaces and stormwater BMPs.

Permeable alley during construction and after completion in Chicago.
Credit: Chicago Dept. of Transportation

Stormwater Ordinance and BMP Guide

The Chicago Stormwater Management Ordinance, effective January 1, 2008, specifically addresses many of the goals of the Water Agenda.[17] The ordinance requires "regulated development" to have an approved stormwater management plan in place for (1) managing the peak rate of stormwater discharge from the property,

and (2) controlling *on site* (by capture) the volume generated by ½ inch of stormwater on the property's impervious surfaces.

The City of Chicago has also developed the "Guide to Stormwater Best Management Practices," which is a "how to" plan for residents, developers, and other community members on several LID BMPs for reducing the amount of stormwater.[18] The guide includes cost estimates and is a helpful resource for more information.

City of Ventura— Green Streets Policy & LID Resolution

In July 2008, the City of Ventura enacted its "Green Street" policy, which directed city staff to "begin incorporating Green Street elements into repaving projects on a city-wide basis," and identified South Catalina Street as the location for a Green Infrastructure Demonstration Project.[19] The projects all incorporate LID practices, and range from street and alley repaving projects to a requirement that all City parking lots include provisions to divert and retain stormwater runoff. To help plan future projects, the City developed a comprehensive "Green Streets Matrix" which contains BMP benefits and costs. *(See Appendix II.)*

City of Ventura, California
Credit: "Solving the Urban Runoff Problem" www.surfrider.org/ventura

At the same time, the Ventura City Council adopted a resolution in support of the "Resolution of the California Ocean Protection Council Regarding Low Impact Development."[20] The resolution, drafted by the Ocean Protection Council, aims to coordinate and improve the protection and management of California's ocean and coastal resources by implementing the Governor's Ocean Action Plan. The resolution states that LID is a "practicable and superior approach to minimize and mitigate increases in runoff and runoff pollutants" at a cost that is 15% to 80% less than when using conventional stormwater treatment facilities. Accordingly, the resolution promotes the use of LID principles for new developments and redevelopments and LID retrofits of existing impervious areas. It also describes a series of recommendations for the implementation of LID at the state and local level, which Ventura seeks to incorporate.

County of Los Angeles— Green Building Ordinances

In October 2008, the County of Los Angeles passed a comprehensive Green Building Program supported by three ordinances: 1) Green Building Ordinance, 2) Drought-Tolerant Landscaping Ordinance, and 3)

Low Impact Development Ordinance.[21] The Green Building Program ordinances apply to the unincorporated portions of Los Angeles County, as well as to all County of Los Angeles capital construction projects.[22] Draft versions of the "Low Impact Development Manual" and the "Green Building and Sustainability Guidelines" have been created.

The **Green Building Ordinance** will apply only to new construction. Buildings, no matter their size, will have to comply with the County's green building standards.[23] Larger residential, mixed use, hotel and high-rise buildings will also have to become LEED certified by the U.S. Green Building Council. The County's Green Building Standards support LID principles by requiring smart irrigation controllers and drought-tolerant plants (selected from a list of approved species) for at least 75% of the total landscaped area. Residential projects are also required to plant a specified number of drought-tolerant trees.

1100 S. Hope Street in downtown Los Angeles

The County's **Drought-Tolerant Landscaping Ordinance** amends Titles 21 and 22 of the Los Angeles County Code by establishing minimum standards for the design and installation of landscaping using drought-tolerant plants. This ordinance will apply to all construction of new private property as well as to expansions of existing buildings or structures in excess of 2,500 square feet; the ordinance requires that at least 70% of the landscaped area shall use plants from the "Drought-Tolerant Approved Plant List" maintained by Los Angeles County Department of Regional Planning.

The objectives of the **Low Impact Development Ordinance** include:[24]

a) Mimic the stormwater and urban runoff rates and volumes that would be found in an undeveloped area in any storm event up to and including the 50-year capital design storm[a] event;[25]
b) Prevent stormwater pollutants of concern from flowing off-site (for storms up to and including the water quality design storm event); and
c) Minimize impacts to natural drainage systems.

The County's LID Ordinance will apply to new development and redevelopments. Redevelopment projects that alter more than half of a site's impervious surfaces must bring the entire site up to LID standards. Otherwise, only the alteration itself needs to meet LID requirements. Projects that 1) alter less than 50% of impervious surfaces, and 2) have no more than four previously existing residential units are exempt from LID standards.[26]

[a] "Capital storm" is a 50-year design storm on a saturated watershed.

City of Los Angeles— River Master Plan and Green Streets

Los Angeles River Revitalization Master Plan

The **Los Angeles River Revitalization Master Plan** (LARRMP), published in April 2007, is a 20-year blueprint for the development and management of the first 32 miles of the river, from Canoga Park to downtown.[27] The goals of this plan are to restore the ecological and hydrological functions of L.A. River, to green adjacent neighborhoods, to capture community opportunities, and to create value for the local area. The plan recommends the transformation of the River Corridor into to a continuous River Greenway. Typical LID elements in the LARRMP include the implementation of greens streets and natural open spaces, daylighting of streams currently hidden by development, and the incorporation of stormwater BMPs into existing roadways, new streetscapes, and in all public landscapes.

Recent photo, San Fernando Valley

Revitalization Concept

Photo Credit: http://www.lariverrmp.org/CommunityOutreach/masterplan_download.htm.

Green Streets L.A. Program

Contaminated runoff is the largest source of ocean pollution in Southern California,[28] [29] and the city's street infrastructure plays a major role in flushing these pollutants out to sea. The city has approximately 6,500 miles of streets[30] with 10,000 miles of sidewalk[31] and 34,000 catch basins.[32] The **Green Streets LA** program[33] was initiated by the Board of Public Works with the idea that the streets of Los Angeles offer an enormous opportunity to infiltrate, capture and filter urban runoff to prevent pollution and to convert stormwater into a valuable resource for groundwater recharge and water reuse.[34]

The **Green Streets Committee** is comprised of representatives from a number of City departments that work on issues related to street infrastructure. Monthly meetings are designed to help facilitate communication and coordination between these entities. Recently, the Green Streets Committee has focused on integrating LID practices into City infrastructure programs and construction standards. A preliminary set of Green Streets design guidelines were developed in 2008.

The **Green Alleys Committee** (a subcommittee of the Green Streets Committee) is working on identifying alleys in Los Angeles that could become pilot projects for a green retrofit. There is a total of 914 linear miles of alleys within the City of Los Angeles.[35] The committee is also investigating funding opportunities. The main representatives on the Green Alleys Committee come from the Board of Public Works, the Community Redevelopment Agency and the USC Center for Sustainable Cities Program (CSC). The CSC has developed detailed characteristics on over 300 alleys in Los Angeles.[36]

Green Streets Projects in Los Angeles

Oros Street is a residential street in the Elysian Valley section of Los Angeles. Runoff from this street drains directly to Los Angeles River. This is one of the first streets in Los Angeles to be converted into a green street. Completed in 2007 at a total cost of about $1 million, this project provides bio-retention areas in the street parkway, additional street landscaping and a large infiltration basin underneath Steelhead Park at the end of the block. The objective was to capture and treat 100% of the dry-weather runoff and at least ¾" of rainfall during storms. This project was a collaboration between North East Trees and the City of Los Angeles, represented by the Bureau of Street Services and the Watershed Protection Division from the Bureau of Sanitation.

Oros Street during and after "green street" reconstruction.

Riverdale Avenue is close to Oros Street and is expected to be converted to a green street by the end of 2009. The purpose of the retrofit is to capture and infiltrate urban runoff and stormwater from a 14.6-acre drainage area by using specially-designed diversion measures and infiltration planters. Existing parkways and sidewalks will be replaced by native plant species. Construction costs of this project are funded by a grant from the State Coastal Conservancy (up to $500,000) and the City of Los Angeles will provide in-kind design services.

Current view of Riverdale Ave. (left) and design concept for Riverdale green street retrofit (right).
Credit: LABOS / D. Deets

Elmer Avenue, between Stagg and Keswick Street in the Sun Valley watershed, will be retrofitted into a green street by the summer of 2009. The focus of this retrofit is to minimize the water demand for irrigation and to improve the quality of runoff that flows into L.A. River.[37] Project elements include runoff capture and infiltration on the public right-of-way and runoff capture and water conservation on residential properties (rain gardens, drought-tolerant landscaping, permeable surfaces). This project is a collaboration between residents, nonprofit organizations, granting agencies, Council District 6, and the Bureaus of Sanitation, Street Services and Engineering.[38] The Los Angeles and San Gabriel Rivers Watershed Council has agreed to provide a grant of $1.25 million. TreePeople will also provide educational and financial assistance to residents for converting their lawns to native landscaping and for using stormwater BMPs. This project is part of the L.A. Basin Water Augmentation Study led by the San Gabriel Rivers Watershed Council.[39]

Bimini Slough Ecology Park, near Second and Vermont Avenues in the Koreatown section of Los Angeles, is a new pocket park built on LID principles. Existing, well-established trees were incorporated into the park's redesign. New plants and trees were selected from native, drought-tolerant varieties. In the dry season, plants are maintained with a state-of-the-art drip irrigation system. The Bimini Slough Ecology Park incorporates a biofiltration swale to reuse stormwater.[40] A decomposed granite walkway allows for infiltration. Los Angeles County oversaw testing[41] to evaluate BMP performance, which indicated that the biofiltration swale effectively reduced total suspended solids, oil and grease and had some impact on reducing other constituents of concern.[b] The park opened to the public on January 26, 2006.

[b] Testing was completed in 2005 and was limited to three sampling events in a particular wet year. Because the testing was very limited, meaningful performance statistics were not generated. However, test results seem to indicate effective performance at reducing oil and grease and Total Suspended Solids. Though not as conclusive, data also appeared to indicate reductions in lead and zinc. Analysis of samples for microorganisms and nutrients were not conclusive other than to indicate there was not a significant change, inlet to outlet.

2005 View of 2nd street before park construction.
Credit: LABOS

Bimini Slough Ecological Park in East Hollywood by after plants became well established.
Credit: North East Trees

Los Angeles Downspout Disconnection Program

The City of Los Angeles initiated a pilot "Downspout Disconnection" program in December 2008 to prevent roof runoff from homes and businesses in the Ballona Creek watershed area from flowing onto into the storm drain system.[42] [43] Instead, the City will offer incentives and educational information to encourage citizens to redirect the water from their downspouts away from impervious surfaces and into planters or rain barrels for later reuse.

Santa Monica— Green Building Program

The City of Santa Monica's Green Building Ordinance[44] is a component of its Green Building Program, which also includes construction guidelines, identifies green building materials, and establishes landscaping and irrigation requirements.[45] The Green Building Program provides incentives in the form of grants—ranging from $20,000 to $35,000—for the design of buildings certified under the U.S. Building Council's LEED Green Building Rating System. Another element of the City's program provides expedited permitting for LEED-registered projects.

A Santa Monica home that collects roof runoff in a rain barrel.

Santa Monica has also published the "Santa Monica Residential Green Building Guide" that describes sustainable building practices that can be incorporated into new or remodel construction.[46] The guide explains the benefits of using environmentally-friendly alternatives for utilities, construction materials and landscaping. The guide includes extensive resources for products, technical guidance and financial resources such as grants.

City of San Diego— Stormwater Management & LID Program

The City of San Diego created the "Low Impact Development Handbook: Stormwater Management Strategies" in December 2007, in part, to satisfy the City's Municipal Stormwater Permit. The city's LID program protects water quality by preserving or mimicking nature through the use of stormwater planning and management techniques. The handbook provides a list of LID planning and stormwater management strategies for developers, builders, contractors, planners, landscape architects, engineers, and government employees to help in planning a new project site.[47] Eventually, all sites larger than one acre in the City of San Diego will be required to incorporate LID features. Though the handbook is now just a guide, many of the techniques will eventually be incorporated into the city's SUSMP (Standard Urban Stormwater Mitigation Plan) requirements.

Northern California

Village Homes in Davis, CA

Village Homes is a well-established community and housing development in Davis, CA that was built around LID concepts. It is located in a climate similar to many parts of Los Angeles—warm summers, cool winters and limited rainfall (approximately 25% more than Los Angeles).[48] Developed in 1970s and early 1980s, Village Homes is an excellent example of residential low impact development. There are 225 homes and 20 apartments on 70 acres, and the entire development relies exclusively on a natural drainage system—creek beds, swales, and pond areas. The development is well known for these unique landscape design features. Village Homes also incorporates many other environmental features such as narrow streets, passive heating and cooling, and organic gardening practices.

Village Homes relies exclusively on natural drainage.
Photo credit: http://www.villagehomesdavis.org

Emeryville— Guidelines for Green Development

The City of Emeryville, CA released "Stormwater Guidelines for Green, Dense Redevelopment" in December 2005. It is a guide to integrating high density live/work communities, parking and ecological benefits.[49] It recommends land use and parking policies that minimize impervious surfaces and maximize green space for recreation, improved water quality, reduced heat-island effects and community aesthetics. The

Stacking cars reduces the need for impervious parking lots at this business in Emeryville.

guide comes with a companion spreadsheet model to evaluate various combinations of LID concepts, including detention systems, infiltration and flow-through planters and biofiltration swales. This simple model makes it easy to evaluate different storm scenarios for Emeryville, and could probably be adapted for use in other regions.

San Francisco— Rainwater Harvesting Program

The San Francisco Public Utilities Commission (SFPUC) began its rainwater harvesting program in October 2008. Its main goal is to reduce the amount of water flowing into the municipal combined sewer system, but it also promotes the use of rainwater for irrigation and non-potable applications.[50] The SFPUC is subsidizing the cost of rain barrels for city residents and not requiring permits for their use. The same program is also promoting the use of cisterns on larger properties.

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Part II:

Making LID Work for Los Angeles

Bioswale installed voluntarily by the developer of 1100 S. Hope Street in downtown Los Angeles.

[6] Funding & Maintaining a LID Program

How Much Does LID Cost?

Pilot projects have shown that using low impact development (LID) techniques instead of conventional stormwater controls can result in considerable capital cost savings. **An analysis of LID projects from across the nation conducted by the U.S. Environmental Protection Agency (EPA) in 2007 found that with just a few exceptions, the capital costs of LID projects were less than conventional water management controls.** As shown in the table below, savings ranged from 15–80%.[1] (Please see Appendix III for a fact sheet about the report.) It is important to note that the EPA's analysis did not account for the value of the environmental, social and community benefits created by the projects.

Project [a]	Estimated Conventional Development Cost	Actual LID Cost	Cost Savings[b]	Percent Savings[b]
2nd Avenue SEA Street (Washington)	$868,803	$651,548	$217,255	25%
Auburn Hills (Wisconsin)	$2,360,385	$1,598,989	$761,396	32%
Bellingham City Hall (Washington)	$27,600	$5,600	$22,000	80%
Bellingham Park (Washington)	$52,800	$12,800	$40,000	76%
Gap Creek (Arkansas)	$4,620,600	$3,942,100	$678,500	15%
Garden Valley (Washington)	$324,400	$260,700	$63,700	20%
Kensington Estates (Washington)	$765,700	$1,502,900	–$737,200	–96%
Laurel Springs (Wisconsin)	$1,654,021	$1,149,552	$504,469	30%
Mill Creek[c] (Illinois)	$12,510	$9,099	$3,411	27%
Prairie Glen (Wisconsin)	$1,004,848	$599,536	$405,312	40%
Somerset (Maryland)	$2,456,843	$1,671,461	$785,382	32%
Tellabs Corporate Campus (Illinois)	$3,162,160	$2,700,650	$461,510	15%

EPA Report:

Cost Comparisons Between Conventional and LID Approaches

Notes:

[a] Some of the case study results do not lend themselves to display in the format of this table (Central Park Commercial Redesigns, Crown St., Poplar Street Apartments, Prairie Crossing, Portland Downspout Disconnection, and Toronto Green Roofs).

[b] Negative values denote increased cost for the LID design over conventional development costs.

[c] Mill Creek costs are reported on a per-lot basis.

Source: "Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices." USEPA, 2007.

The above examples include projects such as Seattle's first green street (SEA Street #1, described earlier in Chapter 5), which cost 25% less than conventional street designs,[2] and the extensive use of swales and rain gardens for a new subdivision in Somerset, MD, which saved developers 32% of the cost for conventional stormwater controls.[3]

Research conducted by the City of Ventura may be helpful in determining the potential costs of implementing low impact development in Los Angeles, as Ventura is also located in Southern California and has a similar climate. A copy of Ventura's "Green Streets Matrix" is included in Appendix II. It

contains an analysis of the costs, benefits, challenges and drawbacks for 17 different kinds of LID best management practices. The City of Los Angeles' Green Streets LA program is also in the process of developing its own cost estimates.

GREEN STREETS MATRIX City of Ventura Department of Public Works, 2008

Level I	Description	Example	Cost / Benefits	Challenges / Drawbacks
Storm Inlet Trash Excluders	Trash excluders are screens that are installed inside catch basins or at curb inlets. They prevent trash from entering the storm drain system. Screen size opening is typically around 4 mm. Smaller debris / silt and contaminants such as heavy metals will still pass through the screens.		Low cost/low effectiveness (~$1,500 each)	On-going maintenance is required to clean trash from catch basins. Only prevents trash from entering tributaries (not chemicals, silt). On-going maintenance costs for cleaning catch basins will increase as more are installed.
Planting of medium to large canopy trees in parkways and medians	Plant new or preserve existing medium to large canopy trees in parkways and medians. Tree species should be compatible with adjacent curbs and sidewalks to minimize potential damage that may be caused by roots.		Low upfront cost /high effectiveness (~$400 for 24" box tree). Once mature, larger canopy trees are effective in reducing peak storm run-off rates by capturing rainfall in their canopy. They are also very attractive and can raise property values by $10,000 or more.	Medium to high maintenance cost to control and preserve the trees. Bulbouts or sidewalk realignments may need to be installed in narrower parkways (see *Parkway Tree Bulbouts*). Tree roots can be destructive to buried utilities, sidewalks, curbs and gutters. Residents may not care for the increased maintenance (leaf pickup). Overhead utilities can be problematic for ongoing pruning that can damage trees.
Utilization of recycled materials in new and resurfaced streets	Utilize rubberized asphalt (recycled tires), 15% recycled mix, in-place pulverized asphalt and aggregates in the construction of new streets or in street resurfacing projects		Cost competitive compared to using new materials. Relative costs are likely to decrease due to supply constraints and hauling costs for new materials.	Projects may take longer to construct depending on time-of-year and other factors. Tighter inspections (QA/QC) also required.

A sample page from the City of Ventura's "Green Streets Matrix"

The Need for Maintenance Funding

In a time of government budget cuts, searching for steady funding to support new public works projects and regular maintenance services has never been more important. Consistent maintenance of low impact development (LID) best management practices will ensure that they continuously perform at a high standard. For instance, porous pavement needs to be vacuum-swept several times per year and vegetated swales may need occasional pruning or irrigation. The rest of this chapter highlights a number of ideas that could help secure a steady revenue stream for city projects and services.

Funding Strategies: Municipal Bonds

Municipal bonds can be issued by the City or its agencies to finance capital expenditures for public-purpose projects.[4] [5] There are two main categories of bonds: general obligation bonds that are secured by the government's taxing powers, and revenue bonds that are secured by a pledge of the project's revenues.[6] Municipal bonds could help raise funds for the construction and installation of new low impact development projects in the City of Los Angeles. However, bond money can only be used to cover capital costs; therefore ongoing maintenance expenditures must be funded from separate sources.

Fees & Assessments

LID In-Lieu Fees

Some areas of the city may be too densely developed to allow for significant levels of infiltration. For these locations, the City could raise funds by charging developers in-lieu fees, which would then go towards developing or maintaining LID projects nearby.[7] In-lieu fees would add some flexibility to low impact development regulations, making this a politically attractive option. Since low impact development aims to treat stormwater on the local level, it is very important that in-lieu projects be located close to their original project locations. (Read more in Chapter 10, p.97.)

Summary of LID Funding Strategies for Construction and Operations & Maintenance

	Strategy	Const.	O & M
Bonds	Municipal bonds	✓	
Fees & Assessments	LID in-lieu fees	✓	✓
	Increased stormwater abatement charge	✓	✓
	Individualized parcel drainage fees	✓	✓
	"One Percent for Green Streets" fund	✓	✓
	Parking increment financing	✓	✓
	Maintenance assessments		✓
	Quimby fees for parks	✓	
Grants	Dept. of Water & Power funding	✓	✓
	Proposition 84 grants	✓	
	Proposition O grants	✓	
	Private foundation grants	✓	✓
Partner-ships	"Adopt-A-Garden" program		✓
	Corporate sponsorship	✓	✓
Emerging Markets	Sales of L.A. City carbon offsets	✓	✓

Increased Stormwater Pollution Abatement Charge

The Stormwater Pollution Abatement Charge (SPAC)—found on residents' L.A. County tax bills—is used to generate "funds for receiving, transporting, pumping, constructing and maintaining storm drain facilities and for the treatment and/or disposal of storm drainage through the storm drain system."[8] The L.A. City Bureau of Sanitation's Watershed Protection Division receives this money (currently, approximately $28.6 million per year[9]) through the County of Los Angeles and uses it to develop and implement stormwater pollution abatement projects within City limits.

Increasing the Stormwater Pollution Abatement Charge could be a very good source of revenue for future LID projects and maintenance costs. The SPAC rate, originally set in 1993, is $23.00 per EDU (equivalent dwelling unit) and due to the constraints of Proposition 218 (which limits the ability of government to increase fees), it has been held at the same level for 15 years. **If the SPAC rate had increased with the national rate of inflation, then in 2008 it would have been $33.81,[10] generating an additional $13.4 million[11] for the City.** Thus the total SPAC revenue for the Watershed Protection Division in 2008 could have been $42 million instead of just $28.6 million, a 46% difference.

Using LID Rebates to Lower Residents' Stormwater Bills:

To create an economic incentive for retrofit of existing private properties, the City could develop an incentive structure that gives a rebate to businesses and residents who install low impact development features on their properties. The system could be designed so that properties which infiltrate and/or capture all of their runoff would not have to pay any SPAC fee at all. However, the fee imposed would likely have to be high enough to create an economic incentive.

Individualized Parcel Drainage Fees

Individualized stormwater drainage fees based on a property's impervious surface area has been a common practice in Germany for a number of years, but is relatively new to the United States.[12] Individual parcel assessments (IPAs) are especially appropriate for low impact development because (1) they provide an economic incentive for citizens to reduce the amount of impervious surface on their lots, (2) they affect the entire city (which supports the LID goal of decentralized stormwater management), and (3) the data collected from parcel assessments can provide the city with useful information for future watershed planning efforts.[13]

A vegetated swale with curb cuts collects runoff at the RioHondo Golf Course in Downey, CA.

In contrast to IPAs, the City of Los Angeles currently bases its stormwater pollution abatement fee on the number of dwelling units per lot—not on the size or amount of water-permeable surfaces found on the property. Consequently, there is no incentive for businesses or residents to install low impact development BMPs. The City could consider a rebate system that reduces or exempts fees for properties that capture or infiltrate 100% of their runoff.

The main drawback to IPAs is that estimating the impervious surfaces for each parcel can be labor intensive and expensive, though new satellite technology and mapping systems have made the task somewhat easier. To help with this problem, some German municipalities rely on customer questionnaires to establish a parcel's stormwater burden and/or to verify the government's estimates.[14] When there are small discrepancies, the customers' estimates are generally accepted. Larger discrepancies are resolved through site visits by the government agency.

To reduce the cost of estimating the impervious surface areas of each property in Los Angeles, during the first year of an IPA program the City could require businesses (and maybe even home owners) to pay for

a professional site assessment, and then in the second year the public would start paying the drainage charges.

Example: Seattle's Stormwater Drainage Fees

The City of Seattle, WA charges all property owners an annual fee for stormwater management services based on each property's estimated impact on the municipal drainage system.[16] The revenues generated by this fee are used to build new stormwater management infrastructure and to fund ongoing operations and maintenance expenses.[17] Small lots are charged a flat-rate fee, while the fees for larger lots are based on their estimated amount of impervious surfaces (as determined by the City from 2007 aerial photos).[18] [19] Properties with functional, on-site stormwater detention basins can apply for credits to reduce their drainage bills. The table on the previous page shows Seattle's 2009 drainage fees.

If Seattle's drainage fees were applied to Los Angeles, a typical residential lot sized at 50 feet x 130 feet (6,500 sq. ft. or about 1/7 of an acre) would be charged $202.17 per year. Again, the City of Los Angeles could then offer a rebate program that would give rebates to businesses and residents who install low impact development features on their properties. The system could even be set up so that properties which infiltrate and/or capture all of their runoff would not have to pay any drainage fee at all.

The City of Minneapolis, MN has a similar stormwater fee and credit program also based on a property's amount of impervious surface.[20]

Seattle's 2009 Drainage Fee Rates [15]

Small Residential, Annual rate per parcel (a)	
Under 3000 sq. ft.	$102.90
3000-4999 sq. ft.	$149.56
5000-6999 sq. ft.	$202.17
7000-9999 sq. ft.	$256.38
All Other Properties, Annual rate per 1,000 sq. ft.	
Undeveloped (0-15% Impervious)	
Regular	$16.85
Low Impact (b)	$10.19
Light (16-35% Impervious)	
Regular	$25.20
Low Impact (b)	$18.98
Medium (36-65% Impervious)	
Regular	$36.61
Low Impact (b)	$29.70
Heavy (66-85% Impervious)	$47.34
Very Heavy (86-100% Impervious) (c)	$56.23

(a) Single Family Residential & Duplex parcels less than 10,000 sq. ft. which are charged a flat rate per parcel rather than a fee based on the percent impervious. Rates for other properties are per 1,000 sq. ft. based on the percent of impervious surface.
(b) A customer in the Undeveloped, Light or Medium rate category with a significant amount of highly pervious (absorbent) surface may qualify for the Low Impact rate.
(c) "Very heavy" does not necessarily mean heavily developed. A parking lot would be classified as "very heavy" since it is 100% impervious.

"One Percent for Green Streets" Fund

The City of Portland, OR currently has a *One Percent for Green* fund that collects 1% of the construction budget for projects within the city's right-of-way that are not subject to the requirements of Portland's Stormwater Management Manual. The fund was established in 2007 when the Portland City Council passed its Green Streets Policy. The *One Percent for Green* fund is used to finance the construction of green street features that follow LID guidelines.[21] Private parties can apply for green streets grants to help fund the design, construction, and materials for LID projects. If a similar program were

implemented in Los Angeles, it could be designed to fund operations and maintenance costs as well as construction costs.

Parking Increment Financing

Parking increment financing has the potential to generate significant revenues that could be used to build new low impact development projects, and more importantly, fund ongoing operations and maintenance costs.[22] "The High Cost of Free Parking" by UCLA Professor Donald Shoup cites Old Pasadena as an excellent local example.[23] In 1993, the City of Pasadena installed parking meters in the rundown area of Old Pasadena in order to raise funds for revitalization. The city reinvested the revenue from parking fees back into the neighborhood. They made local street improvements and repairs, and the Business Improvement District relies on the funds to pay for cleaning and maintenance services. In 2001, the parking meters in Old Pasadena generated $1.2 million in net revenue.[24] Today, Old Pasadena is one of the most popular shopping districts in the Los Angeles region.

One of L.A.'s new parking pay stations

Several factors may make parking increment financing a viable option for Los Angeles. First, the City started replacing its old parking meters in 2007 with centrally-controlled, computerized pay stations.[25] [26] This technological advance allows the City to easily adjust parking fees. (Shoup's research suggests that parking prices should be set high enough to create a 15% vacancy rate on each block so that customers can always find an open spot.[27]) Second, to help tackle climate change, the City of Los Angeles is looking for ways to encourage people to get out of their cars and onto public transit. Higher parking rates could help achieve this goal. Finally, in the past couple years a number of American cities have considered implementing congestion pricing policies to reduce traffic. This has introduced the idea that people should pay for the privilege of driving—a notion that could also apply to parking increment financing.

In order to use parking increment financing to promote LID in Los Angeles, the City would need to ensure that an adequate amount of parking revenues is set aside for funding green streets projects and maintenance.

Special Benefit Assessment Districts

Special benefit assessment districts could be used to raise funds to acquire open space for low impact development programs or to create maintenance districts. Benefit assessment districts typically assess property owners in a defined geographic area and provide benefits to those residents, such as roads, parks, and recreational facilities,[28] but have also been used to fund sidewalk maintenance. An important

principle is that property owners are assessed a fee that is proportional to the special benefits created by the improvements. If the assessment price exceeds the value of the special benefit, then the charges are considered a tax.[29]

The State of California has approximately twenty different statutes that authorize local agencies to levy assessments for specific purposes. The statutes that would be most relevant to a low impact development program include:[30]

1. Open Space Maintenance Act
2. Habitat and Maintenance Assessment District
3. Municipal Improvement Act of 1913
4. Landscaping and Lighting Act of 1972
5. Benefit Assessment Act of 1982—especially appropriate for LID because it is dedicated to assessments for the installation, operation and maintenance of drainage and flood control facilities.

Proposition 218, which was passed in 1996, governs the procedures for establishing a special benefit district. For instance, it requires that local property owners vote to approve assessments. Proposition 218 also rules that increased property values are not enough evidence to demonstrate special benefit; there must be other benefits, such as improved recreational opportunities or flood control.[31] It can be a challenge for government agencies to evaluate exactly how much a property will benefit from a project, making it difficult to determine the appropriate assessment fee.

Quimby Fees for Parks

The 1975 Quimby Act authorizes cities and counties in the State of California to pass ordinances that require developers to set aside land, donate conservation easements, or pay fees for park improvements. Revenues generated by the Quimby Act must go towards the creation of new parks and *cannot* be used for the general operations and maintenance of park facilities.[32] In Los Angeles, the fees must be used within two miles of where they are gathered.[33]

Bimini Slough Ecological Park, created by North East Trees in East Hollywood, daylights an existing storm drain and provides on-site stormwater management. *Credit: North East Trees*

As of February 2008, the City's Department of Recreation and Parks had a balance of $129 million in Quimby fees.[34] This surplus funding could be an excellent opportunity for the City to implement low impact development on a neighborhood scale by creating new parks. (Quimby fees cannot be used for ongoing maintenance operations.) The City could require that all Quimby projects employ LID best management practices, and if possible, runoff from the local area should be directed into the parks

(instead of the storm drains). Additionally, projects would have to be distributed throughout the city since Quimby fees must be used within two miles of their origination. This requirement actually dovetails well with low impact development's goal of decentralized stormwater management using natural drainage techniques.

Grants

Department of Water & Power Funding

The Los Angeles Department of Water & Power (LADWP) is concerned about securing Los Angeles' water supply for the future. Currently only 13% of our water comes from local sources, but widespread implementation of low impact development could increase that amount significantly.[35] LADWP has begun funding LID pilot projects and is considering implementing programs that train landscape maintenance workers in LID techniques.

Proposition 84 Grants

Proposition 84, titled "Water Quality, Safety and Supply. Flood Control. Natural Resource Protection. Park Improvements," was passed by California voters in November 2006.[36] It authorized $5,388,000,000 in general obligation bonds to fund projects for "safe drinking water, water quality and supply, flood control, waterway and natural resource protection, water pollution and contamination control, state and local park improvements, and public access to natural resources, and water conservation efforts."[37] The State Water Resources Control Board runs a Proposition 84 Stormwater Grant Program to provide local agencies with funds to reduce pollution flowing into waterways.[38] This could be a promising source for funding future LID projects in Los Angeles.

Proposition O Grants

Los Angeles voters passed Proposition O in Novermber 2004. It authorized the City of Los Angeles to issue up to $500 million in general obligation bonds for projects that clean up water pollution in order to meet Federal Clean Water Act requirements.[39] It also funds improvements to protect water quality, provide flood protection, and increase water conservation, habitat protection, and open space—all of which are important aspects of low impact development.[40]

Curb cuts leading to an infiltration zone at the Rio Hondo Golf Course in Downey, CA

Private Foundation Grants

Private foundations may be interested in funding low impact development pilot projects, citizen education programs, vocational training for LID landscaping professionals and gardeners.

Public-Private Partnerships

Adopt-a-Garden

The Crown Street pilot project in Vancouver, British Columbia, is a good example of how city residents can help maintain LID landscaping and best management practices.[41] In order to protect local salmon habitat, Vancouver's Green Streets program rebuilt Crown Street to include vegetated swales and rain gardens.[42] Since the city does not have enough funding to maintain the project, they rely on the local community to take care of the landscape features. Residents must apply to adopt a garden.[43] If accepted, the city gives them a manual on how to keep the vegetation healthy. As an incentive, Vancouver also provides some gardening materials and pays for some of the residents' gardening costs.

Swale in the middle of Vancouver's Crown Street pilot project. *Credit: Vancouver Dept. of Eng.*

The Adopt-a-Garden concept is a viable, low-cost idea for the City of Los Angeles that does not involve many political hurdles for implementation. A team of student researchers from Pepperdine University[44] has recommended that Los Angeles hold annual garden competitions to motivate the citizen gardeners and to raise awareness about the Adopt-a-Garden program. Partnerships with organizations such as the Los Angeles chapter of California Garden Clubs Inc., the L.A. County Arboretum, North East Trees, TreePeople, and landscape design schools could help with the design, promotion and implementation of this program.

Corporate Sponsorship

Corporate sponsorship for the installation and/or maintenance of low impact development BMPs could help reduce some of the City's expenditures on green infrastructure and foster the involvement of businesses in the community. Sponsorships can come in various forms, such as cash donations, product donations, pro bono services, and employee volunteers. In exchange, the city could provide some incentives for the businesses such as public recognition or signage that identifies the LID BMPs paid for or maintained by corporations.

Emerging Markets

Sales of L.A. City Carbon Offsets

Recently, a number of companies have made efforts to become "carbon neutral" by purchasing carbon offsets to counterbalance their impacts on the environment. This could be an appropriate option for businesses (such as corporate offices) that traditionally have been seen as non-polluting, but may actually cause local air pollution due to employee travel and the energy used by office buildings. Moreover, ordinary residents who are eager to reduce their carbon footprints can also purchase carbon offsets. Municipal carbon offset programs are relatively new. In the United States, the San Francisco Carbon Fund[45] is currently under development and the Colorado Carbon Fund[46] is up and running.

Establishing a "Los Angeles Carbon Fund" would ensure that carbon offset money goes towards *local* climate change mitigation projects, instead of projects in far-off locations across the globe. Carbon offset money could be used to fund the construction and maintenance of LID projects in Los Angeles such as bioswales and tree plantings. The City of Los Angeles may wish to consider starting with a voluntary carbon offset pilot program, and then making it mandatory in future years. Implementing a simple carbon offset program could be a very cost-effective way to raise funds. Users could make their payments online by credit card.

The greatest hurdles to implementing a carbon offset program are: (1) figuring out how much carbon emissions a person or business generates, (2) calculating the quantity of emissions "saved" by an offset project, and (3) for how much a unit of carbon should be sold. However, to implement a voluntary pilot program, the calculations need not be complicated—rough estimates should be adequate, and Los Angeles may be able to look to Colorado's program as a model.

The Colorado Carbon Fund's website (www.coloradocarbonfund.org) has a simple carbon footprint calculator that lets users figure out how many metric tons of CO_2 are emitted by their homes, automobiles and airplane flights each year. The Fund charges approximately $20.00 per year or $1.67 per month for one metric ton of CO_2.[47] Before the website calculates offset fees, users are directed to a web page that contains advice on how to reduce their energy consumption and environmental impact.[48] This important educational feature may help reduce the carbon footprints of Colorado residents in the future.

For More Information:

For more information and case studies about funding green infrastructure, please refer to the 2008 EPA publication titled, *"Managing Wet Weather with Green Infrastructure: Municipal Handbook - Funding Options."* It can be accessed at http://www.epa.gov/npdes/pubs/gi_munichandbook_funding.pdf.

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[7] Existing Stormwater Regulations & Green Infrastructure Programs in Los Angeles

A comprehensive low impact development (LID) ordinance would help protect the integrity of Los Angeles' natural waterways and ensure a more stable water supply for the future; fortunately, a number of existing regulations and programs could serve as building blocks for the city's future LID efforts. Existing stormwater regulations and green infrastructure programs that apply to the City of Los Angeles originate from the federal, state, county and city levels of government.

Federal and State Regulations & Programs

National Pollution Discharge Elimination System (NPDES)

The federal Clean Water Act requires the U.S. Environmental Protection Agency (EPA) to regulate the amount of pollution that flows into the waters of the United States. The EPA established the National Pollution Discharge Elimination System (NPDES) permitting program to address this issue.[1] There are two types of permits that are most pertinent to LID efforts in Los Angeles: (1) the Municipal Stormwater Permit, and (2) the General Construction Activities Stormwater Permit.

Within California, the EPA authorizes the state government to run the NPDES permitting program. Therefore, our local L.A. County NPDES stormwater permit is essentially overseen by both the state and federal governments.

Municipal Stormwater Permit—In cities like Los Angeles that have a "municipal separate storm sewer system" (known as MS4s), the storm drains flow straight into rivers and oceans, with no treatment facilities along the way.[2] [3] The NPDES permits that

Existing Regulations & Programs

Federal & State Level

- National Pollution Discharge Elimination System (NPDES)
- California Porter-Cologne Water Quality Control Act
- California Model Landscape Ordinance*

County Level

- L.A. County Stormwater Permit and SUSMP
- Low Impact Development Ordinance & Green Building Program

City Level

- City of L.A. Stormwater Program
- Green Streets LA Program
- Million Trees LA Initiative
- Green Building Ordinance
- Landscape Ordinance
- Stream Protection Ordinance*
- Zoning Ordinances
- General Plan, Community Plans & Specific Plans
- L.A. River Revitalization Master Plan
- L.A. River Improvement Overlay District*
- Integrated Resources Plan
- Water Quality Compliance Master Plan

** Regulation that is proposed or in the development stage. Has not been fully adopted or implemented.*

are issued to MS4 municipalities require the use of best management practices (BMPs) to reduce pollutants to the "maximum extent practicable."[4] (A description of the related L.A. County SUSMP stormwater standards can be found on the next page.) The NPDES permits must be renewed every five years, which creates some instability for stormwater protection in Los Angeles because future permits could have less stringent environmental controls.

General Construction Activities Stormwater Permit— The State Water Resources Control Board (SWRCB) adopted its last statewide NPDES General Stormwater Permit for Construction Activities in 1999, and is well overdue for its five-year renewal.[5] The permit's section on "Post-Construction Storm Water Management"[6] contains language to reduce runoff from sites of one acre or more. It states that properties should have best management practices (BMPs) that "minimize impervious surfaces" and treat "storm water runoff using infiltration, detention/retention, biofilter BMPs, and efficient irrigation systems."[7]

Playa del Rey beach in Los Angeles after a storm.
Credit: Heal the Bay / HF Chau

While these requirements speak to fundamental low impact development (LID) principles, there are some limitations to the state's post-construction stormwater permit:[8]

1. ***The permit applies only to large sites*** of one acre or more, which is problematic because the City of Los Angeles has many smaller lots.[9] (Construction projects on smaller lots fall under the municipal MS4 stormwater permit.)
2. ***The permit only regulates newly-built construction or redevelopment projects.*** It does not address older properties that could benefit from a retrofit program.

Porter-Cologne Water Quality Control Act, 1969

The Porter-Cologne Water Quality Control Act (also known as the California Water Code) was enacted by California in 1969 to protect the state's surface and groundwater quality and resources. Under this act, the State and Regional Water Quality Control Boards can establish water policies, administer federally-mandated MTBE permits, enforce water quality standards, and regulate point-source and non-point source discharges.[10] Nine Regional Boards develop regional water quality control plans based on the State Board's policies.[11]

Porter-Cologne makes a very important point related to low impact development (LID) and stormwater management: *waste discharges to state waters are a privilege, not a right.*[12] To further protect ocean and surface water quality, the State Board has adopted statewide water quality control plans such as the California Ocean Plan and a Plan for California's Non-Point Source Pollution Control Program.[13]

State of California Model Landscape Ordinance *(adoption pending)*

California's Department of Water Resources (DWR) is currently working on an update of the state's "Model Water Efficient Landscape Ordinance." DWR planed to adopt the revised ordinance in March 2009,[14] and local municipalities will be expected to adopt it by 2010. Local governments will have the option to adopt their own landscape ordinance as long as it is "at least as effective as" the state's model.[15]

The updated model landscape ordinance will cover new construction and rehabilitated landscapes (both public and private) of at least 2,500 square feet. The ordinance also requires existing landscapes of at least 43,560 sq. ft. to conduct landscape irrigation audits every five years.[16] Compared to the current landscape ordinance, the updated version places a greater emphasis on efficient irrigation systems and reducing water waste.[17]

The model landscape ordinance does require landowners to implement a number of LID strategies such as grading sites to reduce erosion and runoff, installing efficient irrigation systems, and installing recycled water irrigation systems. However, other important LID strategies are highly recommended but *not* required. They include the use of native and drought-tolerant plants and the installation of stormwater BMPs.[18]

Drought-tolerant landscaping in West L.A.

Los Angeles County Regulations & Programs

L.A. County Stormwater Permit and SUSMP

As mentioned earlier in this chapter, the L.A. County Municipal Stormwater Permit addresses federal NPDES requirements and is administered by the State of California. The permit standards are written by the Los Angeles Regional Water Quality Control Board and must be reissued every five years.[19]

An important part of the County's NPDES permit, which applies to the City of Los Angeles, is the Standard Urban Stormwater Mitigation Plan (SUSMP) infiltration requirements. In general, SUSMP applies to new and redevelopments of a certain minimum size.[20] The best management practices installed on-site must be able to infiltrate, capture and reuse, or treat all of the runoff from an 85th percentile storm, which equivalent to a ¾" storm. New guidelines approved on July 9, 2008 require developers to give top priority to BMPs that infiltrate stormwater and lowest priority to mechanical/hydrodynamic units.[21]

Although many of Los Angeles' existing low impact development BMPs were installed thanks to SUSMP requirements, there are some drawbacks to relying solely on SUSMP to fulfill the city's low impact development needs. First, SUSMP was designed to reduce the amount of pollution entering our

waterways and is therefore especially focused on reducing the environmental damage caused by the first flush of a storm. The fact that SUSMP BMPs sometimes address groundwater recharge and can increase local water supply is incidental. Since SUSMP standards do not require native and/or drought-tolerant plants in landscape BMPs, this could actually have the unintended consequence of exacerbating L.A.'s water conservation issues, as developers could install water-thirsty plants requiring large amounts of irrigation during the dry season.

Also, SUSMP only applies to new and major redevelopments, leaving out a large amount of existing development in Los Angeles. Third, the L.A. County Stormwater Permit must be reissued every five years, and there is no guarantee that new stormwater permits will have the same requirements as previous ones. Finally, the legality of the stormwater permit (and accompanying SUSMP requirements) is currently being challenged. In the case of Cities of Arcadia, et al. v. State Water Resources Control Board, et al. (Superior Court of Orange County, 2007, No. 06CCO2974) the court concluded that the L.A. Regional Water Quality Control Board "failed to consider whether the standards could be met and the economic effect they would have."[22] [23] The county's stormwater permit program has been put on hold until the issue is resolved.

Low Impact Development Ordinance & Green Building Program

In October 2008, the County of Los Angeles passed a comprehensive Green Building Program supported by a trio of ordinances: the 1) Green Building Ordinance, 2) Drought-Tolerant Landscaping Ordinance, and 3) Low Impact Development Ordinance.[24] These ordinances are augmented by the "Low Impact Development Standards Manual"[25], "Green Building and Sustainability Guidelines"[26] and a "Drought-Tolerant Plant List."[27] Together, the three ordinances will discourage the use of impervious surfaces and excess turf landscaping, while requiring green building methods, smart irrigation, the use of stormwater BMPs, and drought-tolerant landscaping.[28] [29] [30] [31]

The Green Building Program's ordinances will only apply to the *unincorporated* portions of Los Angeles County. They will also affect the County of Los Angeles' capital construction projects (such as libraries and administration buildings) regardless of the city in which they are located.[32] **Even though the County's ordinances do not apply to the City of Los Angeles, the City will still benefit from the LID improvements made to neighboring portions of the watershed.** Notably, the County's LID Ordinance is that it only applies to new developments and major redevelopments, not existing properties. A more detailed description of the County's Green Building Program can be found in Chapter 5, and a copy of the LID ordinance can be found in Appendix II.

City of Los Angeles Regulations & Programs

City of Los Angeles Stormwater Program

The City of Los Angeles' Stormwater Program is run by the Department of Public Works. It has two major divisions—Pollution Abatement and Flood Control. The program focuses on reducing stormwater pollution through the National Pollutant Discharge Elimination System (NPDES) municipal stormwater permit.[33] The Stormwater Program is the city's major source of public information regarding stormwater best management practices, which include many LID strategies.

Green Streets LA Program

Contaminated stormwater runoff is the largest source of ocean pollution in Southern California,[34] and the city's street infrastructure plays a major role in flushing these pollutants out to sea. The city has approximately 6,500 miles of streets with 10,000 miles of sidewalk and 34,000 catch basins.[35] The **Green Streets LA** program was initiated by the Board of Public Works with the idea that the streets of Los Angeles offer an enormous opportunity to infiltrate, capture and filter urban runoff to prevent pollution, and to convert stormwater into a valuable source of groundwater and recycled water.[36]

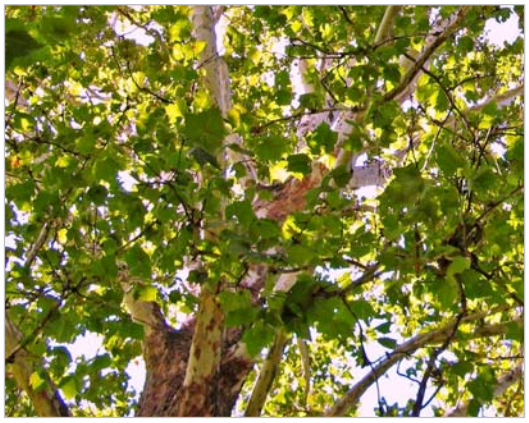
The Green Streets Committee is comprised of representatives from a number of city departments that work on issues related to street infrastructure. Monthly meetings are designed to help facilitate communication and coordination between these entities. Recently, Green Streets has focused on integrating LID practices into City infrastructure programs and construction standards. A preliminary set of Green Streets design guidelines were developed in 2008, and a pilot project on Riverdale Avenue is in development.

The **Green Alleys Committee** (a subcommittee of Green Streets) is working on identifying alleys in Los Angeles that could become pilot projects for a green retrofit. There is a total of 914 linear miles of alleys within the City of Los Angeles.[37] The committee is also investigating funding opportunities. The main representatives on the Green Alleys Committee come from the Board of Public Works, the Community Redevelopment Agency and the USC Sustainable Cities Program.

Million Trees LA initiative

The Million Trees L.A. (MTLA) Initiative was created by Mayor Villaraigosa with the goal of making Los Angeles the largest, cleanest, and greenest city in the United States.[38] Through public-private partnerships, one million trees will be planted throughout Los Angeles.

MTLA can help low impact development by providing more landscaping, stormwater capture and infiltration opportunities in the city. The water benefits of planting



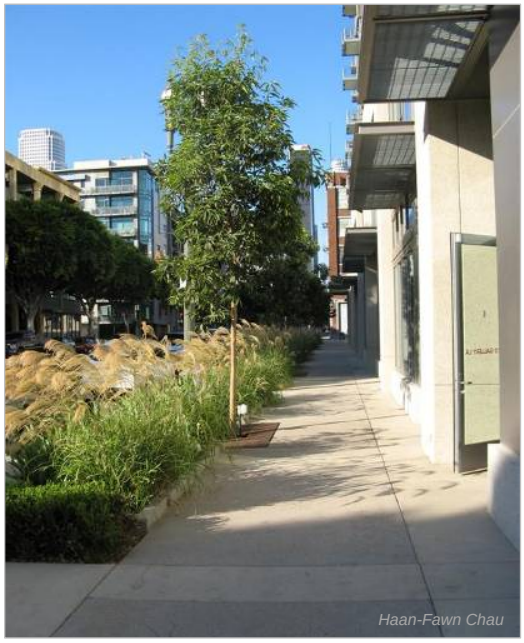
Canopy of a native sycamore tree. *Credit: Haan-Fawn Chau*

trees far outweigh the water lost to irrigation.[39] Additionally, planting large canopy trees reduces the urban heat island effect.

City Green Building Ordinance

Signed by the mayor on Earth Day 2008, the City of Los Angeles' Green Building Ordinance requires large, new developments to meet the intent of the U.S. Green Building Council's LEED green building standards. (Actual LEED certification is optional.) Additionally, large redevelopments that spend more than 50% of the replacement cost of the existing building must also meet LEED standards.[40]

LEED green building standards include a number of LID strategies in the categories of "Sustainable Sites" and "Water Efficiency," but it is possible for a developer to construct a LEED certified building while avoiding any significant water management or conservation measures.[41] LEED does not address exterior landscaping issues nearly as well as it addresses the composition of an actual building. Additionally, only LEED-ND (Neighborhood Design) standards address street infrastructure, and it involves a completely separate process from the LEED certification of an individual building.



Bioswales and tree wells along 1100 S. Hope Street in downtown Los Angeles

City Landscape Ordinance

The L.A. City Landscape Ordinance, originally written in 1996, was revised in April 2005 to make it a "more effective tool for reducing landscape water use, to mitigate the urban heat island effect, to reduce the dependence on fossil fuels to heat and cool buildings, to address surface erosion, and to improve groundwater recharge."[42] As noted earlier in this chapter, in 2010 the City of Los Angeles will be required to either adopt The State of California's "Model Water Efficient Landscape Ordinance" (described earlier in this chapter) or update its current ordinance to meet or exceed the State's standards.

At the heart of the current Landscape Ordinance, there are two points-based systems: a landscape points system and a water management points system.[43] Every new development project must attain a certain number of points for each system based on the size of the site. The landscape points system contains a number of measures that overlap with low impact development, such as the installation of drought-tolerant trees and plants, permeable pavement and reduced grading (cut and fill). The water management points system also includes drought tolerant plants, as well as rainfall recharge areas and the use of reclaimed water for irrigation.

Despite these features, the current Landscape Ordinance cannot fulfill low impact development principles on its own. First, the ordinance applies only to new construction projects and major renovations that

require building, grading, or land-use permits. It does not encompass the vast quantity of existing buildings in Los Angeles. Second, the ordinance mentions a number of LID techniques but does not actually require projects to use them. The current flexibility of the points-based system makes it possible for developers to fulfill their landscape points using measures such as recycling vegetative waste, widening sidewalks at bus shelters, putting utility lines underground, installing ecological art, and providing handicapped accessibility—all of which are beneficial to the community but do not help with low impact development efforts. Finally, the landscape ordinance does not have measures that specifically focus on slowing down the velocity of stormwater.

City Stream Protection Ordinance *(proposed)*

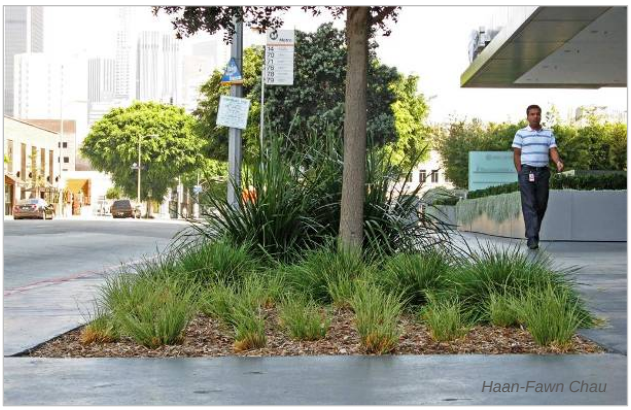
In October 2007, the Stream Protection Task Force completed a draft for a proposed Stream Protection Ordinance. Its goals are to: "(1) protect a valuable natural resource; (2) protect and maintain the existing ephemeral, perennial, intermittent or seasonal streams located within the City of Los Angeles; (3) protect and maintain native vegetation in riparian and wetland areas."[44] The main provision of this proposed ordinance is a 100-foot setback from the stream's edge with two zones: a 30-foot protected zone of no new development and a 70-foot buffer zone that allows limited development.

If enacted, the Stream Protection Ordinance would support low impact development by ensuring enough open space to allow for infiltration and groundwater recharge. By limiting development next to streams, the possibility of new pollution entering the watershed is also reduced.

It is important to note that the proposed ordinance also defines what a stream is. This is essential in L.A.'s dry climate since many streams do not run year-round. The June 2008 decision made by the U.S. Army Corps of Engineers to reduce the status of the Los Angeles River to "non-navigable" in most locations underscores this point. "Non-navigable" rivers are *not* protected by the Clean Water Act, the NPDES permit system, or L.A. County SUSMP standards. Therefore, local ordinances would be a more certain way to protect Los Angeles' waterways in a changeable political climate.

City Zoning Ordinances

The City's zoning ordinances are a major force in shaping the density of and types of land uses found in Los Angeles. Zoning regulations can be used to support low impact development efforts by promoting an even distribution of open space, parks and agricultural land throughout the city. Additionally, zoning can be used to encourage compact and infill development in central city areas, preventing the growth of new developments on open lands.



1150 South Olive Street in downtown Los Angeles

General Plan, Community Plans & Specific Plans

The **General Plan**, created by the Department of City Planning, is the major policy document that informs planning and development decisions in the City of Los Angeles. All zoning ordinances must match the policies put forth in the General Plan. The General Plan is divided into a number of "elements" to address specific issues. The elements most relevant to low impact development include the Land Use Element, Conservation Element (last updated in 2001)[45], Open Space Element (updated 1973)[46] and Transportation Element (updated 1999).[47] [48] Unfortunately many of these elements are outdated and their policies do not adequately address current environmental concerns. Although efforts are underway to update the plans, completion of each element update takes a few years.

The Land Use Element is the largest element in the General Plan. It is actually comprised of thirty-five different **Community Plans** which address the particular needs and character of each area. On an even smaller scale, there are some neighborhoods that have their own **Specific Plans** which are tailored to very local conditions. Specific Plans are only created by the planning department on an as-needed-basis, usually when an area undergoing rapid changes could benefit from having more guidance than what is offered by the Community Plan.[49]

The General Plan (and its elements), Community Plans, and Specific Plans all offer opportunities to institutionalize water management and environmental protection by incorporating LID strategies into planning policies. As Community Plans are rewritten and new Specific Plans are developed, LID could become a standard component.

L.A. River Rivitalization Master Plan

The Los Angeles River Revitalization Master Plan (LARRMP) was completed in 2007.[50] Its recommendations provide "a framework for restoring the River's ecological function and for transforming it into a valuable, celebrated resource for residents and visitors to the City."[51] In the chapter titled "Revitalize the River," most of the goals and recommendations directly support low impact development. Some of these items include:

- Identify opportunities for peak flood storage outside the river channel.
- Emphasize "green infrastructure" improvements.
- Create landscape-based water quality treatment.
- Create "green strips" to treat stormwater runoff from streets.
- Create a continuous riparian corridor.

The Los Angeles River near Steelhead Park

The LARRMP is a policy document that presents a long-range vision and conceptual plan that identifies important revitalization strategies.

L.A. River Improvement Overlay District (proposed)

The proposed Los Angeles River Improvement Overlay District (LA RIO) was created to implement recommendations made in the LARRMP.[52] If enacted by ordinance, the LA RIO would be "a special use district that requires new projects to achieve points in three design categories: Watershed, Urban Design, and Mobility." The district would reach about ½ mile on either side of the L.A. River and would include all neighborhoods directly adjacent to the river. All new developments and significant redevelopments would have to meet LA RIO design guidelines.

Enacting the LA RIO would support low impact development by requiring developers to incorporate green infrastructure into their projects. Examples inlcude bioswales, bioretention ponds, green roofs, high efficiency irrigation systems, porous pavement and native plants.

Integrated Resources Plan

The City of Los Angeles' Integrated Resources Plan (IRP) is a multidisciplinary, cross-departmental effort to integrate the planning of three interdependent water systems: wastewater, recycled water and stormwater.[53] The IRP has worked collaboratively with community stakeholders to address the many water supply, pollution, and management challenges that face the Los Angeles area. Some of the strategies include optimizing the use of existing water infrastructure, increasing water conservation and reuse, and improving the management of dry and wet weather runoff using strategies such as better stormwater treatment infrastructure and low impact development-type projects.

Water Quality Compliance Master Plan

In 2007, the City of Los Angeles' Energy and the Environment/AdHoc River Committee filed a Motion directing the Bureau of Sanitation to create a Water Quality Compliance Master Plan (WQCMP) that outlines a strategy for the City to achieve Clean Water Act standards as well as compliance with all urban runoff regulations and mandates.[54] Some of the principles followed by the WQCMP that support low impact development include:[55]

- Identify all pollutants of concern in the City by type and location, including watershed or water body;
- Prioritize polluted areas within the City and create a compliance timetable;
- Identify strategies — such as on-site retention/infltration, structural best management practices, regional multi-use benefit projects (including the identification of potential sites for such projects), and non-structural educational and regulatory measures (including ordinance changes to encourage on-site infiltration) for the City to meet Clean Water Act standards by pollutant and by water body or watershed;

- Identify water quality data gaps including those that need to be filled in order to determine if the City is in full compliance with water quality requirements in the Los Angeles County stormwater permit and applicable TMDLs; and
- The proposed Master Plan will integrate existing efforts already underway such as the Integrated Resources Plan, Integrated Regional Water Management Plan, the Draft Los Angeles River Revitalization Master Plan, and other relevant watershed management plans, and will be developed in partnership with stakeholders from the public, environmental groups, and regulators including the Los Angeles Regional Water Quality Control Board and local municipalities.
- Include public workshops to seek input from not only from the above stakeholders, but also from the general public.

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[8] Strategies to Codify Low Impact Development and Green Infrastructure

The Benefits of an Ordinance

As described in Chapter 4, low impact development strategies could help the City of Los Angeles tackle a range of urban issues, from stormwater runoff to climate change to green jobs. To reap these benefits, the City's best approach may be to enact a low impact development (LID) ordinance. Chapter 7 details a number of stormwater and green infrastructure regulations, policies and programs that already exist at the federal, state, county and city levels. While these items touch on some low impact development principles, the City still lacks a comprehensive, enforceable law that can be used to make LID a common practice in Los Angeles.

The two greatest advantages to enacting a LID ordinance—as opposed to relying only on LID policies---are (1) enforcement, and (2) long-term reliability. While enacting LID policies (in the General Plan, for instance) may be an important step toward widespread LID implementation, a complementary city ordinance can ensure that LID practices are enforceable by the rule of law and more broadly applicable. Additionally, unlike the L.A. County Municipal NPDES Stormwater Permit which needs to be reissued every five years, city ordinances are a permanent part of the municipal code and can only be reversed with legislative action by the city council.

Recent Challenges to Watershed Protection

Even with federal, state and county water protection regulations, there can be court-ordered changes, and sometimes even reversals. Two recent examples illustrate just how precarious the legal status of watershed protection and stormwater management can be in Los Angeles.

First, on June 4, 2008 the Army Corps of Engineers determined that only two small sections of the Los Angeles River—totaling

Benefits of a LID Ordinance

Two greatest advantages to enacting ordinances, as opposed to relying exclusively on policies:

1. enforcement
2. long-term reliability

Right now, standards from the L.A. County Stormwater Permit's Standard Urban Stormwater Mitigation Plan (SUSMP) are the closest that Los Angeles has to a LID ordinance. However, SUSMP standards are subject to revision and do not yet comprehensively require all the elements of a low impact development strategy.

Alternatives to a City LID Ordinance

1. Meet SUSMP requirements using LID standards
2. Revise Landscape Ordinance to include LID standards
3. Revise Green Building Ordinance to include LID standards
4. Rely on LID planning policies instead of ordinances
5. Combined ordinance and incentive structure
6. Enacting LID ordinance after voluntary pilot phase

8% of its length—qualified as "traditional navigable waters" of the United States.[1] [2] This could have an impact on water quality because only navigable waters of the United States are protected under the federal Clean Water Act.

A driveway that allows for infiltration (Los Angeles)

A second example of a challenge to watershed protection occurred one month later on July 2, 2008. In the case of *Cities of Arcadia, et al. v. State Water Resources Control Board, et al.*, the Orange County Superior Court concluded that the Los Angeles Regional Water Quality Control Board had not properly "analyzed the reasonableness of its stormwater quality control standards," especially with regards to their economic impacts.[3] This ruling directly challenges the validity of NPDES stormwater pollution controls under the Clean Water Act and the accompanying SUSMP standards in Los Angeles and Ventura counties.[4]

If the City of Los Angeles were to codify water protection standards at the *local* level, it would provide some leadership and assurance against unpredictable shifts in federal, state and county regulations.

Alternatives to a Stand-Alone LID Ordinance

A comprehensive low impact development ordinance would be the most effective way to implement LID strategies on a wide scale. However, enacting major new ordinances can take a lot of time and political will. There are a few alternative ways that LID could be implemented on a smaller scale. Also, the following ideas could be used as short-term LID solutions while the City works on developing a full-scale LID ordinance or program.

Alternative #1:
Meet SUSMP Requirements Using LID Standards

The City could require all projects that fall under the L.A. County Stormwater Permit's SUSMP rules to also meet strict LID standards defined by the City.

Drawbacks: (a) SUSMP only applies to major new developments and redevelopments, not existing buildings and infrastructure. (b) The stormwater permit must be renewed every five years, and there is no certainty as to the level of protection in future versions.

Alternative #2

Revise Landscape Ordinance to Include LID Standards

The City's Landscape Ordinance could be revised to include more low impact development strategies. As mentioned in Chapter 7, the State has created a Model Water Efficient Landscape Ordinance with a few LID elements which will apply only to new and major redevelopments.[5] The City will be required to match or exceed the State's landscape ordinance by 2010.

Additionally, a points-based system similar to the U.S. Green Building Council's LEED standards could be initiated for landscapes in the city. The Sustainable Sites Initiative,[6] organized by landscape architects, is currently developing a system to certify environmentally-friendly landscapes and site design.

Drawbacks: (a) Many effective LID techniques fall outside the purview of a landscape ordinance (i.e. green roofs, porous pavement, water storage cisterns, curb cuts leading to swales). (b) A landscape ordinance would miss large areas of the city because it would not apply to infrastructure such as streets, sidewalks, alleys and parks. (c) The proposed State standards do little to address existing landscapes. (d) The proposed State standards recommend but do not require the use of native and drought tolerant plants.

Demonstrating water infiltration through pervious concrete (left) and porous asphalt (right). Parking lot at Villanova University, Pennsylvania. *EPA / Abby Hall*

Alternative #3

Revise Green Building Ordinance to Include LID Strategies

Currently, it is possible for developers to comply with the City's Green Building Ordinance without implementing stormwater BMPs and water efficiency measures. The ordinance could be revised to require buildings to achieve specific points related to low impact development in the "Sustainable Sites" and "Water Efficiency" categories of LEED green building standards.

Drawbacks: (a) Stormwater management is an optional, but not required, part of LEED certification and only counts for one out of 26 points necessary for certification.[7] (b) Water efficiency points are also optional, and only two points relate to LID strategies.[8] (c) The Green Building Ordinance does not apply to existing buildings and only covers major redevelopments. (d) The Green Building Ordinance does not apply to infrastructure such as streets, sidewalks, alleys and parks.

Alternative #4

Rely on LID Planning Policies Instead of Ordinances

Adopting policies can sometimes be more politically feasible for the City than adopting ordinances. City-wide goals and policies for low impact development could be added to the General Plan, possibly in the conservation element. Then, as the city's 35 community plans are updated one by one, LID strategies can

be tailored to each area's potential to manifest LID principles. (i.e. Some areas have very permeable soils and therefore can infiltrate more water than others. Conversely, some locations may be too densely developed to rely heavily on infiltration.)

Even if the City decides to move forward with developing a LID ordinance, LID policies could be adopted first. These policies will then provide the foundation and information to support the passage of a LID ordinance.

Drawbacks: (a) It takes a long time to update all 35 community plans, so LID implementation would happen very slowly. (b) Policies are not enforceable in the same way as ordinances. (c) Policies can be changed without exhaustive public review, making a LID policy potentially more vulnerable than an ordinance. (d) Policies are more subject to alteration with a change in executive leadership.

Alternative #5
Combined Ordinance and Incentive Program

The City could establish a low impact development program that relies on a combination of a LID ordinance and a LID incentive structure. First, the ordinance would require that new developments and redevelopments use LID techniques. Then, to promote LID for existing developments, the City would create a rebate program to provide some reimbursement for people who choose to install low impact development BMPs on their properties.

This combined strategy (ordinance + incentive program) could use individualized parcel stormwater assessments, a concept which is described in greater detail in Chapter 6. Assessments would be based on the amount of impervious surface found on a property, and rebates could be offered for people who install LID BMPs to increase on-site permeability. To make this work, the assessment fees would have to be high enough to motivate people to install LID projects that qualify for a rebate.

Infiltration swale for a supermarket parking lot.
7676 Firestone Blvd., Downey, CA.

Alternative #6
Enacting LID Ordinance After Voluntary Pilot Phase

Because the widespread use of low impact development strategies is a relatively new idea for Los Angeles, the City may want to begin with a voluntary, one-year LID program that serves as an instructive pilot phase. To ensure enough participation during this test period, the City could offer incentives such as rebates for the installation of LID best management practices. At the end of the year, the City would revise and codify the LID ordinance, making it mandatory for property owners to follow. However, there is a drawback to relying on a voluntary program to implement low impact development: it would take a

long time for the widespread use of LID to occur, and due recent droughts throughout the state, the City of Los Angeles has an imminent need to conserve water now.

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[9] Defining the Scope of a LID Strategy for Los Angeles

This chapter sets forth possibilities for the scope of a low impact development (LID) strategy for the City of Los Angeles. Since the city could greatly benefit from implementing LID on a wide scale (see Chapter 4), the sections below assume that it would take a comprehensive, thorough approach to LID.

1150 S. Olive Street, Los Angeles

To Whom Would LID Apply?

Currently, most LID-type requirements in Los Angeles apply only to new developments or major redevelopments; they do not address the enormous mass of existing development in the city. Additionally, regulations tend to focus on individual sites and parcels of land, not the connecting infrastructure of roads, sidewalks, parks and alleys. Therefore, a comprehensive LID program would encompass all of the following:

- **Government & public infrastructure:** The City government controls large portions of land, buildings, streets, parks and infrastructure throughout Los Angeles. *The Green Solutions Project* report written by Community Conservancy International found that close to 40% of L.A. County's urban runoff needs could be met by implementing LID on publicly-owned lands.[1] Additionally, more than half of Los Angeles is covered by impermeable surfaces.[2] Thus, integrating public green spaces into the water management network and changing the City's street paving and construction practices could have very positive effects.
- **Private residences:** Private homes and apartment buildings cover a sizeable proportion Los Angeles, and they often have lawns and gardens which are prime candidates for LID infiltration projects. Additionally, lawns are a major source of pollution because nutrients and fertilizers flow into the storm drain system. Infiltration would reduce these impacts.
- **Commercial/retail:** Commercial and retail developments often have very large, paved surfaces (such as parking lots) that produce contaminated runoff. They provide an opportunity to infiltrate using permeable pavement and bioswales.
- **Industrial:** Even though many industrial buildings are already subject to pollution controls, implementing LID practices in areas that do not have serious contamination issues would also

help to recharge groundwater supply. Like commercial properties, industrial lots often have large, paved surfaces that could be converted to infiltration zones.

Encompassing New and Existing Development

Applying LID requirements to all sectors and to both new and *existing* developments of all sizes would move beyond the limited scope of L.A. County's current SUSMP stormwater management standards and the City's Green Building Ordinance. Again, this is important because **low impact development practices are most effective when distributed throughout the watershed.** As highlighted in Chapter 4, *widespread* implementation of low impact development on public lands could address 40% of L.A. County's polluted runoff needs,[3] and so one could hypothesize that extending LID practices to private lands would greatly increase this percentage. Additionally, it has been found that implementing LID on suitable public and private properties could reduce the amount of water imported by 74,600–152,500 acre-feet per year.[4] Thus, to achieve wide-scale benefits, existing development should be included in the City's strategy for LID.

Since existing developments are currently exempt from the LID measures found in the County's SUSMP standards and the City's green building and landscape ordinances, there may also be some resistance to including existing developments in a mandated low impact development strategy. **Introducing a city-wide LID rebate program for existing development could be a successful way to address these concerns and provide a financial incentive to install green infrastructure features on these properties.** The City could develop a rebate structure that allows property owners to recoup some (or all) of their stormwater fees by using low impact development BMPs such as rain gardens, bioswales, cisterns and even permeable pavement.

In very densely developed areas, it may be difficult to infiltrate or capture all runoff on-site, so the city may consider using in-lieu fees to allow developers to compensate for any shortfalls. The in-lieu fees could then be used to install additional LID projects nearby. (See Chapter 6 for a detailed discussion of in-lieu fees.)

A 2008 publication by the EPA, titled *"Managing Wet Weather with Green Infrastructure: Municipal Handbook - Green Infrastructure Retrofit Policies,"* contains more information and case studies on this topic. It can be accessed at http://www.epa.gov/npdes/pubs/gi_munichandbook_retrofits.pdf.

Brownfields and LID

Los Angeles' brownfields provide good opportunities for infill redevelopment. However, depending upon the characteristics of the site, infiltration BMPs may not always be appropriate. Factors to consider when developing brownfields include the level and type of contamination, how much remediation has already been done, the type of soil in the area, the depth of groundwater, and the rates and direction of

hydrologic flow on-site. Many brownfield sites may be better served by mechanical and chemical treatment methods instead of infiltration. However, brownfields could still be part of a groundwater recharge system. Water from contaminated sites could be captured and cleaned, and then be piped to a recharge location outside of the contaminated area.

The City of Emeryville, CA has been particularly successful in using low impact development and green infrastructure techniques for brownfields redevelopment.[5] The city's handbook, *Stormwater Guidelines for Dense, Green Redevelopment*, details some of the LID options that developers can use for infill sites.[6] Due to soil contamination, the Emeryville brownfields projects do not infiltrate stormwater into the aquifers. Instead, stormwater is captured for filtration and/or reuse. Vegetated detention basins and swales use plants to remove pollutants from stormwater (bioremediation).

Reaching Beyond Current Performance Standards

Chapter 7 noted that the L.A. County Stormwater Permit's "Standard Urban Stormwater Mitigation Plan" (SUSMP) contains the most important LID-related infiltration and stormwater capture requirements that apply to the City of Los Angeles. **While SUSMP standards are the closest that Los Angeles has to a LID ordinance, they still fall short of a comprehensive low impact development strategy for a number of reasons.**

A clogged catch basin in Los Angeles.

For instance, SUSMP does not require native and/or drought-tolerant plants for landscape BMPs[7]. If developers install water-thirsty plants requiring large amounts of irrigation during the dry season, this could have the unintended consequence of exacerbating L.A.'s water conservation issues. And as mentioned above, the standards only apply to major new developments and redevelopments, not existing developments. (See Chapter 7 for more SUSMP information.)

Moreover, it is worth noting that SUSMP is especially geared towards dealing with the pollution in the first flush of a storm, and was not designed to encompass concerns about groundwater recharge. Given Los Angeles' concern about long-term water supplies, the City may want to adopt *even more* ambitious performance standards than SUSMP. (Current SUSMP standards require that a project capture, infiltrate or treat all of the runoff from an 85th percentile storm, which equivalent to a ¾" storm.)

Setting New Performance Standards

Some basic questions to consider when setting new performance standards for low impact development are listed below. A more extensive list can be found at the beginning of the next chapter.

- Should LID performance standards vary with soil type and the character of the local water table?
- LID attempts to restore pre-development hydrology and flows, but these have changed quite a bit over history. How far back in time should we look?
- Should LID performance standards vary with building size or type?
- Should there be different expectations for dense neighborhoods vs. low density neighborhoods?
- How should the performance of a LID program or project be measured?
- On what scale or level should LID performance be measured—by parcel, block, neighborhood or watershed?
- What will be measured? Water quality parameters, water flow from a site, etc.
- Who will be responsible for monitoring?

Contents of a LID Ordinance

If the City of Los Angeles were to adopt a low impact development ordinance, what would it contain? LID ordinances passed by other municipalities provide good examples, though the City may want to adapt them to suit the unique needs and goals of Los Angeles. Of particular interest is the Low Impact Development Ordinance recently passed by the County of Los Angeles in October 2008 as part of its landmark green building program.[8] Chapters 5 & 7 contain more detailed descriptions and analysis of the County's LID Ordinance, and the text of the ordinance can be found in Appendix II.

Rain chains guide water into rocky infiltration swales in Seattle's High Point neighborhood.

The components of a LID ordinance for the City of Los Angeles should include:[9] [10]

- The purpose of the ordinance
- Definitions of important terminology
- To what and whom the ordinance applies
- LID standards for the pre-development (site planning) phase and construction phase
- LID performance standards for specific types of properties
- Whether performance standards are prescriptive (requiring the use of specific BMPs) or flexible (using BMPs preferred by the developer to meet performance thresholds)
- The prioritization of BMPs to place emphasis on infiltration into aquifers (see Chapter 3)
- Tying LID standards to a manual of LID standards for the City of Los Angeles (see next section)

- Tying LID standards to a list of recommended native and/or drought tolerant plants suited to the local habitats and climate
- Stream and riparian habitat protection measures
- Any incentives offered by the City to encourage property owners to install LID measures
- LID site plan review and approval process
- Requirements for continued maintenance and operation of LID best management practices
- Monitoring and evaluating the performance of LID programs and projects
- Adapting the LID standards or ordinance to reflect the knowledge gained from monitoring program.

Developing a LID Manual for Los Angeles

Every major municipal low impact development program has developed a technical manual to accompany its policies or ordinances. Particularly notable examples are from Prince George's County (MD), the Puget Sound region (WA), Emeryville (CA), Los Angeles County, San Diego County and the U.S. Department of Defense. Web links to all of these manuals can be found in Appendix I.

In general, LID manuals do the following:

- Explain the purpose of and principles behind low impact development
- Clarify the meaning and application of LID performance standards
- Describe site assessment, planning and design techniques
- Describe an array of LID best management practices (including advantages, drawbacks, cost considerations, and maintenance needs)
- Provide diagrams and plans for common BMPs
- Supply information on hydrologic flow modeling

If L.A. City were to create a low impact development manual, it would not have to start from scratch. Much of the material from L.A. County's new "Low Impact Development Manual," as well as its old 2002 "Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP)," can be applied to the needs of the City of Los Angeles.[11]

Endnotes

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[10] Considerations for LID Implementation

Low impact development (LID) offers promising strategies for the City of Los Angeles to significantly improve stormwater management, water supply and green space while reducing its impact on climate change and the environment in general. However, the city should consider the following challenges and issues before developing and implementing a comprehensive LID program.

Curb cut that directs water from the street into a bioswale. Voluntarily installed at 1100 S. Hope Street in downtown L.A.

Defining LID Goals & Standards

Some questions to consider when defining LID goals and standards include:

Determining goals:

- How much water should be infiltrated and/or captured? Should LID requirements be similar to current SUSMP standards or more ambitious?
- Should the City create a LID rebate program to encourage property owners to install more best management practices (BMPs)?
- LID attempts to restore pre-development hydrology and flows, but these have changed quite a bit over the city's history. How far back in time should we look?
- Our urban landscape is always changing, and it may be a challenge for LID projects to keep up with those changes. For example, if a low density area with plenty of LID BMPs starts changing to a high density area, would this change any of the fundamental LID infrastructure or strategies?

Defining standards:

- Should LID standards be performance-based (to allow for flexibility) or should they prescribe the use of specific LID best management practices?
- What methods should be used to measure the performance of a LID program or project?
- On what scale or level should LID performance goals be measured—by parcel, block, neighborhood or watershed?
- Should LID performance standards vary with soil type, the character of the local water table and the slope of the land?

- Should there be different expectations for dense neighborhoods vs. low density neighborhoods?
- Should LID performance standards vary with building size, type or purpose?

Balancing Smart Growth and Infiltration

Smart growth planning practices encourage compact development for a number of reasons: to reduce a city's environmental impact, to preserve open space, support access to public transportation, and improve walkability. Nonetheless, increased urban density can make it difficult or expensive to infiltrate on-site, especially if a building's footprint takes up the entire lot of land. How can the city encourage LID infiltration, but not at the expense of compact development?


Portland, OR EPA / Abby Hall

Four options may help solve this dichotomy: (1) in-lieu fees, and (2) reduced parking requirements in exchange for the installation of low impact development BMPs,[1] (3) requiring that properties capture, filter and reuse runoff water instead of infiltrating it, and (4) setting LID infiltration goals on a larger, neighborhood scale instead of parcel-by-parcel.

In-Lieu Fees

In very densely developed areas, it may be difficult to infiltrate or capture all runoff on-site, so the city may consider using in-lieu fees to allow developers to compensate for any shortfalls. The in-lieu fees could then be used to install additional LID projects nearby.[2] The *advantages* of this system include that (1) it raises money for the City to pay for general LID implementation and maintenance projects, and (2) it creates some flexibility in how developers can decide to fulfill LID requirements. *Disadvantages* of this system include that (1) it may actually be more cost-effective and less burden for the City to require developers to install infiltration BMPs, and (2) by allowing property owners a way to avoid installing infiltration BMPs, the City runs the risk of having no LID infiltration BMPs at all in very dense neighborhoods.

If the City were to move forward with allowing in-lieu fees, the fees should go towards the installation of LID projects that are close to the original development sites that generated the fees. Also, the in-lieu-fees should not be used to build centralized treatment plants, as these would not fulfill the LID goals of enhancing natural drainage systems and managing stormwater on a local scale.

Exchanging Parking Requirements or Density Bonuses for LID BMPs

The City could use density bonuses or reduced parking requirements as incentives for installing low impact development features in highly urbanized areas. Both incentives increase the amount of space that can be built—a valuable opportunity for developers working in such areas.

As shown by the table on the right, parking facilities are very expensive to build, and City-mandated parking requirements can place major constraints on how developers can use their land.[3] In very dense portions of the city, exchanging parking spaces for effective, well-planned LID infiltration projects could prove to be a powerful economic incentive.[4]

Average Development Cost of Parking (excluding land)

Source: http://www.livableplaces.org/bpolicy/parking.html

Type of parking facility	Cost/space
Surface lot	$2,000
Multi-level above ground	$10,000
Subterranean	$20,000

Capture, Filtration & Reuse

The City could designate certain "densely developed areas" of the Los Angeles (such as downtown, where soils are not conducive to infiltration and basement width often extends under the sidewalk area), where it would allow developers to capture, filter and reuse water runoff from a property instead of infiltrating it into the ground. On-site treatment facilities could be used to remove pollutants from runoff. If the property has no way of reusing the filtered water, the City could allow it to connect to the storm drain system or direct its flow to another property for reuse.

Setting LID Goals at Neighborhood Level

Basing LID infiltration goals on larger areas—such as entire neighborhoods or watersheds instead of parcel-by-parcel—could allow some flexibility to deal with infiltration problems at an individual site while still achieving the City's overall infiltration goals. Making some concessions to accommodate compact growth could help prevent suburban sprawl, saving valuable open space from being developed. To successfully adhere to low impact development principles, the City would need to evaluate the amount of filtration and groundwater recharge that would be gained by preserving open space in comparison to requiring smaller infiltration zones in dense urban locations.

Administrative Challenges

Before implementing a low impact development program, the City would need to resolve a number of administrative challenges:

Administering a LID program:

- Which department would be responsible for LID implementation? A comprehensive LID program would probably require coordination between several departments.
- Will additional staff be needed to administer the LID program?

- To encourage innovative LID projects, the process for approving non-standard BMP designs should be streamlined.
- A plan to monitor adherence to LID standards and to tell whether property owners continue to maintain their low impact development BMPs should be developed.
- The LID program should be administered in a way that will not create an extra layer of bureaucracy for building plan checks.
- Possible increases in maintenance: porous pavements need to be vacuum-swept several times a year.

Resolving conflicts with LID:

- Some LID practices may conflict with building and safety codes. Historically, building and safety codes have aimed to direct water out to the storm drain as fast as possible—the opposite of what low impact development tries to accomplish. Also, there may be some building codes that restrict how water can be reused and what kinds of pavement can be used for fire lanes.
- Sometimes the City requires developers to change the slope of the site in a way that does not benefit low impact development. The City's grading requirements tend to favor the urban street grid and are not based on the land's natural topography.
- Hillside areas may not be conducive to infiltration due to the potential for soil subsidence, and may need to be exempted from LID.

A large cistern collects roof runoff from a commercial building in Chicago.

Other points of note:

- Potential private property issues: For LID to have a significant positive impact, it should be employed on private as well as public property. From an environmental standpoint, if a particular property has very little infiltration area but an adjacent property has plenty of space for infiltration, low impact development goals could be fulfilled by infiltrating the runoff from the first property on the second property. However, allowing one property to manage the other's runoff could cause some legal complications.
- A LID ordinance for the City of Los Angeles would not apply to the Los Angeles Unified School District (LAUSD), a major land holder. The school district is currently following county-wide SUSMP stormwater management standards because of political pressure. Moreover, LAUSD generally uses state architects to design their sites. Instead of using the LEED green building certification system run by the U.S. Green Building Council (which is the centerpiece of L.A.'s Green Building Ordinance), they use the CHPS program (Collaborative for High Performance Schools) which applies only to K-12 schools.

LID Readiness & Education

Low impact development will be a new concept to many. To properly implement a LID program, the City should take steps to ensure that there is an adequate support structure and professional knowledge base.

- How ready are we for LID change? City planning staff, engineers and street maintenance crews would need to learn about LID principles and standards.
- Are Los Angeles' architecture and landscape design professionals ready to design and install LID features? Local landscape architects may not have enough knowledge about ecology and native plants to implement LID techniques effectively. Making a landscape look attractive is very different from designing it to successfully perform stormwater management functions.
- Low impact development training should be offered to the landscape and gardening industry so that they can understand how to maintain landscape BMPs and smart irrigation systems.
- More trained professionals are needed to help monitor, collect data and analyze the effectiveness of LID projects in Los Angeles. They will be needed in both the government and private sectors.
- The people who evaluate LID programs and projects must have a thorough understanding of the biological and ecological calculations that go into LID.

Implementing LID Effectively

In order to effectively implement low impact development in Los Angeles, a number of points should be kept in mind:

- Site evaluation is very important to ensure that LID best management practices appropriate for the local drainage patterns are installed at optimal locations on a property.
- If the city's goal is to maximize groundwater recharge, then it must emphasize drought-tolerant plants. Planting additional water-thirsty species could actually increase the city's demand for water. Therefore, to fulfill the goal of increasing water supply while reducing demand, planting drought-tolerant plant and tree species is imperative.
- Infiltration and groundwater recharge is not necessarily optimal where the ground is composed of impenetrable clay, as the case in some areas of the city. In such areas, the emphasis should be placed on slowing and cleaning instead.
- Development companies must carefully plan the paths for their construction equipment in order to prevent the removal of topsoil and excess grading and compaction, all of which reduce the effectiveness of LID infiltration techniques.

LID Knowledge, Data and Evaluation

Since low impact development and green infrastructure programs are relatively new in the United States, the knowledge base is still developing. There is a need to gather information about LID projects in dry climates such as Los Angeles. The City can help fill these information gaps by considering the following:

Vegetated swale with curb cuts at a shopping center. 8500 Firestone Blvd., Downey, CA.

- Who will be responsible for monitoring and evaluating LID programs and projects? What will be measured? (Water quality parameters, water flow from a site, rate of infiltration, etc.) How does LID data compare to baseline data for conventional stormwater practices in Los Angeles?
- There is quite a bit of existing data on implementing LID in wet climates, but not enough for dry climates. There needs to be more test cases and studies specific to Southern California's climate, especially regarding effectiveness and costs of LID. The City may be able to cooperate with universities to accomplish this.
- The City could develop a methodology to quantify and assess the true value of low impact development strategies. It is important to account for all the economic, environmental and social benefits and costs when conducting a financial analysis of LID. Many analyses tend to focus only on capital costs, but when looking at the large-scale ecological picture, LID is often a more cost-effective strategy than conventional stormwater management. There is significant value created by nature's services, such as pollution removal by plants, potential flood waters absorbed by soil, and carbon sequestered by trees.
- The results of a cost-benefit analysis can also vary from site to site. For instance, the value of removing a certain amount of bacterial pollution may be worth more at one site than another. How could this be included in a comprehensive LID program?
- Some BMPs may have long-term issues with maintenance, so more test cases are needed to gather data on this topic.

Equity Issues

Implementing low impact development throughout Los Angeles may generate some concerns about equity issues in low-income areas. For instance, because dense neighborhoods have relatively small lots and are dominated by buildings and paved surfaces, there is little space to install LID infiltration BMPs. Therefore, drainage fees based solely on the percentage of impervious surface that covers a property may place a proportionately higher burden on dense neighborhoods. Since low-income neighborhoods are often located in very dense parts of the city, these residents could be subject to relatively high fees.

One way to ameliorate this problem would be to base drainage fees on the total square footage of a property's impervious surfaces. Since central-city properties and buildings tend to be more compact than suburban ones, this approach is more likely to result in lower fees per living unit for dense neighborhoods. The City may wish to explore other options, such as subsidies and rebates, to help ensure that low-income communities are not unfairly burdened by LID fees.

Endnotes

[1] Conversation with Dr. W. Bowman Cutter (Assistant Professor, Department of Economics, Pomona College), 8/13/08.

[2] ibid.

[3] Shoup, Donald. "Graduated Density Zoning." *Zoning Practice*, January 2009, p. 2–7. Accessed on 1/20/09 from the University of California Los Angeles website, http://its.ucla.edu/shoup/GraduatedDensityZoning.pdf

[4] Conversation with Dr. W. Bowman Cutter (Assistant Professor, Department of Economics, Pomona College), 8/13/08.

[11] Recommended Next Steps

This chapter recommends a number of steps that the City of Los Angeles can pursue to implement a more comprehensive low impact development (LID) and green infrastructure program. The recommendations are listed roughly in the order in which they should be accomplished. Additional background on these items can be found in Chapters 6–10.

Tree well near the intersection of Grand and 12th Streets in downtown Los Angeles.

Internal Review

1. Review low impact development strategy with the City's Green Team, Green Streets Committee and City Council committees.

Stakeholder Review

1. Determine which groups need to be involved with LID brainstorming, review and feedback: environmental groups, developers, architects, landscape architects, planners, civil engineers, community organizations, gardening industry, etc.

Analysis and Foundation Steps

1. Create a task force or implementation team for LID and green infrastructure.
2. Survey and analyze current policies, ordinances and standards to identify potential conflicts with LID and green infrastructure. Make recommendations for necessary changes. (See Chapters 7 & 10.) Engineering and building & safety standard plans, practices, and ordinances should be a top priority. Also check fire and flood ordinances and insurance maps for conflicts with LID.
3. Create a menu of best management practices (BMPs) appropriate for LID projects in Los Angeles. Place special focus on natural/biological BMPs.
4. Create design and engineering guidelines for LID best management practices. These standard plans will allow LID BMPs to be easily approved.
5. What can be done to make it easier to implement LID projects until we have sufficient cost-benefit information for our climate?
6. Examine questions regarding scope, applicability, and internal process & management. (See Chapters 9 & 10.)
7. Develop methodology for cost-benefit analysis to include capital costs AND a way to quantify nature's services.
8. Generate comprehensive cost-benefit estimates for implementing LID.

Testing & Evaluation

1. Identify potential LID and green infrastructure pilot projects to gather LID data for our area/climate.
2. Develop and implement pilot projects.
3. Collect and analyze data from pilot projects to help inform future LID efforts and to enhance our understanding of how LID can be implemented in dry climates.
4. Universities and nonprofit organizations may be good partners to help with identifying and designing projects, data collection and analysis.

Policy Development & Implementation

1. Develop a BMP manual for LID practices. Include list of drought-tolerant, native plants suitable for bioswales in our climate. It would be helpful to suggest: (1) BMPs for different climate/environmental conditions, and (2) BMPs that remove specific pollution constituents. (Northeast Trees is already working on a project that matches chemical constituents to appropriate BMPs.)
2. Create decision trees to help developers and the general public to understand what kinds of LID decisions need be made for each type of development. Decision trees should be made for new development, redevelopments and existing developments.
3. Integrate LID principles into the Conservation Element of the General Plan.
4. Integrate LID principles into a revised Landscape Ordinance, which the state requires every city to adopt by 2010. (See Chapter 7.)
5. Explore the feasibility of integrating LID into the Green Building Ordinance.
6. As the city's 35 community plans are updated, integrate LID principles into each plan. This will especially help to address land use issues as they relate to LID.
7. Create Green Streets design guidelines for incorporation into standard plans.
8. Review the need for a LID ordinance.
9. Develop a working group to draft a LID ordinance.

[12] Conclusion

Southern California was designed and built mostly in the 20th Century, and the prevailing idea at the time was to move water quickly and directly to the ocean. In the 21st Century, we have learned how to design our streets, sidewalks, and landscaping to soak up runoff through a more natural process, weaving the textures of nature into the fabric of the city. We have begun to capitalize on the valuable services that nature can offer us: capturing, cleaning, and storing stormwater.

Low impact development is an emerging and important international stormwater management trend. Nationwide research has proven that low impact development can be a cost effective solution to pressing problems pertaining to water quality and water supply, as well the other benefits noted in this paper, such as flood control, mitigation of climate change, and creation of more natural spaces. For instance, studies have shown that if runoff is directed over vegetated areas, or areas with other kinds of porous material, the process of soaking through the soil cleans up or treats the pollution naturally and recharges groundwater aquifers as well.

Urban runoff is the number one source of water pollution in Southern California. Research conducted in Los Angeles has found that the City can significantly increase its water supply, ameliorate climate change issues, and address of much of the pollution found in urban runoff by converting its paved areas from gray to green. Moreover, implementing low impact development will create new, local "green-collar" jobs through the development of a workforce trained to install and maintain green infrastructure features.

A curb cut that directs water from the street and sidewalk into a bioswale. 1100 S. Hope Street in downtown Los Angeles.

The LID principles become particularly crucial as climate change impacts to our environment produce changing weather patterns that are currently predicted to result in longer term drought

conditions throughout California. Harvesting all available rainwater by the various methods shown in this paper is an important means of addressing this looming problem.

The City of Los Angeles is well underway toward implementing the principles of low impact development into its designs for streets, sidewalks and alleys, through its Green Streets and Green Alleys program. With over 6,500 miles of streets and 900 miles of alleys, much could be accomplished by incorporating LID principles into new construction and by phasing in LID conversions for existing infrastructure. However, these paved areas only account for a portion of the hardscape found in Los Angeles, and thus only a portion of the stormwater burden. Implementation of low impact development on a wider and more intensive scale throughout the city is worth consideration, both on public and private property.

Appendices

A large neighborhood development in Wilsonville, Oregon that incorporates decentralized stormwater management features throughout.

Appendix I:

Additional LID Resources & Information

General Information About LID

The following websites are excellent sources of information about low impact development (LID) in general, and often serve as clearinghouses for LID knowledge, developments and issues. Some sites are focused on green infrastructure or stormwater best management practices (BMPs), which also apply to LID. Additionally, most the manuals and technical guides listed in the next section contain a wealth of low impact development information.

Low Impact Development Center— a non-profit organization dedicated to the advancement of Low Impact Development technology. Has a wealth of projects, research, publications and web links to pull from. http://www.lowimpactdevelopment.org/

U.S. Environmental Protection Agency

- *Low Impact Development (LID),* http://www.epa.gov/nps/lid/
- *Managing Wet Weather with Green Infrastructure,* http://cfpub.epa.gov/npdes/home.cfm?program_id=298
- "Green Infrastructure Municipal Handbook," http://cfpub.epa.gov/npdes/greeninfrastructure/munichandbook.cfm
- "Case Studies for Stormwater Management on Compacted, Contaminated Soils in Dense Urban Areas," April 2008. http://www.epa.gov/brownfields/publications/swcs0408.pdf
- "Reduce Runoff: Slow It Down, Spread It Out, Soak It In," online video. http://www.epa.gov/owow/nps/lid/video.html
- Green infrastructure photo gallery, by Abby Hall of the USEPA. http://picasaweb.google.com/buildgreeninfrastructure

The Conservation Fund, Green Infrastructure Program

- Green infrastructure website, http://www.greeninfrastructure.net/
- "Green Infrastructure: Smart Conservation for the 21st Century," by Mark A. Benedict and Edward T. McMahon, http://www.sprawlwatch.org/greeninfrastructure.pdf

Natural Resources Defense Council— "Stormwater Strategies: Community Responses to Runoff Pollution," Chapter 12, Low Impact Development. May 1999. http://www.nrdc.org/water/pollution/storm/chap12.asp

The Green Infrastructure Center— assists communities in developing strategies for protecting and conserving their ecological and cultural assets through environmentally-sensitive decisions planning. http://www.gicinc.org/

Center for Neighborhood Technology—website contains information on a number of green infrastructure projects. http://www.cnt.org/natural-resources/

Greenroofs.com— news portal that promotes green roofs. Has a significant green roofs project database. www.greenroofs.com

Manuals and Technical Guides

The following manuals and technical guides provide valuable information on how other cities approach low impact development and contain research on effective stormwater best management practices. Most of these publications also have introductory information about low impact development, green infrastructure and stormwater BMPs. Some also contain technical information on specific projects.

California

County of Los Angeles

- Green Building Program, http://planning.lacounty.gov/green
  - "Low Impact Development Standards Manual," January 2009. http://planning.lacounty.gov/assets/upl/project/green_la-county-lid-manual.pdf
  - "Green Building and Sustainability Guidelines for the County of Los Angeles," 2008 Edition. http://planning.lacounty.gov/assets/upl/project/green_20080507-rpc-attachment-6.pdf
  - "Drought-Tolerant Plant List," http://planning.lacounty.gov/assets/upl/project/green_drought-tolerant-plants.pdf

- Department of Public Works
  - "Development Planning for Storm Water Management: A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP)," September 2002 Revision. http://ladpw.org/wmd/NPDES/table_contents.cfm
  - *Methodology For Prioritizing Structural BMP Implementation*, overview webpage. http://ladpw.org/WMD/bmpmethod/overview.shtm
  - "Los Angeles County-Wide Structural BMP Prioritization Methodology: A Guidance Manual for Strategic Storm Water Quality Project Planning," 2006. http://ladpw.org/WMD/bmpmethod/manual.shtm
  - "Hydrology Manual," January 2006. http://dpw.lacounty.gov/wrd/publication/engineering/2006_Hydrology_Manual/2006%20Hydrology%20Manual-Divided.pdf

City of Santa Monica— "Santa Monica Residential Green Building Guide." http://greenbuildings.smgov.net/pdf/Residential_GB_Guidelines.pdf

TreePeople— "Rainwater as a Resource: A Report on Three Sites Demonstrating Sustainable Stormwater Management." Description, cost assessments, maintenance schedules and schematics for three projects in Los Angeles. http://www.treepeople.org/vfp.dll?OakTree~getPage~&PNPK=207

City of Emeryville— "Stormwater Guidelines for Green, Dense Redevelopment," December 2005. Department of Planning & Building. http://www.ci.emeryville.ca.us/planning/pdf/stormwater_guidelines.pdf

County of San Diego— "Low Impact Development Handbook: Stormwater Management Strategies," December 31, 2007. Department of Planning and Land Use. http://www.co.san-diego.ca.us/dplu/docs/LID-Handbook.pdf

Other States / National

U.S. Environmental Protection Agency— "Storm Water Technology Fact Sheet—Vegetated Swales," September 1999. http://www.epa.gov/npdes/pubs/vegswale.pdf

U.S. Department of Defense— "United Facilities Criteria (UFC): Low Impact Development," October 25, 2004. http://www.wbdg.org/ccb/DOD/UFC/ufc_3_210_10.pdf

Prince George's County (MD)— Department of Environmental Resources, Programs and Planning Division.

- "Low Impact Development Design Strategies: An Integrated Approach," June 1999. www.lowimpactdevelopment.org/pubs/LID_National_Manual.pdf
- "Low-Impact Development Hydrologic Analysis," July 1999. http://www.lowimpactdevelopment.org/pubs/LID_Hydrology_National_Manual.pdf

State of Maryland— *Maryland Stormwater Design Manual—Volumes I & II*, effective October 2000. Department of the Environment. http://www.mde.state.md.us/Programs/WaterPrograms/SedimentandStormwater/stormwater_design/index.asp

Puget Sound Area (WA)— "Low Impact Development: Technical Guidance Manual for Puget Sound," January 2005. Puget Sound Action Team, Washington State University Pierce County Extension. www.psp.wa.gov/downloads/LID/LID_manual2005.pdf

City of Portland (OR)— "City of Portland Stormwater Management Manual," Revision 4, July 1, 2008. Bureau of Environmental Services. http://www.portlandonline.com/bes/index.cfm?c=47952&

Fairfax County (VA)— "Fairfax County – LID BMP Fact Sheets" February 28, 2005. These fact sheets contain detailed information about the specific stormwater BMPs (purpose, costs, benefits, effectiveness, maintenance requirements, technical drawings, LEED credits, etc.). Includes bioretention systems, filtering technologies, permeable pavements, site design strategies, soil amendments, vegetative systems and water conservation measures. http://www.lowimpactdevelopment.org/fairfax.htm

City of Chicago (IL)—

- "The Chicago Green Alley Handbook." http://egov.cityofchicago.org/webportal/COCWebPortal/COC_EDITORIAL/GreenAlleyHandbook.pdf
- "A Guide to Stormwater Best Management Practices: Chicago's Water Agenda," 2003. http://egov.cityofchicago.org/webportal/COCWebPortal/COC_ATTACH/GuideToStormwaterBMPs.pdf

State of Idaho— Department of Environmental Quality

- "Stormwater: Catalog of Stormwater BMPs for Idaho Cities and Counties," September 2005. http://www.deq.state.id.us/water/data_reports/storm_water/catalog/
    - "Volume 3. Low Impact Development Techniques," http://www.deq.state.id.us/water/data_reports/storm_water/catalog/vol_3.pdf

Implementing LID in Los Angeles

The following resources investigate important issues pertaining to the implementation of low impact development specifically in Los Angeles.

Community Conservancy International— "The Green Solutions Project" report, March 2008. Assesses the benefits of using LID on public lands in Los Angeles. http://www.ccint.org/greensolution.html

USC Center for Sustainable Cities— http://college.usc.edu/geography/ESPE/

- "Transforming Alleys into Green Infrastructure for Los Angeles," June 2008. http://college.usc.edu/geography/ESPE/documents/alleyreport_final_reduced.pdf

Greenforall.com— "Job Implications in Los Angeles' Green Building Sector," by Signalle Rosner, May 2006. http://www.greenforall.org/resources/job-implications-in-los-angeles-green-building

Los Angeles & San Gabriel Rivers Watershed Council (LASGRWC)

- *L.A. Basin Water Augmentation Study*. The Groundwater Water Augmentation Model (GWAM) was developed by the U.S. Bureau of Reclamation and the LASGRWC for the Los Angeles Basin Water Augmentation Study. By performing a soil moisture accounting, the model provides an estimate of the amount of infiltration, runoff and deep percolation under current conditions and the potential for greater groundwater recharge if various capture strategies are implemented. http://www.lasgrwc.org/WAS.htm

City of Los Angeles—

- "Porous Pavement Report," May 21, 2008. "CF: 05-0752 Alternative Street Surfacing Materials." Interdepartmental correspondence, to: Energy and the Environment Committee, from: Department of Public Works and Environmental Affairs Department. http://www.lacity.org/ead/greenbuilding/eadgreenbuilding298555988_10022008.pdf
- *Elmer Avenue: A Model Stormwater Green Street.* Department of Public Works, Stormwater Program. http://www.sga-inc.net/BACKUP/LA_newsletter/Elmer_Avenue.html*Coming to a Neighborhood Near You - Disconnected Downspouts.* Department of Public Works, Stormwater Program. http://www.sga-inc.net/BACKUP/LA_newsletter/Coming_to_a_Neighborhood_Near_You.html

- "Los Angeles River Revitalization Master Plan," April 2007. Bureau of Engineering. http://www.lariverrmp.org/CommunityOutreach/masterplan_download.htm
- "RIO Fact Sheet: River Improvement Overlay District," July 2007. Department of City Planning. http://cityplanning.lacity.org/Code_Studies/Rioproject/factsheet.pdf
- "Integrated Resources Plan (IRP): A New Strategy for LA's Water Infrastructure—Information Sheet," January 26, 2006. Department of Public Works, Bureau of Sanitation. http://www.lacity.org/SAN/irp/documents/factsheet012006.pdf

County of Los Angeles—

- "Los Angeles County BMP Effectiveness Study," August 2005. Department of Public Works. http://dpw.lacounty.gov/wmd/NPDES/1994-05_report/Appendices/Appendix%20H-BMP%20Effectiveness.pdf
- "Watershed Management Techniques: Economic Valuation Model," February 28, 2005. Report prepared by the Natelson Company, Inc. for the Department of Public Works, Watershed Management Division. Presents a methodology for cost-benefit analysis.

California State Water Resources Control Board— "A Review Of Low Impact Development Policies: Removing Institutional Barriers to Adoption," December 2007. Prepared by the Low Impact Development Center. http://www.waterboards.ca.gov/water_issues/programs/low_impact_development/docs/ca_lid_policy_review.pdf

California Department of Water Resources— Office of Water Use and Efficiency Transfers.

- *Updated Model Water Efficient Landscape Ordinance AB 1881*, overview webpage. http://www.owue.water.ca.gov/landscape/ord/updatedOrd.cfm/
- "Modified Text of Proposed Regulation," California Code of Regulations, Title 23, Sections 490 - 495 regarding the Model Water Efficient Landscape Ordinance. November 26, 2008. http://www.owue.water.ca.gov/docs/Modified_Text_of_Proposed_Regulation.pdf

Evaluating the Effectiveness of LID

Reports and articles regarding the effectiveness of LID for controlling water flows and mitigating pollution levels. Some of these are case studies that included monitoring and evaluation.

County of Los Angeles— "Los Angeles County BMP Effectiveness Study," August 2005. Department of Public Works. http://dpw.lacounty.gov/wmd/NPDES/1994-05_report/Appendices/Appendix%20H-BMP%20Effectiveness.pdf

Los Angeles & San Gabriel Rivers Watershed Council (LASGRWC)— *L.A. Basin Water Augmentation Study*. The Groundwater Water Augmentation Model (GWAM) was developed by the U.S. Bureau of Reclamation and the LASGRWC for the Los Angeles Basin Water Augmentation Study. By performing a soil moisture accounting, the model provides an estimate of the amount of infiltration, runoff and deep percolation under current conditions and the potential for greater groundwater recharge if various capture strategies are implemented. http://www.lasgrwc.org/WAS.htm

U.S. Environmental Protection Agency— "Urban Stormwater BMP Performance Monitoring: A Guidance Manual for Meeting the National Stormwater BMP Database Requirements," April 25, 2002. http://www.epa.gov/guide/stormwater/files/montch1and2.pdf

City of Portland (OR)— "Flow Test Report: Siskiyou Curb Extension, August 4th 2004." Bureau of Environmental Services. http://www.portlandonline.com/shared/cfm/image.cfm?id=63097

Prince George's County (MD)— "Final Technical Report: Pilot Projects for LID Urban Retrofit Program in the Anacostia River Watershed, Phase III," December 30, 2006. Department of Environmental Resources. http://www.co.pg.md.us/Government/AgencyIndex/DER/ESG/pdf/Final%20Technical%20Report_Phase%20III.pdf

Costs of Implementing LID & Funding Strategies

The reports, articles and web pages listed below analyze the economic costs and benefits of LID projects and programs. They also contain strategies for funding LID efforts.

California

County of Los Angeles— "Watershed Management Techniques: Economic Valuation Model," February 28, 2005. Report prepared by the Natelson Company, Inc. for the Department of Public Works, Watershed Management Division. Presents a methodology for cost-benefit analysis.

UC Riverside, Department of Environmental Sciences—

- "Costs and Infiltration Benefits of the Watershed Augmentation Study Sites," by Autumn DeWoody, W. Bowman Cutter, David Crohn. April 17, 2006. Five non-residential land uses located in Los Angeles County were equipped with infiltration BMPs. Study estimated the groundwater recharge benefits relative to total costs. http://www.lasgrwc.org/WAS/Documents/UCR_LASGRWC_041806.pdf
- "Capturing Urban Stormwater Runoff: A Decentralized Market-Based Alternative," by Kenneth A. Baerenklau, W. Bowman Cutter, Autumn DeWoody, Ritu Sharma, and Joong Gwang Lee. *Policy Matters*, Volume 2, Issue 3. Fall 2008. Investigates the cost-effectiveness of implementing parcel-level BMPs in a Los Angeles area watershed using competitive bidding. http://policymatters.ucr.edu/pmatters-vol2-3-water.pdf
- "Costs and Benefits of Capturing Urban Runoff With Competitive Bidding for Decentralized Best Management Practices," by W. Bowman Cutter, Kenneth A. Baerenklau, Autumn DeWoody, Ritu Sharma, and Joong Gwang Lee. *WaterResources Research*, September 6, 2008. Investigates the cost effectiveness of implementing BMPs in a Los Angeles area watershed with two voluntary incentive mechanisms: competitive bidding and a fixed subsidy. http://www.agu.org/pubs/crossref/2008/2007WR006343.shtml

Kolozsvari, Douglas and Donald Shoup— (2003). *Turning Small Change Into Big Changes*. Article about parking increment financing. http://www.walkablestreets.com/meter.htm

Institute For Local Government— (2005) *Funding Open Space Acquisition Programs: A Guide for Local Agencies in California*, "Chapter 8: Creating Benefit Assessment Districts."
http://www.cacities.org/resource_files/23925.ILG_OpenSpace_Ch8.pdf

City and County of San Francisco—*Press Room: Press Release.* "Mayor Newsom Unveils First-Ever City Carbon Offsets to Fight Global Warming," December 18, 2007. http://sfgov.org/site/mayor_index.asp?id=72509

Other States/National

U.S. Environmental Protection Agency

- *Fact Sheet: Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices*, December 2007. http://www.epa.gov/owow/nps/lid/costs07/factsheet.html

- "Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices," December 2007. EPA Document #EPA 841-F-07-006.
  http://www.epa.gov/owow/nps/lid/costs07/documents/reducingstormwatercosts.pdf
- "Managing Wet Weather with Green Infrastructure: Municipal Handbook - Funding Options." 2008.
  http://www.epa.gov/npdes/pubs/gi_munichandbook_funding.pdf

Keely, Melissa— "Using Individual Parcel Assessments to Improve Stormwater Management." Journal of the American Planning Association, Vol. 73, No. 2, Spring 2007.

The Trust For Public Land— *Benefit Assessment Districts.* How benefit assessment districts can be used for conservation finance. http://www.tpl.org/tier3_cd.cfm?content_item_id=1058&folder_id=825

ECONorthwest— "The Economics of Low Impact Development: A Literature Review," November 2007.
http://www.econw.com/reports/ECONorthwest_Low-Impact-Development-Economics-Literature-Review.pdf

City of Seattle (WA)— *Drainage Rate Schedule*. Stormwater drainage fees for 2009.
http://www.ci.seattle.wa.us/util/Services/Drainage_&_Sewer/Rates/DrainageRates/RateSchedule/index.htm

City of Minneapolis (MN)— *Stormwater Utility Fee: Frequently Asked Questions.*
http://www.ci.minneapolis.mn.us/stormwater/fee/stormwater_faq.asp

City of Portland (OR)— *1% for Green* funding program. Portland Bureau of Environmental Sciences.
http://www.portlandonline.com/bes/index.cfm?c=48702&

Colorado Carbon Fund— *Project C: We Have The Power.* Website for the State of Colorado's carbon offset sales program.
http://www.coloradocarbonfund.org/

LID-Related Performance & Rating Systems

The following websites and article highlight rating systems that were created or are in development to help implement LID and green infrastructure practices in a systematic way.

U.S. Green Building Council— LEED (Leadership in Energy and Environmental Design) green building rating system.
http://www.usgbc.org/DisplayPage.aspx?CategoryID=19

Sustainable Sites— a system proposed by landscape architects to certify the ecological design of outdoor spaces, separate from buildings. www.sustainablesites.org

City of Seattle (WA)— *Seattle Green Factor: What is the Seattle Green Factor?* Department of Planning & Development.
http://seattle.gov/dpd/permits/greenfactor/Overview/

Keely, Melissa— "Using Individual Parcel Assessments to Improve Stormwater Management." Journal of the American Planning Association, Vol. 73, No. 2, Spring 2007. Article discusses the Green Area Ratio as a way to assess how "green" properties are.

Examples of LID Programs & Projects

Listed below are links to low impact development programs and projects happening in other cities. The earlier section on "Manuals and Technical Guides" and the items featured in Appendix II also contain references to programs in other cities.

Wise, Steve— "Green Infrastructure Rising: Best Practices in Stormwater Management." *Planning*, the magazine of the American Planning Association. August/September 2008. Pages 14-19. Article describes a wide variety of projects from around the United States.

County of Los Angeles— Green Building Program, Department of Regional Planning. http://planning.lacounty.gov/green

City of Santa Monica— Energy & Green Building Programs. http://greenbuildings.smgov.net/index.html

Village Homes (Davis, CA)— *About Village Homes.* http://www.villagehomesdavis.org/public/about

City of Portland (OR)—

- *A Sustainable Approach to Stormwater Management*, http://www.portlandonline.com/bes/index.cfm?c=34598
- "NE Siskiyou Green Street Project: Project Summary," April 2005. Bureau of Environmental Services. http://www.portlandonline.com/bes/index.cfm?a=78299&c=45386
- *Hyperlocalizing Hydrology in the Post-Industrial Urban Landscape*. February 18, 2008. An independent blog that features excellent photos of the NE Siskiyou Street project. http://pruned.blogspot.com/2008/02/hyperlocalizing-hydrology-in-post.html

City of Seattle (WA)— *Street Edge Alternatives (SEA Streets) Project.* Public Utilities Commission.
http://www.seattle.gov/UTIL/About_SPU/Drainage_&_Sewer_System/Natural_Drainage_Systems/Street_Edge_Alternatives/index.asp

City of Chicago (IL)— Green Alleys program, Department of Transportation.
http://egov.cityofchicago.org/city/webportal/portalContentItemAction.do?BV_SessionID=@@@@1030171822.1233726916@@@@&BV_EngineID=cccdadeggjimimjcefecelldffhdfhm.0&contentOID=536946345&contenTypeName=COC_EDITORIAL&topChannelName=Dept&blockName=Transportation%2FGreen+Alleys%2FI+Want+To&context=dept&channelId=0&programId=0&entityName=Transportation&deptMainCategoryOID=-536883915

City of Boston (MA)— *Low Impact Development Tool Kit.* Boston Metropolitan Area Planning Council.
http://www.mapc.org/LID.html

City of Vancouver (Canada)—

- Green Streets Program, Department of Engineering Services.
  http://vancouver.ca/engsvcs/streets/greenstreets/index.htm
- Sustainable Streets and "Country Lanes" programs, Department of Engineering Services.
  http://vancouver.ca/ENGSVCS/streets/design/enviro.htm
- *Streets: Environmentally Sustainable Options.* Department of Engineering Services.
  http://vancouver.ca/ENGSVCS/streets/design/enviro.htm
- Green Streets and Adopt-A-Street Garden programs, http://vancouver.ca/engsvcs/streets/greenstreets/index.htm

Appendix II:

LID Ordinances and Programs from Other Municipalities

The following items have been included in this appendix:

1. County of Los Angeles: Low Impact Development Ordinance
2. City of Ventura: Green Streets Matrix

Additional resources on LID ordinances and programs can be found at these websites:

Clean Air Cool Planet— website that lists community programs around the county with Green Building Ordinances. http://www.cleanair-coolplanet.org/for_communities/green_building_ordinances.php

County of Los Angeles— "Ordinances for Green Building, Low Impact Development and Drought-Tolerant Landscaping," November 14, 2008. http://planning.lacounty.gov/assets/upl/data/ord_green-building-final-ordinances.pdf

City of Santa Monica— Energy & Green Building Programs. *New Green Building Ordinance.* http://greenbuildings.smgov.net/index.html

State of Maryland— *Maryland Stormwater Mangement Act of 2007*. Department of the Environment. http://www.mde.state.md.us/Programs/WaterPrograms/SedimentandStormwater/swm2007.asp

Vermont League of Cities & Towns—

- "Model Low Impact Development Stormwater Management Bylaw," May 2008. http://resources.vlct.org/u/o_LID-secured.pdf
- "Riparian Buffer Model Ordinance," http://resources.vlct.org/u/o_riparianbuffer-secured.pdf

County of Los Angeles: LID Ordinance

The County's Low Impact Development Ordinance was one of three "green" ordinances passed on October 7, 2008. The text of the other two ordinances (Drought Tolerant Landscaping Ordinance and Green Building Ordinance) can be found at http://planning.lacounty.gov/assets/upl/data/ord_green-building-final-ordinances.pdf.

COUNTY OF LOS ANGELES
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RAYMOND G. FORTNER, JR.
County Counsel

November 14, 2008

Agenda No. 76
10/07/08

The Honorable Board of Supervisors
County of Los Angeles
383 Kenneth Hahn Hall of Administration
500 West Temple Street
Los Angeles, California 90012

Re: Ordinances for Green Building, Low Impact Development, and Drought-Tolerant Landscaping

Dear Supervisors:

Following your hearing on October 7, 2008, your Board instructed our office to prepare final ordinances, subject to the modifications approved by your Board, to establish development standards for green building, low impact development, and drought-tolerant landscaping for projects constructed after January 1, 2009. As instructed, enclosed are the analyses and ordinances for your consideration and adoption, with your Board's approved modifications.

Very truly yours,

RAYMOND G. FORTNER, JR.
County Counsel

By
LAWRENCE L. HAFETZ
Principal Deputy County Counsel
Property Division

APPROVED AND RELEASED:

RAYMOND G. FORTNER, JR.
County Counsel

LLH:gl

Enclosures

HOA.565921.1

ANALYSIS

This ordinance amends Title 12 - Environmental Protection, Title 21 - Subdivisions, and Title 22 - Planning and Zoning of the Los Angeles County Code to establish low impact development standards for developments constructed after January 1, 2009. The low impact development standards are intended to distribute stormwater and urban runoff across development sites to help reduce adverse water quality impacts and help replenish groundwater supplies. The ordinance creates low impact development standards which are to be reflected in development site plans and in separate low impact development plans.

RAYMOND G. FORTNER, JR.
County Counsel

By
LAWRENCE L. HAFETZ
Principal Deputy County Counsel
Property Division

LLH:sh
10/09/08 (requested)
11/12/08 (revised)

ORDINANCE NO. _____

An ordinance amending Title 12 - Environmental Protection, Title 21 - Subdivisions, and Title 22 - Planning and Zoning of the Los Angeles County Code to establish low impact development standards for developments constructed after January 1, 2009.

The Board of Supervisors of the County of Los Angeles ordains as follows:

SECTION 1. Chapter 12.84 is hereby added to Title 12 to read as follows:

CHAPTER 12.84

LOW IMPACT DEVELOPMENT STANDARDS

Sections:

12.84.410 Purpose.

The purpose of this chapter is:

A. To require the use of low impact development ("LID") standards in developments. LID encourages site sustainability and smart growth in a manner that respects and preserves the characteristics of the County's watersheds, drainage paths, water supplies, and natural resources. LID builds on conventional design strategies by utilizing every softscape and hardscape surface in a development to perform a beneficial hydrologic function by retaining, detaining, storing, changing the timing of, or

filtering stormwater and urban runoff. LID encompasses the use of structural devices, engineered systems, vegetated natural designs, and education in order to distribute stormwater and urban runoff across a development site. LID reduces the impact from the development and provides the benefits of:

1. Replenishing groundwater supplies;
2. Improving the quality of surface water runoff;
3. Stabilizing natural stream characteristics;
4. Preserving natural site characteristics; and
5. Minimizing downstream impacts.

B. The provisions in this Chapter 12.84 shall be construed to augment any county, state, or federal ordinance, statute, regulation, or other requirement governing the same or related matter, and where a conflict exists between a provision in this Chapter 12.84 and such other ordinance, statute, regulation, or requirement, the stricter provision shall apply to the extent permitted by law.

12.84.420 Definitions.

The following definitions shall apply to this chapter:

A. "Beneficial Use" means the existing or potential use of receiving waters as designated by the Los Angeles or Lahontan Regional Water Quality Control Boards in their respective basin plans for the County.

B. "Best management practices (BMPs)" are the methods, measures, and/or practices designed and selected to reduce or eliminate the discharge of pollutants to surface waters from point and nonpoint source discharges, including stormwater.

C. "County" means the County of Los Angeles.

D. "Development" means activity requiring discretionary or non-discretionary land use or construction approval from the County that results in the creation, addition,

modification, or replacement of impervious surface area, which replacement is not part of routine maintenance activity. Development includes, but is not limited to, land subdivisions; the construction, installation, addition, or replacement of a building or structure; expansion of a building footprint; and land-disturbing activities related to structural or impervious surfaces. Development shall not include routine maintenance of original lines and grades and/or hydraulic capacity.

E. "Director" means the Director of Public Works.

F. "Drainage system" means a conveyance or system of conveyances, including paths, drives, roads, streets, alleys, catch basins, curbs, gutters, ditches, man-made channels, or storm drains designed or used to collect or convey urban runoff and stormwater.

G. "Excess Volume" means the additional volume of stormwater caused by development; excess volume is determined by calculating the difference in the volume of runoff under undeveloped and post-developed conditions, using the water quality design storm event.

H. "Hardscape" means any durable pervious or impervious surface material, including paving for pedestrians and vehicles.

I. "Hydromodification" means the alteration of a natural drainage system through a change in the system's flow characteristics.

J. "Low impact development ("LID")" means technologies and practices that are part of a sustainable stormwater management strategy that controls stormwater and urban runoff on site.

K. "Natural drainage system" means any unlined or unimproved (not engineered) creek, stream, river, or similar waterway.

L. "Pollutants of concern" means chemical, physical, or biological components of stormwater that impair the beneficial uses of receiving waters, including those defined in the federal Clean Water Act Section 502(6) (33 United States Code Section 1362(6)), and incorporated by reference into California Water Code Section 13373.

M. "Public Works" means the Los Angeles County Department of Public Works.

N. "Softscape" means the horticultural elements of a landscape, such as soil and plants.

O. "Stormwater" means runoff that occurs as the result of rainfall.

P. "Urban runoff" means dry weather surface flows emanating from urban development.

Q. "Water quality design storm event" means any of the volumetric or flow rate based design storm events for water quality BMPs identified in the National Pollutant Discharge Elimination System Municipal Stormwater Permit for the County of Los Angeles.

12.84.430 Applicability.

A. This chapter shall become effective on January 1, 2009, and shall apply to all development within the unincorporated areas of the County after that date except for the following:

1. Any development where a complete discretionary or non-discretionary permit application was filed with the Los Angeles County Department of Regional Planning, Public Works, or any County-controlled design control board, prior to January 1, 2009;

2. Any development involving emergency construction activities required to immediately protect public health and safety; or

3. Public road and flood control infrastructure developments, which shall be subject to Public Works' design standards that incorporate LID principles.

B. Unless excluded by subsection A above, any development that alters an existing impervious surface area shall comply with this Chapter 12.84 as follows:

1. Where the development results in an alteration of at least fifty (50) percent of the impervious surfaces of an existing developed site, the entire site shall be brought into compliance with the standards and requirements of this Chapter; and

2. Where the development results in an alteration of less than fifty (50) percent of the impervious surfaces of an existing developed site, only such incremental development shall meet the standards and requirements of this Chapter; and

3. Where a development results in an alteration of less than fifty (50) percent of the impervious surfaces of an existing developed site consisting of four (4) or fewer residential units, the development shall be exempt from this Chapter.

12.84.440 Low Impact Development Standards.

A. The LID standards of this Chapter are:

1. Mimic undeveloped stormwater and urban runoff rates and volumes in any storm event up to and including the "50-year capital design storm event," as defined by Public Works;

2. Prevent pollutants of concern from leaving the development site in stormwater as the result of storms, up to and including a water quality design storm event; and

3. Minimize hydromodification impacts to natural drainage systems.

B. The Director shall prepare, maintain, and update, as deemed necessary and appropriate, a manual ("LID Standards Manual"), which shall include urban and stormwater runoff quantity and quality control development principles and technologies for achieving the LID Standards described in subsection A of this Section. The LID Standards Manual shall also include technical feasibility and implementation parameters, as well as other rules, requirements and procedures as the Director deems necessary, for implementing the provisions of this Chapter 12.84.

C. To meet the standards described in subsection A of this Section, developments shall install and maintain minimum site design features as follows:

1. A development consisting of four (4) or fewer residential units shall implement at least two LID BMP alternatives listed in the LID Standards Manual, which alternatives include, but are not limited to, disconnecting impervious surfaces, using porous pavement, downspout routing, a dry well, landscaping and irrigation requirements, and a green roof.

2. A development consisting of five (5) or more residential units, or a nonresidential development, shall comply with the following requirements:

a. The excess volume from each lot upon which such development is occurring shall be infiltrated at the lot level, or in the alternative, the excess volume from the entire development site, including streets and public right-of-way, shall be infiltrated in sub-regional facilities. The tributary area of a sub-regional facility shall be limited to five (5) acres, but may be exceeded with approval of the

Director. When infiltration of all excess volume is not technically feasible, on-site storage, reuse, or other water conservation uses of the excess volume is required and shall be implemented as authorized by the Director in accordance with the requirements and provisions in the LID Standards Manual.

b. The runoff from the water quality design storm event associated with the developed site hydrology must be treated to the satisfaction of the Director before discharge.

12.84.450 Site Plan/LID Plan Review.

Compliance with the LID standards of this Chapter 12.84 shall be shown through a site plan review described in subsection A, below, and a LID plan review described in subsection B, below.

A. Site plan review.

1. The County Department of Regional Planning shall conduct a site plan review in accordance with Title 22 of the Los Angeles County Code to determine compliance with this Chapter 12.84. The site plan submitted for the development shall clearly depict any and all LID standards that will be incorporated into the development. Regional Planning shall approve compliance with these standards in concept only, subject to the setback and development standards in Title 22. Final approval of such compliance shall be made by Public Works in conjunction with its review and approval of the LID plan described in subsection B.

2. The same site plan shall be used to show compliance with this Chapter 12.84, the green building requirements of Part 20, Chapter 22.52, and the drought-tolerant landscaping requirements of Part 21, Chapter 22.52, to the extent these other requirements apply to the development.

3. In any case where a site plan for a development has been or will be concurrently filed with an application for a permit, variance, zone change, development agreement, or other discretionary approval under Title 22, or with an application for a subdivision under Title 21, the site plan procedure set forth in this Section 12.84.450 shall not apply and instead, the Exhibit "A," tentative map, or other site plan required for such other approval shall be used to show compliance with this Chapter 12.84.

B. LID plan review.

In addition to the site plan required by subsection A of this Section, the applicant shall also submit a LID plan to the Director for review and approval that provides a comprehensive, technical discussion of how the development will comply with this Chapter 12.84 and the LID Standards Manual. A deposit and fee to recover the costs associated with LID plan review shall be required. The time for obtaining LID plan approval shall be as follows:

1. For subdivisions, the LID plan shall be approved prior to the tentative map approval;

2. For any development requiring a conditional use permit ("CUP") or other entitlement required under Title 22 of the Los Angeles County Code, the LID plan shall be approved prior to the issuance of any such CUP or other entitlement; and

3. For all other development, the LID plan shall be approved prior to issuance of a grading permit for such development, and when no grading permit is required, prior to the issuance of a building permit for such development.

12.84.460 Additional Requirements.

Compliance with this Chapter 12.84 shall also require a development to satisfy the following:

A. All grading and/or site drainage plans for the development shall incorporate the features of the approved LID plan described in subsection B of Section 12.84.450.

B. The development's LID features shall be maintained and shall remain operable at all times and shall not be removed from the development unless and until such features have been replaced with other LID features in accordance with this Chapter 12.84. A covenant or agreement shall be recorded in the office of the Los Angeles County Registrar-Recorder/County Clerk indicating that the owner of the subject development is aware and agrees to the requirements in this subsection B. The covenant or agreement shall also include a diagram of the site indicating the location and type of each LID feature incorporated into the development. The time to record such covenant or agreement shall be as follows:

1. For any subdivision, prior to final map approval; and

2. For any other development, prior to issuance of a grading permit for the development, and when no grading permit is required, prior to the issuance of a building permit for the development.

SECTION 2. Section 21.24.420 of Title 21 of the Los Angeles County Code is hereby added to read as follows:

21.24.420 Low Impact Development.

All subdivisions shall comply with the low impact development requirements of Chapter 12.84 of Title 12 of the Los Angeles County Code, subject to the applicability provisions of said Chapter.

SECTION 3. Part 22 of Chapter 22.52 is hereby added to read as follows:

Part 22

LOW IMPACT DEVELOPMENT

22.52.2210 Applicability.

All development, as defined in Chapter 12.84 of Title 12 of the Los Angeles County Code, shall comply with the low impact development requirements of said Chapter, subject to the applicability provisions of said Chapter.

[LOWIMPACTDEVLHCC]

GREEN STREETS MATRIX **City of Ventura Department of Public Works, 2008**

Level I	Description	Example	Cost / Benefits	Challenges / Drawbacks
Storm Inlet Trash Excluders	Trash excluders are screens that are installed inside catch basins or at curb inlets. They prevent trash from entering the storm drain system. Screen size opening is typically around 4 mm. Smaller debris / silt and contaminants such as heavy metals will still pass through the screens.		Low cost/low effectiveness (~$1,500 each)	On-going maintenance is required to clean trash from catch basins. Only prevents trash from entering tributaries (not chemicals, silt). On-going maintenance costs for cleaning catch basins will increase as more are installed.
Planting of medium to large canopy trees in parkways and medians	Plant new or preserve existing medium to large canopy trees in parkways and medians. Tree species should be compatible with adjacent curbs and sidewalks to minimize potential damage that may be caused by roots.		Low upfront cost /high effectiveness (~$400 for 24" box tree). Once mature, larger canopy trees are effective in reducing peak storm run-off rates by capturing rainfall in their canopy. They are also very attractive and can raise property values by $10,000 or more.	Medium to high maintenance cost to control and preserve the trees. Bulbouts or sidewalk realignments may need to be installed in narrower parkways (see *Parkway Tree Bulbouts*). Tree roots can be destructive to buried utilities, sidewalks, curbs and gutters. Residents may not care for the increased maintenance (leaf pickup). Overhead utilities can be problematic for ongoing pruning that can damage trees.
Utilization of recycled materials in new and resurfaced streets	Utilize rubberized asphalt (recycled tires), 15% recycled mix, in-place pulverized asphalt and aggregates in the construction of new streets or in street resurfacing projects		Cost competitive compared to using new materials. Relative costs are likely to decrease due to supply constraints and hauling costs for new materials.	Projects may take longer to construct depending on time-of-year and other factors. Tighter inspections (QA/QC) also required.

Parkway Tree Bulbouts	Parkway bulbouts may be used to preserve shallow roots on large trees that may be damaging curbs and sidewalks. Bulbouts are a localized extension of the curb and gutter at parkways in the immediate vicinity of a tree. They may be used where new trees are planted so that shallow roots are less likely to cause expensive damage to curbs and gutters when they mature. Wider parkways generally make healthier trees.		Medium cost / relatively effective in preserving older trees. May provide the added benefit of traffic calming.	May be difficult to accomplish on flat streets where the bulbout may impede drainage flows along the gutter. Reduces on-street parking, which is problematic in medium to higher density residential developments. Could be difficult to install if underlying utilities are present.
Recycled rubber sidewalks	Rubberized sidewalks are best used at locations where sidewalks have or may continue to buckle from existing tree roots.		Medium to high lifetime cost. 3 times the cost of concrete @ $15 to $20/square foot to install plus reinstallation costs over time. Environmentally friendly by using recycled rubber from tires.	Rubber sidewalks may need to be reinstalled every 5-10 years as tree roots continue to grow and cause uneven surfaces in the sidewalk.

GREEN STREETS MATRIX **City of Ventura Department of Public Works, 2008**

Level 2	Description	Example	Cost / Benefits	Challenges / Drawbacks
Permeable concrete sidewalks	Install permeable concrete for sidewalks in new or existing streets – particularly where sidewalks are in close proximity to new trees. As opposed to rubber sidewalks, permeable concrete is better suited at locations where new trees are planted and roots have not yet been established.		Provides storm water detention and treatment. Creates a "barrier" for storm run-off between impervious driveways and streets. Allows rainfall/irrigation to percolate into the ground to feed tree roots. Approximately twice the cost of conventional concrete, not including over excavation and aggregate subgrade.	More stringent QA/QC requirements to insure proper functioning. Surface of concrete is much rougher than traditional concrete and is not as attractive. More feasible if done only around trees to allow infiltration of storm and irrigation run-off to reach tree roots under tree drip lines.
Storm drain biotreatment curb inlets (i.e. Filterra)	Low flow biotreatment units typically come premanufactured and are installed upstream from storm curb inlets or catch basins. They typically remove chemicals, oils, and particulates from initial storm runoffs (which often contain the lions' share of contaminants).		Can be very effective in removing pollutants from storm run-off if sized right for the runoff area and adequately maintained. Cost to install is anywhere from $10,000 to $35,000 per unit. There is an on-going annual maintenance cost which is uncertain at this time.	Need an existing storm drain system to be in place. Larger units can only treat about 0.5 acres of impervious street. If there is only one curb inlet on a 5-acre street, the unit's effectiveness is substantially diminished. The units are better suited for relatively small watershed areas.
Stormwater detention and percolation curb inlets	– same as above without special media and no connection to storm drain system is made. Storm water percolates naturally into the ground.	Similar appearance to above without the tree	Can be very effective in removing pollutants from storm run-off if sized right for the runoff area and adequately maintained. Cost to install is anywhere from $10,000 to $35,000 per unit. There is an on-going annual maintenance cost, which is not known.	Similar to the biotreatment units. Does not require an existing underground storm drain system. The bottom of the unit is broken out and allows water to percolate into the ground.

GREEN STREETS MATRIX **City of Ventura Department of Public Works, 2008**

Sidewalk "bridges" and realignments to preserve mature trees	Sidewalk bridges and realignments may also be used to preserve shallow roots on trees that may be damaging sidewalks. Bridges allow roots to continue to grow without causing the adjacent sidewalk to buckle.		Medium to high cost (estimated at $2,250 each / very effective. Low maintenance if proper materials and construction techniques are used.	Bridges may pose tripping, slipping and similar hazards unless careful attention is made in the design. Maintenance can be high if weather/rot resistant materials are not used. Realignments as depicted may require obtaining easements onto private property.

GREEN STREETS MATRIX **City of Ventura Department of Public Works, 2008**

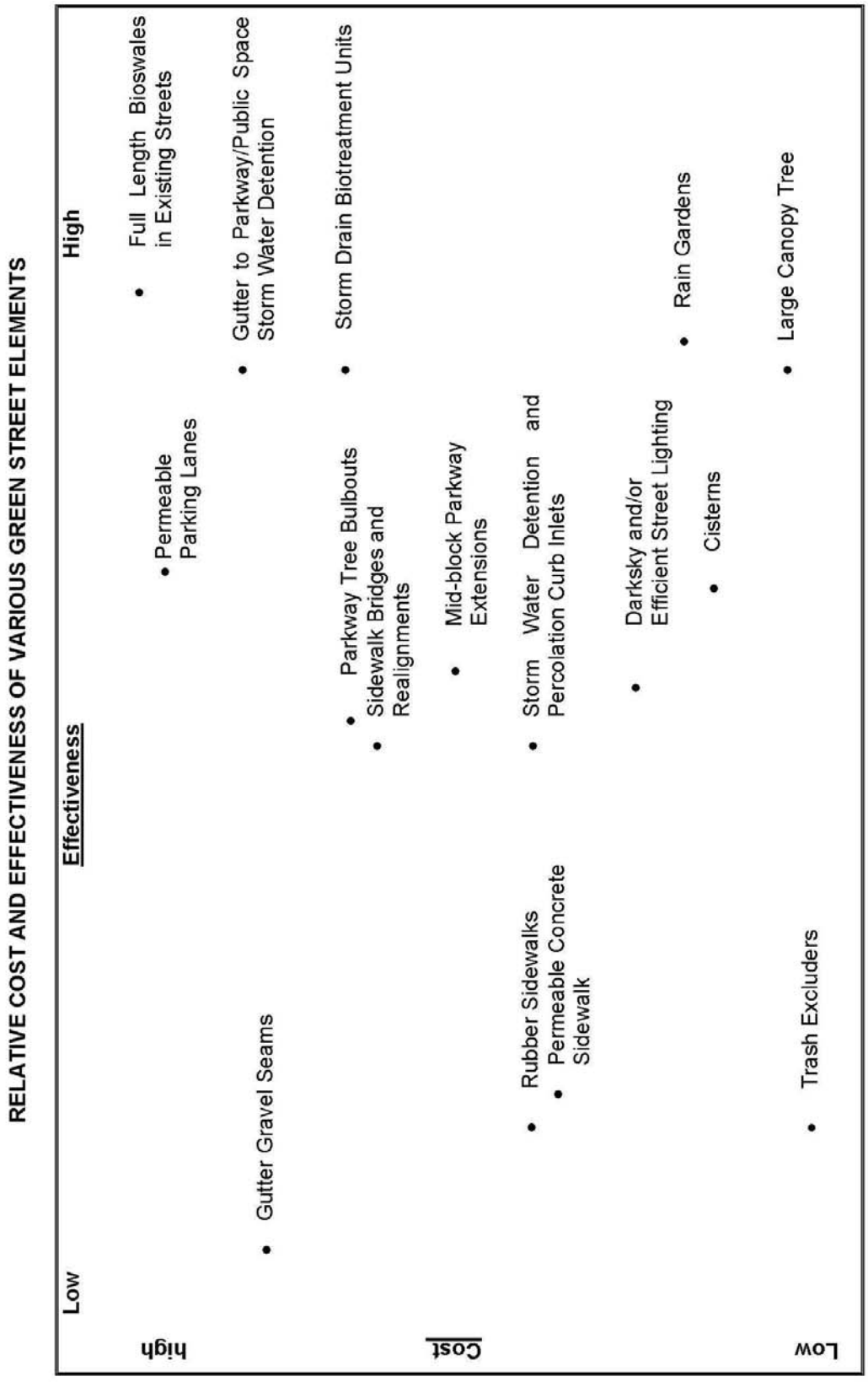
Level 3	Description	Example	Cost / Benefits	Challenges / Drawbacks
Bioswales in existing developed neighborhoods	Install bioswales within the street right-of-way of existing developments. Bioswales are typically rock or grass-lined depressions that detain and treat storm water prior to flowing into a storm drain system.		Very high upfront and on-going maintenance cost. Provides storm water detention, percolation and treatment and improved street aesthetics. Can be very effective at treating storm run-off and reducing peak storm run-off rates. More cost effective if installed as part of new developments.	Will be difficult to maintain without an on-going funding commitment such as a Maintenance Assessment District. Eliminates on-street parking. The need to remove or relocate underground utilities will increase upfront costs significantly.
Permeable parking lane via asphalt, concrete, pavers or turfcrete	Install permeable material in the parking lane only for existing streets.		Very high upfront cost but lower life-cycle cost than the installation of a bioswale in an existing street. On-street parking would not be lost. Provides storm water detention and treatment but to a lesser extent than bioswales.	Upfront cost will be high if done along the entire stretch of a street (as opposed to pockets). Subgrade will likely need to be dugout 2-feet. Will require off-hauling large amounts of in-situ soil and importing large amounts of aggregate for underlying base. Will significantly increase truck/hauling traffic on local City Streets. Can't be done on streets with grades exceeding 5%. Vacuum cleaning may be required every several years to remove trapped particles.

GREEN STREETS MATRIX **City of Ventura Department of Public Works, 2008**

Mid-block parkway extension for bioswales/stormwater detention	A mid-block and/or end-of-block parkway extension can provide detention for storm run-off, percolation and treatment. The design would consist of 50 to 100-foot long extensions in the parkway. The concept could be extended to intermittent locations along a stretch of road.		This is a less expensive alternative than running a bio-swale down the entire length of a street. Relatively small upfront costs and medium lifetime costs for on-going maintenance. Provides some detention and percolation, provides traffic calming and improved street aesthetics.	On-going maintenance costs can be an issue without a Maintenance Assessment District. Loss of parking in the street is also a concern, especially for the property owners that are directly impacted.
Cisterns/rainbarrels at individual private properties	Home owners would install cisterns that collect storm water from roof tops for later use as irrigation water. This is an inexpensive alternative to modifications within the street right-of-way for reducing peak storm run-off rates.		Low upfront and maintenance cost/high effectiveness (~$140 per barrel). Conserves drinking water used for irrigation purposes and reduces peak storm run-off rates.	Would need to set up an incentive/subsidy/ educational program to implement. Cisterns that prevent mosquito breeding are available. Program could be on a citywide or street resurfacing project basis. They cannot be funded with gas tax since they are on private property.
Rain gardens at individual private properties	Home owners would install rain gardens that consist of "depressed" areas on private property that collect rainwater from roof tops. This is an inexpensive alternative to modifications within the street right-of-way for reducing peak storm run-off rates.		Potentially low upfront cost/high effectiveness (cost can vary). Conserves drinking water used for irrigation purposes and reduces peak storm run-off rates.	Would need to set up an incentive/subsidy/ educational program to implement. Program would be on a citywide or street resurfacing project basis. Rain gardens require more maintenance than cisterns. They cannot be funded with gas tax since they are on private property.

Gutter to parkway/public space stormwater detention	This design concept provides some detention, percolation and treatment without actually extending or widening the parkway into the street. Different from rain gardens in that runoff is diverted from street to a "rain garden".		Low to medium upfront cost but potentially high lifetime costs for on-going maintenance. Can provide good detention and percolation and improved street aesthetics if properly maintained.	On-going maintenance costs can be an issue without a Maintenance Assessment District.
Gravel Gutter Seams	Install a 12-inch to 24-inch wide band of gravel along curbs in streets to capture and percolate storm water.	PICTURE NOT AVAILABLE	Relatively high upfront cost and potentially high on-going maintenance cost.	Gravel would likely spill out and cause tripping / roadway hazards. Only recommended for rural and unpaved streets/roadways.
"Dark-sky" and/or energy efficient (LED) street lighting	Dark sky streetlights are designed so that lighting is directed downward onto the street surface and not into the sky. This allows stars to remain visible at night and eliminates wasted energy. LED-type light fixtures are a highly energy efficient type of "bulb" that may be combined with Dark Sky housing.		Medium to high upfront cost (~$5,000) including the pole. Existing poles can be retrofitted but spacing may not be adequate. Lifetime cycle costs are anticipated to be much less than traditional high pressure sodium or metal hallide lights. The costs for LEDs is expected to decrease substantially in coming years.	To obtain adequate spacing, new poles, conduit and wiring may be required which may significantly increase cost. Most lights in the City are owned and maintained by Edison, which will require interagency cooperation for replacement.

City of Ventura: Green Streets Matrix



Appendix III:

Research on the Costs of LID

EPA Fact Sheet: Reducing Costs Through LID

"Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices" This fact sheet provides additional information about EPA's report Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices, EPA publication number 841-F-07-006, December 2007. Available online at http://www.epa.gov/owow/nps/lid/costs07/documents/factsheet-reducingstormwatercosts.pdf

EPA Fact Sheet: Reducing Costs Through LID

Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices

This fact sheet provides additional information about EPA's report *Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices*, EPA publication number 841-F-07-006, December 2007.

BACKGROUND

Stormwater has been identified as a major source of pollution for all waterbody types in the United States, and the impacts of stormwater pollution are not static; they usually increase with land development and urbanization. The addition of impervious surfaces, soil compaction, and tree and vegetation removal result in alterations to the movement of water through the environment. As interception, evapotranspiration, and infiltration are reduced and precipitation is converted to overland flow, these modifications affect not only the characteristics of the developed site but also the watershed in which the development is located.

Low Impact Development (LID) is a stormwater management strategy that seeks to mitigate the impacts of increased runoff and stormwater pollution. LID comprises a set of site design approaches and small-scale stormwater management practices that promote the use of natural systems for infiltration, evapotranspiration, and reuse of rainwater. These practices can effectively remove nutrients, pathogens, and metals from stormwater, and they reduce the volume and intensity of stormwater flows.

Parking lot runoff is allowed to infiltrate through a vegetated bioretention area

COST ANALYSIS

This report is an effort to compare the projected or known costs of LID practices with those of conventional development approaches. Traditional approaches to stormwater management typically involve hard infrastructure, such as curbs, gutters, and piping. LID-based designs, in contrast, are designed to use natural drainage features or engineered swales and vegetated contours for runoff conveyance and treatment. In terms of costs, LID techniques can reduce the amount of materials needed for paving roads and driveways and for installing curbs and gutters. Other LID techniques can eliminate or reduce the need for curbs and gutters, thereby reducing infrastructure costs. Also, by infiltrating or evaporating runoff, LID techniques can reduce the size and cost of flood-control structures. Note that in some circumstances LID techniques might result in higher costs because of more expensive plant material, site preparation, soil amendments, underdrains and connections to municipal stormwater systems, as well as increased project management costs. Other considerations include land required to implement a management practice and differences in maintenance requirements. Finally, in some circumstances LID practices can offset the costs associated with regulatory requirements for stormwater control.

EPA Fact Sheet: Reducing Costs Through LID

FINDINGS

Seventeen case studies were evaluated for this report. In general, the case studies demonstrated that LID practices can reduce project costs and improve environmental performance. Although not all the benefits of the projects highlighted in the case studies were monetized, with a few exceptions, LID practices were shown to be both fiscally and environmentally beneficial to communities. In a few case studies, initial project costs were higher than those for conventional designs; in most cases, however, significant savings were realized due to reduced costs for site grading and preparation, stormwater infrastructure, site paving, and landscaping. Total capital cost savings ranged from 15 to 80 percent when LID methods were used, with a few exceptions in which LID project costs were higher than conventional stormwater management costs. (Table 1)

Table 1. Cost Comparisons Between Conventional and LID Approaches

Project[a]	Conventional Development Cost	LID Cost	Cost Difference[b]	Percent Difference[b]
2nd Avenue SEA Street	$868,803	$651,548	$217,255	25%
Auburn Hills	$2,360,385	$1,598,989	$761,396	32%
Bellingham City Hall	$27,600	$5,600	$22,000	80%
Bellingham Bloedel Donovan Park	$52,800	$12,800	$40,000	76%
Gap Creek	$4,620,600	$3,942,100	$678,500	15%
Garden Valley	$324,400	$260,700	$63,700	20%
Kensington Estates	$765,700	$1,502,900	–$737,200	-96%
Laurel Springs	$1,654,021	$1,149,552	$504,469	30%
Mill Creek[c]	$12,510	$9,099	$3,411	27%
Prairie Glen	$1,004,848	$599,536	$405,312	40%
Somerset	$2,456,843	$1,671,461	$785,382	32%
Tellabs Corporate Campus	$3,162,160	$2,700,650	$461,510	15%

[a] Some of the case study results do not lend themselves to display in the format of this table (Central Park Commercial Redesigns, Crown Street, Poplar Street Apartments, Prairie Crossing, Portland Downspout Disconnection, and Toronto Green Roofs). [b] Negative values denote increased cost for the LID design over conventional development costs. [c] Mill Creek costs are reported on a per-lot basis.

A rain garden manages runoff from impervious surfaces such as roofs and paved areas.

In all cases, LID provided other benefits that were not monetized and factored into the project bottom line. These benefits include improved aesthetics, expanded recreational opportunities, increased property values due to the desirability of the lots and their proximity to open space, increased total number of units developed, increased marketing potential, and faster sales. The case studies also provided other environmental benefits such as reduced runoff volumes and pollutant loadings to downstream waters, and reduced incidences of combined sewer overflows.

CONCLUSIONS

This report summarizes 17 case studies of developments that include LID practices and concludes that applying LID techniques can reduce project costs and improve environmental performance. In most cases, LID practices were shown to be both fiscally and environmentally beneficial communities. In a few cases, LID project costs were higher than those for conventional stormwater management projects. However, in the

vast majority of cases, significant savings were realized due to reduced costs for site grading and preparation, stormwater infrastructure, site paving, and landscaping. Total capital cost savings ranged from 15 to 80 percent when LID methods were used, with a few exceptions in which LID project costs were higher than conventional stormwater management costs.

Green roofs capture rainfall, promote evapotransporation, and offer energy savings. This is a photo of a green roof on the EPA Region 8 building in Denver, CO.

EPA has identified several additional areas that will require further study. First, in all cases, there were benefits that this study did not monetize and did not factor into the project's bottom line. These benefits include improved aesthetics, expanded recreational opportunities, increased property values due to the desirability of the lots and their proximity to open space, increased total number of units developed, increased marketing potential, and faster sales. Second, more research is also needed to quantify the environmental benefits that can be achieved through the use of LID techniques and the costs that can be avoided. Examples of environmental benefits include reduced runoff volumes and pollutant loadings to downstream waters, and reduced incidences of combined sewer overflows. Finally, more research is needed to monetize the cost reductions that can be achieved through improved environmental performance, reductions in long-term operation and maintenance costs, and/or reductions in the life cycle costs of replacing or rehabilitating infrastructure.

AVAILABILITY

The full report is available for download at www.epa.gov/nps/lid.

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